SUMMER RESEARCH 2024/25 PROJECT ABSTRACT

THE UNIVERSITY OF WAIKATO
Te Whare Wānanga o Waikato

PROJECT # 44

SUPERVISOR/S:	Professor Michael Walmsley & Mark Apperley
PROJECT TITLE:	Hybrid Renewable Energy Systems for New Zealand Factories
FIELD:	Energy Engineering
DIVISION/SCHOOL:	HECS - Te Kura Mata Ao School of Engineering
PROJECT LOCATION:	Hamilton

PROJECT ABSTRACT:

This project will investigate the electrical issues of integrating intermittent renewable electricity from utility solar PV and wind into a factory centred microgrid. The microgrid will be run using either DC or AC electricity as part of a hybrid utility system that produces 140-200C low pressure steam, 90C hot water, 4C chilled water and -10C freezing via refrigeration. Batteries and thermal energy storage (TES) will also be part of the factory utility systems to better match energy supply and demand. Utility solar PV is now the cheapest electricity generation method, so the co-location of solar PV near large energy users like factories has the potential to lower overall energy costs.

STUDENT SKILLS:

- Electrical engineering knowledge of electrical components that make up a microgrid. Second year BE(Hons) EE student acceptable, especially if they have industry experience (e.g. adult learner who has returned to study)
- Electricity and energy system modelling and optimisation experience - spreadsheet, MATLAB, Python programming.
- Candidate upgrading from an NZCE Electrical to BE(Hons) Electrical, with industry experience would be valuable. There is a second year EEE student that fits this criterion.
- Has familiarity with costing engineering projects.

PROJECT TASKS:

1. Review the current electricity and process heat demand for a typical NZ meat processing factory and NZ dairy milk powder plant and determine the hourly electrical demand if all the heat process were electrified. e.g. Heat Pumps for hot water, Electric boilers for low pressure steam.
2. Hourly energy demand data is available from two previous projects for these types of factories.
3. Review the two previous projects on renewable energy supply for a meat factory and a milk powder plant, and confirm that renewable electrical supply, battery storage and thermal storage data are based on sound assumptions and adequately account for losses and efficiencies.
4. Develop a preliminary microgrid design for a factory (dairy or meat) considering
    - electricity generation from solar PV or wind,
    - battery storage and thermal storage
    - factory use (machinery, pumps refrigeration, boilers etc.)
5. giving recommendations for which sections should be AC versus DC to minimise losses and costs, and maximise reliability.
6. Identify the conditions required for the microgrid to function reliably, and the conditions when it will not function reliably. Demonstrate the findings by model the dynamic behavior of the microgrid from Task 3, under normal use cases, and for extreme use cases of energy supply and energy demand. The microgrid includes all components of energy supply, storage, distribution and demand. Give recommendations to mitigate some of these potential electrical engineering issues and to save costs.
7. Apply the findings from Task 4 into a revised microgrid design to better meet the hourly electricity demands of a fully electrified dairy factory or a fully electrified meat factory with rendering.
8. Optimise the total CAPEX and OPEX of the system assuming buying and purchasing from the grid is allowable.
9. If time permits, compare the costs of supplying electricity to the factory via the national grid and local network versus supplying renewable electricity directly to the factory via a utility solar facility located next to the factory.

EXPECTED OUTCOMES:

- Student's Research Poster (as per clause 6 of the Scholarship regulations)
- A generic AC/DC microgrid design for a typical NZ factory (dairy or meat) will be proposed. The design will take into account the key electrical engineering issues present with integrating intermittent renewable electricity from utility solar PV or wind with storage.
- Better understanding of all the costs involved for setting up and running a microgrid to fully electrify a factory without adding more demand to the electricity network.