Diffuse Energy: Reliable and resilient wind energy for off-grid telecommunication towers

LESSONS LEARNT REPORT 1

Project Details

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Reporting Period	Milestone 2

This Project received funding from ARENA as part of ARENAs Advancing Renewables Program.

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EXECUTIVE SUMMARY

Diffuse Energy's second milestone had two key technical outcomes: first was to build a representative micro-grid, typical in small-load remote telecommunications; and second to build an anemometry / data logging system to record performance of the local test site. The data logging system is to be deployed on customer's sites in the future.

The micro-grid is based around an Eaton -48V system controller (SC200 with installed solar controller) with a Hyland 920 wind turbine, 1375 W of solar panels, 8 kWh of AGM batteries and an Eaton 240 V inverter. This system operates as a standalone system but supplies an existing 240 V micro-grid that was already on site.

The data system has required both hardware and software development. The hardware is able to monitor the Diffuse Energy turbines through either analogue or serial connection while also reading the serial data from an anemometer. This data is collated on board and sent periodically to a cloud-based database, from which we can access the data directly. A web platform has been created for viewing the output either at site level or as a whole group.

The non-standardisation of mounting systems for our wind turbines on a telecommunications tower and the structural analysis of tower loadings has caused delays with projects outside of the ARENA project, where a 3rd party certifier has been engaged to certify both the turbine mounting system and structural integrity of the tower with a wind turbine mounted. It is believed that standardisation of mounting systems will greatly streamline this process and it is currently being investigated by DiffuseEnergy for future installations.

COVID, and the associated travel restrictions, have created some difficulties in coordinating projects with customers within Australia. It is envisaged that this will have a reduced impact in the future as Australia's management of the pandemic strengthens, although it will likely continue to hinder the development of international projects.

KEY LEARNINGS

Lesson Learnt No.1:
The Hyland 920 turbine can be integrated with an Eaton SC200 system.

Category: Technical

Objective:
Reduction in or removal of barriers to renewable energy uptake through a greater understanding of the technical challenges of installing small wind turbines in a number of different power supply configurations, including siting to maximise wind/power output as well as managing theelectrical integration.

Detail Learning 1a:
There had been previous concern from some vendors that it would be difficult for our turbine to be integrated with the Eaton SC200, hence its choice. After some help from Eaton's technical support this process proved to be rather simple.
The Eaton system has a shunt resistor it uses to monitor total battery current. The shunt monitor board has a secondary RS485 connector that allows a second shunt to be read directly from it, using the first two pins, to read the voltage across the additional shunt resistor.
Once this is connected, the shunt can then immediately be monitored through the Eaton system with some setup required for the individual shunt used, in our case a 100A 55mV shunt resistor.
There is room in the SC200 enclosure to mount the shunt resistor behind the existing one which makes wiring neat and simple. The negative wire from the turbine simply passes through the shunt before connection to the breaker mounted at the front of the enclosure.
This setup allows individual monitoring of the wind, solar and battery current. Should a generator be included it would normally be fed through an Eaton rectifier that will report its current directly - the same as the solar controller.

A system schematic can be found in Appendix A

Detail Learning 1b:
Integration issues arose when trying to power the same 240 V output with two different battery inverters. This is unlikely to be an issue in a telecommunications scenario but is interesting nonetheless as it seems that there is not a simple solution on the market but having one would allow the extension of existing micro-grids through the addition of modular systems.
The reason for the problem is that battery inverters typically like to be 'the grid' with solar invertors being controlled to supply either all their available power or to curtail as required. This curtailment is achieved through frequency shifting of the battery inverter's output, typically from 50Hz up to 54Hz. The solar inverters are programmed to read this shift and reduce their output to match the load.
Most battery inverters also allow a secondary grid supply for on-grid applications, for off-grid applications this is left disconnected, or used for generator input.
In our case we needed to supply the 240 V output from our micro-grid system into the existing micro-grid, however the following problems occurred.

- The Eaton inverter did not like there being any existing supply on its 240 V output and went into Fault.
- The frequency shifting of the original inverter to control the two existing solar controllers gave rise to a mismatch if our system was used as a grid supply. This also caused a fault due to a perceived apparent power.
- Following questioning and investigation of the issue, several equipment suppliers told us that what we were trying to do would not work and an alternative solution was required.

The solution arrived at was to have the new Eaton system to act as the ‘grid input’ to the existing Studer battery inverter of the existing system which could be limited to accept a maximum of 480W. The Studer system also has a setting called active AC filtering, which controlled the mismatch in frequency. This active filtering is designed to filter harmonics delivered from a generator, but the filter works both ways and allowed us to integrate our micro-grid with the existing micro-grid.

Power is delivered from the Eaton system acting as the grid with these settings, with the Studer operating as though it was on the grid but using the battery power as a priority.

Implications for future projects: Installation of the Diffuse Energy wind turbine with the Eaton system is straightforward from both a hardware and software configuration perspective. The Eaton System is used quite broadly in the telecommunications space.

The connection of the Eaton micro-grid system into an existing micro-grid created issues, as discussed, although this issue is unlikely to arise in future work for this project as we will not be setting up an entirely new micro-grid to integrate into an existing micro-grid, but rather will be simply plugging our wind turbine into the DC bus of the existing micro-grid.

The monitoring system created as part of Milestone 2 of this project will provide important operational data of our system and will be an important feature of almost all of our installations in the future.

Lesson Learnt No 2
Non-standardisation of turbine mounting systems and tower structural loading

Category: Risk

Objective: Milestone 3 –installation of turbines

Detail Learning No3
Delays of install due to engineering sign-off have occurred in other projects (outside of ARENA) recently where sign-off of structural designs and tower loadings has delayed the commencement of works for the project by several months. This is largely caused by each installation having a bespoke mounting system for the tower, as there is a large number of tower designs.
This may have implications for the installations planned in WA with Positive Off Grid Solutions (POGS), Vertel are already approved and planned to be installed in late March/ early April. We are trying to bring forward the planning approvals in WA to alleviate or remove this risk.
James Bradley and Joss Kesby will visit POGS in April to ensure that we are confident that the project will not be delayed in a similar fashion. Note that the POGS sites are all new-build sites, while Vertel's are existing sites.

Implications for future projects:
Diffuse have already raised this as an issue in the knowledge sharing meeting conducted on the 17/03/21 with a view to streamline this process by standardising themounting equipment. It seems the vendors are amenable to this approach and it will be further investigated throughout the project by engaging with 3rd party certifiers.

Lesson Learnt No 3
Impacts of COVID

Category: Risk

Objective: Milestone 3 –installation of turbines

Detail Learning No3
COVID has had significant impact on the business due to us not being able to visit interstate clients and limiting contact with our client base in NSW. Being a hardware company, it is simpler and quicker to organise and problem solve in person and/or on site. To date we haven't been able to physically visit POGS due to WA's heavy travel restrictions. These restrictions, for the moment, have been lifted and a visit is planned in the near future.

The movement restrictions due to COVID have also caused a minor delay in the installation of the solarpanels at the test microgrid site, due to a backlog of installations for the contractor engaged to install the system. The delay was in the order of two weeks and has not had a material impact on the project.

Implications for future projects:
It is envisaged that the travel restrictions within Australia will remain lifted, with the current management plans of both state and federal governments (along with the rollout of the vaccines) having good effect. However, Diffuse Energy's ability to proceed with projects in international jurisdictions will most likely be delayed for some time, particularly where COVIDhas not been as well managed, for example in the US and EU.

Appendix A: System Layout