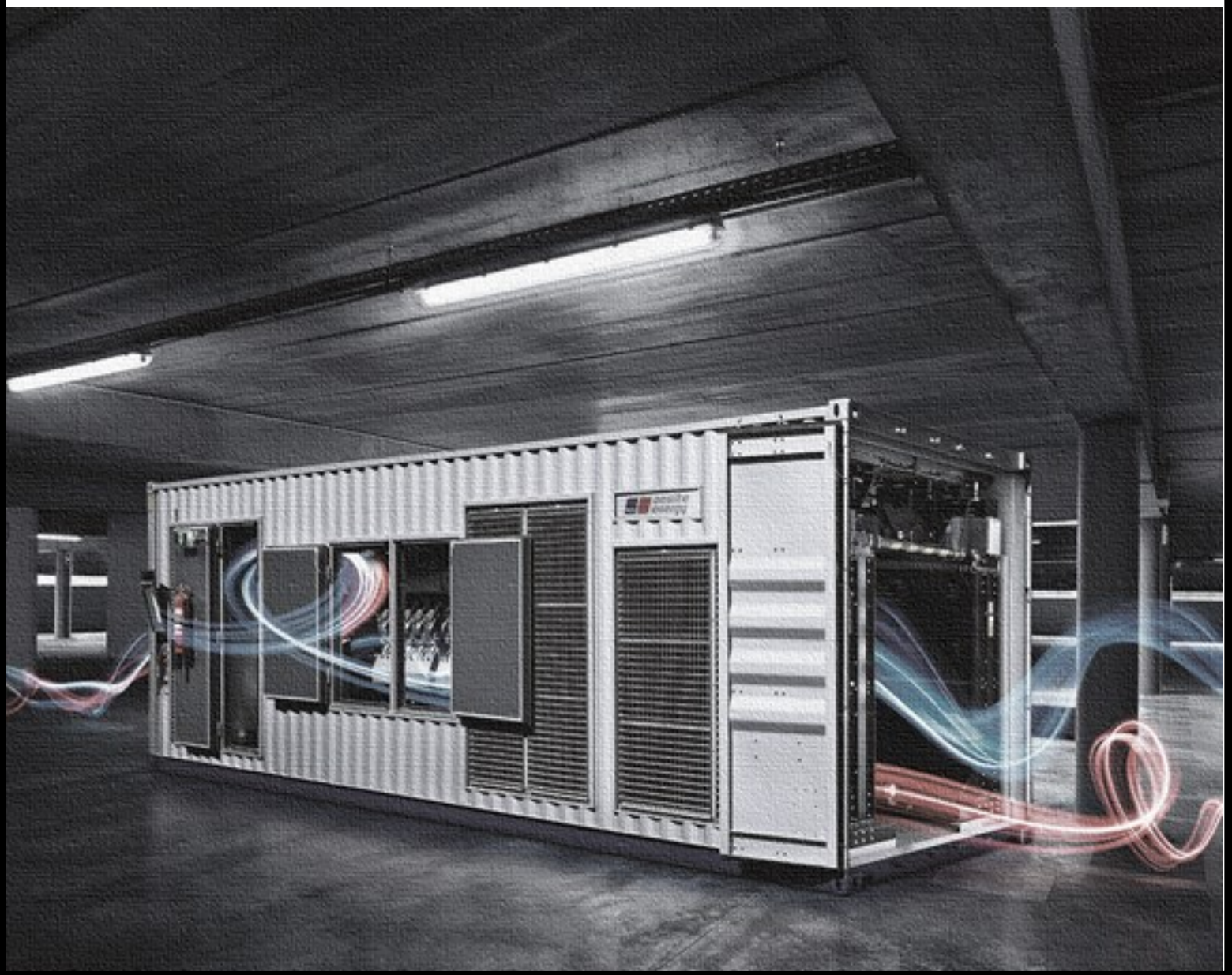
UNIVERSITY of TASMANIA

# Variable Speed Diesel Hosting FAQ



# Frequently Asked Questions

## Introduction

The University of Tasmania will be leading a 3 year variable speed diesel pilot, commencing 2018. The pilot will bring together a range of industry stakeholders, including opportunity for a hosting contribution, the focus of this question and answer leaflet.

### 1. What is variable speed diesel?

Conventional diesel generators run at a fixed speed, for 50Hz systems this is generally 1500 rotations per minute (rpm).
Variable speed diesel generators can run at any rotational speed, as determined by which speed provides the greatest efficiency for any load setting.

The generator is still able to meet the 50Hz system frequency, as a power converter is placed between the generator and the load. The role of the power converter is to ensure the variable frequency output of the generator is conditioned to meet the network frequency. This approach is common across wind, solar PV and battery technologies, which generate at either variable speed or are direct current (DC) technologies. Reliance on a power converter does not reduce the reliability of the approach, however it does improve the power quality and security which can be offered to support the network.

The ability of the variable speed generator to select its preferred speed setting is responsible for the dramatic performance improvements. The generator is no longer constrained to a very narrow speed reference (akin to driving your car without ever changing gear).

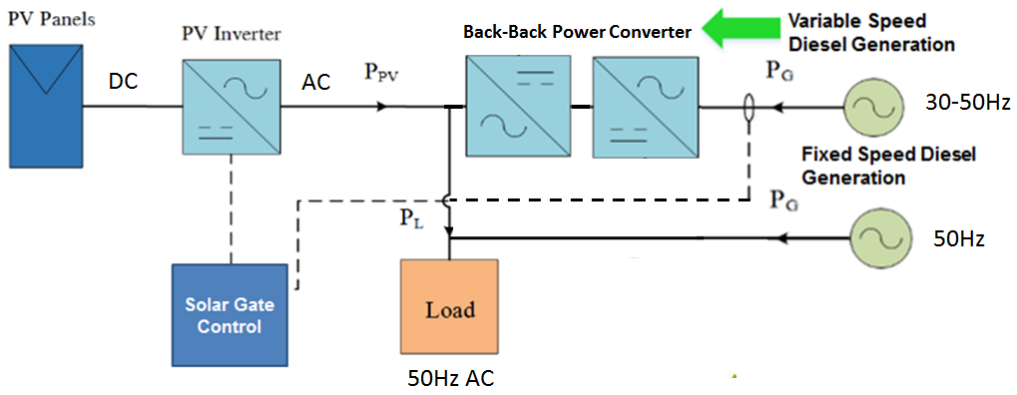



**Figure 1 Single Line Diagram of a typical variable speed diesel concept**

### 2. Why have diesel generators developed as fixed speed if it is efficient?

Fixed speed configurations are appropriate for constant, steady load applications. However with the emergence of cheap clean renewable generation, the load seen by the diesel generator is highly variable. Fixed speed diesel generators are poorly suited to renewable pairing for this reason.

### 3. Doesn't the power converter introduce losses to the system?

The introduction of a power converter is responsible for a 1-1.5% loss, however, given the ability of a variable speed diesel to run without load limit constraint, the approach returns a 20-30% improvement in renewable penetration, more than compensating for any converter inefficiency.

### 4. When does the pilot commence and conclude?

The program commences in March 2018, with approximately 6 months of laboratory based development, ahead of site works. The project will run out until September 2020.

### 5. What are the requirements for the host site?

The host site will consist of an existing load, to be provided for by a hybrid diesel power supply. It is likely that diesel generators will already be in use at the site to meet the current load. Solar PV and/or wind generation may also form part of the existing power system. If no renewable generation exists on-site, integration of renewable generation will be required in support of the variable speed diesel pilot. While the renewable integration works will not be funded by the University, a number of innovative aspects of the variable speed diesel pilot can be leveraged in support of these infrastructure costs, for example, by packing the works as an ARENA or NERA co-funded development. Should renewable capacity be packaged under an additional such award the assets should be operational by Sept 2019 at the latest.

### 6. What does the host receive from participation?

A key question we seek to answer early in participant engagement is, what would you like to receive? A range of benefits can be structured around your requirements, including:

- Improved diesel generator efficiency, resulting in significant fuel savings in comparison to conventional generator performance. Fuel efficiency is improved by up to 40% at low load.
- Lower acoustic and exhaust emission intensity.
- Optimisation of system configuration and control ahead of battery integration. (variable speed diesel is very much a transitional technology able to align system performance to suit battery integration at a later date.)
- Gifted variable speed diesel assets upon conclusion of the pilot (a variable speed diesel generator will be fully funded by the University and gifted to the host organistaion).
- Technical and engineering support involved in commissioning and station integration works.
- Technical and operational support through-out the duration of the pilot.
- Support in securing external co-funding for renewable development at the host site (should this not already be in place).

## 7. What are the risks?

The project has some level of technology risk, however these risks have been minimised by the following approach:

- Variable speed diesel units use a standard diesel engine. You can specify the unit to align with your current diesel units.
- Variable speed diesel units use a high efficiency and reliable permanent magnet generator, as common across many other technologies such as utility scale wind turbines.
- Variable speed diesel units use modular and robust power electronics as proven across applications such as battery energy storage.
- Variable speed diesel units can operate as conventional fixed speed diesel generators without issue.
- The look and feel of the asset will be similar to a conventional diesel asset, following an identical service routine.

The pilot presents a comparable level of risk to that associated with integrated a replacement generator set. However to ensure the reliability of the asset both inspection and sampling (oil and emissions) will be increased to provide additional assurance.

## 8. What are the costs?

The variable speed diesel generator will be fully funded by the University. The unit will be delivered to site, and can be containerised if required.
Any balance of plants works required for integration of an additional generator at the site will be provided by the host.
Routine operations and maintenance will be provided by the host, including fuel consumption (in reality a significant fuel saving will be observed).
Should the host require a unit above the 222kW, 400V basis of design currently envisaged, the costs in upscaling the concept will be shared across the project participants.
Additionally a range of technology exclusivity and IP options can be discussed.

## 9. What is the process to participate?

To discuss your interest further please contact the project lead, Dr James Hamilton on +61 (03) 6226 1857.
Shortlisted host partners will be finalised in February 2018.
Shortlisted partners will be required to provide a letter of support to the University, nominating an Industry Partner Representative.
A Partnership Organisation Agreement (POA) will be executed with the selected host in Q2 2018. The agreement will detail the obligations and expectations of both parties. Ahead of POA execution no legal binding commitments are required.

## 10. How does the Partner Organisation Agreement work?

At a high level the POA stipulates the cash and in-kind contributions of both parties to the project, within the context of the project schedule. The host is responsible for a range of provisions, including access to the site and the timely completion of system

integration works. The University is responsible for leading the research obligations of the pilot, extending to commitments outlined in any related grant or award funding provisions.

## Metrics

This project aims to demonstrate:

- improved unit fuel efficiency at low load by up to 40%.
- expanded operability, offering an expanded service range via removal of load limits.
- enhanced generation pairing, facilitating >60% alternative energy supply without battery energy storage integration.
- extended service life via a reduction in step load (acceptance and rejection) transient loading and improved inertia response.
- reduced acoustic and exhaust emission intensity, irrespective of load.

## Management Approach

The proposed works will be conducted in a highly collaborative environment with research accountabilities lead by the University of Tasmania. Engine development will be supported by our Industry Partner, Regen Power. System control will be supported by our Industry Partner, Magellan Powertroncis. Professor Negnevitsky has built significant standing and success across power engineering, renewable energy and power systems. He is director of the Universities Centre for Renewable Energy and Power System. Assoc. Professor Wang has built international standing in the thermodynamics of power and cooling systems, he is currently head of Engineering within the University. Professor Nayar is managing director of Regen Power, holding a number of technology patents with regard to variable speed diesel application.

**A full technical proposal and project schedule are available in support of this brief upon request.**