DER Control and Optimisation on Horizon Power's Microgrids

1 November 2017

CS10# 5301059

Demand for PV & Hosting Capacity

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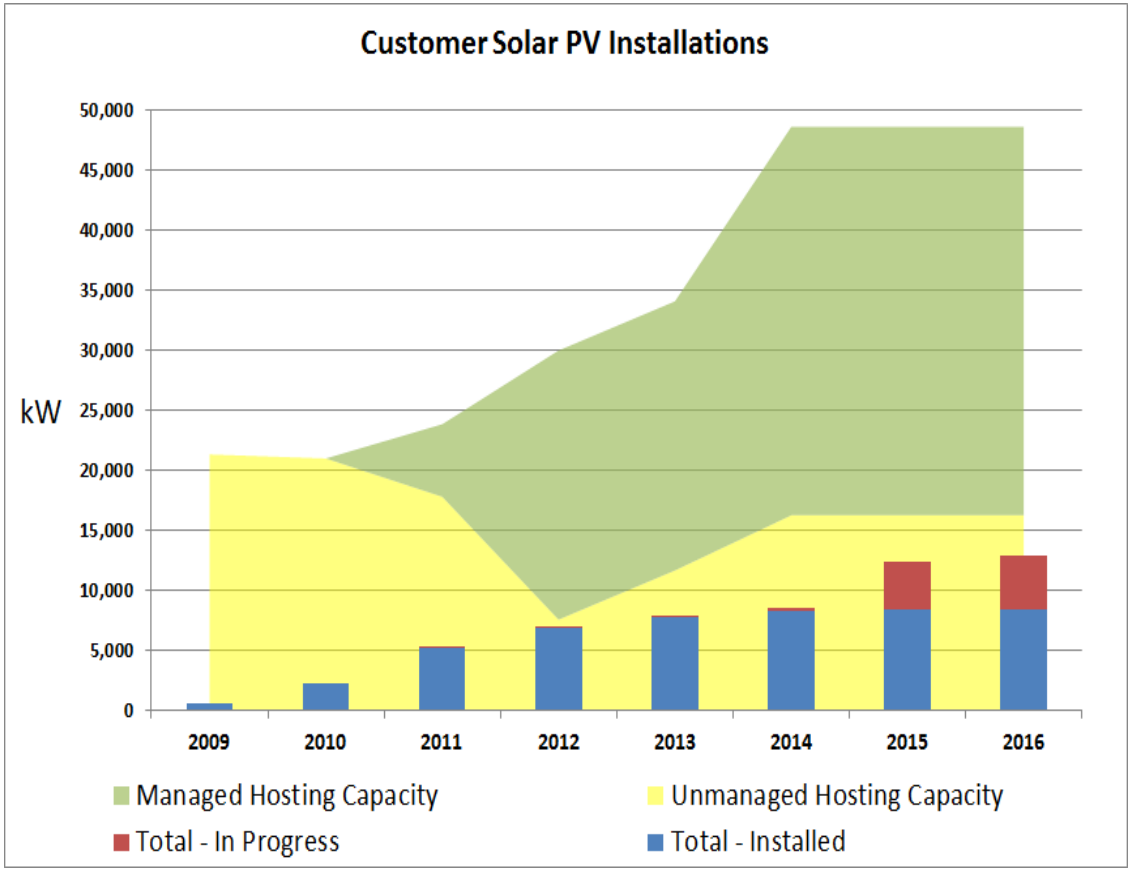
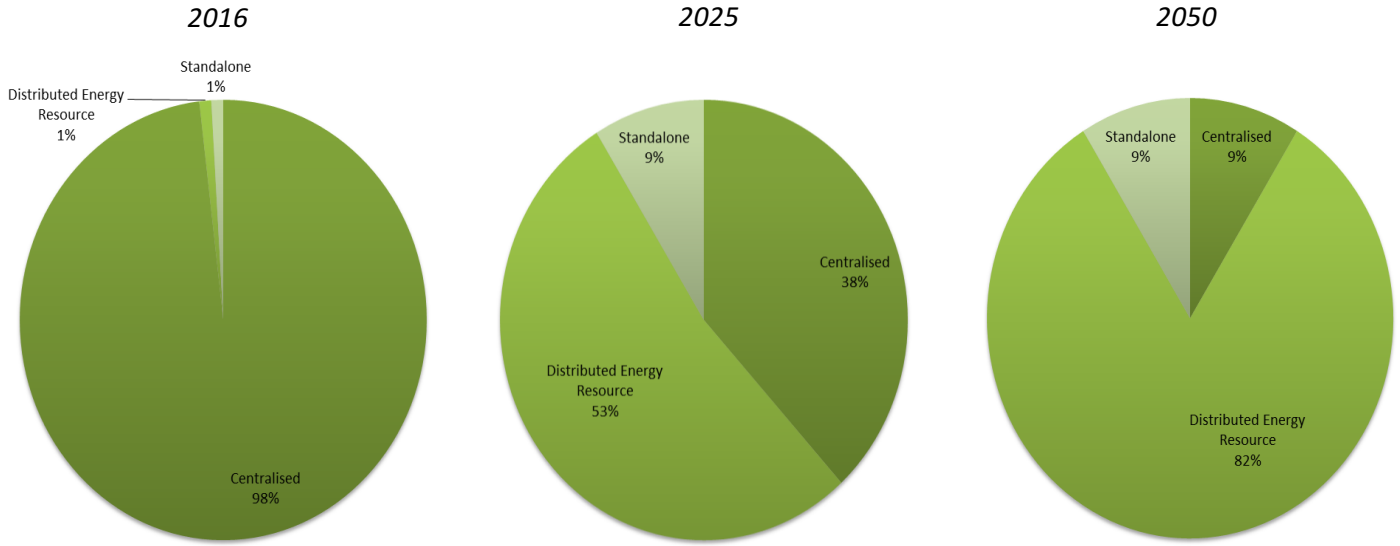
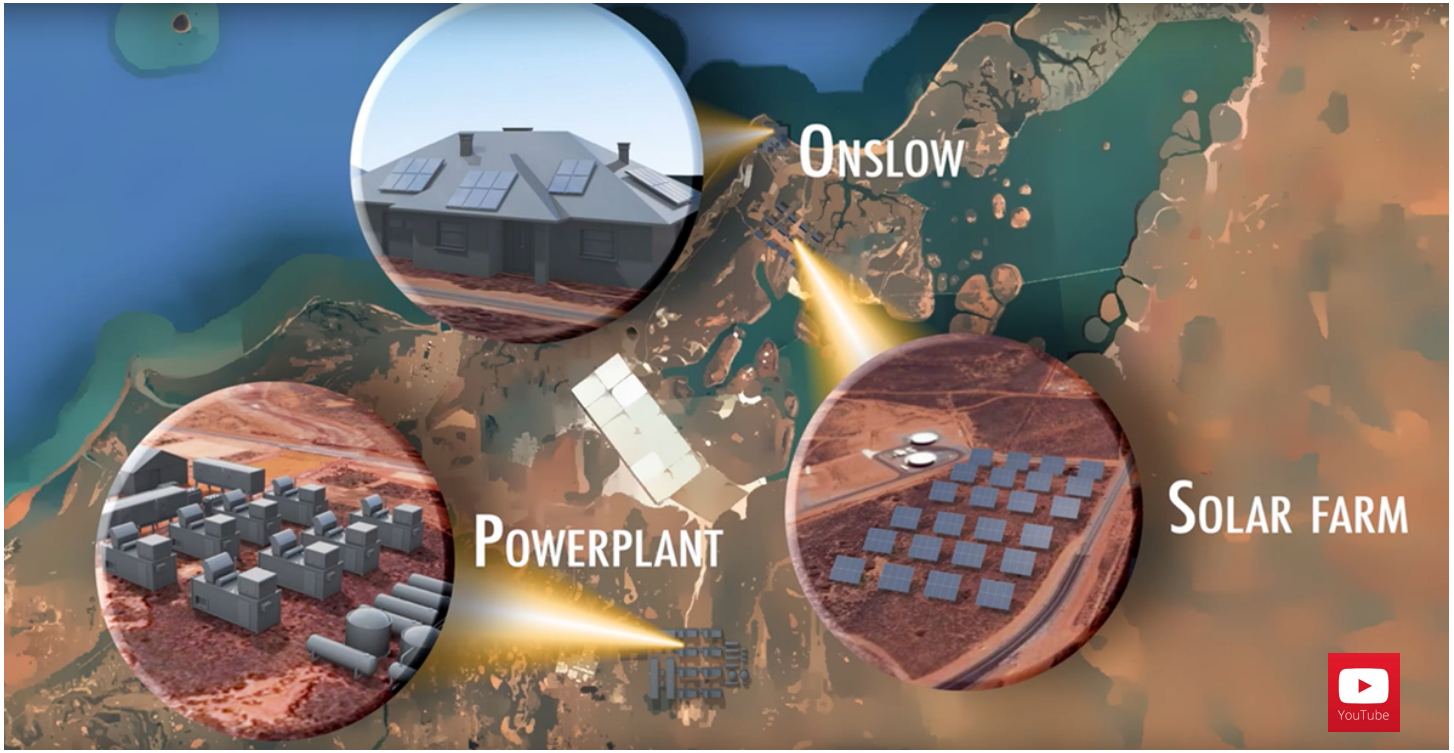


System Blueprints

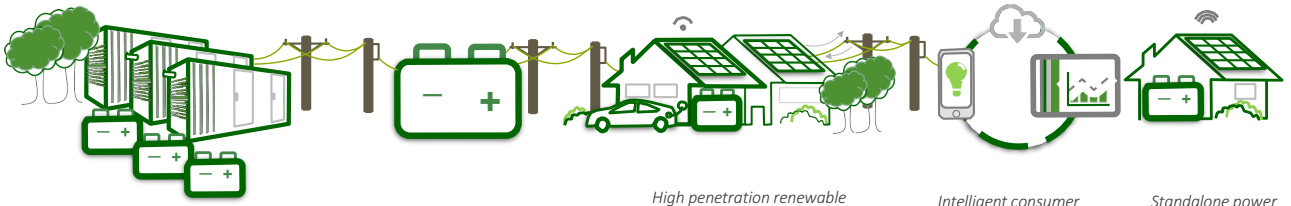


Graphs: Breakdown of Horizon Power systems per most economic business future including a 25% reduction in LCOE for DER systems.

The Onslow Vision



Transition to Distributed Energy Resources



Modular Generation | *Multi-flow network* | *Intelligent system control* | *High penetration renewable energy and storage* | *Intelligent consumer services* | *Standalone power systems*

...TO THIS.

Multi-Flow Networks – Technical Studies

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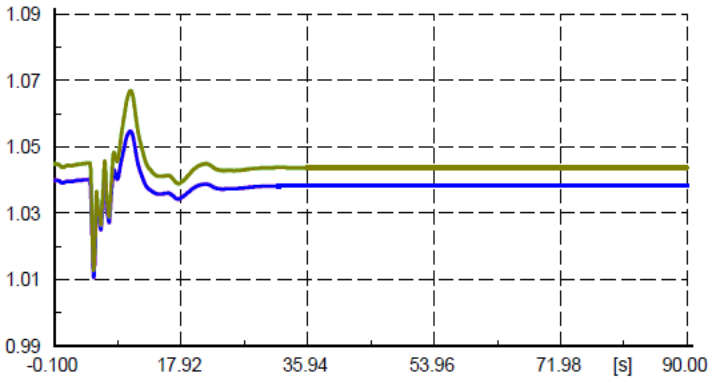
- Power Quality & Fault Level Issues
  - Reduced Protection Sensitivity
  - Motor Starting
  - Voltage Stability
  - Frequency Stability
  - Harmonics & Flicker
  - Black Start
- Voltage & Frequency Control
- Network Optimisation, Network Losses, Optimal Generator Placement
- Real Power Balancing & Load Control

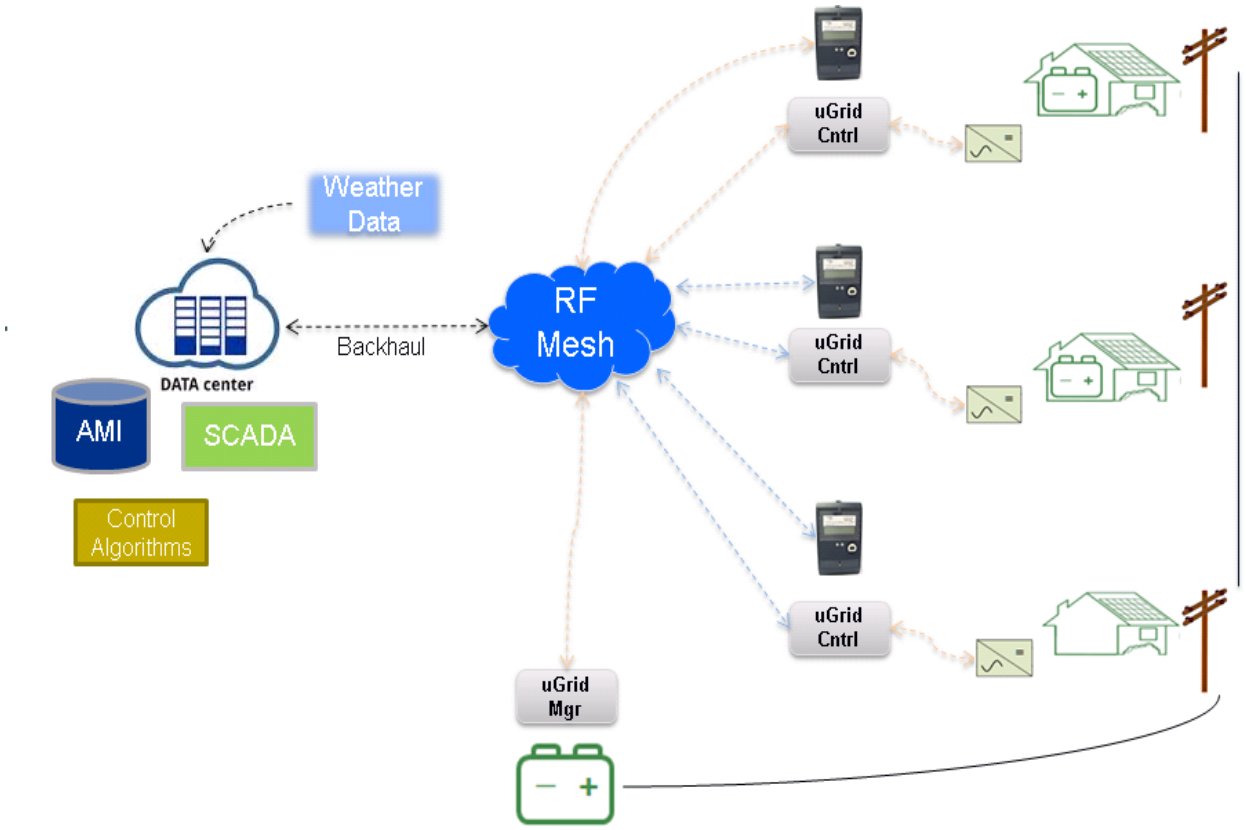


Network Studies – Recommendations

The following summarises the recommendations arising from this study:

- Implement Feed in Management control scheme
- Develop voltage control scheme (primary & secondary)
- Develop frequency control scheme (primary & secondary)
- Inverter 10sec fault ride through capability
- DER inverters – capable of power factor of 0.95 or better
- Optimised charge coordination of energy storage
- Develop a suitable black start control scheme
- Detailed protection study
- Develop ‘fall back’ strategies
- Update Horizon Power’s technical rules and Technical Requirements.

Principles of DER Control



Principles of DER Control

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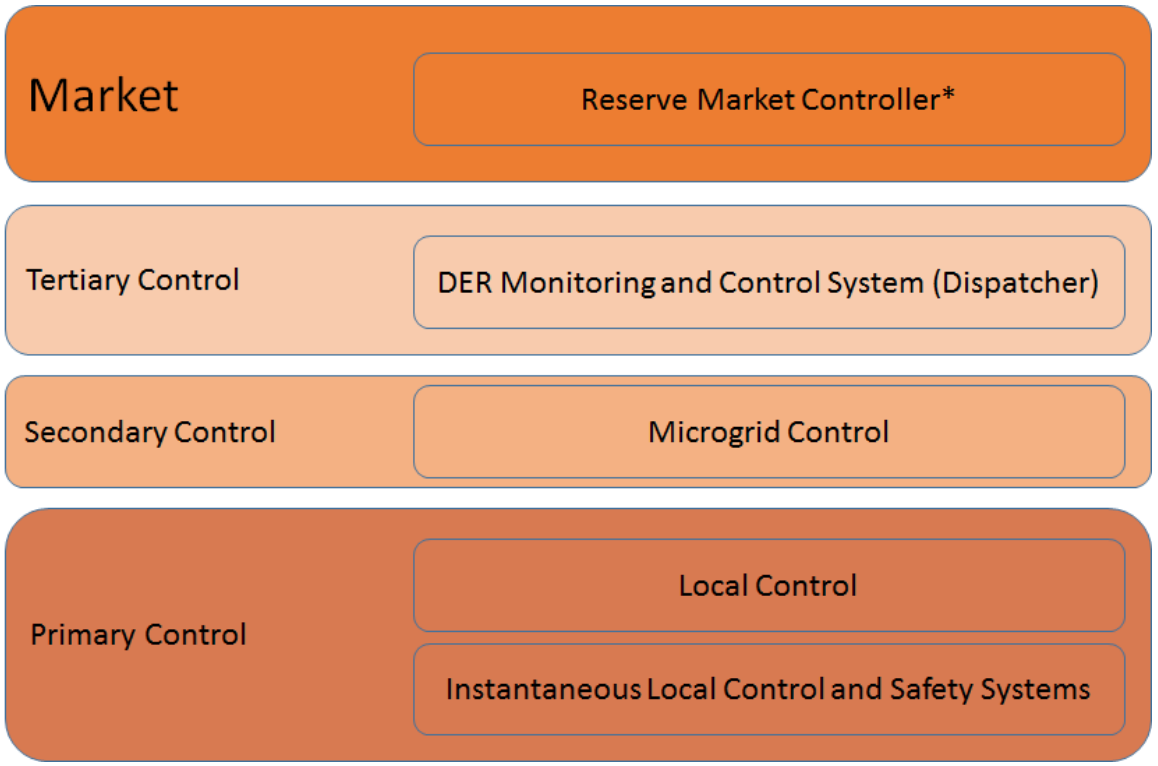
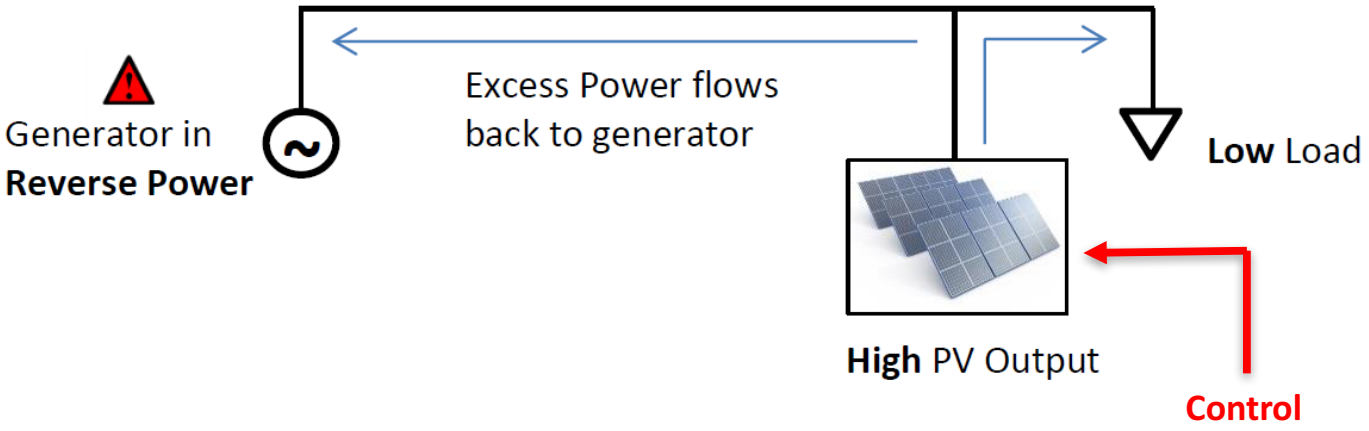
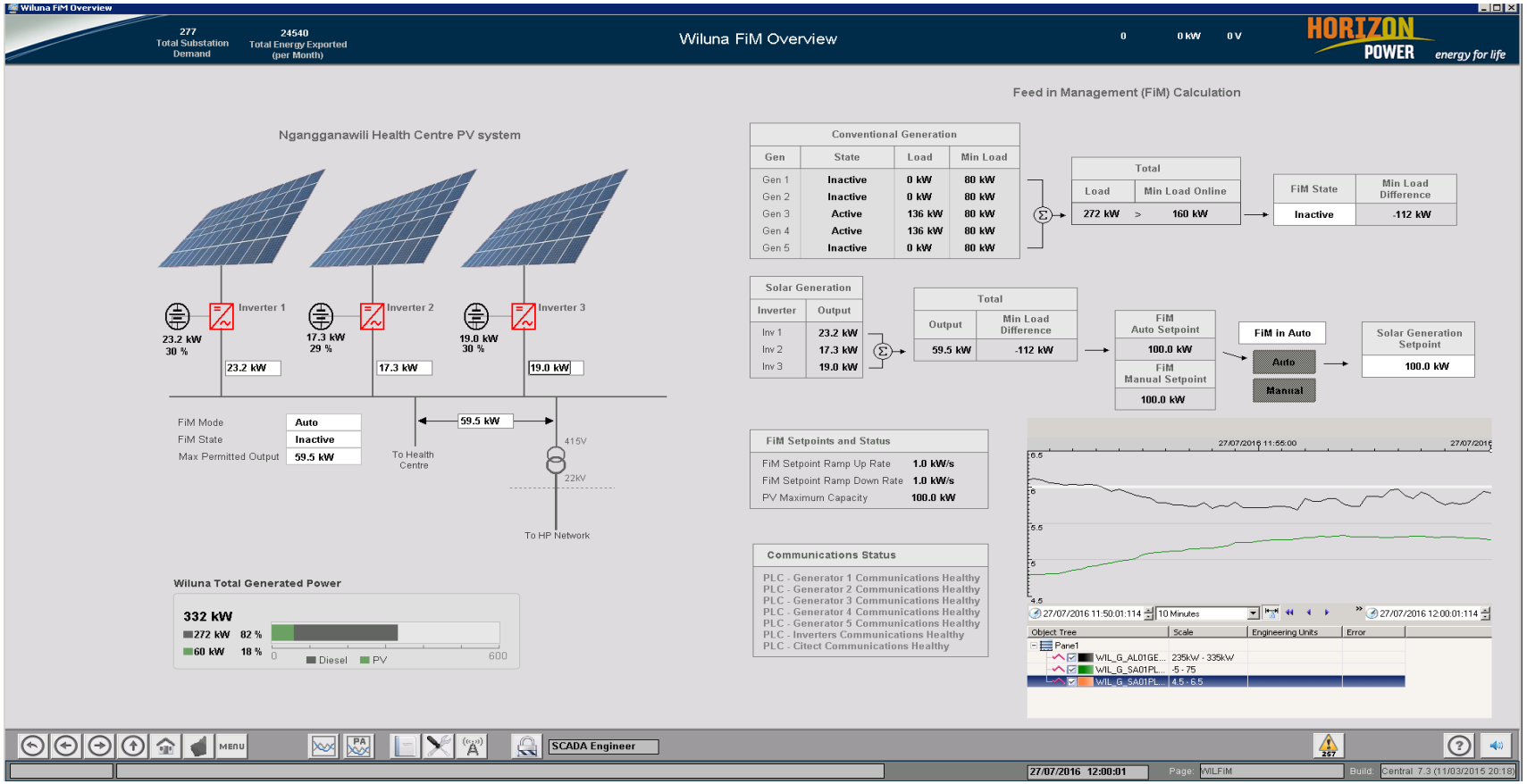


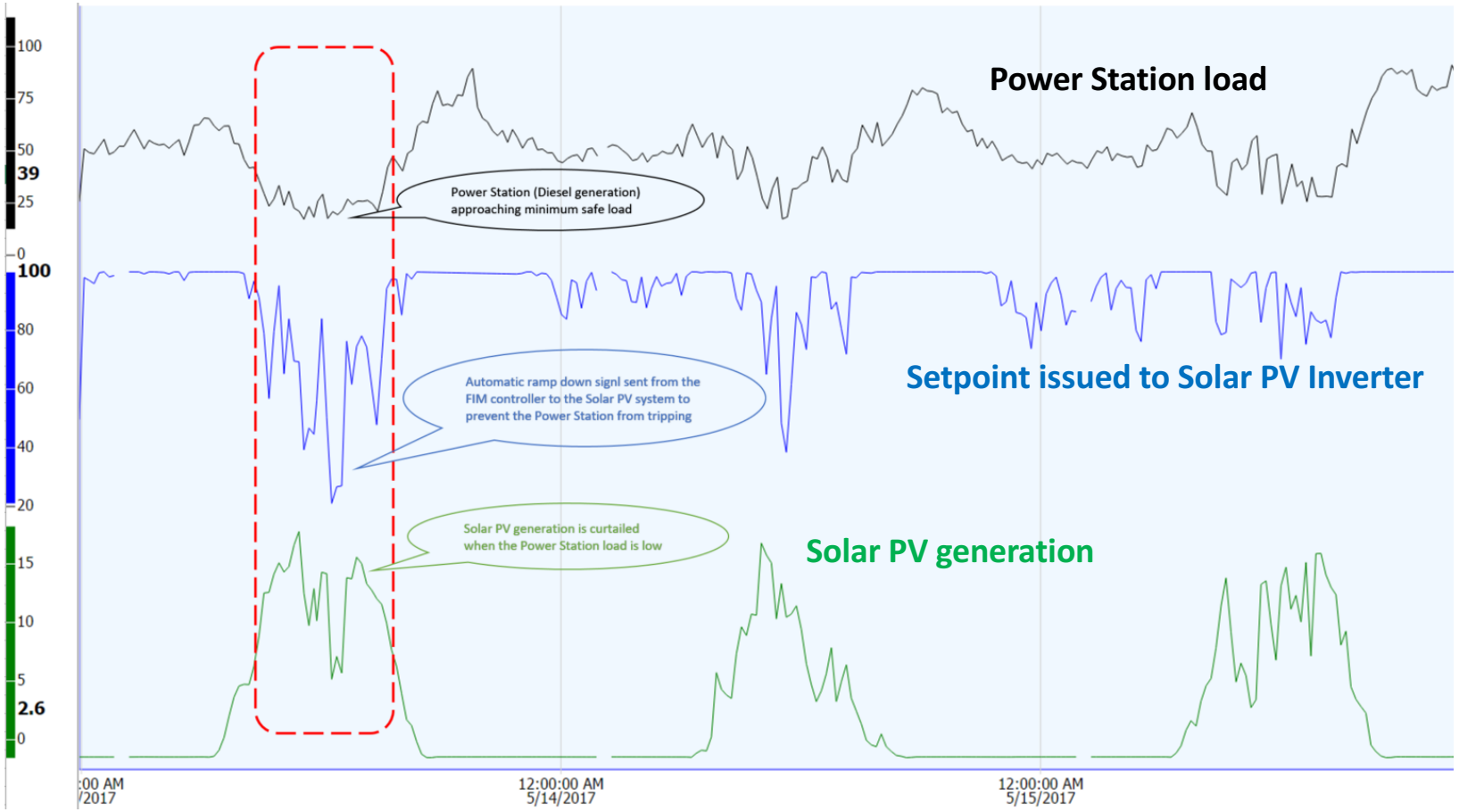
Feed in Management



Feed in Management



Feed in Management – In Action



Carnarvon DER Monitor & Control Trial

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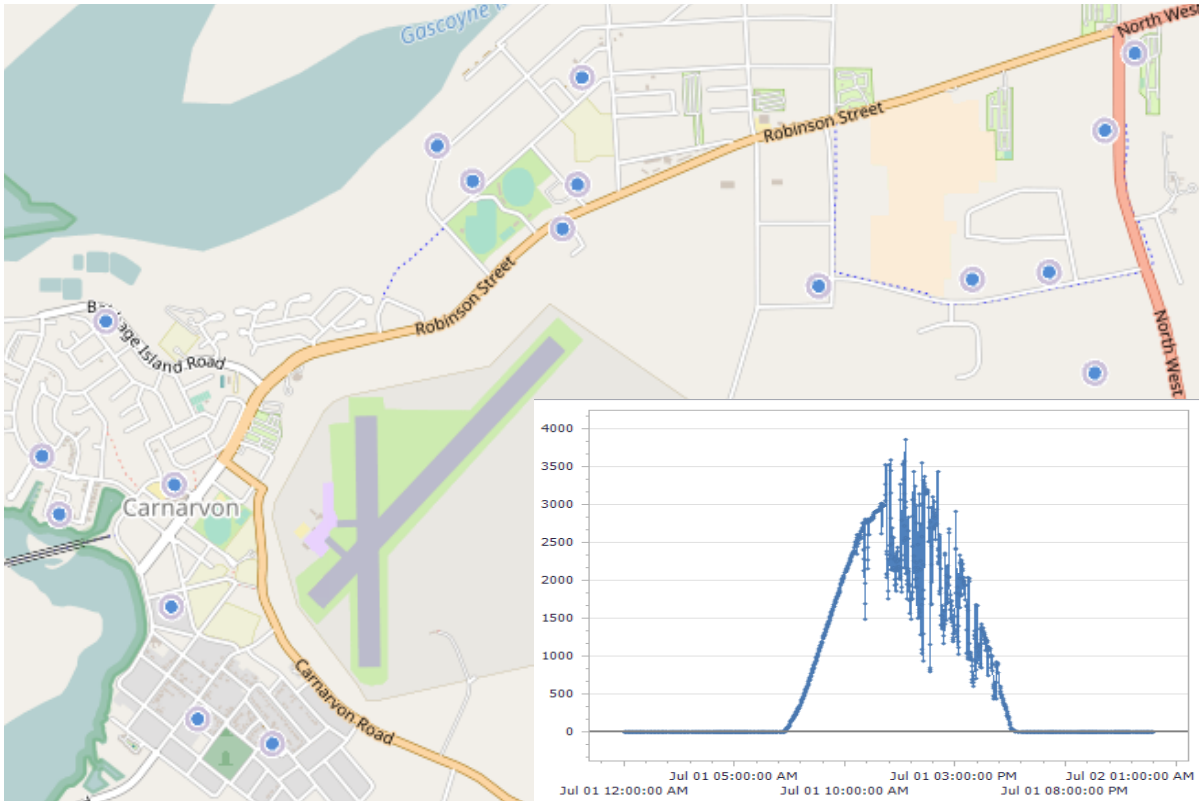

Carnarvon DER Monitor & Control Trial

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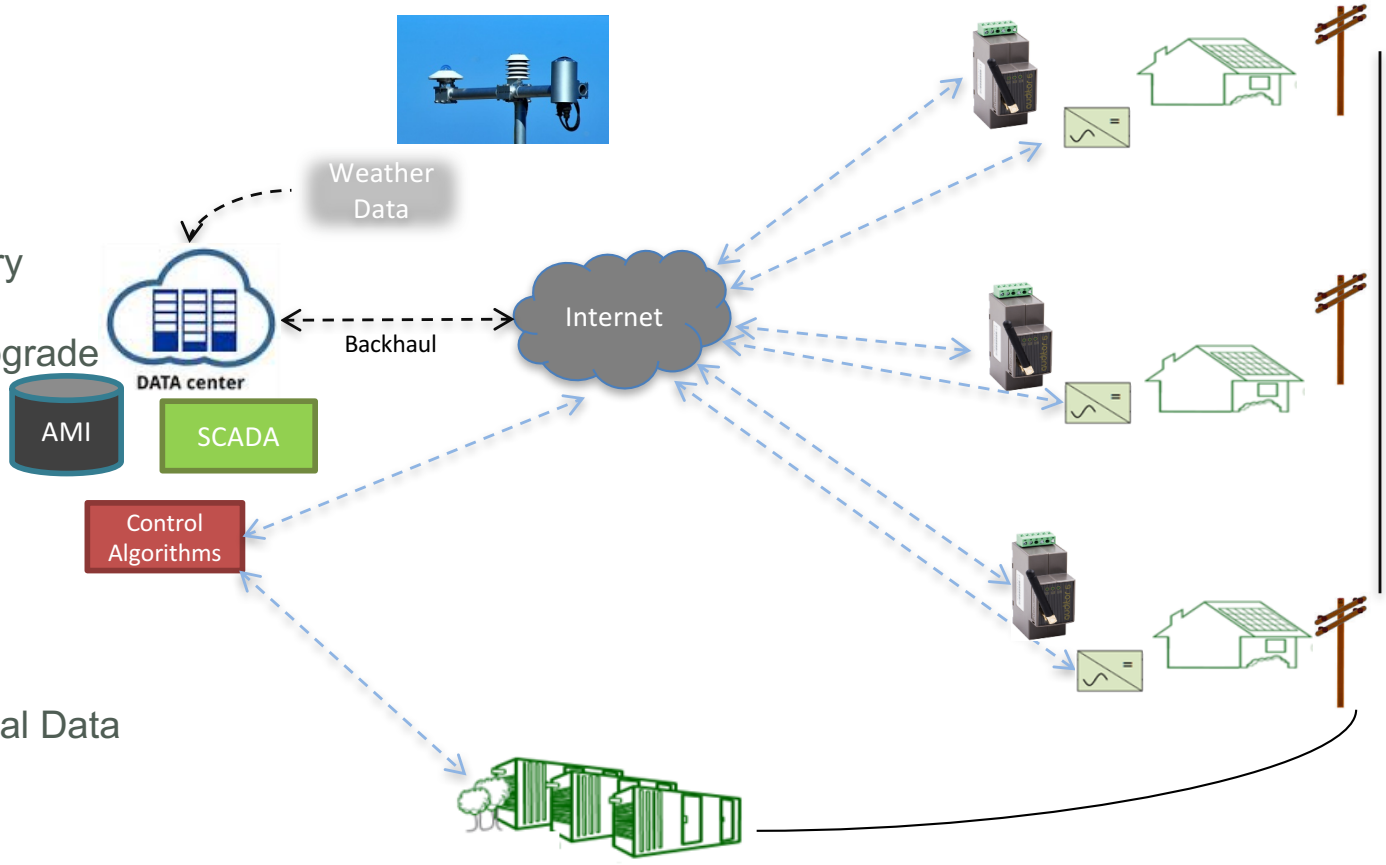
DER Control

Participants:

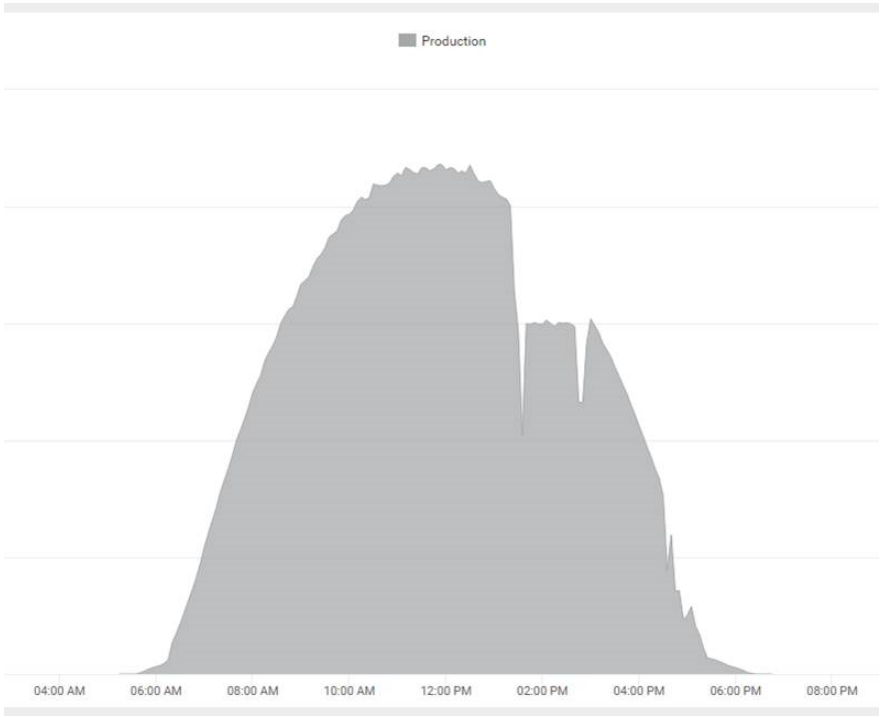
- 10 Customers – PV/Battery system
- 5 Customers – Inverter upgrade
- 5 customers
- Police & Justice Centre
- EMC Solar farm

Including:

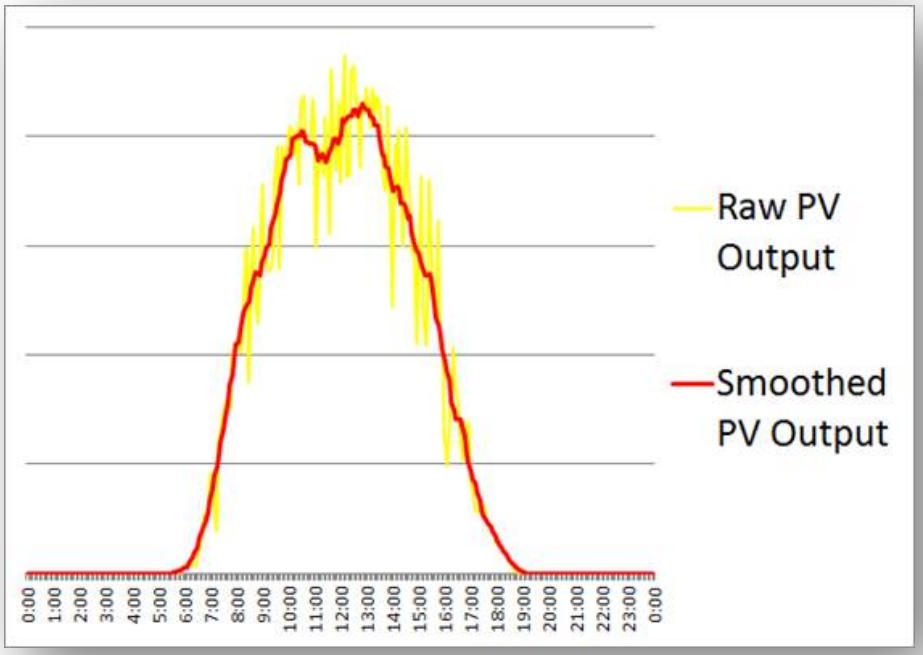
- 1 Sky Camera
- 1 Meteorological Stations
- Build Back-end – Relational Data base

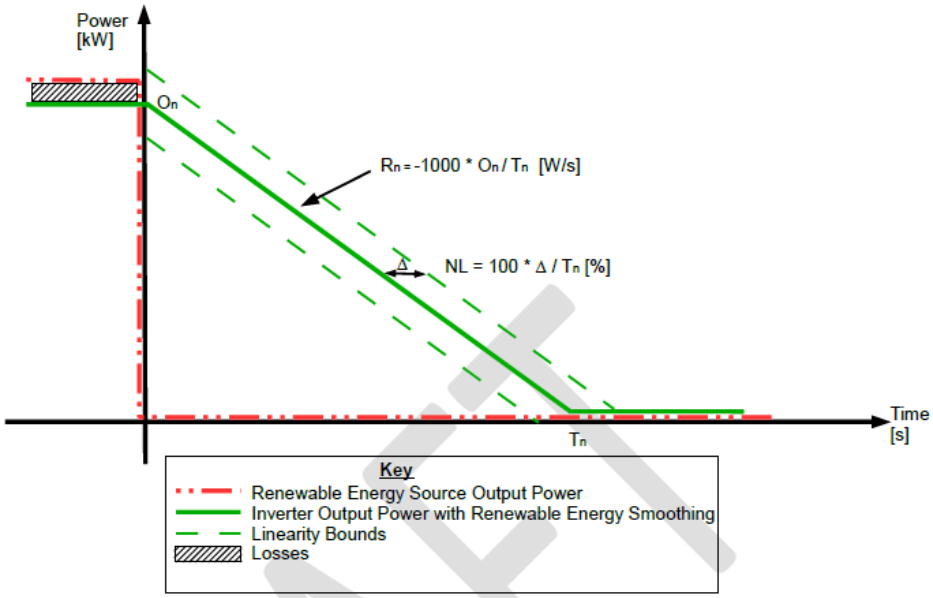


Carnarvon DER Monitor & Control Trial

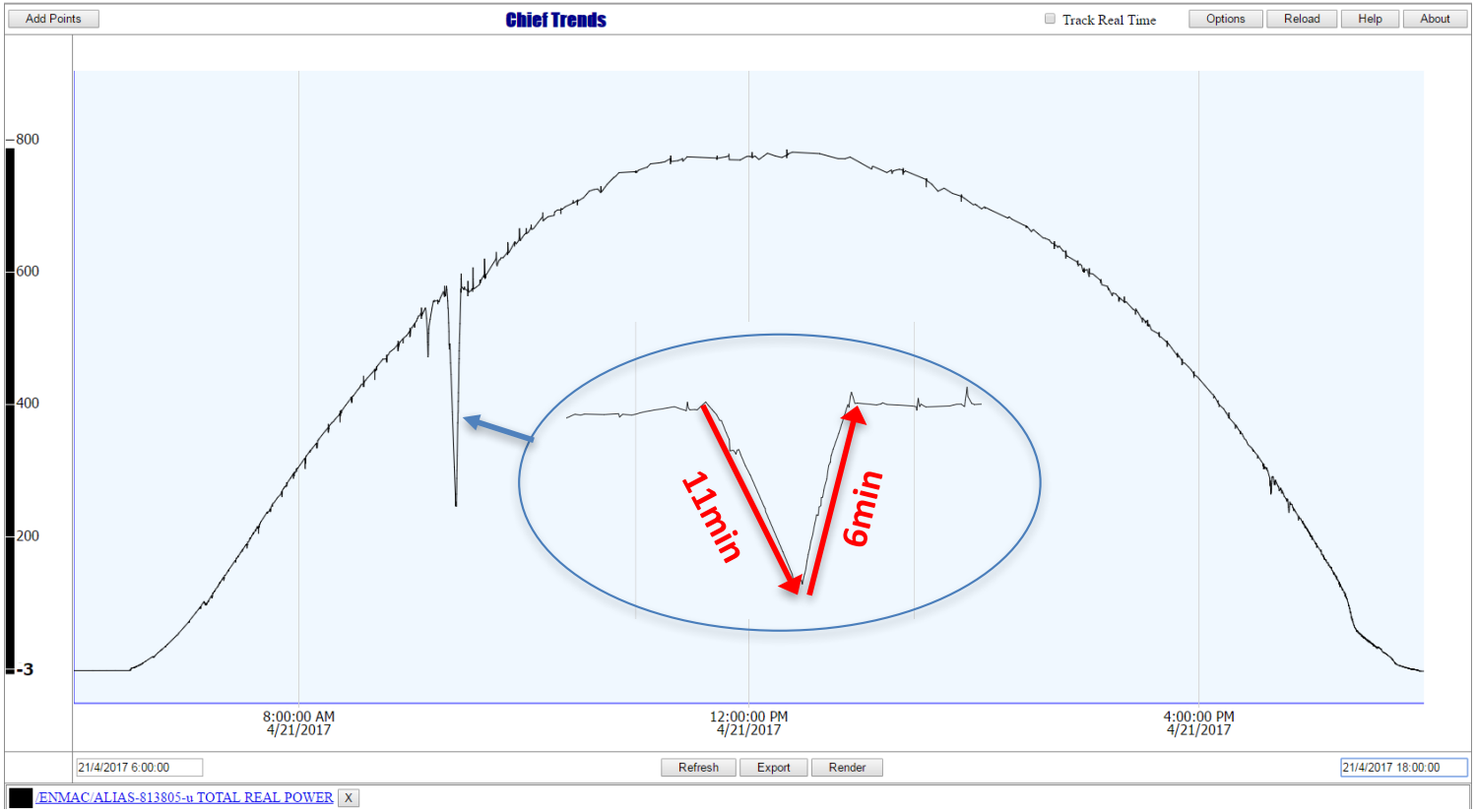


Renewable Energy Smoothing





Karratha Airport Solar Smoothing



Carnarvon Energy Storage Trial

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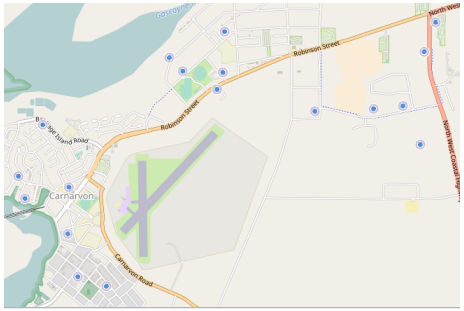
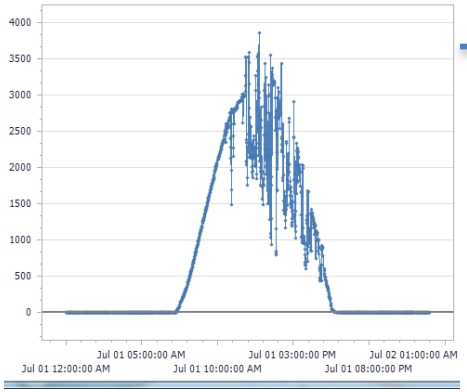
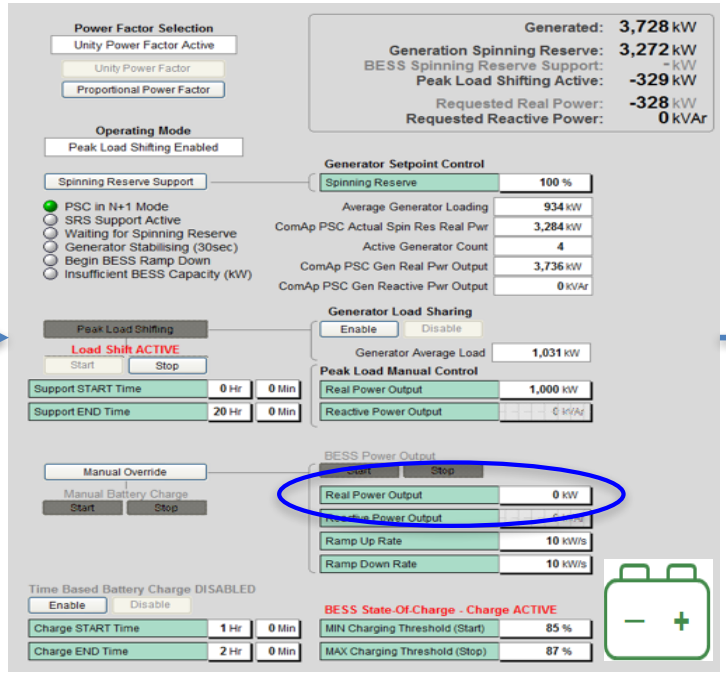
Carnarvon Energy Storage Trial

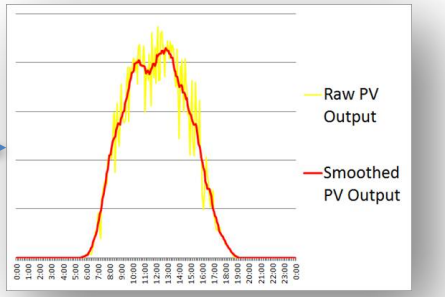
HORIZON POWER energy for life



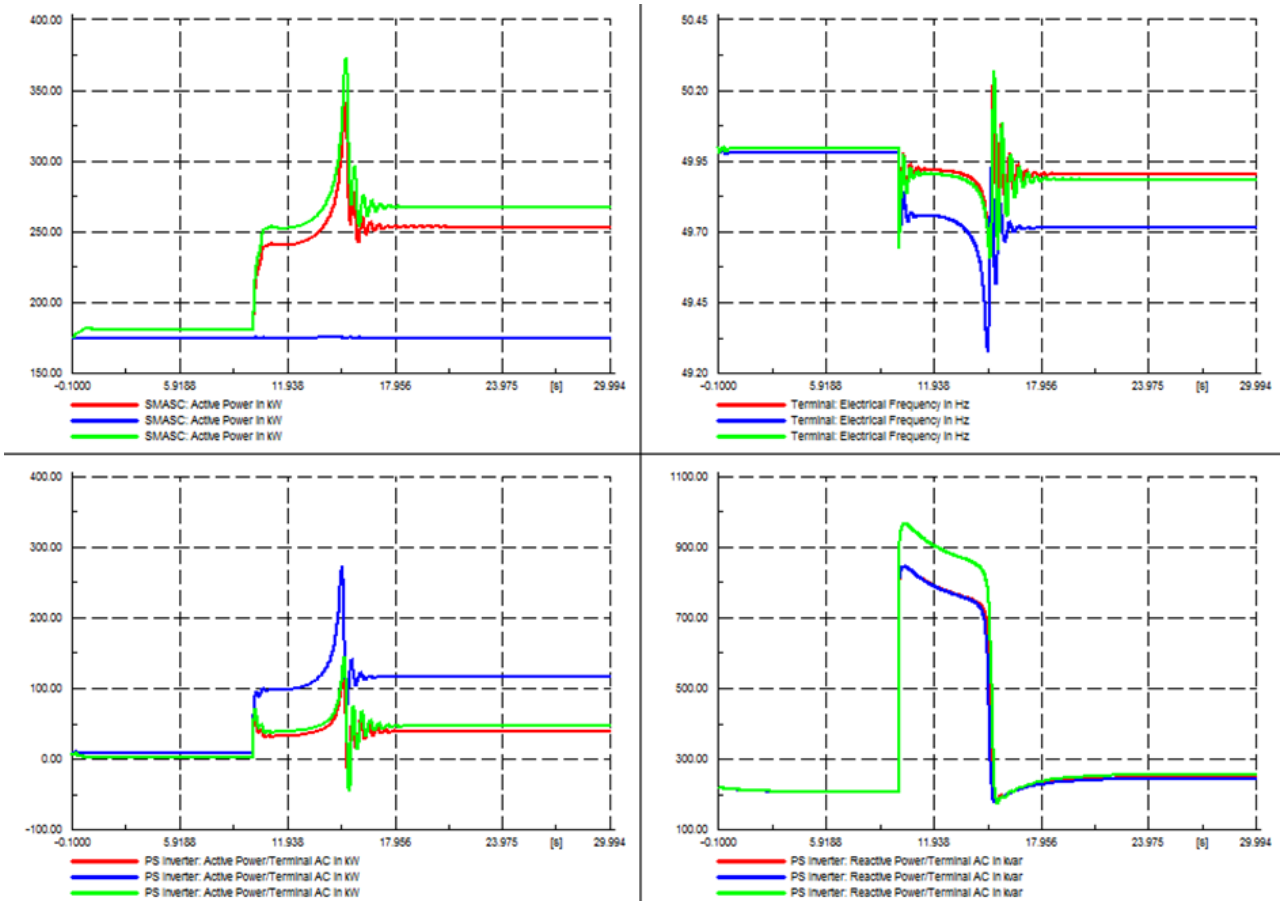


DMCS





Motor Starting Requirements



Multiflow Network Design Optimisation

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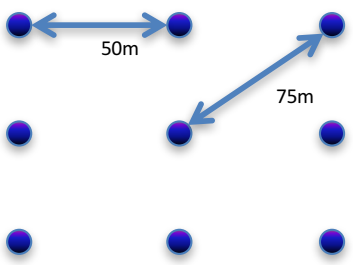
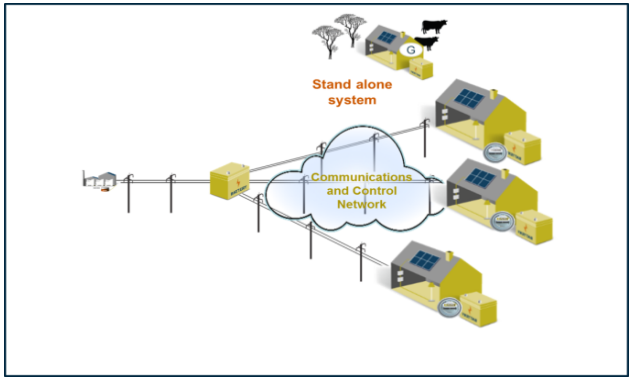
- **Objective:** Define the most economically efficient way to design a system as customer density and customer PV penetration increases.

- **Key Questions:** Customer Density? Additional Equipment? Suitability of existing networks? Technical Limitations?





Multiflow Network Design – Load Profiles

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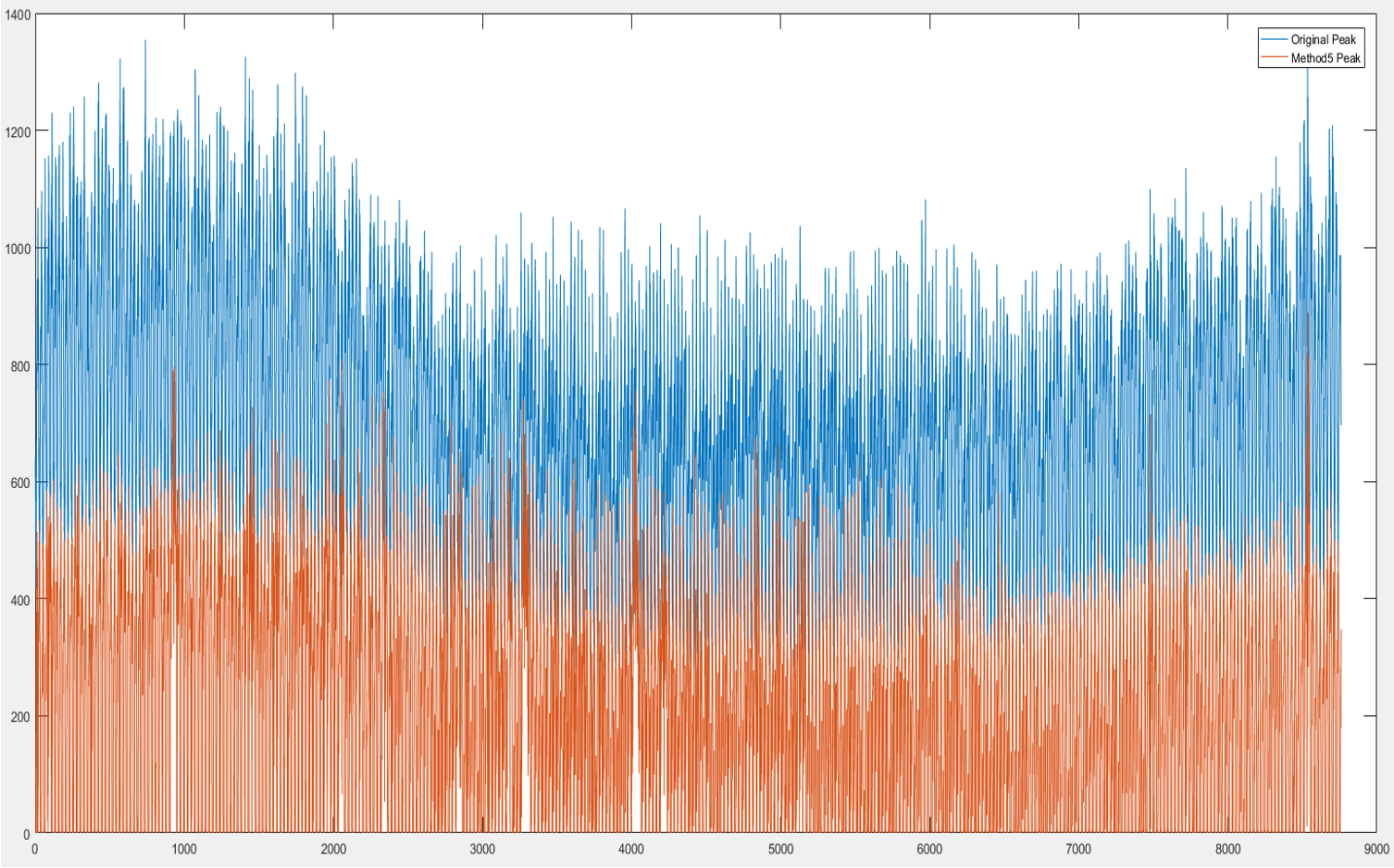

Multiflow Network Design Optimisation

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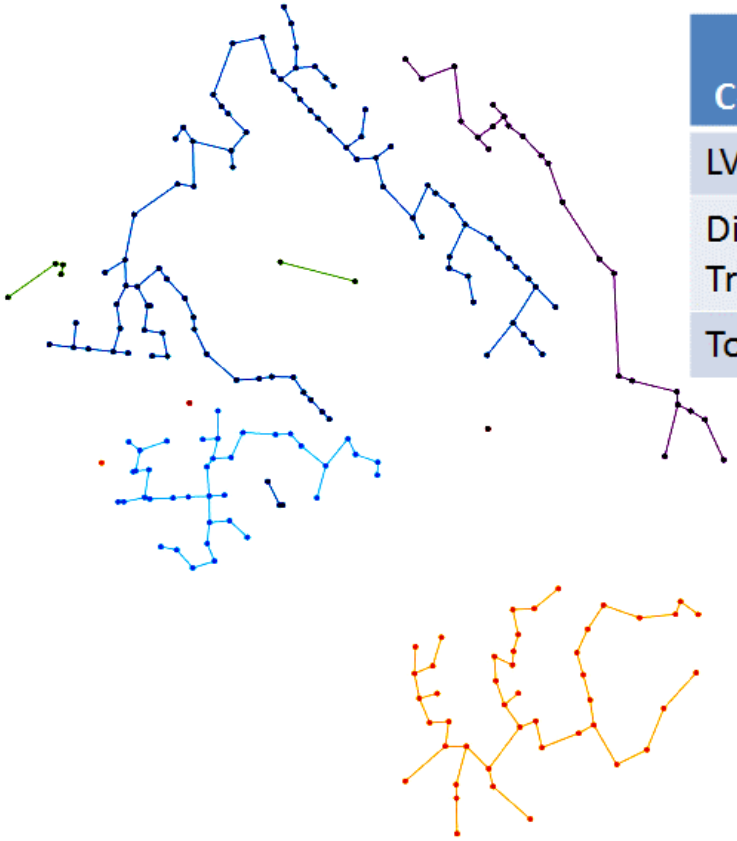
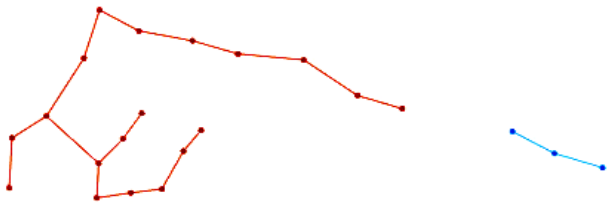
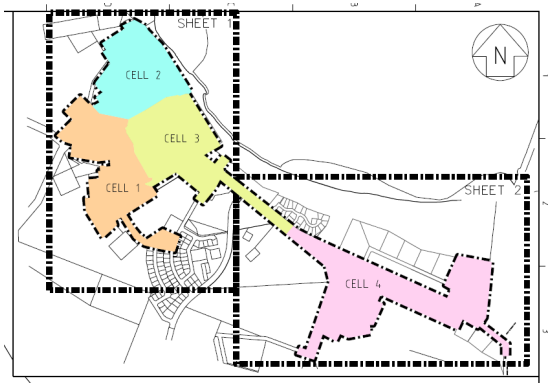


System Component	Base Model	Optimised DER Model	Savings	
LV Network	$2.98M	$2.60M	$0.38M	13%
Distribution Transformers	$2.15M	$1.39M	$0.76M	35%
Total	$5.13M	$3.99M	$1.14M	22%



Design Validation



- Reduced transformer capacity
- Reconfigured cabling and RMUs
- Reduced LV cable size
- LV cost reduction of 21%
- HV cost reduction of 10.5%

The Solar Story

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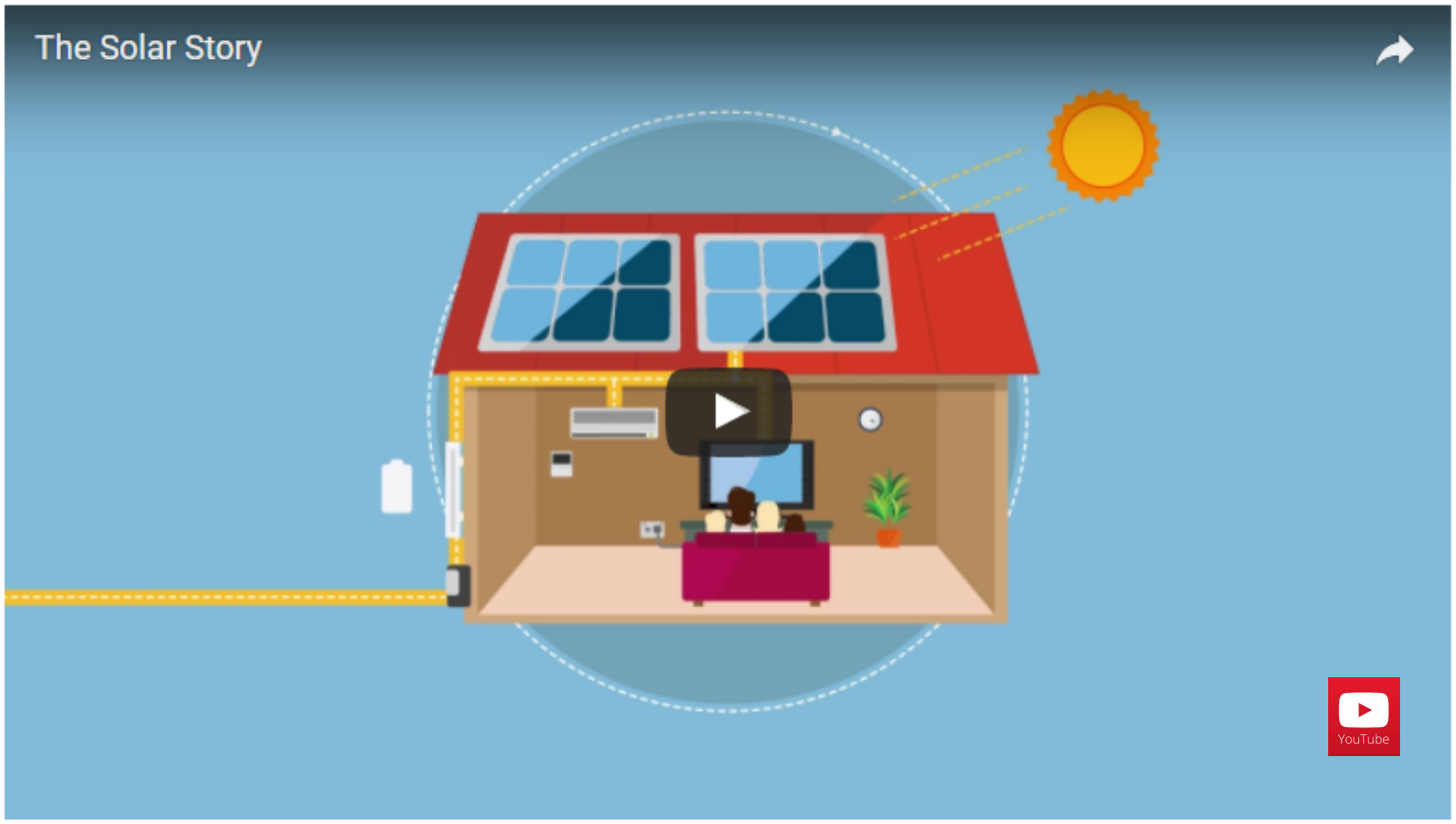

Customers – Technical Requirements

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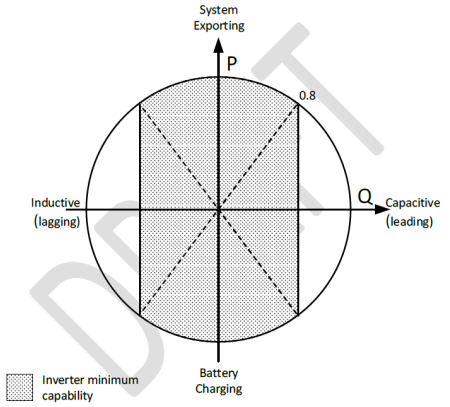
- Feed in Management
- Sunspec
- New requirements under AS4777 – Settings
- Inverter reactive power capability
- Extended Ramp Rate Installations
- Changeover switches
- Updated Testing Requirements
- Updated Information requirements



APPENDIX B. REQUIRED SUNSPEC PARAMETERS

Required Functionality	SunSpec Variable Name/ID	Unit	Data Type	Size	Read/Write	Variable Description
Inverter Controls Nameplate Ratings	WRtg	W	uint16	1	R	Continuous power output capability of the inverter.
	WRtg_SF	-	sunssf	1	R	Scale factor
Control of inverter active power output set point via SCADA	WMax	W	uint16	1	RW	Setting for maximum power output. Default to WRtg.
	WMax_SF	-	sunssf	1	R	Scale factor for real power.
Automated inverter output ramp-down (inverter emergency shutdown)	WMaxLimPct	% WMax	uint16	1	RW	Set power output to specified level.
	WMaxLimPct_RmpTms	secs	uint16	1	RW	Ramp time for moving from current setpoint to new setpoint.
Monitoring of the following on-site generation resource data:	WMaxLim_Ena	-	enum16	1	RW	Enumerated valued. Throttle enable/disable control: 0: DISABLED 1: ENABLED
	ChaState	% AhrRtg	uint16	1	R	Currently available energy as a percent of the capacity rating.
	InBatV	V	uint16	1	R	Internal battery voltage.
	InBatV_SF		sunssf	1	R	Scale factor for battery voltage.
	A	A	uint16l	1	R	AC Current
	A_SF		sunssf	1	R	Current scale factor
	PhV	V	int16	1	R	Line to Neutral AC Voltage (average of active phases)
	V_SF		sunssf	1	R	Voltage scale factor
	Hz	Hz	int16	1	R	Frequency
	Hz_SF		sunssf	1	R	Frequency scale factor
	W	W	int16	1	R	AC Power
	W_SF		sunssf	1	R	Real Power scale factor
	VAr	VAr	int16	1	R	AC Reactive Power
	VAR_SF		sunssf	1	R	Reactive Power scale factor
	W	W	int16	1	R	Total Real Power
	W_SF		sunssf	1	R	Real Power scale factor
	VA	VA	int16	1	R	AC Apparent Power

David Stephens
Senior System Technology Engineer
(08) 6310 1853
david.stephens@horizonpower.com.au

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