

# Update on Performance Testing

ESCRI Knowledge Sharing Reference Group

12 June 2018

In partnership with:



**ARENA**  
Australian Government  
Australian Renewable  
Energy Agency



**Advisian**  
WorleyParsons Group

This activity received funding from ARENA as part of ARENA's Advancing Renewables Programme

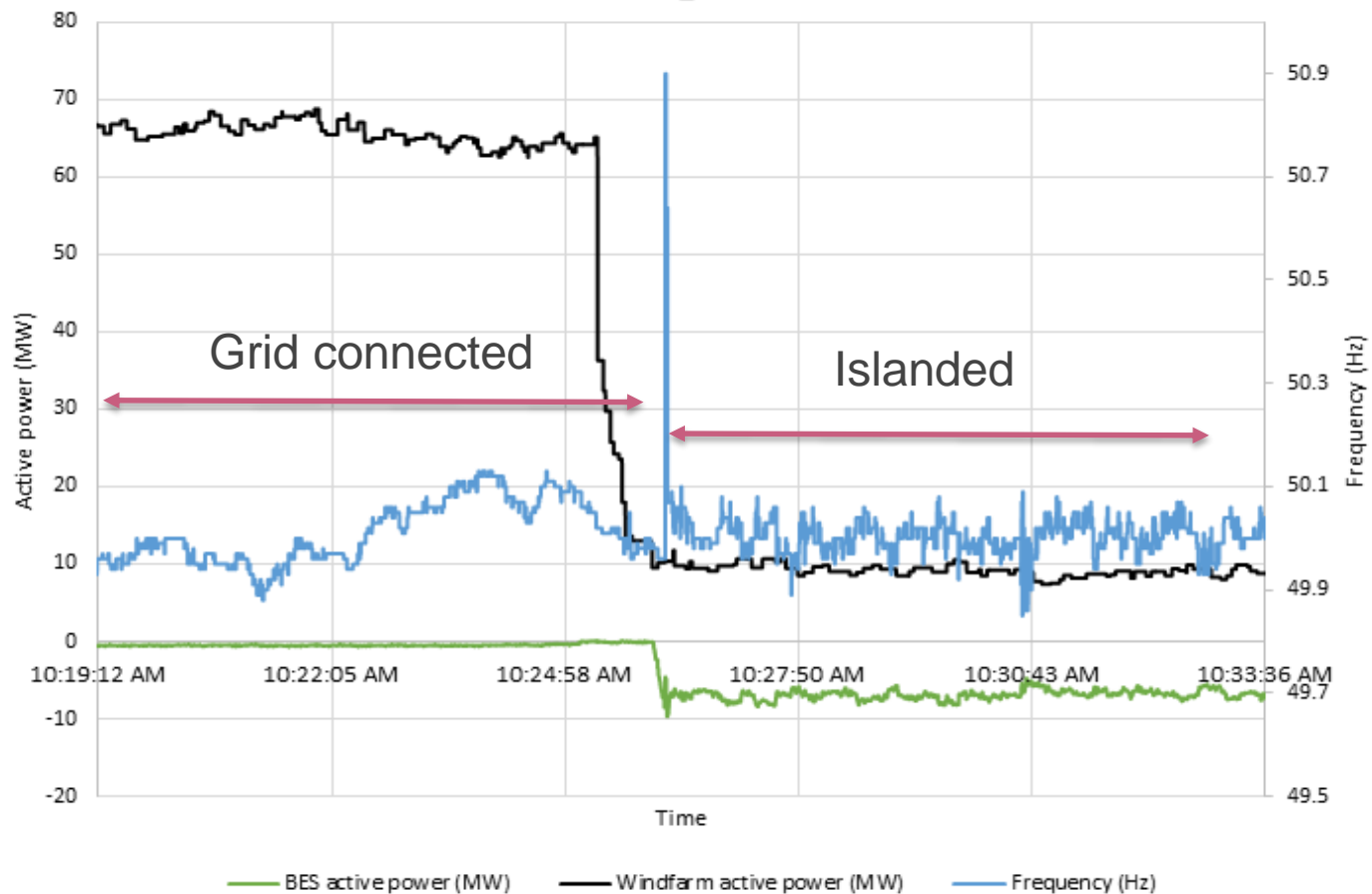
# Presentation outline

- > Challenges to achieve islanding
- > Islanding testing
- > Inverter overload capability tests
- > Inspection and Test Report (ITR) summary
- > R2 Model Validation Tests

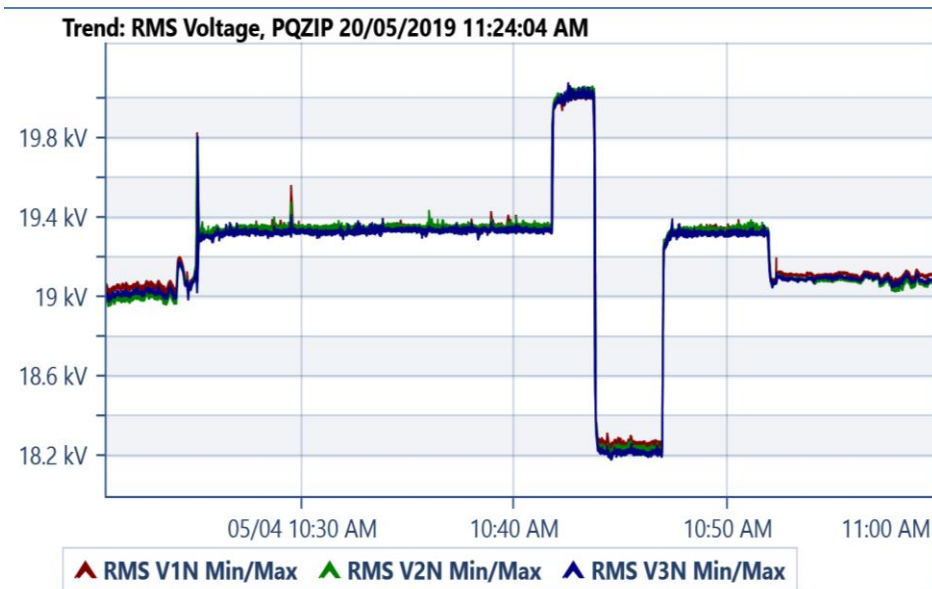
# Model refinements (July '18 – April '19)

|   | Grid connected   | Islanded  |
|---|--|---|
| GPS compliant model (R1)                        | ✓  | - Inter inverter oscillation (inverter inertial gains were different to factory test) |
| Fixed inter inverter oscillation                | - Active power recovery issue<br>- Distribution fault ride through issue                           | ✓   |
| New model submission to match hardware settings | - GPS negotiated<br>- Inverter overload issue during frequency events (inertial response) S5.2.5.3 | - BESS control interactions with transformer saturation and network loading level     |
| Retuned inverter gains                          | - Inverter overload issue still existed  | - Islanding with SAPN load (pass)<br>- Oscillation during Islanding with windfarm     |
| Further tuning of inverter gains                | - Inverter overload issue still existed  | ✓   |
| Modification in BESS protection settings        | ✓  | ✓   |

# Planned islanding test with windfarm and SAPN load



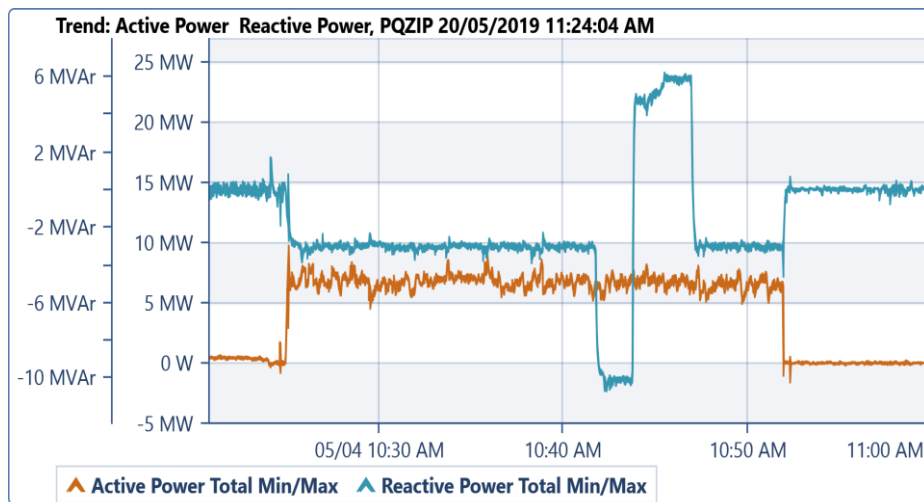
- Frequency went up to 50.8 Hz for short amount of time



Voltage changed in islanded network from:

- 1 to 1.05 pu
- 1 to 0.95 pu

Fig 6.1 Voltage step change in an islanded network



Active and reactive power responses are completely decoupled

Fig 6.2 BESS active and reactive power with voltage step change

# Unplanned islanding test with windfarm output > 60 MW

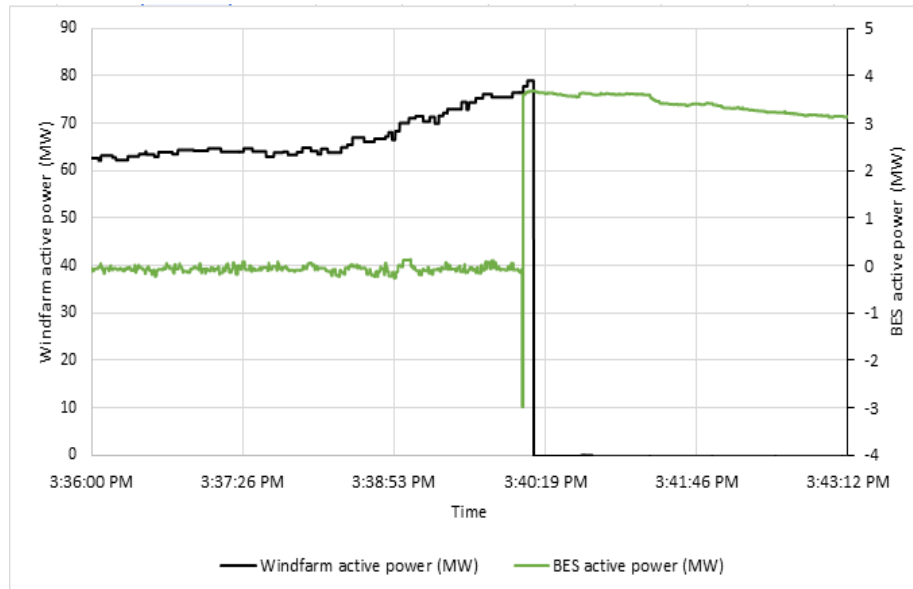


Fig 7.1 Successful unplanned island transition but windfarm trips on over frequency

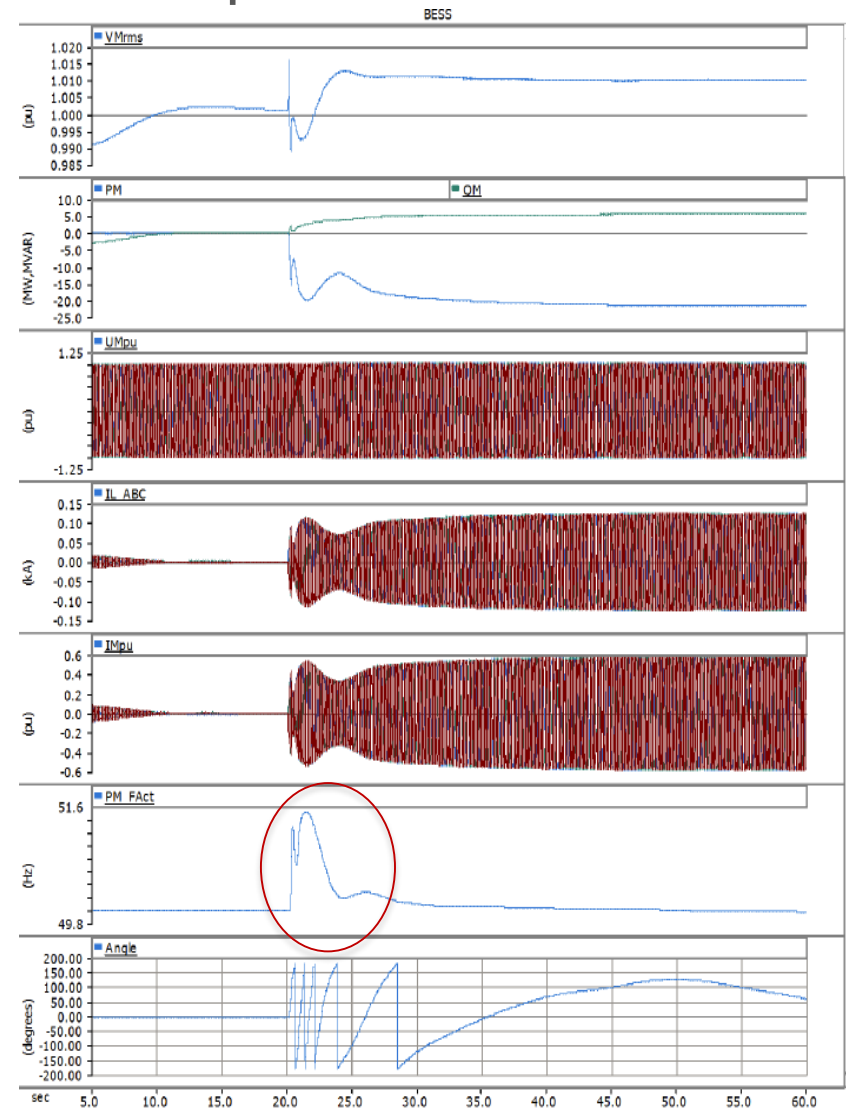
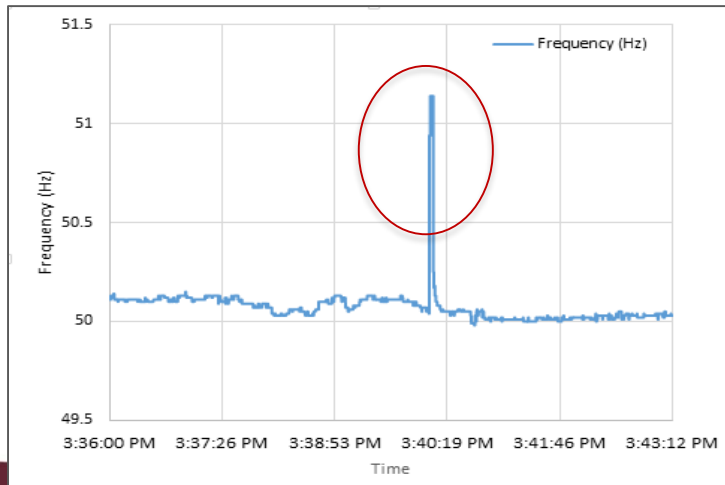


Fig 7.2 Simulation results

# BESS inverter overload capability test (one BESS module)

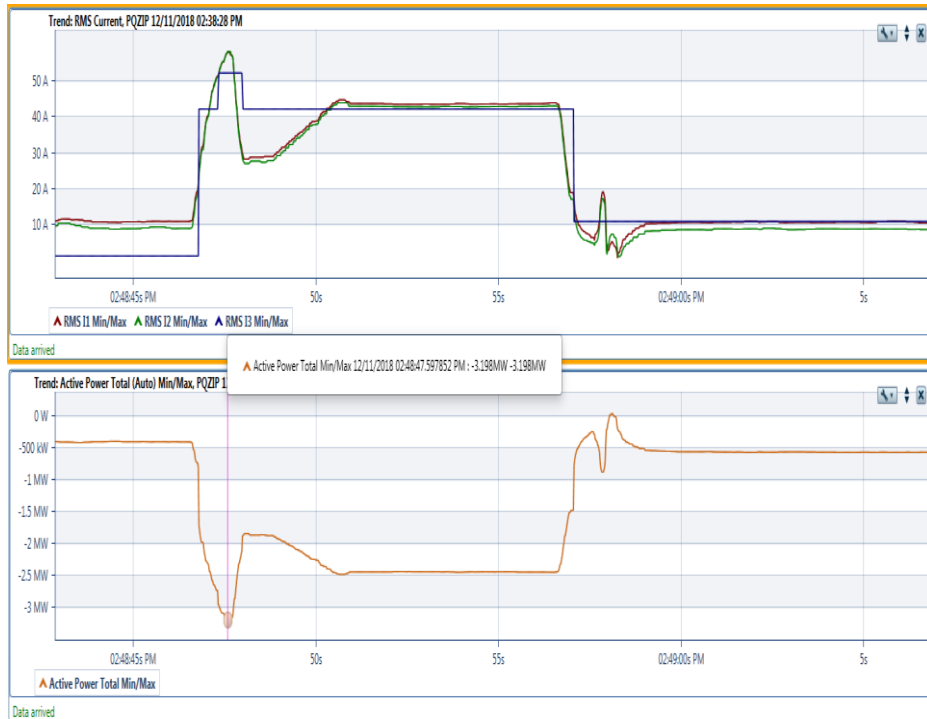


Fig 8.1 Frequency event at 3Hz/s while charging at -7.5 MW ( hardware results from single inverter module) **passed**

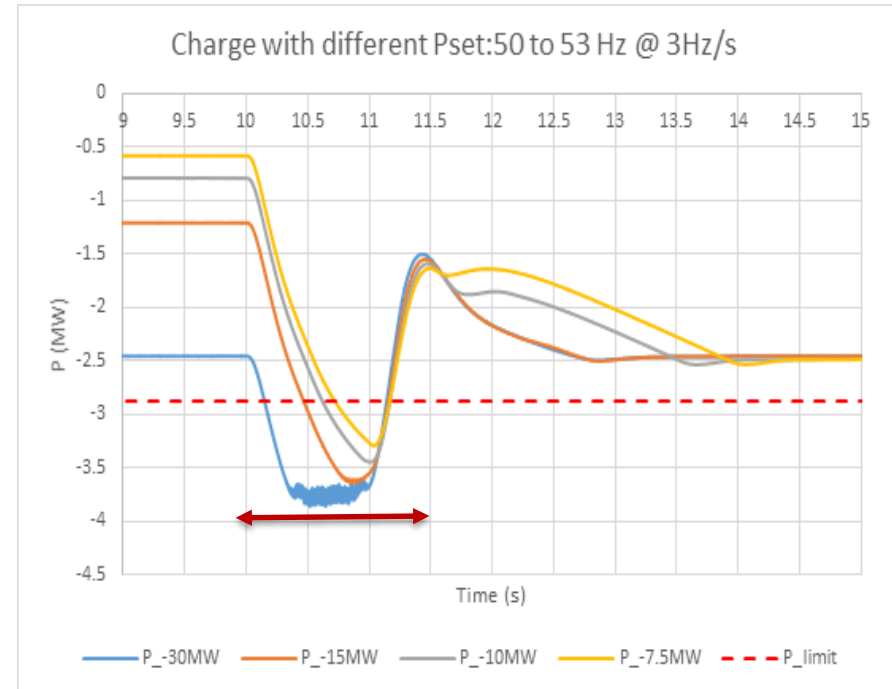
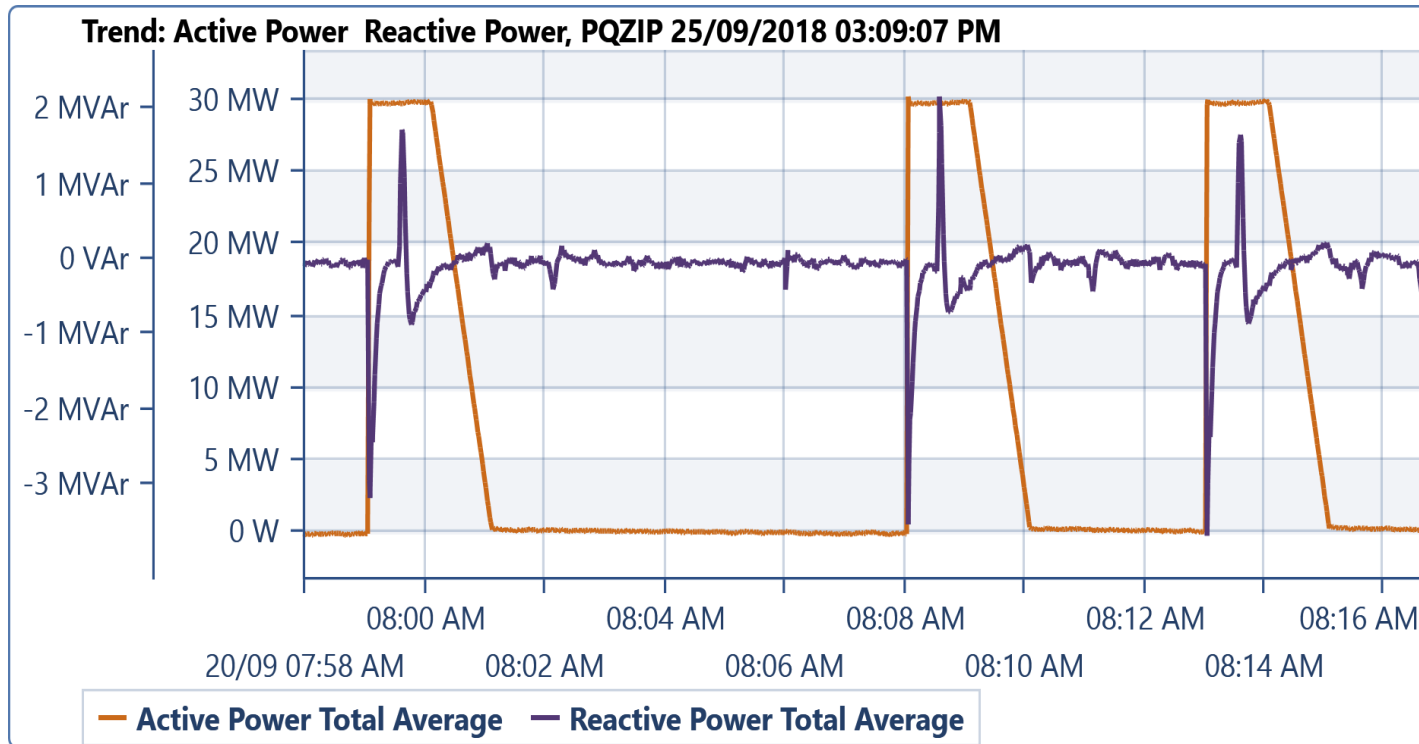


Fig 8.2 Different BESS dispatch comparison with 3Hz/s frequency event in PSCAD model

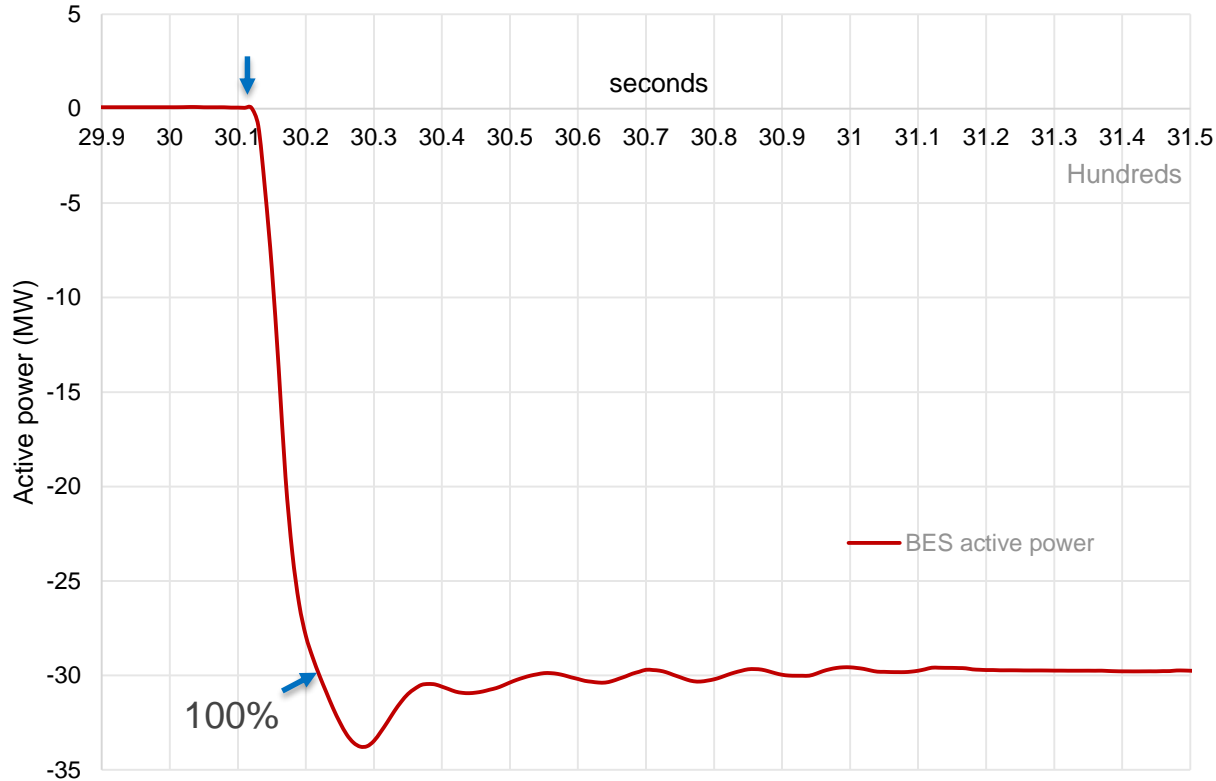
# Summary

- > Detailed simulations using PSCAD by Electranix and ElectraNet have been conducted using the same parameters as those used in the hardware and island test
- > These simulations have been successful in replicating the test results
- > Results of the simulation have concluded that:
  - In full island mode a minimum of 10 BESS modules in-service is required to meet fault current requirements
  - Wattle point windfarm needs to fix their frequency protection settings
  - Transformer saturation needs to be properly considered for islanding studies

# Responses from SIPS test



# Detailed SIPS response



- ❖ Signal propagation delay from SEAS – 30 ms
- ❖ BESS control action – 120ms
- ❖ BESS response from 0 to 100% (discharge) - 100 ms

# ESCRI SA – BESS R2 Model Validation Tests

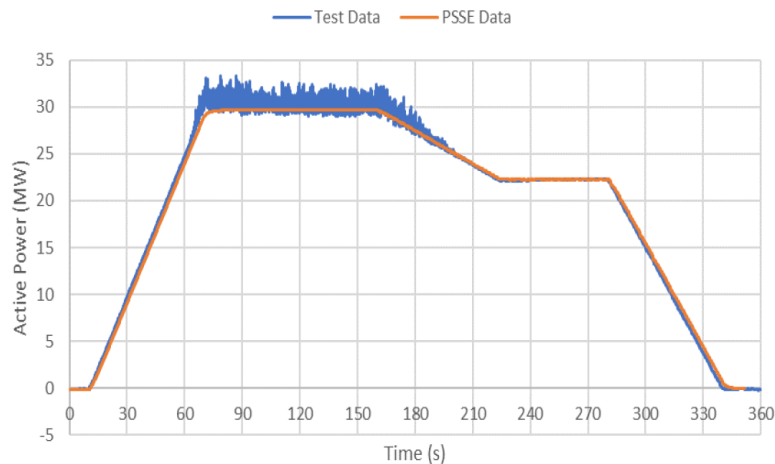
- > R2 model validation tests for the Dalrymple were performed by FortEng under the supervision of ElectraNet 13 April 2019, following the completion of the following commissioning tests:
  - Hold-point 1 Test at +/-15 MW and +/-12.1 Mvar – Grid connected operations only
  - Hold-point 2 Test at +/-30 MW and +/-12.1 Mvar – Grid connected operations only
  - Inspection and Test Report (ITR 38) BESS Isolated Test
  - Inspection and Test Report (ITR 39) BESS Partial Islanding and Full Islanding with WPWF.
  - Inspection and Test Report (ITR 40) BESS on Grid Connected and Islanded Operation
  - Inspection and Test Report (ITR 41) BESS Black Start
  - Inspection and Test Report (ITR 42) BESS Partial Islanding with SAPN load only

# R2 Model Validation

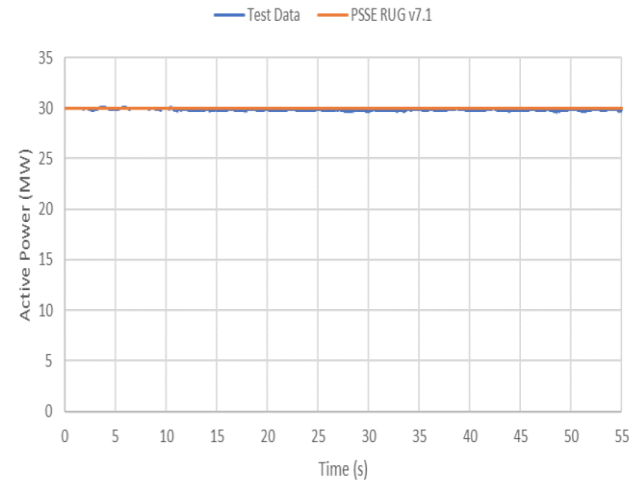
- > R2 Tests include
  - Offline tests
  - Online tests
  - Online Compliance Monitoring Program
- > R2 tests went well – Examples of R2 test overlays on following slides
- > R2 test report expected soon

# R2 Test Model Response Overlay

- > +5 % Voltage Step Response at +30 MW in voltage control mode
- > Previous oscillation at high discharge resolved
- > No change in MW output at voltage step

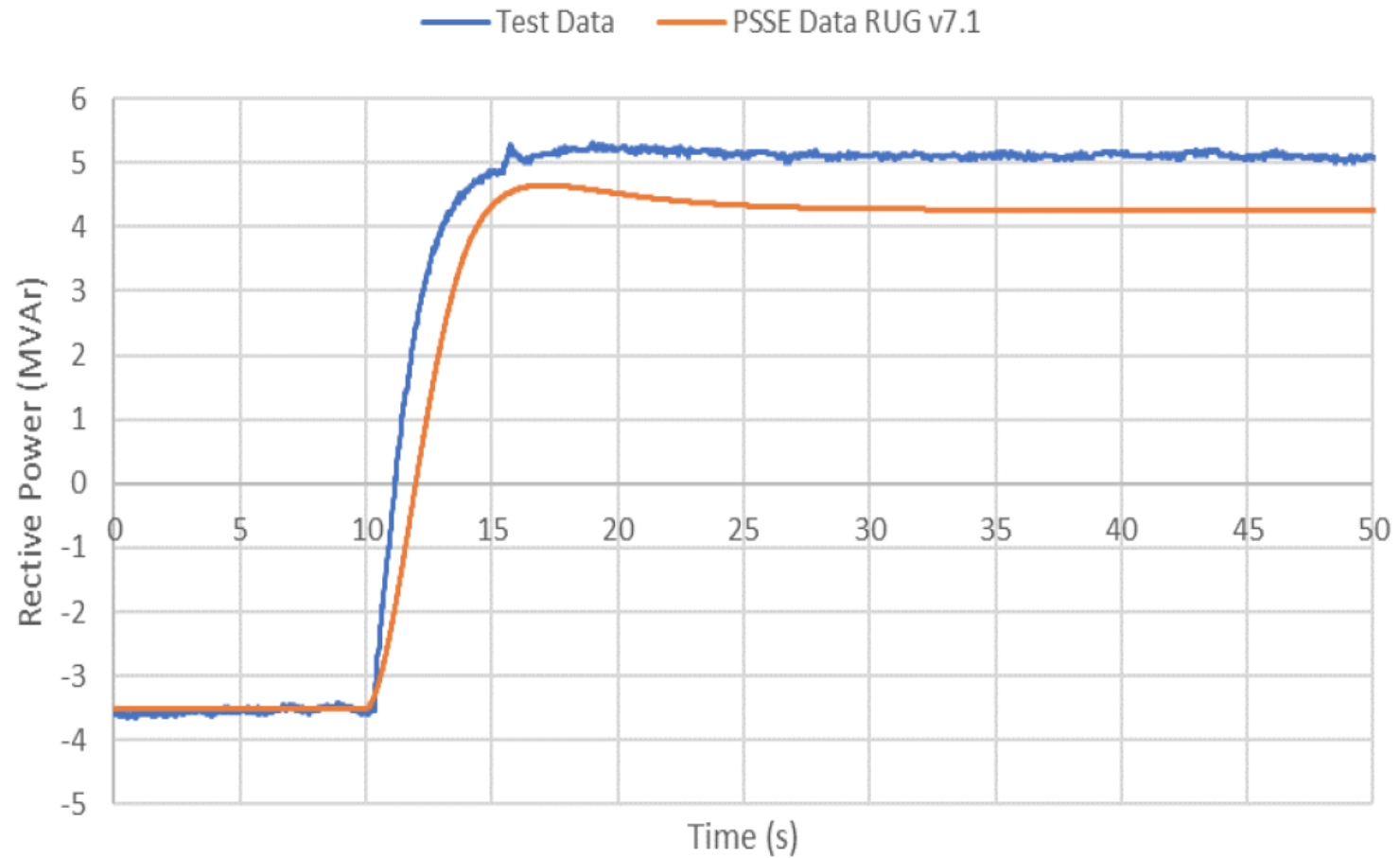


**R1 result – July 2018**

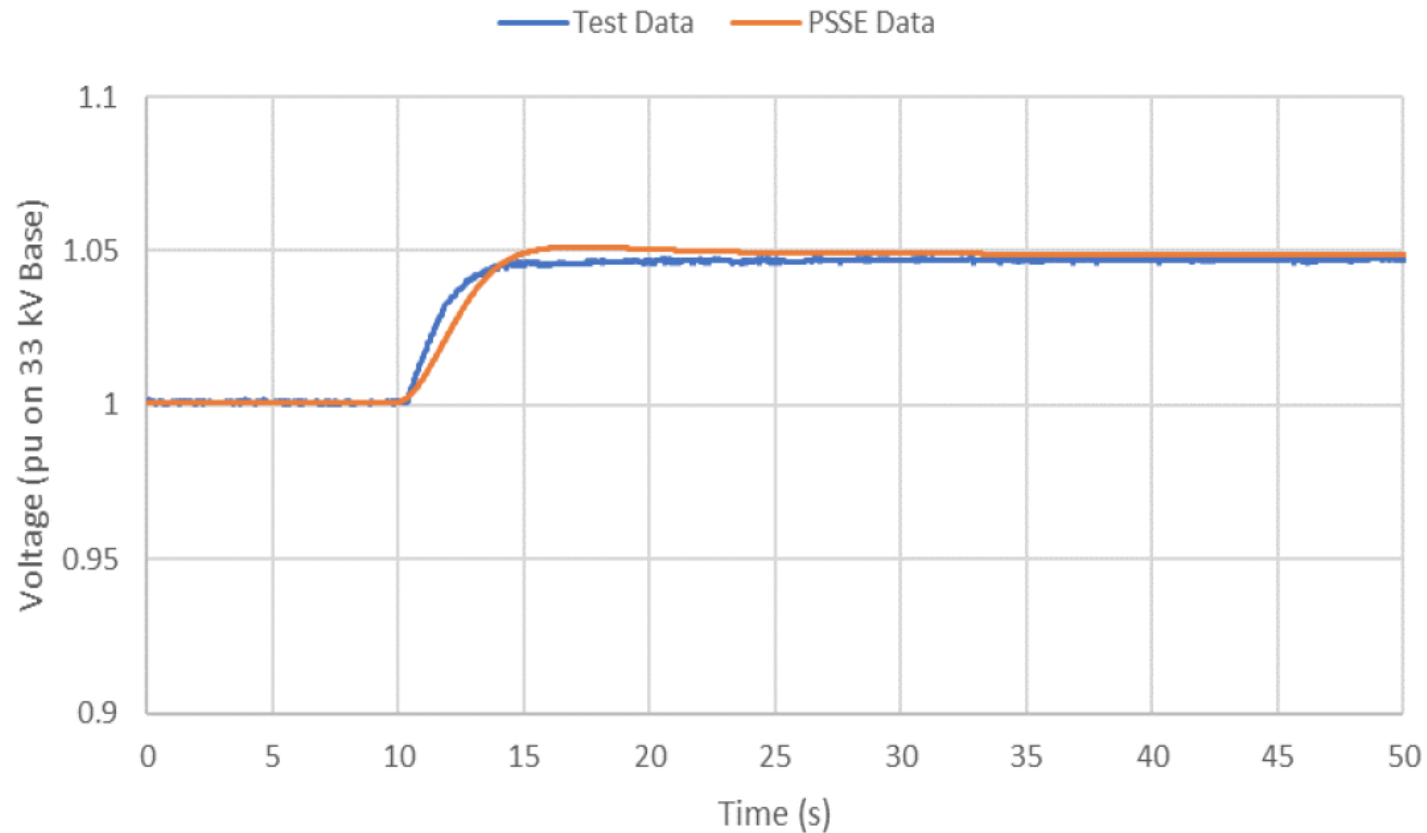


**R2 result – April 2019**

# Voltage step response – Reactive Power



# Voltage step response – Voltage

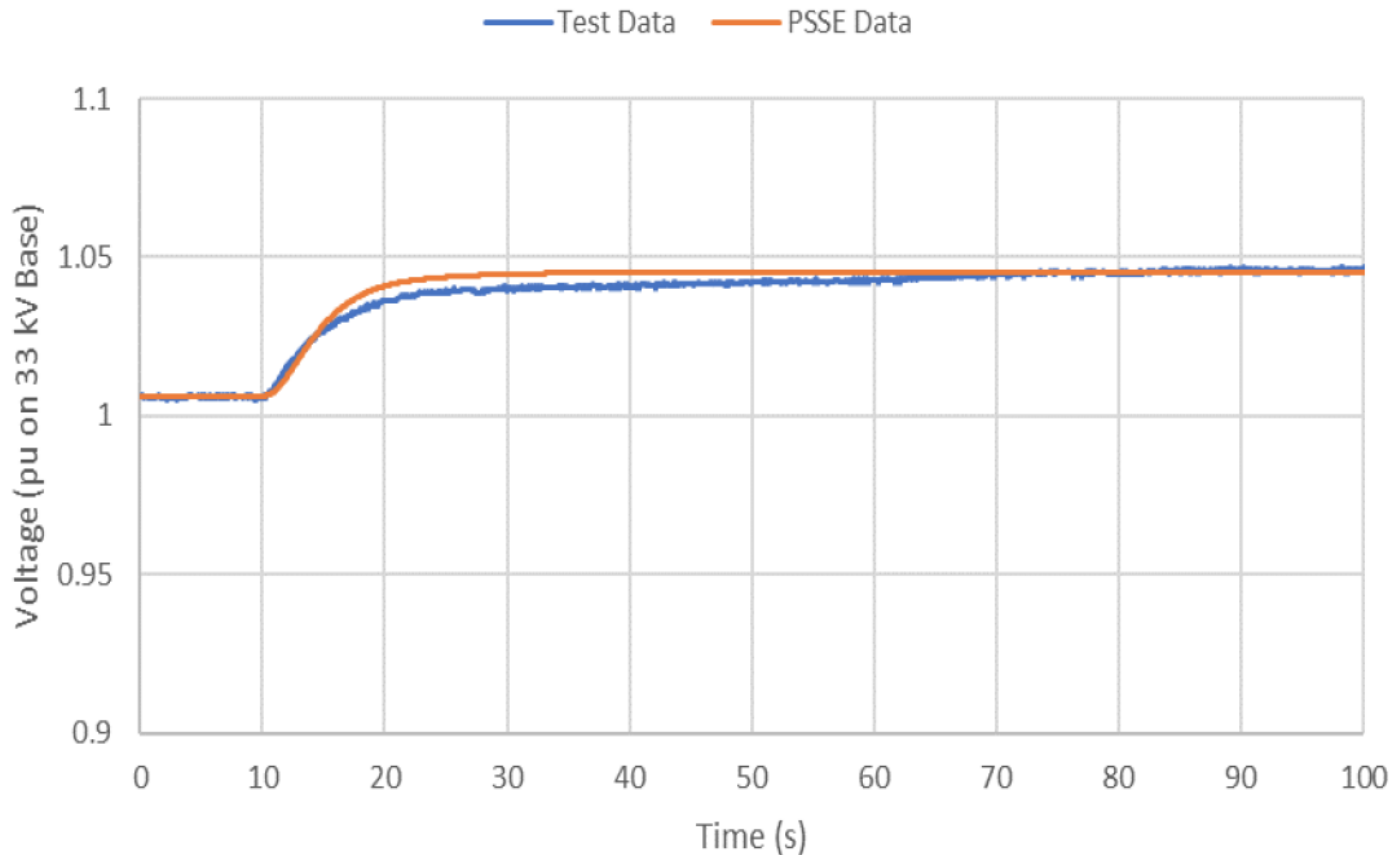


# R2 Test Model Response Overlay

- > +0.98 Power factor response in power factor control mode at 30 MW
- > No change in MW output observed

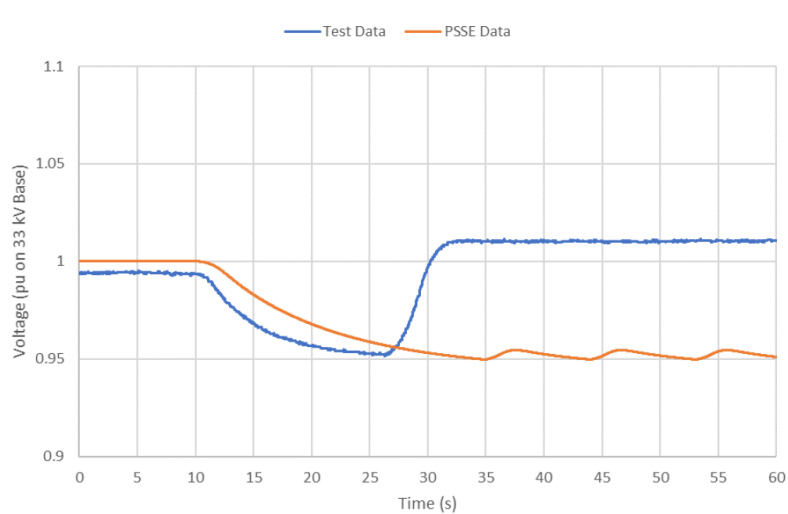


# Power factor step response – Voltage

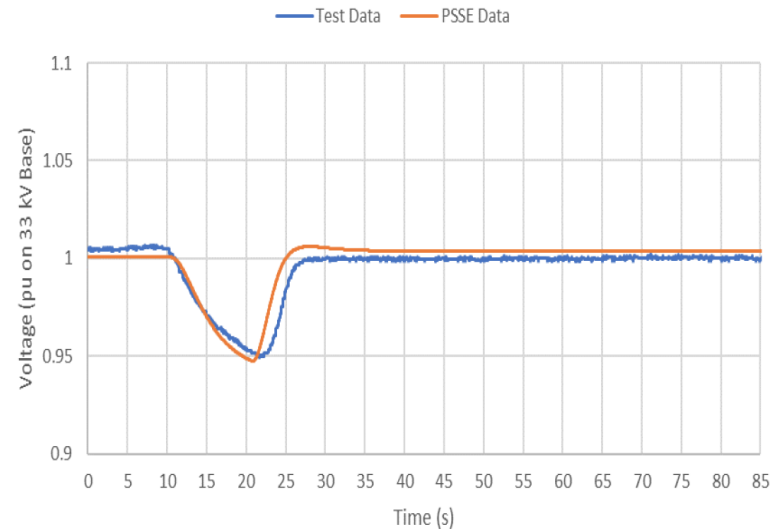


# Automated control change over

- Forced PF to result in voltage excursion below 0.95 pu
- As voltage drops below 0.95 pu, control mode switches to voltage control



**R1 result**



**R2 result**

# ESCRI - PCS100 BESS Modules



# Questions



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# Thank you

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