ESCRI-SA
Technical Performance during Commissioning - ElectraNet

ESCRI Knowledge Sharing Reference Group

14 August 2018

In partnership with:

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ESCRI - Dalrymple North BESS

Presentation outline

- Hold Point Test Results and Issues
  - Hold Point Test Overview
  - Hold Point Tests 1 and 2
- Refinement of Parameters
- Commissioning next steps
- Lessons Learnt during Testing

Hold Point Test Overview

Hold Point Tests

- Hold Point Test 1 (HP1) was conducted by FortEng on 12 and 13 July 2018
- Hold Point Test 2 (HP2) was conducted by FortEng on 18 to 20 July 2018
- Representatives from ABB, CPP, AGL and ElectraNet in attendance
- Testing is required to demonstrate actual plant compliance to GPS/CPS performance standards
- The tests consisted of 4 hold point tests, 2 for discharge and 2 for charge
  - Two generation discharge test limited to 50% (15 MW) and to 100% (30 MW)
  - Two load charge test limited to 50% (15 MW) and to 100% (30 MW)

Hold Point Test Overview cont.

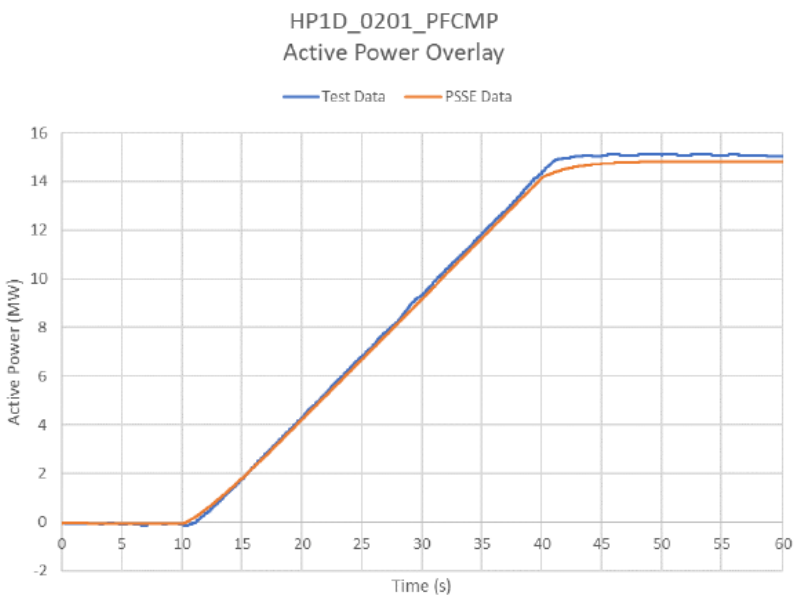
Equipment used

- Non-Synchronous Generating Unit Aggregate and Generating Unit Controller Aggregate
- Generating System Power Plant Controller (Feeder Controller and External Set Point Interface Aggregate, FCAS Auxiliary Control)
- ABB HMI
- Elspec G4500 Portable Power Quality Analyser (3)
- Omicron test set for SIPS tests

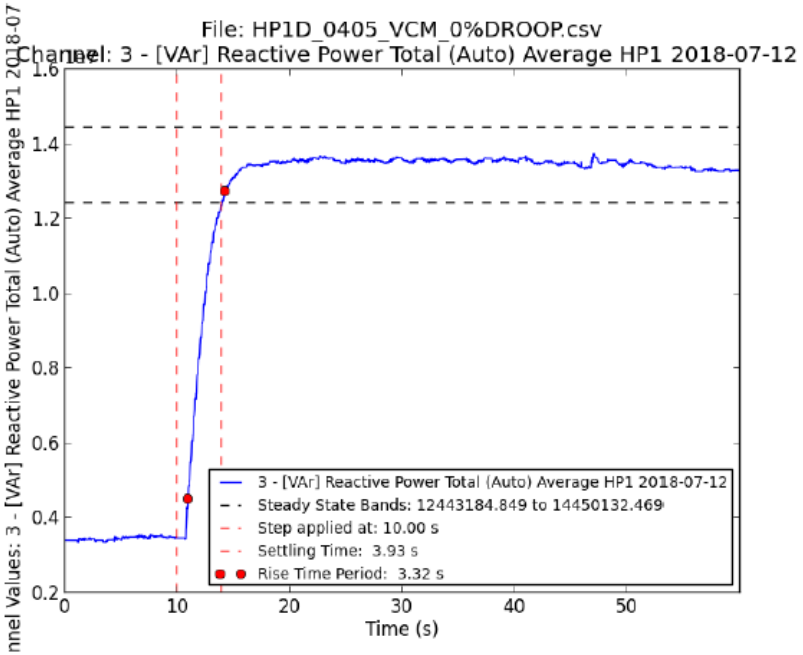
Hold Point 1 Test Results (Discharge)

Hold Point 1 – 50% (-15 MW, Discharge)			
Hold Point Test	**Test Description**	**Report Requirements**	**HP1D Result**
HP1D-01	Reactive Capability	300 second steady state recording	Capable of meeting reactive power capability for active power dispatch between 0 to +15 MW
HP1D-02	Active Power Steps (Power Factor Control Mode)	±15 MW step only Pre-test simulations and overlay required	Active power, reactive power and voltage responses match the generating system model. *See Graph 1*
HP1D-04	Voltage Steps	±5% step only Pre-test simulations and overlay required	Reactive power rise times for ±5% voltage steps exceeded 2.7 seconds *See Graph 2*
HP1D-05	Power Factor Steps	1.00 to ±0.95 step only Pre-test simulations and overlay required	Active power, reactive power and voltage responses match the generating system model but with reduced rise and setting times
HP1D-06	Partial Load Rejection (FCAS Mode)	±0.25 Hz steps ±1.00 Hz steps Pre-test simulations and overlay required	Active power, reactive power and voltage responses match the generating system model response for the same step change profile
HP1D-09	Control Mode Transitions (Power Factor to Voltage Control Mode)	< 0.95 pu V for > 1 s > 1.05 pu V for > 1 s Pre-test simulations and overlay required	Generating system does not regulate the voltage at the connection point to within 0.5% of its setpoint with the R1 parameters (5% voltage droop, and ±0.5% dead band) in voltage control mode *See Graph 3 & 4*

Hold Point 1 Discharge Graphs

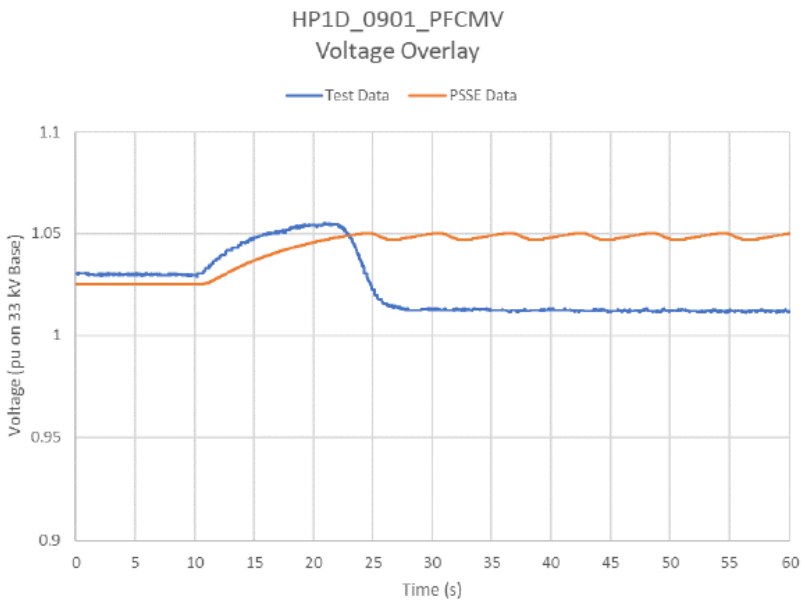


Hold Point 1 Test Discharge *(Graph 1)*
Overlay Plot of Active Power at the Connection Point
(Active Power Step 0 MW to +15 MW)

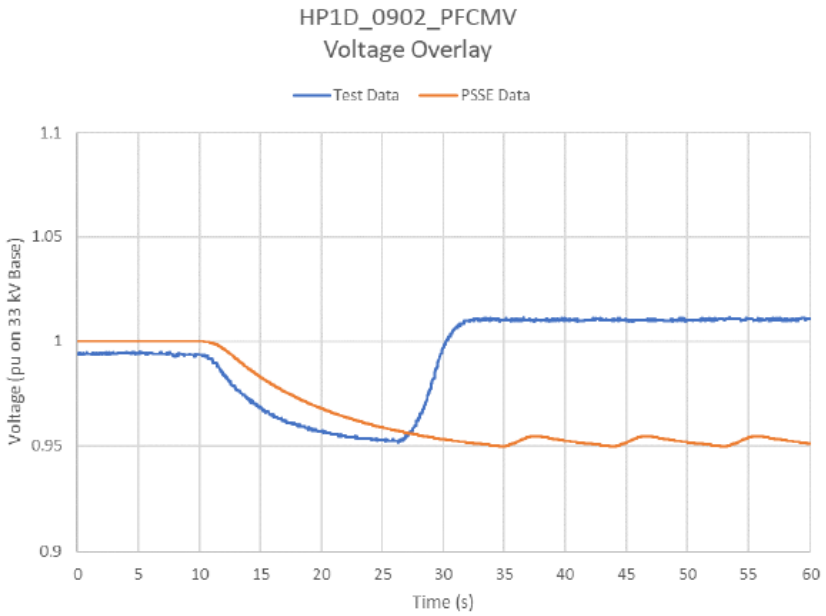


Hold Point 1 Test Discharge *(Graph 2)*
Reactive Power at the Connection Point with Rise Time and Settle Time and Steady State Bands Overlayed

Hold Point 1 Discharge Graphs



Hold Point 1 Test Discharge *(Graph 3)*
Overlay Plot of Voltage at the Connection Point
(+15 MW, PF Step from 1.0 to +0.95)

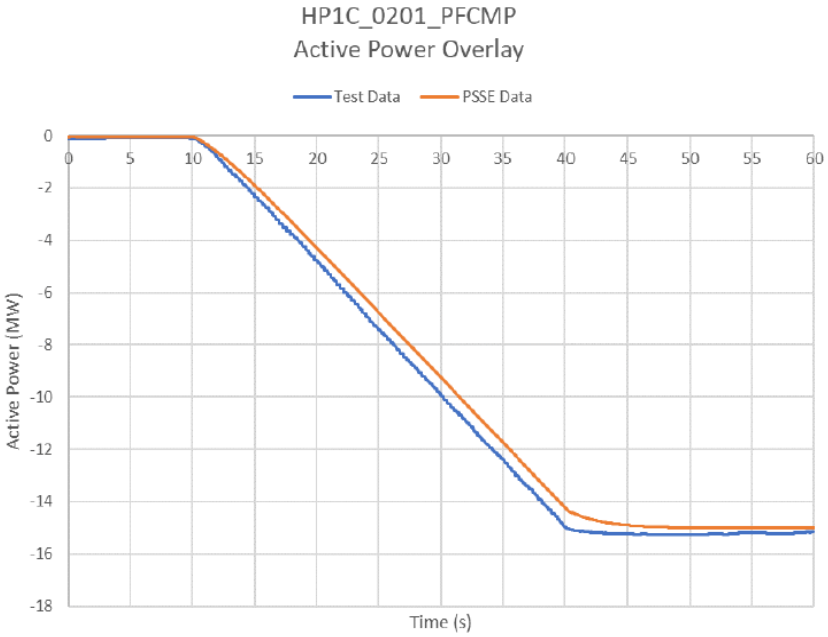


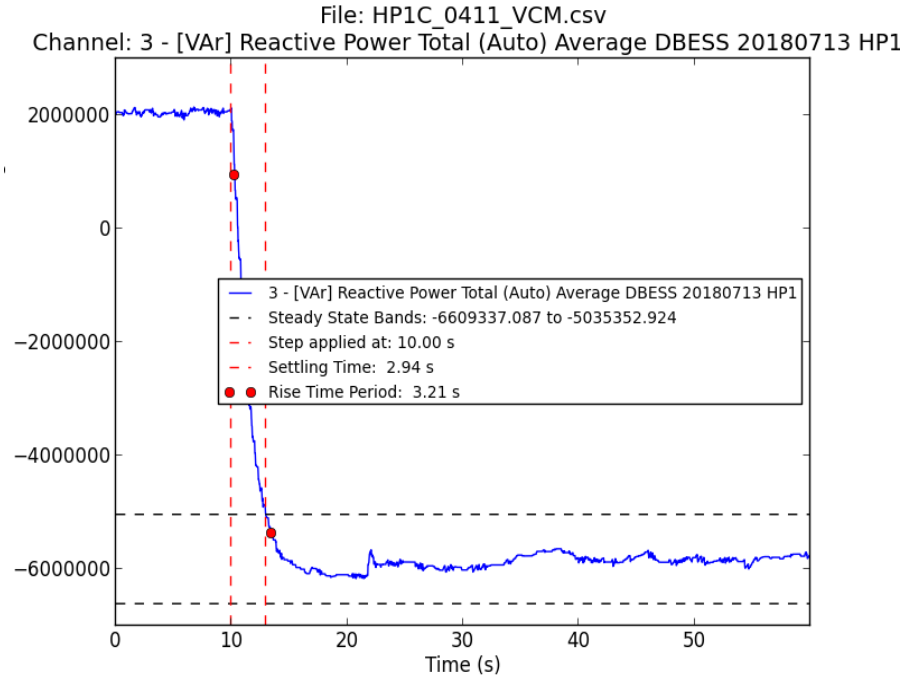
Hold Point 1 Test Discharge *(Graph 4)*
Overlay Plot of Voltage at the Connection Point
(+15 MW, PF Step from 1.0 to -0.95)

Hold Point 1 Test Results (Charge)

Hold Point 1 – 50% (+15 MW, Charge)			
Hold Point Test	**Test Description**	**Report Requirements**	**HP1C Result**
HP1C-01	Reactive Capability	300 second steady state recording	Capable of meeting reactive power capability for active power dispatch between 0 to +15 MW
HP1C-02	Active Power Steps (Power Factor Control mode)	+15 MW step only Pre-test simulations and overlay required	Active power, reactive power and voltage responses match the generating system model. *See graph 5.*
HP1C-04	Voltage Steps	±5% step only Pre-test simulations and overlay required	Reactive power rise times for ±5% voltage steps were greater than 2.7 seconds. *See graph 6*
HP1C-05	Power Factor Steps	1.00 to ±0.95 step only pre-test simulations and overlay required	Generating system has been demonstrated to be capable of regulating the connection point power factor to within 0.5% of its setpoint.
HP1C-06	Partial Load Rejection (FCAS Mode)	±0.25 Hz steps ±1.00 Hz steps Pre-test simulations and overlay required	Active power, reactive power and voltage responses match the generating system model response for the same step change profile.
HP1C-09	Control Mode Transitions (Power Factor to Voltage Control Mode)	< 0.95 pu V for > 1 s > 1.05 pu V for > 1 s Pre-test simulations and overlay required	The actual plant response reflects the expected behaviour as defined in the GPS and VCS whereas the PSS®E model does not.

Hold Point 1 Charge Graphs





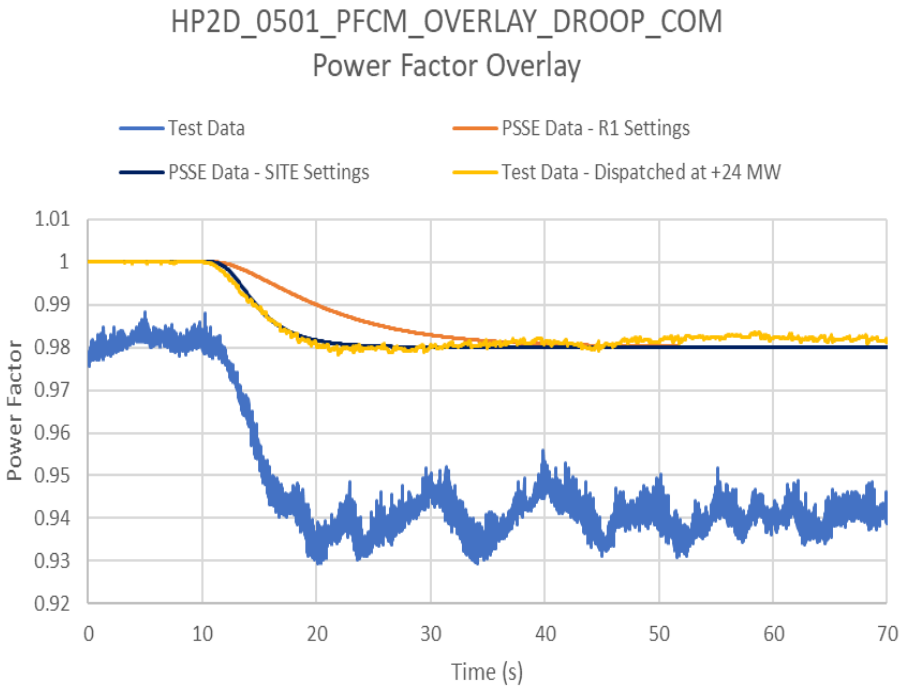
Hold Point 1 Test Discharge *(Graph 5)*
Overlay Plot of Active Power at the Connection Point (Active Power Step 0 MW to -15 MW)

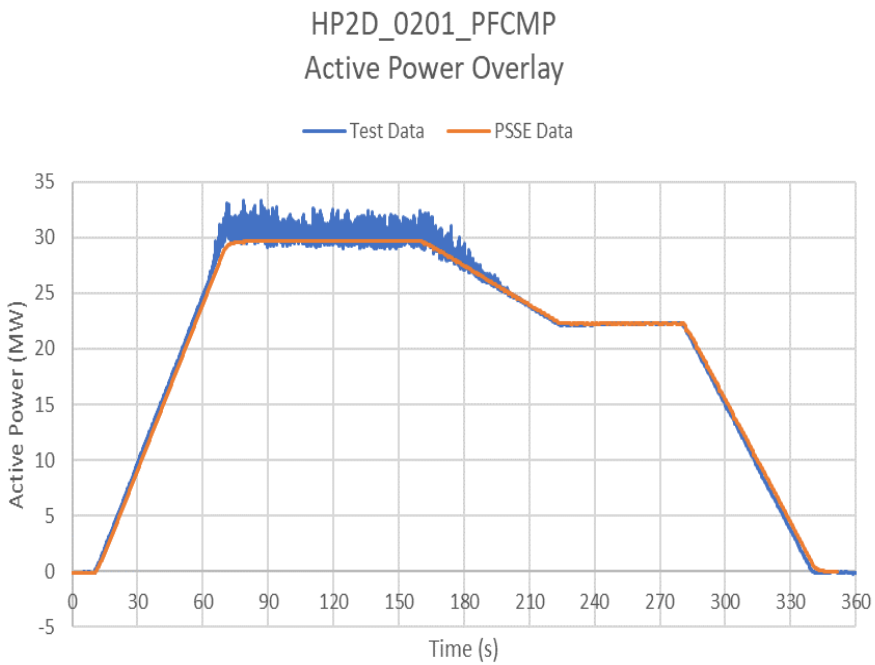
Hold Point 1 Test Discharge *(Graph 6)*
Power at the Connection Point with Rise Time and Settle Time and Steady State Bands Overlayed (-15 MW, -5.0% Voltage Step)

Hold Point 2 Test Results

- Hold Point 2 tests were conducted following the same parameters as outlined in Hold Point 1 Discharge and Charge tests
- Results at or below 24 MW show similar results to Hold Point 1 test results
- Test indicate that BESS did not achieve -30 MW active power during charge mode for a -30 MW active power set-point (now fixed)
- BESS does not regulate the power factor at the connection point to within 0.5% of its set point in power factor control mode as shown in Graph 7
- Test results as shown in Graph 8 show that BESS was unable to maintain stable operation during discharge test above 24 MW
- BESS did not remain in continuous uninterrupted operation during testing of current limiter when dispatching power – test resulted in tripping of BESS on over-frequency fault

Hold Point 2 Discharge Graphs





Hold Point 2 Test Discharge (Graph 7)
Power Factor at the Connection Point
(+30 MW and +24 MW, PF Step from 1.0 to +0.98)

Hold Point 2 Test Discharge *(Graph 8)*
Active Power at the Connection Point
(Active Power Step 0 MW to +30 MW)

Refinement of Parameters

- R1 model meets GPS (complete), Hold Point is to ensure plant meets GPS (in this stage, some non-conformances), R2 is to ensure model matches plant (still to come).
- Model/parameter changes are the responsibility of the contractor, ElectraNet, FortEng and AEMO to assess these changes for compliance
- The contractor should have sufficient experience on site and testing with the plant now to propose suitable parameters
- Priority of fixes:
  - Grid connected functionality and capability
  - SIPS
  - Islanded operation with load
  - Islanded with Wattle Point Wind Farm

Refinement of Parameters cont.

Hold Point 1 (15 MW) results

1. Does not meet the 2.7 second reactive power rise time when operated in voltage control mode for a voltage set point change of ±5%
2. The generating system does not regulate the voltage at the connection point to within 0.5% of its set point with the R1 parameters approved at registration (5% voltage droop, and ±0.5% dead band) in voltage control mode

Hold Point 2 (30 MW) results

1. Same Results as item 1 and 2 above
2. The generating system does not regulate the power factor at the connection point to within 0.5% of its set point at discharge levels greater than 24 MW in power factor control mode
3. The generating system did not remain in continuous uninterrupted operation during testing of over-excitation limiter (current limiter) when dispatching power – test resulted in tripping of BESS on over-frequency fault

Refinement of Parameters cont.

Other results:

1. Did not achieve -30 MW active power during charge mode for a -30 MW active power set-point
2. Instability in active power occurs above 24 MW in discharge mode with corresponding disturbance to reactive power in both voltage control and power factor control modes

Refinement of Parameters

- Post Hold Point Testing workshop held between ABB, CPP, FortEng and ElectraNet on 31 July and 1 August 2018 to determine actions to address Hold Point 1 and 2 Test results.
- ABB refining Secondary Voltage droop set points and primary voltage dead band values. This should improve reactive power rise and regulation of voltage at the connection point. *(Item 1 & 2 in 15 MW and 30 MW test)*
- ABB carried out simulation testing of SIPS/NLCAS and Islanded operation to determine suitable settings for the BESS modules which should fulfil the following: *(Item 2 other issues)*
  a) Enable stable operation in islanded mode (no inter-BESS module oscillations in active power)
  b) Enable fast response time (250 msec) to the SIPS trigger
  c) Enable compliance with the NER clause S5.2.5.5
- ABB experience has shown that items a) and b) can be achieved by the system with a set of low gains, however these gains are not deemed adequate for GPS compliance.

Commissioning: Next Steps

- Actions
  - ABB to update the BESS models with new parameters and complete simulations by mid August 2018 (In progress)
  - FortEng, ElectraNet and AEMO to conduct due-diligence
  - FortEng to retest a selected number of aspects of Hold Point 2 Test Plan
  - Finalise Hold Point 2 Test Report and agree any GPS parameters to be varied – Completion of Milestone 3 –September 2018
  - Islanding tests to follow
  - R2 Testing to follow
  - Handover for Commercial Operation to AGL – End September 2018

Commissioning Lessons Learnt

- The complexity of developing an integrated grid and island BESS solution was underestimated in time, effort and cost, resulting in setting very ambitious expectations. This included:
  - Modelling and commissioning of the BESS system to met NER requirements
  - Expertise and experience of this type and application of a BESS in the NEM has resulted in multiple model revisions
  - Deeper network changes on the planned island distribution network (local load)
  - Integration with the Wattle Point Wind Farm, due to the age and lack of available models of the wind farm
- Performance standards can be negotiated (within limits)

ESCRI - PCS100 BESS Modules

Questions

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Thank you

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