Alinta Energy

35MW / 11.1MWh Newman Battery Storage System Project

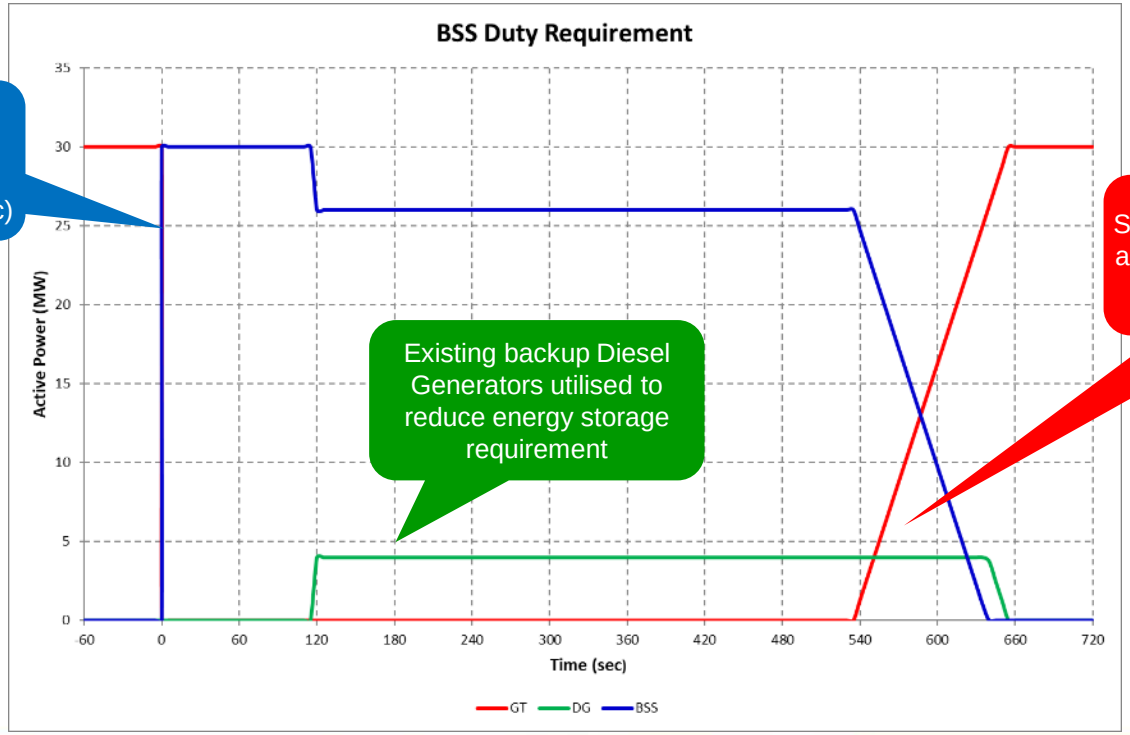
Roadmap

1. Performance Requirements
2. Inverter and Battery Selection Considerations
3. Newman BSS Components
4. Synthetic Inertia
5. Actual Performance
6. Chichester Solar Gas Hybrid Project

BSS Performance Requirements - 1

- Provide **UPS Functionality** to automatically **accept all load** in the event of a Gas Turbine trip
- **Seamlessly Integrate** with existing power generators (Gas Turbine and Reciprocating Diesel)
- **Discharge Profile**# of 30MW for 2mins, 26MW for 7 mins, ramp down to 0MW over 2 mins
- Provide **Fault Current** to ensure power system electrical faults are detected and cleared
- **Rest/Recharge Time**:- System to be ready within ~4hrs of deep discharge event

GT Trip
BSS accepts all load (frequency restored to above 49Hz within 0.5sec)

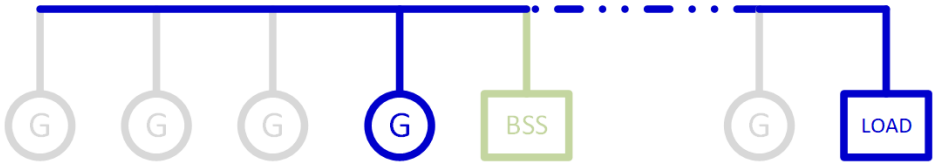


Existing backup Diesel Generators utilised to reduce energy storage requirement

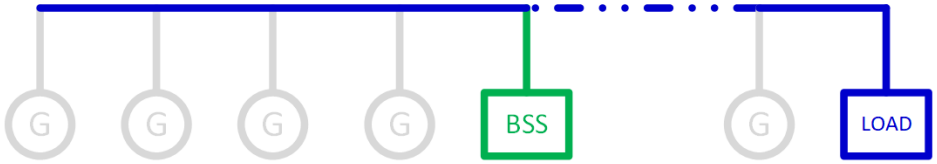
Standby GTs synchronises and takes on the customer load

BSS Performance Requirements - 2

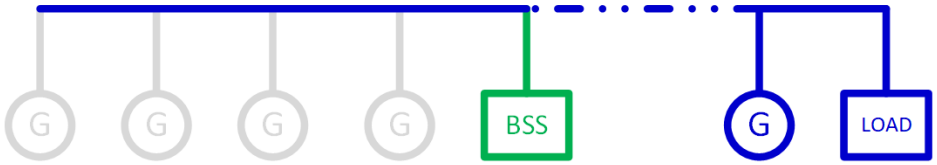
1. Normal Operation – BSS Standby



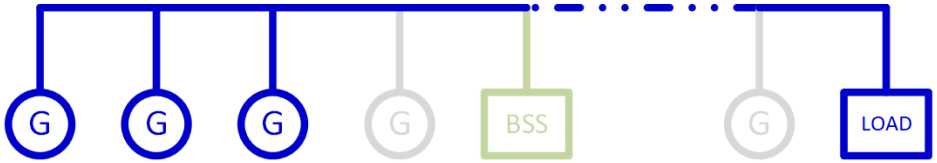
2. GT Trip – **BSS Standalone**



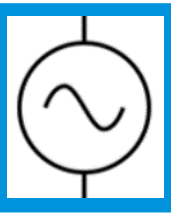
3. Local Diesel Generation (6MW) Online



4. Replacement GT's online – BSS Recharging



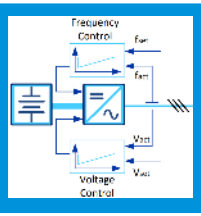
Inverter Considerations



1

Grid Forming Capability

Voltage Source Inverter – does not require “grid reference” like typical Solar PV inverters – VSI inverters can set grid voltage and frequency
It can operate as the **ONLY** energy source within the power system



2

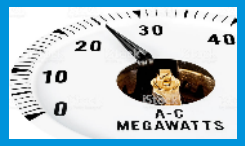
Synchronous Generator Emulation

“Virtual Generator” emulates the mechanical, magnetic and electrical properties of conventional synchronous generators - **grid stability**
Synthetic **Inertia**, **Frequency** Control, **Voltage** Control

3

Fault Current Contribution

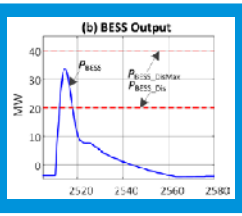
Have ability to supply “fault current” to ensure electrical protection systems continue to protect people, livestock and equipment if a defect in the power system occurs



4

Real/Reactive Power Rating

Sized to meet duty requirement – overload capacity can be used
Note:- battery must also have overload capacity to meet real power

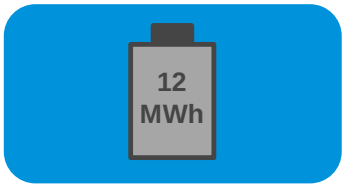


5

Speed of Response

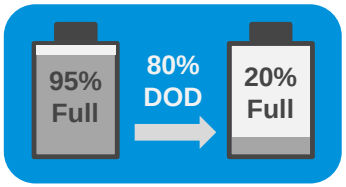
Fast response essential to enable inverter to provide synthetic inertia response
Note:- battery must also have fast discharge response

Battery Considerations



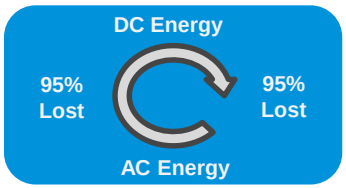
1 Nominal MWh

The original manufacturer stated MWh storage capacity – reduces over time, must deliver duty requirement at End of Life (EoL)



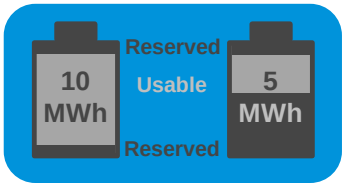
2 Depth of Discharge (DOD) / C-Rate

The percentage of the nominal MWh available – and how fast can it charge/discharge



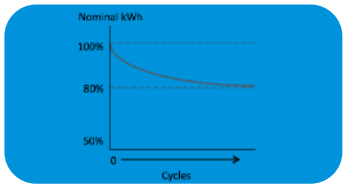
3 Roundtrip Efficiency

The efficiency coefficient representing the ratio electricity discharged from the battery over the electricity charged into the battery (<100%)



4 Usable MWh (BOL, EOL)

The total MWh useable during normal operation where some portion of the nominal MWh is reserved to protect against over/under voltage or to preserve cycle life



5 Cycle-life / Calendar Life

The approximate number cycles / years until the storage MWh capacity degrades below the nominal MWh.

For Newman BSS:

High C-Rate (~4) – to give smaller foot-print, optimal capital cost

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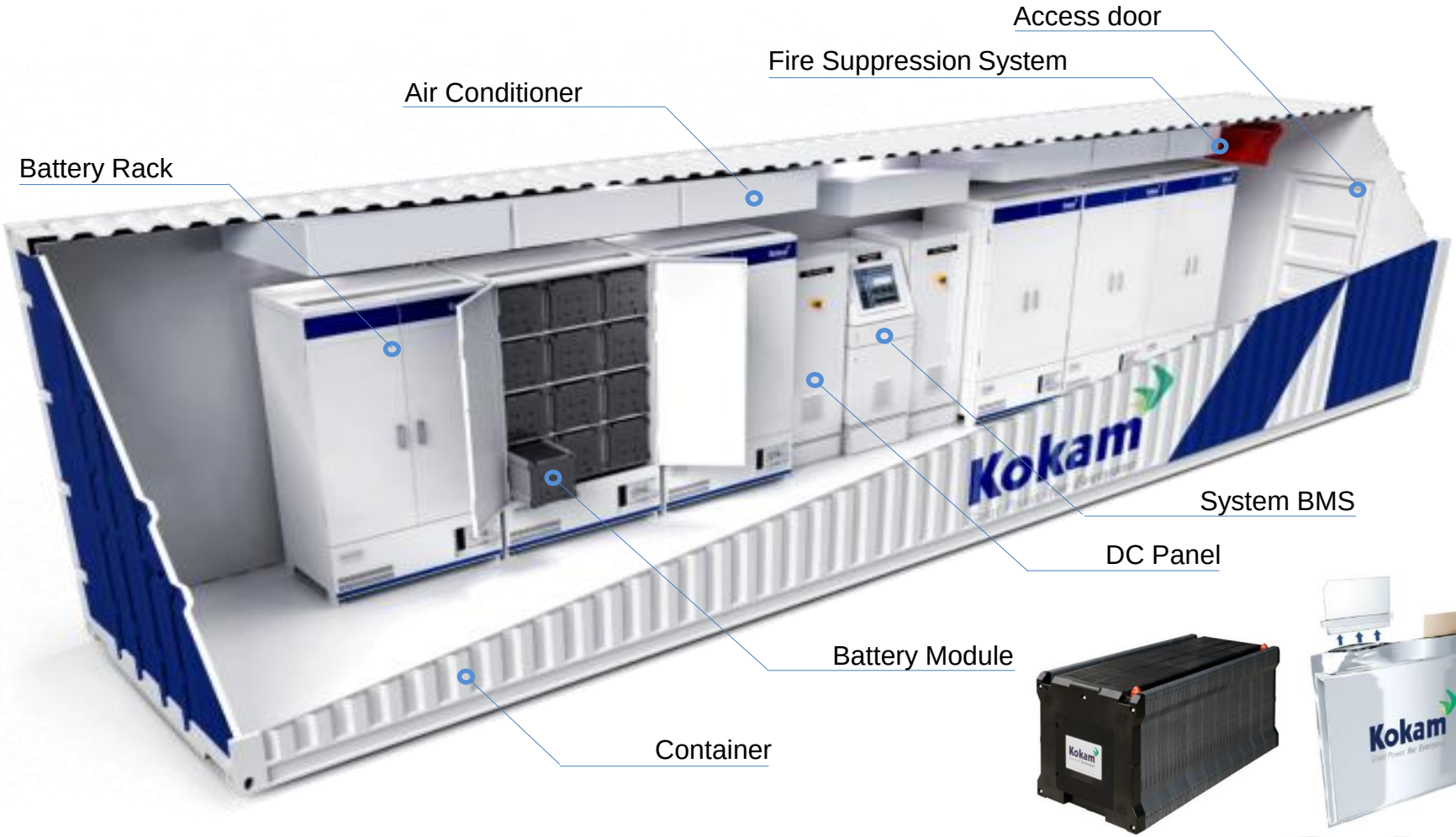
The Newman BSS

35m x 60m footprint containing:

- 5 Battery Containers (2.2MWh)
- 5 Inverter Containers (7MW)
- 33kV Switchroom
- Transformers
- *Space for an additional container pair*

Battery – Kokam – 2.2MWh per 40’ container



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Inverters – ABB – 7MW per 40’ container

- 2 PowerStores per Container
- 32 PCS100 modules per PowerStore
- **Virtual Synchronous Generator**
- High quality sinusoidal voltage output, RFI Filter included.
- Total of 320 PCS100 installed
    - 310 inverters required to ensure electrical protection schemes will operate

Synthetic Inertia

- Kinetic energy released/absorbed proportional to rate of change of frequency as a result of some network disturbance. Counteracts the change in frequency - provides a dampening effect.

- Power electronics incorporating “Virtual Generator” functionality **synthesises** the function of **kinetic energy**. No tangible difference when compared to mechanical (rotating mass) systems.

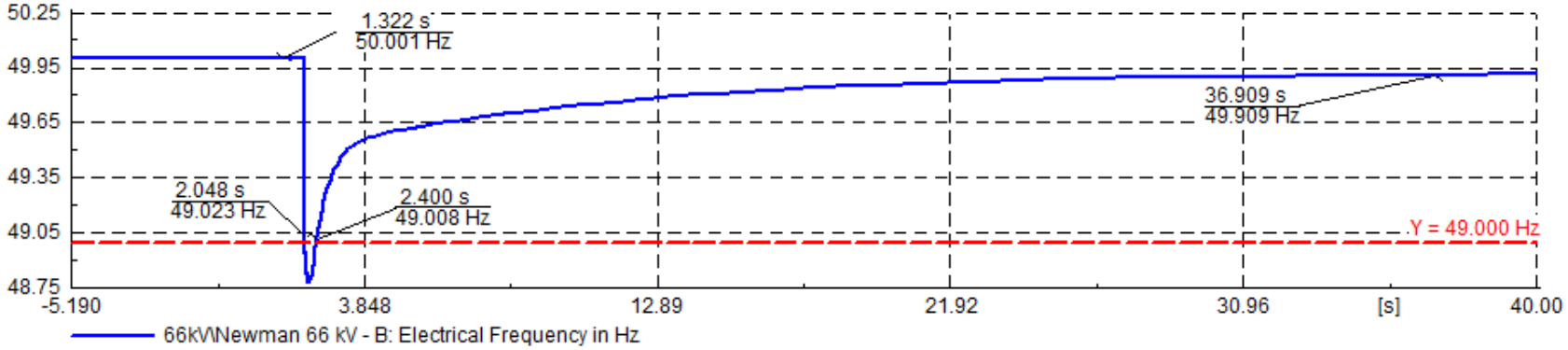
- Power Electronics offer configurable inertia constant. Selection of constant is a compromise between stability and fast response.
  - Higher inertia constant reduces rate of frequency change (down and up).
  - Smaller inertia constant results in faster response reducing frequency excursion when accepting a step load.

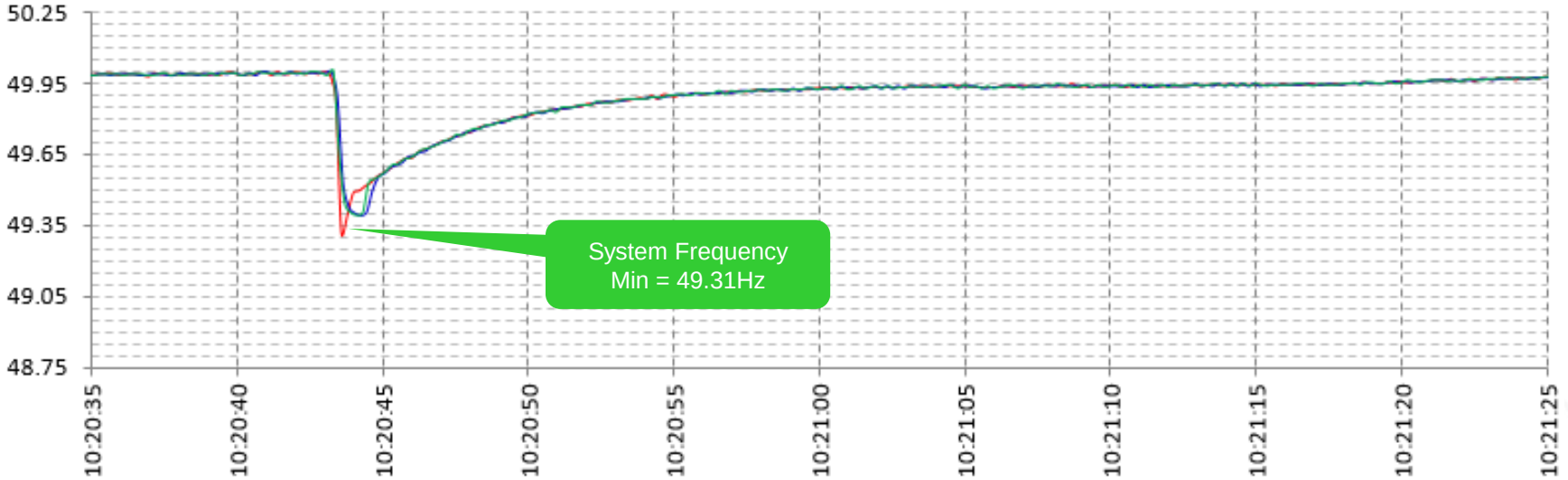
- Battery must be capable of very rapid and large changes of discharge and recharge to support the synthetic inertia function.

Newman Power Station Generating Unit	Inertia Constant MWs/MVA
Frame 6 Gas Turbine	~6
Trent 60 Gas Turbine	~1.4
Alinta BSS	4.3 (configurable 0 -10)

Performance – 32MW Transition to Standalone

Performance Parameter	Predicted	Actual
Minimum Frequency:	48.78Hz	49.31Hz ✓
Duration below 49.0Hz:	<0.35sec	N/A ✓
Time to recover to 49.9Hz:	~35sec	~12sec ✓





Performance – Summary

Alinta BSS

- provides **Synthetic Inertia** and **Fast Frequency Response**
- provides **Voltage Control** and **Reactive Power Support**
- provides **Fault Current** to enable electrical protection to operate
- capable of operation in **Standalone** – no other source of synchronous generation

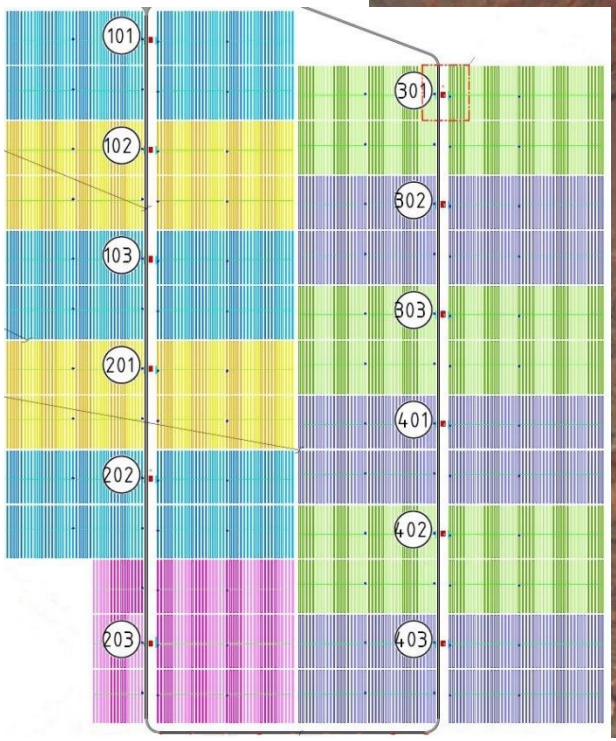
What Next?

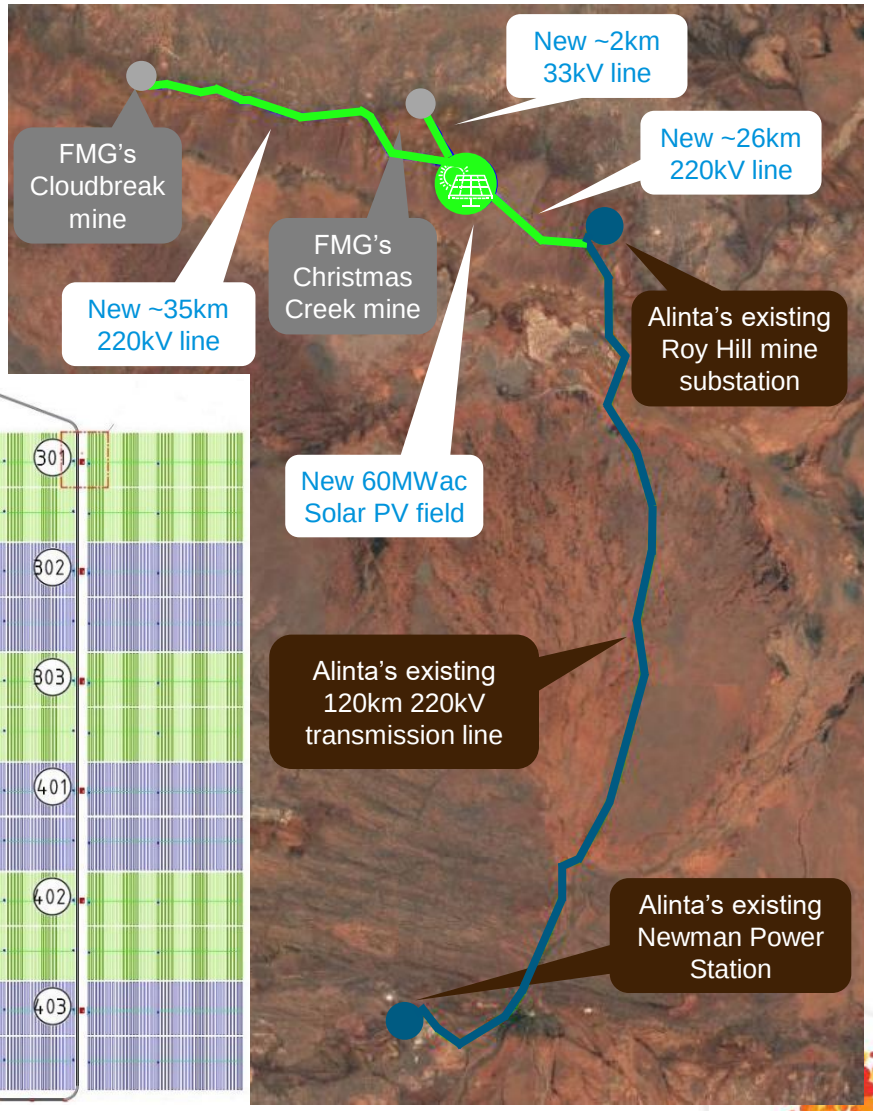
Chichester Solar Gas Hybrid Project

Chichester Solar Gas Hybrid Project - 1

The Chichester Solar Gas Hybrid Power Project consists of:

- Expansion of an existing 220kV substation
- Construction of 2 new 220kV substations
- ~60km of 220kV transmission infrastructure
- 60MWac single axis tracking Solar PV
  - >165 000 PV Modules
  - 48 Inverters
  - 118 Hectares
  - 24hr Voltage Support

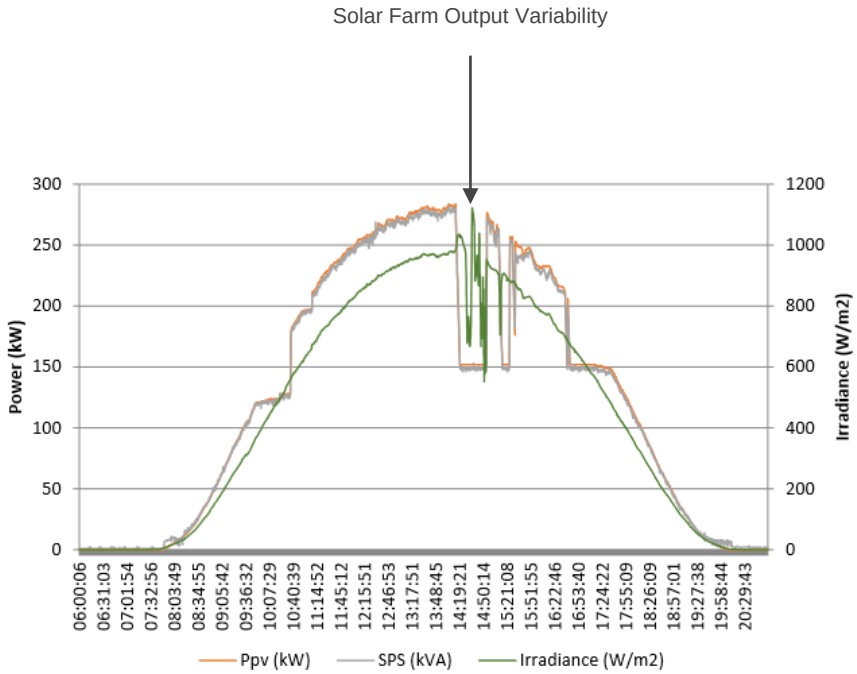




Chichester Solar Gas Hybrid Project - 2

Role for BSS:

- Short term energy shifting in response to cloud movement
  - Reduce need for pre-emptive ramp down of Solar Farm output
  - Reduce number of GT starts and loading rates – lower maintenance costs
- Provide system inertia
  - Solar Farm is offsetting synchronous generators



Source: http://www.fulcrum3d.com/wp-content/uploads/2019/08/CloudCAM-Reference-Site-Northern-Territory-Australia-.pdf

Chichester Solar Gas Hybrid Project - 3

Acknowledgements:

- The Nyiyaparli People
- Northern Australia Infrastructure Facility for a $90M loan
- Australian Renewable Energy Agency for a $24.2M recoupable loan
- The Western Australian State Government and their Departments
- Our Customers

ARENA are providing support to assist us in establishing one key thing and it is an ambitious objective:

Can a large scale mining operation operate on renewable and battery alone?

Australian Government
Australian Renewable Energy Agency
ARENA

Australian Government
NAIF
Northern Australia Infrastructure Facility

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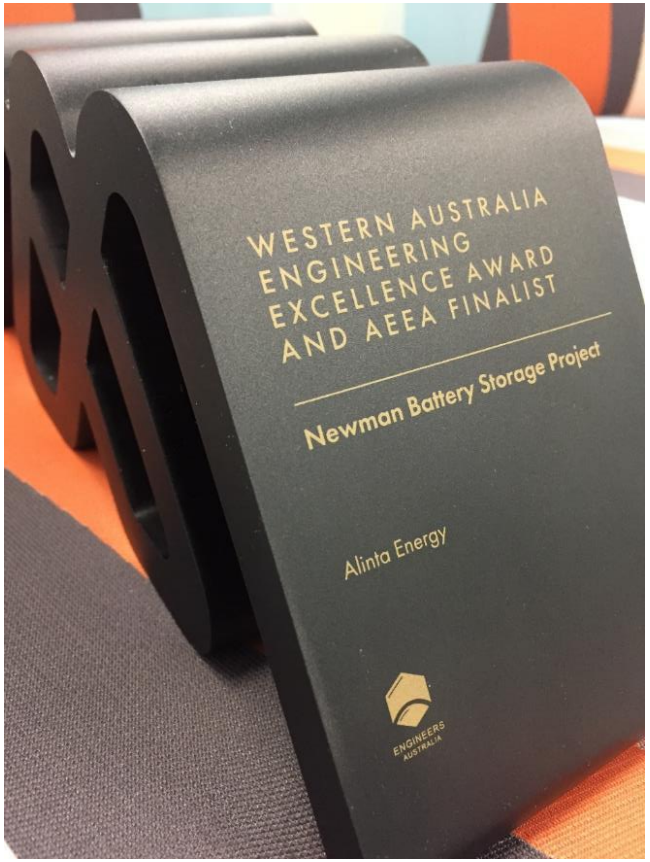
Thankyou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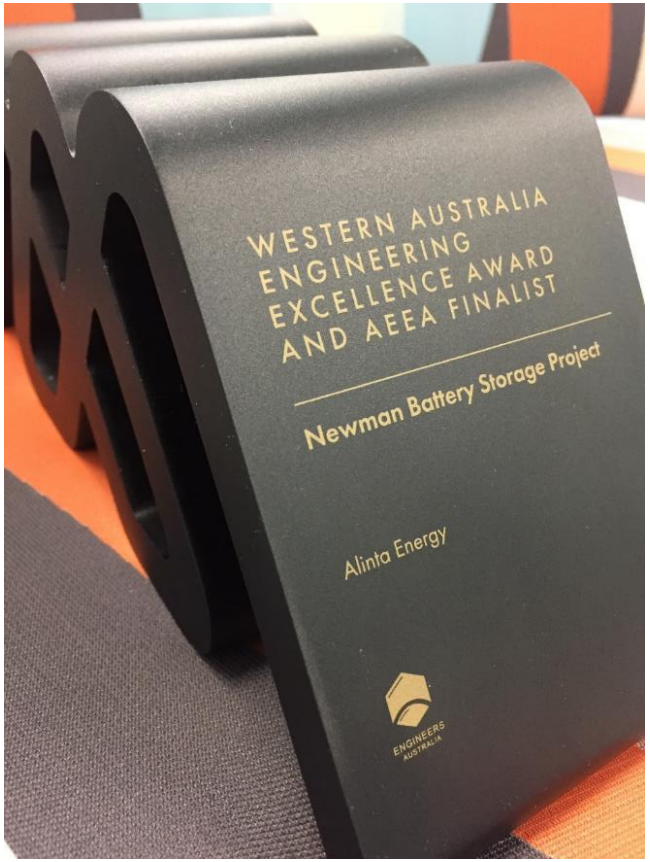
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