Calculation Status

Name of Calculation	Clements Gap BESS Substation 110V DC Sizing Report
Document Number	PSD1834-100-005
Prepared By	Kyle Taberer
Prepared For	ENZEN
Calculation Revision	0
File Name	PSD1834-100-005 - DC SIZING REPORT - REV-0.xlsx

Calculation History

Rev	Revision Description	Date Issued	Reviewed By	Approved By
A	First issue	06/09/2024	SK Hards	
0	Issue for Construction	14/02/2025	SK Hards	

Clements Gap BESS Substation 110V DC Sizing Report
Index

110V DC System Proposal:

It is proposed that the 110V DC battery banks and charger systems used for the X and Y DC supplies, housed in panels in the Control room building, be of the same type and rating.

The DC Loads have been split to X & Y circuits respectively where so required, however where there are loads only requiring one source, these have been allocated to both X & Y as they could be fed from the X batteries or Y batteries via change-over switching.

The minimum requirements for the X & Y DC Systems is as follows:

* Battery bank size:	300 Ah	nominal capacity
	15.0 A	at 8hr constant-current discharge rate to 1.8V/cell
* Charger capacity:	41 A	minimum required.

The proposed system is as follows:
CENTURY YUASA BATTERIES PTY LTD

ITEM DESCRIPTION	**QTY REQ'D**
a) Intelepower Dual 110V 300Ah Battery Bank containing:	2
* 110Vdc Battery bank comprising 54 x 2V cells of the type UPZ12-150F (12V Battery / 18 pce x UPZ12-150F batteries per 300Ah System)	
* 1200mm wide version of the 'C' type rack including doors and sides	
* Dimensions: 1200W x 500D x 2100H	
b) 6.6kW Battery Charger Cabinet:	2
* with 1 x populated distribution section for DC loads	
* with 3-position changeover switch (Only in X-Charger)	
* with internal cabinet light	
* with earth leakage detection	
* with 2 x current shunts to differentiate battery current from load	
* with 1 x Battery cabinet link kits for DC cabling	
* with 'Smart Pack 2' battery monitoring and controller	
* with panel meters for DC Voltage monitoring	
* with battery testing points	
* with alarming contacts for interface to Station BCU	
* mounted in standard 19" swing frame cubicle	
* Dimensions: 800W x 800D x 2200H	
c) 110/24V DC/DC Converter	2
* with 1 x BENBRO 300 Series 19" Rack Mount 3RU, Eurocard modular DC-DC Converter	

DESIGN STANDARD & ASSUMPTIONS

Compliance: AS/NZS 4029.2 : 2000 Stationary Batteries-Lead Acid
IEEE 485 : Recommended Practice for Sizing Lead-Acid Batteries

Nominal DC Voltage -	=	110	Vdc
Cell Nominal Voltage -	=	2	Vdc
Cell Min Discharged Voltage -	=	1.8	Vdc
Cell Min Charged Voltage -	=	2.3	Vdc
Cell Float Voltage -	=	2.275	Vdc
Minimum Operating Temperature -	=	25	°C
Discharge Cycle -	=	8	h
Charge Cycle -	=	12	h
Existing battery nominal capacity @ 20 hour rate -	=	154.4	Ah
Existing battery nominal capacity @ 10 hour rate -	=	150.1	Ah
Existing battery constant current discharge (R10hr) - 1.8 V per cell	=	15	A
Battery capacity at Momentary Rate - 1.8 V per cell			
- Current		36	A
- Time		3	h
Equivalent momentary battery Capacity		108	Ah
Aging Margin (As per IEEE 485)	=	20%	
Temperature Margin (As per IEEE 485)	=	5%	
Design Margin	=	10%	

General Notes:
The standing and momentary loads on the Y distribution system are lower than or equal to the loads on the X distribution system in all cases. The battery banks are identical so only the figures for the X system are investigated on this sheet.

DC LOADS

110V DC Total Standing Load - Upper Limit (A_1)	**Total**	=	1740	W
		=	15.82	A
110V DC Max Momentary Load (A_4)	**Total**	=	1190	W
		=	10.82	A

Worst case momentary load assumption:

Tripping of one of the 33kV Busbar protection schemes, with 7 breakers

Typical 33kV Switchgear = 170W per trip coil.

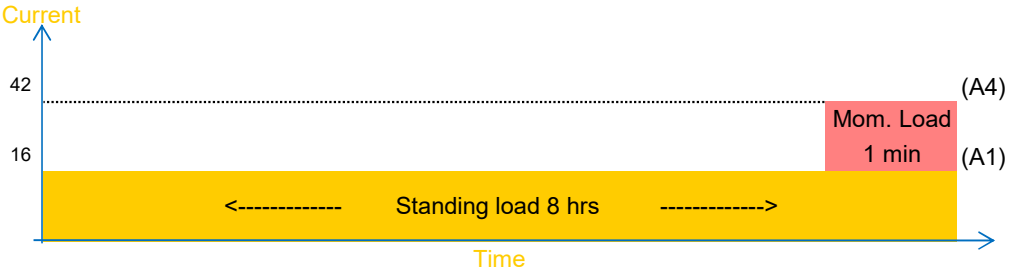
Assuming Trip coil rating of 33kV breaker is 170W.				
Breaker trip coil rated voltage -		=	110	Vdc
Breaker trip coil power consumption (per coil at rated voltage) -		=	170	W
Breaker trip coil current at rated voltage -		=	1.5	A
Breaker trip coil rated min voltage (V_{CB}) -		=	77	Vdc
Breaker trip coil current (at min volts, per coil) -		=	1.1	A
Distance from DC Charger -	(Estimated one way distance)	=	50	m
Trip wiring dc resistance -	(Assumed Min. 2.5mm^2 wiring)	=	9.01	Ω/km
Breaker max volt drop (V_{CBmax}) -		=	0.97	V
Batteries internal impedance per cell -		=	0.66	mΩ
Batteries Max end of life impedance per cell -		=	1.98	mΩ
Discharged batteries max end of life Imp. Z_{max} (@ typical 40% increase) -		=	2.772	mΩ
Maximum Voltage drop at peak momentary load (V_{drop}):				
(V_{drop} = Existing No. of Cells * Z_{max} * [A1 + A_4])[Note 1]		=	3.99	V
Required min battery terminal voltage (V_{MinTer}):				
(V_{MinTer} = V_{CB} + V_{CBmax} + V_{drop})		=	81.96	V

Note 1: Relays are not affected by the maximum momentary load voltage drop.

BATTERY & CHARGER SIZING

Battery Nominal Voltage -	=	110	Vdc
Minimum Terminal Voltage required-	=	81.96	Vdc
Minimum number of cells required -	=	46	
Existing number of cells -	=	54	Ok
Battery Voltage Charged -	=	124.2	Vdc
Battery Float Voltage -	=	122.85	Vdc

As per IEEE 485 the batteries must be rated to supply the standing load for the required duty cycle. In addition to this the batteries must be able to supply the require maximum momentary load at the end of the duty cycle.



As per IEEE 485 maximum standing load on the batteries is:

Standing load (A1) -	=	15.82	A
Effective battery capacity required by standing load ($F_{Standing}$) -	=	158.27	Ah

As per IEEE 485 maximum Momentary load on the batteries is:

Momentary load (A_4) + Standing Load (A_1)	=	26.63	A
Effective battery capacity required during momentary load ($F_{Momentary}$) -	=	0.62	Ah

The minimum AH battery requirement is:

Effective battery capacity required ($F = F_{Standing} + F_{Momentary}$)	=	158.89	Ah

Selected battery capacity -	**No. of parallel strings:** **2**	=	300.20	Ah
Selected battery capacity - with required derating		=	205.34	Ah
Selected battery capacity check -			Ok	

The minimum battery charger required is:

Standing load + Ah/Charge Cycle		=	41	A
Battery Charger	**No. of 1.1kW units:** **6**	=	60	A
Battery Charger check -			Ok	

110VDC SYSTEM LOAD

110VDC Total Load	**Total X**	=	1722	W
110VDC Total Load	**Total Y**	=	1740	W

Note: No additional allowance was made for emergency lighting, or indication circuits.
Emergency lighting circuits are fitted with internal batteries.

33kV Switchgear Protection (Onboard Switchgear Panels)

IED	Qnt	Circuit			
PCS-9611S	5	X	=	150	W
PCS-9611S	5	Y	=	150	W
Breaker - Indication LED (Red/Grn)	5	X	=	15	W
Breaker - Indication LED (Red/Grn)	5	Y	=	15	W
(Can be on X or Y Supply - Includes possible future panels)					
Panel Total Load	1	**Total X**	=	165	W
Panel Total Load	1	**Total Y**	=	165	W

Transformer Protection Panel (+2A2)

IED	Qnt	Circuit			
Siemens 7UT85 +4 Module	1	X	=	27	W
PCS-978S	1	Y	=	45	W
MR TAPCON	1	X	=	55	W
MR TAPCON	1	Y	=	55	W
SEL 2506	1	X	=	5	W
SEL 2506	1	Y	=	5	W
(Can be on X or Y Supply)					
Panel Total Load	1	**Total X**	=	87	W
Panel Total Load	1	**Total Y**	=	105	W

33kV Busbar 1 Protection Panel (+2A3 Part)

IED	Qnt	Circuit			
PCS-9611S	1	X	=	30	W
PCS-9611S	1	Y	=	30	W
(Protection can be on X or Y Supply)					
Panel Total Load	1	**Total X**	=	30	W
Panel Total Load	1	**Total Y**	=	30	W

33kV Harmonic Filter 1 Protection Panel (+2A3 Part)

IED	Qnt	Circuit			
Siemens 7SJ82_85 +3 Module	1	X	=	22	W
Siemens 7SJ82_85 +3 Module	1	Y	=	22	W
Interlocking Solenoid	1	X	=	50	W
Interlocking Solenoid	1	Y	=	50	W
(Protection can be on X or Y Supply)					
Panel Total Load	1	**Total X**	=	72	W
Panel Total Load	1	**Total Y**	=	72	W

PQM Panel (+2A4)

IED	Qnt	Circuit			
PQM G4430	2	X	=	69	W
PQM G4430	2	Y	=	69	W
PFM300 (Power System Monitor)	1	X	=	50	W
PFM300 (Power System Monitor)	1	Y	=	50	W
BOBCAT BRS30 Switches	1	X	=	20	W
BOBCAT BRS30 Switches	1	Y	=	20	W
(PQM Panel can be on X or Y Supply)					
Panel Total Load	1	**Total X**	=	139	W
Panel Total Load	1	**Total Y**	=	139	W

Substation SCADA, RTU, Aux BCU Panel (+2A5)

IED	Qnt	Circuit			
SEL 3555 RTAC GATEWAY	2	X	=	320	W
SEL 3555 RTAC GATEWAY	2	Y	=	320	W
SEL 2488 GPS CLOCK	2	X	=	90	W
SEL 2488 GPS CLOCK	2	Y	=	90	W
SEL 2240 Axion	1	X	=	75	W
SEL 2240 Axion	1	Y	=	75	W
SWITCH GRS1030	2	X	=	24	W
SWITCH GRS1030	2	Y	=	24	W
GRM20 (HIRSCHMANN 1030 module)	2	X	=	18	W
GRM20 (HIRSCHMANN 1030 module)	2	Y	=	18	W
Misc. Control & Indications (50W)	1	X	=	50	W
Misc. Control & Indications (50W)	1	Y	=	50	W
(SCADA equipment on X or Y Supply)					
Panel Total Load	1	**Total X**	=	577	W
Panel Total Load	1	**Total Y**	=	577	W

DC/DC Convertor Module (Internal)

IED	Qnt	Circuit			
Misc. Control & Indications (300W)	1	X	=	300	W
Misc. Control & Indications (300W)	1	Y	=	300	W
(Can be on X or Y Supply)					
Panel Total Load	1	**Total X**	=	300	W
Panel Total Load	1	**Total Y**	=	300	W

400V AC Distribution Board (+1A1)

IED	Qnt	Circuit			
Misc. Control & Indications (50W)	1	X	=	50	W
Misc. Control & Indications (50W)	1	Y	=	50	W
(Can be on X or Y Supply)					
Panel Total Load	1	**Total X**	=	50	W
Panel Total Load	1	**Total Y**	=	50	W

External Plant Standing DC Loads

IED	Qnt	Circuit			
TMK - Indication LED (White/Ambre)	4	X	=	12	W
TMK - Indication LED (White/Ambre)	4	Y	=	12	W
TMK - Digital Temp Device	2	X	=	20	W
TMK - Digital Temp Device	2	Y	=	20	W
Misc. Control & Indications (50W)	1	X	=	50	W
Misc. Control & Indications (50W)	1	Y	=	50	W
(Can be on X or Y Supply)					
Panel Total Load	1	**Total X**	=	82	W
Panel Total Load	1	**Total Y**	=	82	W

TRINA Power Plant Controller Panels (+2A14 & +2A15)

IED	Qnt	Circuit			
PPM-10 Plant Controller	1	X	=	0	W
PPM-10 Plant Controller	1	Y	=	0	W
(Can be on X or Y Supply)					
Panel Total Load	2	**Total X**	=	0	W
Panel Total Load	2	**Total Y**	=	0	W

Note: PPM Load catered for under 24V DC/DC Converter module

TRINA OEM SERVER Panel (+2A13)

IED	Qnt	Circuit			
No DC Load	1	X	=	0	W
No DC Load	1	Y	=	0	W
(Can be on X or Y Supply)					
Panel Total Load	1	**Total X**	=	0	W
Panel Total Load	1	**Total Y**	=	0	W

Note: only ac needed

BOP/OT SERVER Panel (+2A12)

IED	Qnt	Circuit			
BOBCAT BRS30 Switches	1	X	=	20	W
BOBCAT BRS30 Switches	1	Y	=	20	W
Misc. Control & Indications (100W)	1	X	=	100	W
Misc. Control & Indications (100W)	1	Y	=	100	W
(Can be on X or Y Supply)					
Panel Total Load	1	**Total X**	=	20	W
Panel Total Load	1	**Total Y**	=	20	W

ENET SAIT RAS Panel (+2A7)

IED	Qnt	Circuit			
ENET SAIT RAS Cabinet	1	X	=	100	W
ENET SAIT RAS Cabinet	1	Y	=	100	W
(Can be on X or Y Supply)					
Panel Total Load	1	**Total X**	=	100	W
Panel Total Load	1	**Total Y**	=	100	W

ENET TELECOMS Panel (+2A6)

IED	Qnt	Circuit			
ENET Telecommunications Cabinet	1	X	=	100	W
ENET Telecommunications Cabinet	1	Y	=	100	W
(Can be on X or Y Supply)					
Panel Total Load	1	**Total X**	=	100	W
Panel Total Load	1	**Total Y**	=	100	W