

DBSA PSA SOLAR BACKUP PROGRAMME

FINAL ENGINEERING REPORT FOR TENDER SUPPORT

Christ the King Hospital

Draft v2.4 for Review | Not Issued for Construction

Document Item	Detail
Client / Programme	Development Bank of Southern Africa (DBSA), acting as Implementing Agent on behalf of the National Department of Health
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Stage 1 Foundation	Christ the King Hospital Preliminary Technical Report

Professional verification: [Rajandren Chetty - ECSA PrivySeal](#)

Document Control

Revision	Date	Prepared by	Reviewed by	Description
Draft v2.1	July 2026	Durapi Consulting	Rajandren Chetty	Expanded tender-support structure and detailed BOQ.
Draft v2.4	July 2026	Durapi Consulting	Rajandren Chetty	Final master-template amendments: warranties, fire safety, solar carport, generic SLD and appendix corrections.

Cluster 1 issue-control requirement: the report shall first be signed off by Durapi Consulting and thereafter reviewed and signed off by Rajandren Chetty before submission to DBSA.

Table of Contents

1. Executive Summary
 2. Project Background and Objective
 3. Project Execution Philosophy
 4. Site Assessment Summary
 5. Design Development Methodology
 6. Recommended Technical Solution
 7. Energy Resilience and Operating Philosophy
 8. Civil / Structural / Mounting Recommendation
 9. Electrical Design Basis
 10. Mandatory Seven-Day PSA Load Profile Study
 11. Tender Scope and EPCM Returnables
 12. Standards and Compliance Requirements
 13. Risks, Assumptions and Exclusions
 14. Recommended Tender Configuration
 15. Conclusion
- Appendices A-O

List of Abbreviations

Abbreviation	Meaning
AC	Alternating Current
BESS	Battery Energy Storage System
BOQ	Bill of Quantities
CoC	Certificate of Compliance
DB	Distribution Board
DBSA	Development Bank of Southern Africa
DC	Direct Current
EMS	Energy Management System
EPCM	Engineering, Procurement and Construction Management Contractor
FAT	Factory Acceptance Test
PCS	Power Conversion System
PSA	Pressure Swing Adsorption
PSP	Professional Service Provider
SAT	Site Acceptance Test
SLD	Single-Line Diagram
SPD	Surge Protective Device
STS	Static Transfer Switch

List of Figures

Figure 1: DBSA PSA Solar Backup Programme delivery methodology

Figure 2: Indicative PSA energy resilience profile

Figure M-1: Typical secure solar carport and equipment bay

Figure N-1: Generic functional SLD - tender support concept

Figure O-1: Typical outdoor BESS configuration (illustrative)

List of Tables

Table 1: Executive design basis

Table 2: Site assessment summary

Table 3: Recommended technical solution

Table 4: Electrical design basis

Table 5: Seven-day load study requirements

Table 6: EPCM returnables

Table 7: Risks, assumptions and controls

Table G-1: Site-specific detailed BOQ

1. Executive Summary

This Final Engineering Report has been prepared for the DBSA PSA Solar Backup Programme to support tender development, technical review and EPCM procurement for Christ the King Hospital. It builds on the completed Stage 1 preliminary technical assessment and preserves the engineering truth thread established during site reconnaissance, concept development and preliminary design.

The PSA oxygen generation plant is treated as a critical medical load because it produces medical-grade oxygen for patients requiring oxygen support. The proposed solution therefore prioritises continuity of PSA operation during load shedding, grid interruptions, weak-grid conditions and extended outages.

The retained tender-support basis comprises approximately 83.850 kWp of solar PV using approximately 130 modules at 645 Wp each, preliminary annual solar generation of 142,973 kWh/year, a 200-250 kWh BESS planning class, a 100 kW PCS planning class and a 150 kVA standby generator planning class.

The operating philosophy is based on supply-on-demand resilience. Solar PV supports the PSA during daylight and charges the BESS. The BESS supports morning and evening shoulder periods, short interruptions, transient events and controlled source transfer. The generator provides extended-duration support during prolonged outages, poor solar availability or low state of charge. Grid supply remains a fallback where present.

OpenSolar values from the preliminary reports are retained for tender support. They remain preliminary. Final module orientation, azimuth, inclination, shading and yield shall be verified during EPCM detailed design. Non-optimal preliminary layouts shall be corrected to a north-facing orientation where practical before procurement.

This report provides engineering due diligence supporting the tender documentation and establishes the technical guardrails within which the appointed EPCM shall complete the final design. Detailed cost build-up and rates remain in the BOQ, cost register and tender evaluation matrix.

Before construction, the appointed EPCM shall undertake a mandatory seven-consecutive-day load profile study and site verification exercise. The measured data shall establish steady-state load, maximum demand, transient starting current, compressor cycling, daily energy consumption, power factor and time-of-use behaviour.

Based on the current PSP-stage assessment, the Christ the King Hospital PV-BESS-PCS-generator solution is technically feasible for tender development, subject to the verification gates and sign-off requirements in this report.

Executive Design Item	Tender-Support Basis
PSA critical load	Stage 1/nameplate basis
Solar PV	83.850 kWp; approx. 130 x 645 Wp modules
Estimated annual PV generation	142,973 kWh/year
BESS	200-250 kWh
PCS	100 kW planning class
Standby generator	150 kVA planning class
Mounting	One new purpose-designed solar PV carport, subject to civil confirmation.
Report decision	Proceed to tender support subject to the verification gates in this report.

2. Project Background and Objective

The DBSA PSA Solar Backup Programme seeks to improve the energy resilience of hospital PSA oxygen generation facilities. Christ the King Hospital forms part of Cluster 1 within the 20-hospital programme. This report provides the technical basis for tender documentation and EPCM procurement. It is not an issued-for-construction package.

3. Project Execution Philosophy

The project separates PSP engineering guardrails from EPCM construction design. The PSP defines the critical-load philosophy, preliminary sizing, functional architecture, site constraints, minimum technical requirements, BOQ scope and acceptance gates. The appointed EPCM verifies the site, completes the mandatory load study, develops the final design and BOQ, and submits construction-ready information for review.

- PSA treated as a critical medical load requiring supply-on-demand resilience.

- Stage 1 reconnaissance and preliminary reports retained as the engineering foundation.
- Final engineering report used for tender support and due diligence, not as an IFC package.
- Detailed BOQ is the principal input to tender pricing and evaluation.
- EPCM final design reviewed by PSP / DBSA electrical engineer before proceed approval.
- FAT, SAT, commissioning, training and close-out required before handover.

4. Site Assessment Summary

A rapid site reconnaissance was undertaken to capture available PSA nameplate information, breaker ratings, visible cable routes, equipment locations, potential PV mounting areas, roof and carport condition, open-space opportunities, access and security constraints. The assessment was visual and concept-level; final verification forms part of the appointed EPCM scope.

Assessment Item	Christ the King Hospital Finding / Basis
PSA plant	Stage 1/nameplate basis
PV capacity	83.850 kWp Stage 1 basis
Mounting opportunity	One new purpose-designed solar PV carport, subject to civil confirmation.
Cable route	Final route, trenching and service clashes to be confirmed by EPCM.
Security	Anti-tamper module fixing, fenced equipment bay, controlled access and equipment protection.
Key uncertainty	Measured PSA load profile, transient behaviour and final structural design.

5. Design Development Methodology

The methodology below records the engineering and procurement sequence from site reconnaissance through handover and separates the PSP advisory role from the appointed EPCM detailed-design and construction role.

DBSA PSA Solar Backup Programme - Delivery Methodology

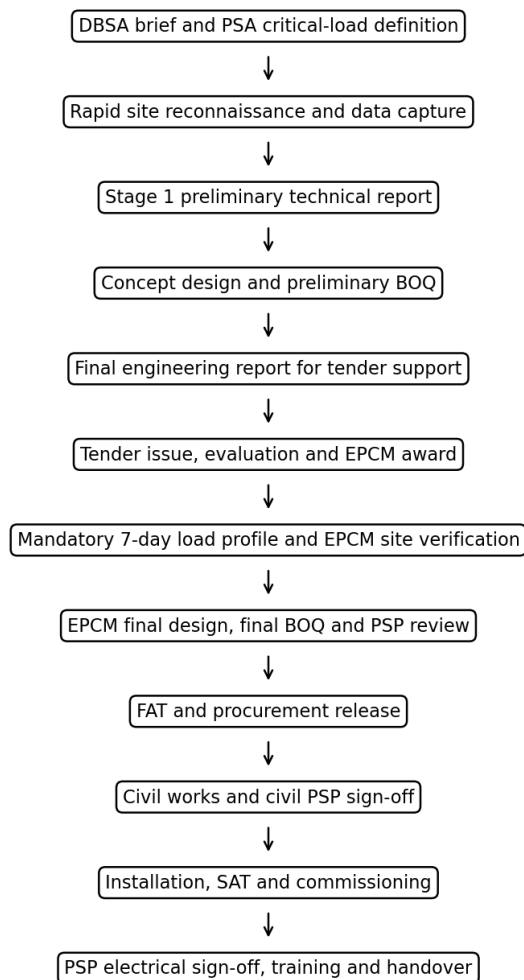


Figure 1: DBSA PSA Solar Backup Programme delivery methodology.

6. Recommended Technical Solution

The recommended architecture comprises a solar PV array, LFP BESS, grid-forming or grid-supporting PCS, EMS, dedicated standby generator, source integration, new AC protection and isolation, export limiting where applicable, earthing and bonding, safety labelling, remote monitoring and the civil works required for the selected mounting route.

System Element	Recommended Tender-Support Basis
Solar PV	83.850 kWp Stage 1 basis; 130 x 645 Wp Tier 1 modules.
Mounting	One new purpose-designed solar PV carport, subject to civil confirmation.
BESS	200-250 kWh planning class; outdoor IP-rated LFP system with integrated BMS, thermal monitoring, smoke detection and fire suppression.
PCS / inverter	100 kW class with grid-forming / grid-supporting functions.
Generator	New low-noise 150 kVA standby generator class with automatic control and soft-load acceptance where applicable.
EMS / monitoring	Integrated operating modes, alarms, event records, remote monitoring and reporting.
Protection	AC/DC isolation, SPDs, MCCBs, emergency stop, source labelling and protection coordination.
Earthing / bonding	Equipotential bonding, lightning / surge protection and neutral-earth philosophy to applicable SANS / IEC requirements.

7. Energy Resilience and Operating Philosophy

Solar PV is the primary daytime energy source. The BESS supports shoulder periods, transient events and short-duration interruptions. The standby generator supports extended low-solar or low-state-of-charge conditions. Grid supply remains a fallback where available. The EMS shall preserve PSA continuity, coordinate source transitions, maintain battery reserve and limit unnecessary generator runtime.

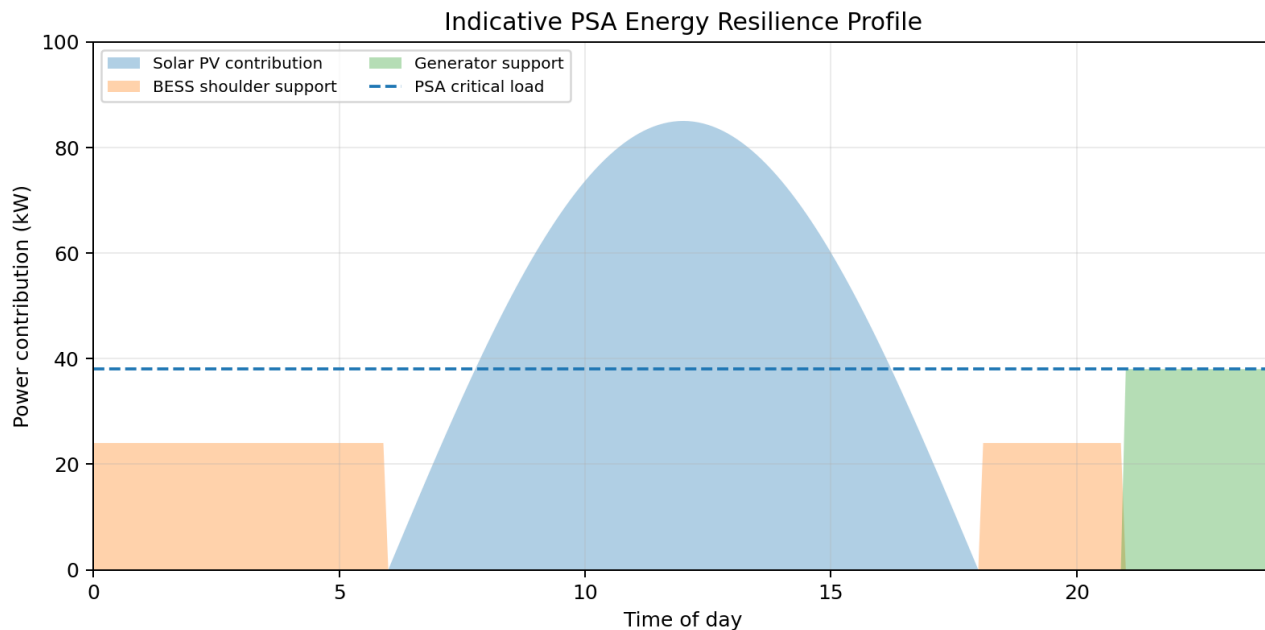


Figure 2: Indicative PSA energy resilience profile. This is a programme-level operating profile and does not represent measured site load data.

OpenSolar values are retained for preliminary energy estimation and concept development. Final orientation, azimuth, inclination, shading and production modelling shall be confirmed during EPCM detailed design. Any preliminary non-optimal orientation shall be corrected to the preferred north-facing arrangement where practical before final layout approval.

8. Civil / Structural / Mounting Recommendation

One new purpose-designed solar PV carport, subject to civil confirmation. A new solar carport shall be a single-pitch structure orientated towards true north, or as close as practical, at an inclination selected to maximise annual yield while maintaining drainage, wind loading, maintenance access and hospital operational requirements.

Civil / Structural Item	Requirement
New solar carport	Confirm footprint, true-north orientation, inclination, foundations, drainage, corrosion protection, wind loading, access and anti-tamper fixing.
Roof alternative	Only where sheeting, purlins, trusses, bracing, fixings, access, remaining life and waterproofing are confirmed.
PCS / BESS / generator	Confirm plinths, anchoring, drainage, bollards, fencing, fire access and maintenance clearances.
Cable routes	Confirm trenching, service clashes, reinstatement and hospital disruption controls.
Dual-use benefit	Where practicable, use the structure for protected staff / ambulance parking or another approved hospital use.

9. Electrical Design Basis

Design Item	Christ the King Hospital Tender-Support Basis	Final Verification
PSA planning load	Stage 1/nameplate basis	Seven-day load logging and OEM data.
Solar PV	83.850 kWp; 130 x 645 Wp	Final layout, azimuth, shading, yield and stringing.
Annual PV generation	142,973 kWh/year	Final EPCM simulation and selected equipment.
BESS	200-250 kWh	SOC, DoD, efficiency, autonomy and thermal / fire review.

PCS	100 kW class	Transient response, overload, fault contribution and source interface.
Generator	150 kVA class	Starting support, fuel, exhaust, controls and operating logic.
AC/DC protection	Tender-support concept	Fault level, discrimination, SPD and cable calculations.
Neutral-earth bonding	To be finalised	Final topology for grid, generator, PCS and islanded operation.
Design spreadsheet	PSP electrical sizing workbook	Reviewed flattened PDF extract to be included in Appendix A; no live formulas issued.

10. Mandatory Seven-Day PSA Load Profile Study

The appointed EPCM shall undertake a minimum seven-consecutive-day electrical monitoring campaign before final design approval. The study is mandatory because nameplate information does not define actual running load, compressor cycling, transient current, daily energy or time-of-use behaviour.

Study Element	Minimum Requirement	Engineering Use
Instrumentation	Class 0.5 or better three-phase power-quality logger.	Reliable measurement basis.
Logging interval	Not greater than one minute; 30 seconds preferred where practical.	Capture daily profile and short-duration events.
Parameters	Phase V/I, kW, kVA, kVA _r , power factor, frequency, kWh and power-quality indicators.	Confirm steady-state demand and energy use.
Transient events	Capture compressor starts, inrush, cycling and maximum demand.	Confirm PCS overload and generator response.
Operating notes	Record grid outages, generator operation, PSA downtime and abnormal events.	Separate representative operation from abnormal days.
Daily energy	Determine kWh/day and night-time demand.	Confirm usable BESS energy and autonomy.
Time-of-use	Identify daytime, shoulder and night operating periods.	Configure charging, discharge reserve and generator logic.
Review gate	Submit raw CSV/Excel data, plots, interpretation and revised design.	PSP / DBSA electrical engineer approval before proceed.

Illustrative example only: a 36-46 kW planning load may operate at 32-38 kW steady state, peak at 44-50 kW during compressor cycling, and produce a short-duration start current of approximately 2.0-2.5 times nominal current. The final design shall use measured values rather than this example.

11. Tender Scope and EPCM Returnables

Returnable	Minimum Requirement
Load study	Raw logger data, profiles, events and engineering interpretation.
Final design report	Operating philosophy, calculations, assumptions and interfaces.
SLD / construction drawings	Final source integration, isolation, protection and metering detail.
PV layout and stringing	Final module count, orientation, string voltages/currents and DC protection.
BESS / PCS sizing	Usable kWh, autonomy, SOC reserve, efficiency, transient and thermal limits.
Generator integration	Start/stop logic, load acceptance, fuel, exhaust, acoustic and access details.
Cable schedule / protection	Cable sizing, voltage drop, fault level, discrimination and SPD coordination.
Earthing / bonding	Grid, generator, PCS and islanded-mode neutral-earth philosophy.
Civil / structural	Carport, plinth, trench, security and drainage signed design inputs.
FAT / SAT / commissioning	Approved scripts, witnesses, test results, CoC, as-builts, O&M manuals and training.
Final BOQ	Site-specific quantities, rates and total tender price.
Discrepancy justification	Technical and commercial motivation for any deviation from PSP guardrails.

12. Standards and Compliance Requirements

The installation shall comply with applicable South African legislation and current applicable editions of SANS 10142, NRS 097 where applicable, IEC 62548, IEC 62446-1, IEC 60364-7-712, IEC 61215, IEC 61730, IEC 62109, IEC 62933, IEC 62619 / IEC 63056 as applicable, IEC 61439, IEC 60947, IEC/SANS 62305, SANS 10400-T, the Occupational Health and Safety Act and Construction Regulations. SSEG documentation shall be completed by the EPCM and submitted to the relevant supply authority where required.

13. Risks, Assumptions and Exclusions

Risk / Assumption	Implication	Required Control
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PSA load not yet logged	BESS, PCS and generator sizing may change.	Mandatory seven-day monitoring and OEM data.
OpenSolar values preliminary	Yield may change with final azimuth, shading and equipment.	Final EPCM energy model and north-facing optimisation where practical.
Structural design pending	Carport foundations and steel sizes may change.	Civil / structural design and certification.
Cable route not final	BOS quantities and cost may change.	Confirm routes and service clashes during detailed design.
Fire / environmental interfaces	Additional controls may be required.	Outdoor IP-rated BESS with integrated detection and suppression, minimum separation in accordance with OEM and fire authority requirements, and full fire/OHS/environmental review.
Final price not in report body	Commercial values may differ at tender.	Use detailed BOQ, cost register and competitive tender evaluation.

14. Recommended Tender Configuration

Item	Recommended Configuration
Solar PV	83.850 kWp Stage 1 basis; approximately 130 x 645 Wp Tier 1 modules.
Mounting	One new purpose-designed solar PV carport, subject to civil confirmation.
BESS	200-250 kWh outdoor LFP BESS planning class; integrated BMS, fire detection, fire suppression and minimum 10-year warranty.
PCS	100 kW grid-forming / grid-supporting PCS planning class.
Generator	New low-noise 150 kVA standby generator class.
EMS and monitoring	Remote monitoring, alarms, source control and event recording.
Protection	Complete AC/DC protection, emergency isolation, earthing, bonding, surge protection and permanent labelling.
Implementation gate	Mandatory seven-day load study, EPCM final design and BOQ, PSP review, FAT/SAT, commissioning and handover.

Proceed with a new solar carport and full resilience architecture.

The full site-specific detailed BOQ is provided in Appendix G and shall form a principal input to the tender documentation.

15. Conclusion

The Christ the King Hospital PSA solar backup solution is technically feasible as a tender-support basis. This report preserves the Stage 1 engineering truth thread, records the recommended technical solution and defines the EPCM verification gates required to protect the PSA critical medical load. Final implementation remains subject to the required PSP sign-off, EPCM detailed design and formal DBSA approval.

Appendix A - Design Sheet Extract

Design Parameter	Current Tender-Support Value
PV capacity	83.850 kWp
Module count	130 x 645 Wp
Annual generation	142,973 kWh/year
BESS	200-250 kWh
PCS	100 kW
Generator	150 kVA

The reviewed PSP electrical design spreadsheet shall be inserted as a flattened PDF/image extract before final issue. The report will not include live formulas or an editable workbook.

Appendix B - Preliminary Technical Specification

- Tier 1 PV modules certified to IEC 61215 and IEC 61730.
- Minimum PV module product warranty: 15 years.
- Minimum PV module performance warranty: 25 years.
- Maximum first-year power degradation: 2%.
- Maximum subsequent annual degradation: 0.55%.
- LFP BESS as design basis with integrated BMS, EMS communications and minimum 10-year warranty.
- Outdoor IP-rated equipment cabinets suitable for the hospital environment.
- Grid-forming / grid-supporting PCS, AC/DC isolation, SPD protection, earthing and bonding.
- Remote monitoring, OEM-supported commissioning, FAT/SAT and full handover documentation.

Appendix C - Standards and Compliance Matrix

Discipline	Principal Requirement
LV installation and CoC	SANS 10142-1
Grid interface	NRS 097 where applicable
PV array design	IEC 62548
PV commissioning	IEC 62446-1
PV modules	IEC 61215 and IEC 61730
PCS safety	IEC 62109
BESS safety	IEC 62933 and IEC 62619 / IEC 63056 as applicable
LV assemblies	IEC 61439
Switchgear	IEC 60947
Lightning and earthing	IEC/SANS 62305 and SANS 10142-1
Fire safety	SANS 10400-T and local authority requirements
OHS	OHS Act and Construction Regulations

Appendix D - Civil / Structural Review

The civil / structural review shall confirm the final carport footprint, foundations, true-north orientation, inclination, wind loading, drainage, corrosion protection, access, maintenance clearances, plinths, trench routes, security and reinstatement requirements.

Appendix E - Fire Safety and OHS Requirements

- Outdoor IP-rated LFP BESS enclosure with integrated thermal monitoring, smoke detection and approved fire suppression.
- Minimum separation and emergency access to be confirmed by the OEM, fire authority and final site layout; a 3 m separation shall be targeted where practicable.
- Emergency stop and source isolation procedures.
- Generator fuel, exhaust and heat-source controls.
- Safety file, RAMS, hospital access and traffic controls.
- Permanent warning signage and staff awareness.

Appendix F - Environmental Requirements

- Environmental screening and permitting triggers.
- Dust, noise, waste, traffic and hospital-access controls.
- Stormwater, drainage, erosion and trench reinstatement.
- Waste disposal and recycling records.
- Protection of hospital operations during construction.

Appendix G - Site-Specific Detailed BOQ

Item	BOQ Item	Description	Unit	Quantity
1	PV modules	Tier 1 modules, nominal 645 Wp or approved equivalent	No.	130
2	PV mounting structure	One new purpose-designed solar carport / approved mounting structure including steel, foundations, rails, clamps and fasteners	lot	1
3	Anti-tamper fixing	Security clamps / anti-tamper fasteners for accessible PV modules	lot	1
4	PV DC cabling	UV-rated red/black solar cable, final length by routing study	m	TBC
5	PV connectors	Certified compatible connectors and spares	pairs	TBC
6	DC protection box	String combiner / protection, DC isolator, gPV fuses where required and Type 1/2 SPD	No.	1
7	PCS / inverter	Grid-forming / grid-supporting PCS, 100 kW class	No.	1
8	BESS	Outdoor LFP BESS, 200-250 kWh class, including BMS, thermal management, detection, suppression and 10-year minimum warranty	No.	1
9	EMS / control	EMS, source control, monitoring gateway and HMI	lot	1
10	Static transfer / changeover	STS / source integration and maintenance bypass arrangement	No.	1
11	Standby generator	150 kVA class low-noise generator with controls, weather/acoustic enclosure and integration	No.	1
12	AC protection kiosk	New AC protection / isolation kiosk adjacent to PSA MCCB kiosk, including MCCB, SPD, metering, labels, E-stop and maintenance bypass	No.	1
13	AC cable rerouting	Remove existing grid feeder from PSA kiosk, terminate at new AC kiosk, install new 16/25 mm ² 4-core feeder to STS grid input, return protected PCS output to AC kiosk and short loop to existing PSA MCCB	m	TBC
14	Cable containment	Trays, conduits, sleeves, glands, lugs and accessories	lot	1
15	Earthing and bonding	Earth electrodes, conductors, lugs, bonds and test points	lot	1

16	Lightning / surge protection	AC/DC SPDs and lightning-risk coordination measures	lot	1
17	Civil plinths and foundations	BESS, PCS, generator and carport foundations / plinths	lot	1
18	Trenching and reinstatement	Cable trenches, ducts, backfill and reinstatement	lot	1
19	Security works	Fencing, gate, double locks, bollards and access control	lot	1
20	Remote monitoring	LTE/Wi-Fi router, metering integration, dashboard setup and alarms	lot	1
21	Safety signage and labelling	DB, circuit, power-point, source, isolation and dual-supply labels	lot	1
22	Seven-day load study	Logger installation, monitoring, data export, analysis and revised design report	lot	1
23	Shading / wind / structural studies	Final shading, orientation, wind-load and structural verification	lot	1
24	FAT	OEM-neutral FAT scripts, witness attendance and records	lot	1
25	SAT and commissioning	Functional testing, protection tests, outage simulation and performance verification	lot	1
26	CoC and handover	CoC, as-builts, test sheets, O&M manuals, training and close-out pack	lot	1

Appendix H - Mandatory Seven-Day Load Profile Study

Appendix H incorporates the detailed requirements in Section 10 and forms a mandatory post-award EPCM deliverable before final design approval.

Appendix I - Safety Signage and Labelling Requirements

- All DBs, breakers, circuits, socket outlets and isolation points shall be permanently labelled.
- Kiosks, PCS, BESS, STS, generator interface, AC protection and DC protection boxes shall identify all sources.
- Dual-supply warning: THIS EQUIPMENT IS FED FROM MORE THAN ONE SOURCE. ISOLATE ALL SUPPLIES BEFORE WORKING ON THIS EQUIPMENT. VERIFY DEAD BEFORE TOUCH.
- Kiosk warning: THIS KIOSK IS FED FROM TWO SUPPLY POINTS. ISOLATE BOTH SUPPLIES BEFORE WORKING ON THIS EQUIPMENT.

Appendix J - Commissioning and Handover Checklist

- Final approved design, SLD, cable schedule and protection settings submitted.
- Seven-day load study reviewed by PSP / DBSA electrical engineer.
- PV, BESS, PCS, generator, STS, EMS and monitoring commissioned.
- Earthing, insulation, polarity, phase rotation, protection and neutral-earth arrangement tested.
- Normal, outage, low-SOC, generator-support and grid-restoration modes demonstrated.
- CoC, OEM certificates, as-builts, warranties, O&M manuals and training records submitted.
- Safety signage and labelling installed and inspected.
- Snags closed or accepted with defined close-out dates.

Appendix K - EPCM Final Design Returnables

The EPCM shall submit the final design report, project-specific SLD, layouts, cable schedules, protection coordination, earthing and neutral-earth philosophy, structural design, fire/OHS method statements, environmental controls, final BOQ, FAT/SAT procedures and commissioning plan before proceed approval.

Appendix L - Preliminary Report Reference

Foundation document: Christ the King Hospital Preliminary Technical Report. The preliminary report shall be read together with this final engineering report, the detailed BOQ and subsequent approved EPCM final-design submissions.

Appendix M - Typical Secure Solar Carport and Equipment Bay

The illustration below is conceptual and does not represent the final construction design. The solar carport shall be a single-pitch structure orientated north where practical, with an inclination selected to maximise annual energy yield and to provide effective

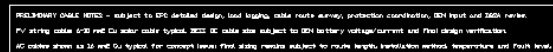
drainage. Modules shall use approved clamps and anti-tamper fasteners. The first bay may accommodate the PCS and BESS on a raised plinth within a lockable palisade enclosure, subject to final fire, ventilation, access and structural requirements.



Figure M-1: Typical secure solar carport and equipment bay - illustrative only.

Appendix N - Generic Functional Single-Line Diagram

The generic diagram below illustrates the tender-support functional architecture only and is not an official or issued-for-construction SLD. The appointed EPCM shall prepare the final project-specific SLD, protection settings and cable schedules. The retrofit cable philosophy is: locate a new AC protection kiosk next to the existing PSA MCCB kiosk; remove the existing grid feeder from the PSA kiosk and terminate it at the new AC kiosk; install a new 16/25 mm² four-core feeder from the AC kiosk to the STS grid input; return the protected PCS output to the protection side of the AC kiosk; and use a short AC loop from the AC kiosk output to the existing PSA MCCB kiosk.



Drawing Type A Refractory 03.3 – symbol view
Project: OSHA PSA Solar Resilience
Revises: 007 – refined schedule
Prepared for engineering review
Not issued for construction

Organisation / Role	Name	Signature	Date
Durapi Consulting - Prepared / reviewed by	Durapi Consulting representative		13/07/2026
Durapi Consulting - Authorised sign-off	Authorised Durapi representative		
Lead Electrical Engineer - Reviewed and signed off	Rajandren Chetty, Professional Engineering Technologist		13 July 2026

Professional verification: [Rajandren Chetty - ECSA PrivySeal](#)