



ENGINEERING PACKAGE

Solar Chargers & Charging Stations

Design basis and engineering task sheet for Precifarm route hubs, campus stations and private house hybrid charging.

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Owner: Precifarm Engineering

Status: Concept / feasibility reference — not a construction drawing set

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Construction requires site surveys, Kenya Power connection studies, licensed Kenyan electrical design, and statutory approvals. Figures and costs are planning assumptions unless labelled otherwise. Solar and storage optimise cost and resilience; they do not replace a feeder study or a contracted demand case.

1. Purpose

This package is the engineering design basis and single-site delivery task sheet for Precifarm solar-assisted DC charging stations.

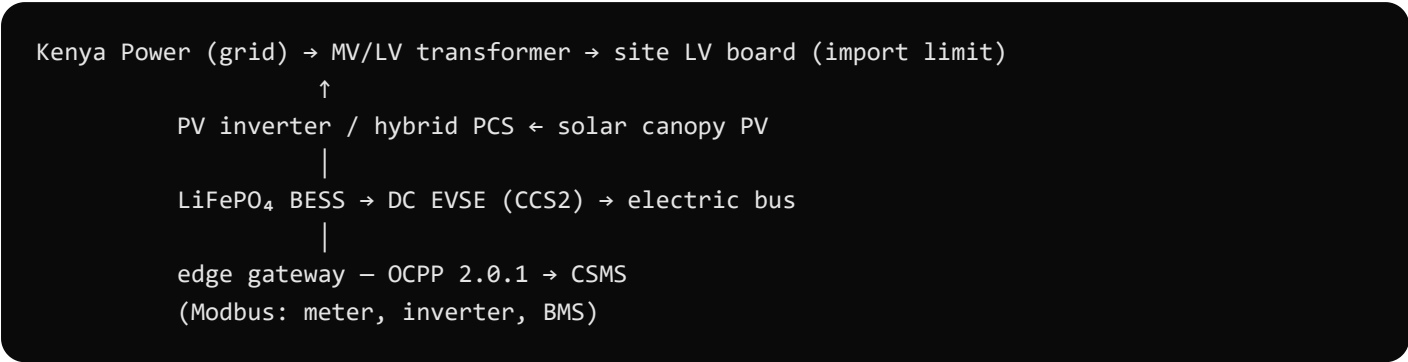
Type	Role	Typical user
Route charging hub	Reserved CCS2 windows for scheduled electric buses on Nairobi–Kisumu	Partner operator + Precifarm ops
Private campus / in-house	Multi-pedestal AC/DC on private land	Host organisation
Private house hybrid	Charger on the customer meter; optional rooftop solar + storage	Homeowner / estate

Governing design principles

- Type 2 public AC · CCS2 public DC. CHAdeMO / GB/T only for defined fleets.

- Contracted bus demand before speculative public capacity.
- Modular shared-power cabinets; expand against measured utilisation.
- Electrical safety and the site import limit stay local (edge clips cloud commands).
- OCPP 2.0.1 greenfield baseline; OCPP 2.1 / ISO 15118-20 upgrade path.
- KPIs: first-attempt charge success and delivered kWh — not heartbeat-only uptime.
- Kenya Power connection study before land or charger commitments.

2. System concept



Dispatch order at the edge (cloud is advisory):

1. Electrical safety, emergency stop, insulation and thermal interlocks
2. Declared site import limit (utility + transformer + switchboard)
3. Reserved bus windows (timetable energy before public or opportunistic load)
4. Tariff / demand-charge reduction
5. Solar self-consumption and BESS state-of-charge floors

Layer	Function
Energy supply	Grid import + canopy/rooftop PV + optional LiFePO ₄ storage
Fast charging	Modular CCS2 DC (120–180 kW town/bus · 240–320 kW highway class)
Civil / canopy	Weather protection, PV mounting, bus approach, queue, dwell
Operations	OCPP 2.0.1 sessions, metering, reserved windows, remote monitoring



Figure 1 — Route hub concept: solar canopy, DC dispensers, storage cabinets, electric bus.

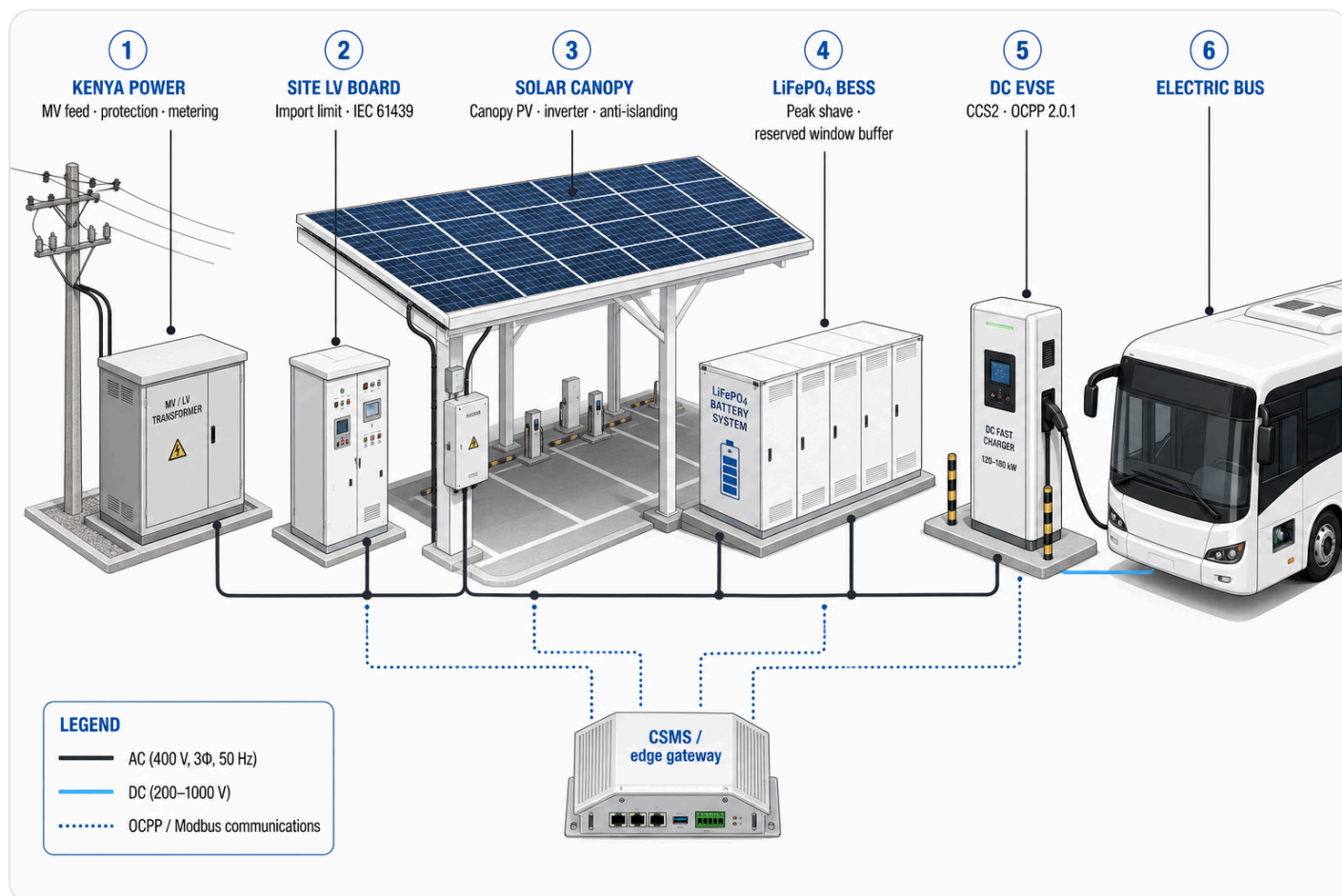


Figure 2 — System architecture: Kenya Power · canopy PV · LiFePO₄ · CCS2 DC · OCPP edge / CSMS.

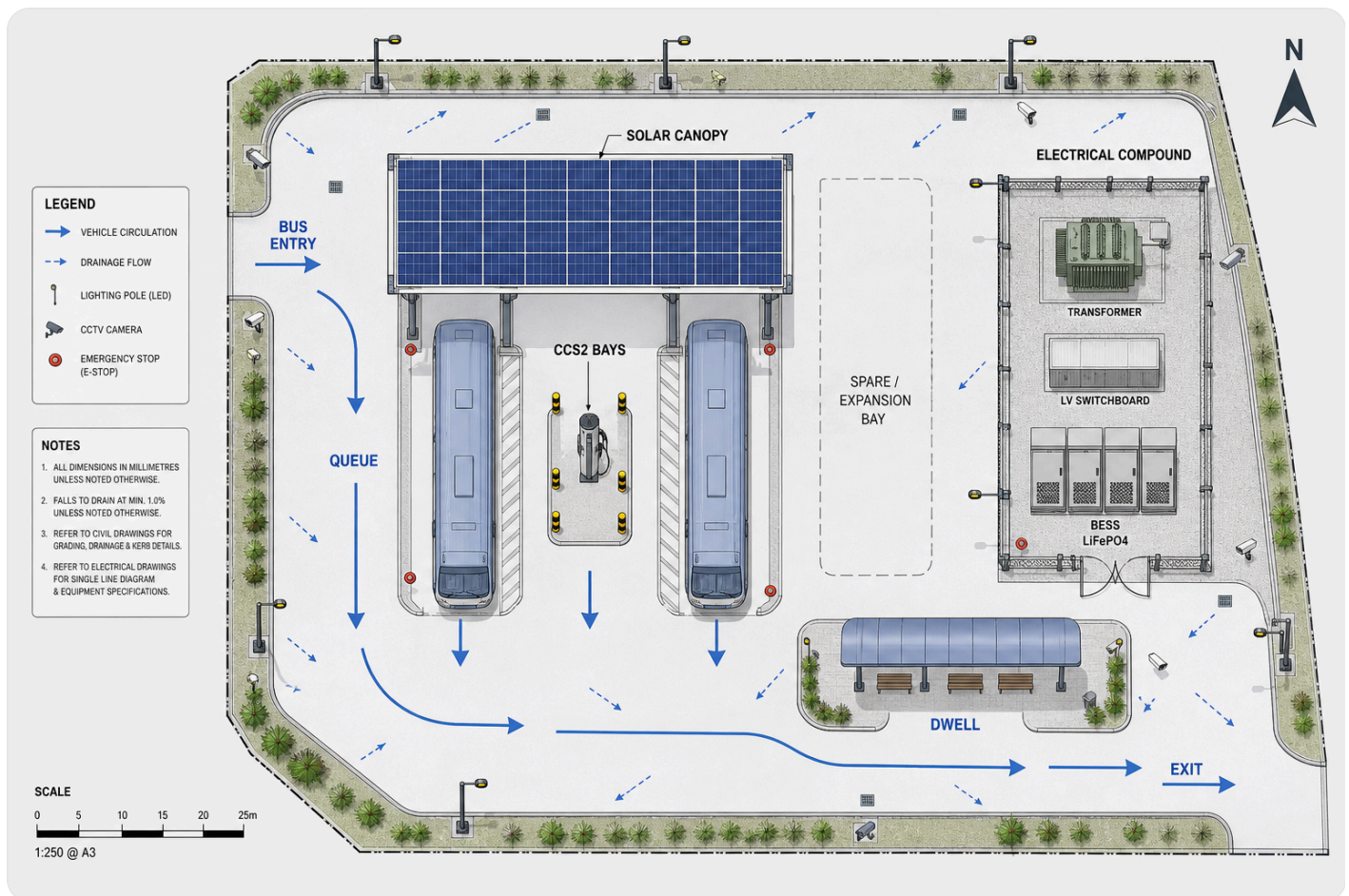


Figure 3 — Typical two-bay route hub plan: one-way bus circulation, solar canopy, separated electrical compound, dwell, expansion bay. Illustrative — not a surveyed layout.



Figure 4 — Private house hybrid: grid + rooftop solar + wall charger + home storage.

2.1 Photo annex — stations, sites and vehicles

Additional reference imagery used across Precifarm charging surfaces. Illustrative — not as-built photography.



Figure 5 — Route charging hub (marketing reference): solar canopy, DC fast charger, electric bus.



Figure 6 — Premium corridor hub concept in Kenya landscape context.



Figure 7 — Private in-house / campus station: multi-pedestal solar canopy site.



Figure 8 — Private house hybrid install: wall charger, rooftop solar, home storage.



Figure 9 — Residential charging reference install.



Figure 10 — Yutong U18 electric intercity bus (route vehicle reference).



Figure 11 — Yutong U12 electric city bus (fleet / urban reference).



Figure 12 — Electric bus on corridor service (brand reference).

3. Design basis — route charging hub

3.1 Functional requirements

ID	Requirement
R-01	Deliver reserved CCS2 DC energy so scheduled electric buses leave on timetable
R-02	Prefer Type 2 (AC) / CCS2 (DC) as Kenya public defaults
R-03	Modular shared-power cabinets; expand only against contracted demand
R-04	Integrate solar canopy where irradiance and structure allow
R-05	LiFePO ₄ storage for peak shaving / weak-grid resilience (site-dependent)
R-06	OCPP 2.0.1 to CSMS; durable edge queue for offline recovery
R-07	First-attempt charge success and delivered kWh as primary KPIs
R-08	At least two operational DC ports at a corridor hub so one fault does not strand the route
R-09	Hard site-import clip from local metering — cloud setpoints cannot exceed the utility envelope
R-10	Identify the coach, start the reserved session, and write a metered session record for settlement

3.2 Nairobi–Kisumu site classes (planning)

Route one is Nairobi–Kisumu (~345 km, ~4 h 45 m). Hubs exist to protect the timetable.

Site class	Planning role	Typical dwell	Equipment class
Nairobi depot / terminus	Overnight and pre-departure top-up	Hours (managed)	120–180 kW DC + 11–22 kW AC
En-route (e.g. Nakuru)	Opportunity charge if remaining range is insufficient	20–40 min	120–180 kW; 240–320 kW if dwell is shorter
Kisumu terminus	Arrival recovery + next-day readiness	Hours / overnight	120–180 kW DC + AC as dwell allows

3.3 Energy model (planning assumption)

Parameter	Planning value	Note
Specific consumption	1.2 kWh/km loaded	Replace with OEM / loaded test
Route distance	~345 km	Nairobi–Kisumu
Trip energy	~414 kWh	1.2×345
Beachhead departures	5/day	Canon planning assumption
Mid-route opportunity charge	80–150 kWh	20–40 min at 150–180 kW usable

Worked example — one reserved window (illustrative): 120 kWh in 30 min → 240 kW at the vehicle. At 95% charger efficiency, AC input ≈ 253 kW. If the Kenya Power import limit is 180 kW, BESS must cover the gap: $(253 - 180) \times 0.5 \approx 37$ kWh plus reserve → usable BESS typically ≥ 80 –100 kWh for that window.

A 40–80 kWp canopy in Kenya yields roughly 180–440 kWh/day. Against a 1,500 kWh/day hub, PV covers on the order of 12–30% of daily energy. Use it for cost, shade and resilience — not as a substitute for the feeder.

3.4 Typical equipment class (planning)

Element	Planning class	Notes
DC dispenser	120–180 kW (town/bus) · 240–320 kW (highway)	RFQ against Chinese charger shortlist
Architecture	Modular shared-power preferred	Add cabinets against utilisation
Connector	CCS2 dual-port at corridor hubs	CHAdEMO/GB/T only if fleet-specific
PV canopy	40–80 kWp typical two-bay	Export only with written utility approval
BESS	LiFePO ₄ , 100–250 kWh usable first site	Dispatch under import limit; fire separation
Transformer	Concept 315–500 kVA after diversity	Site study required
Communications	Dual path at critical hubs	Ethernet + cellular

3.5 Solar canopy sizing method

1. Structure first — canopy area is set by bus geometry, wind and seismic.
2. Module packing — planning ~ 160 –200 Wp per m² of canopy plan area.
3. Yield — Kenya planning 4.5–5.5 kWh/kWp/day (site PVsyst later).
4. Self-consume into BESS and site load; export only if the connection offer allows it.

5. Anti-islanding — inverter/PCS trip on loss of mains.

Illustrative two-bay canopy: $12\text{ m} \times 24\text{ m} \approx 288\text{ m}^2 \rightarrow \sim 50\text{ kWp} \rightarrow \sim 225\text{--}275\text{ kWh/day}$.

3.6 BESS sizing method

Size storage to the binding constraint, then take the larger of: reserved-window gap, peak-shave to an affordable kVA, ride-through for one abort/restart, and SoC floors for the next contracted window.

Chemistry: LiFePO_4 outdoor cabinets.

3.7 Electrical design checklist

☐	Item
☐	Kenya Power connection study and declared POC voltage (LV or MV)
☐	15-minute load profile: reserved windows, public, auxiliaries, PV, BESS
☐	Transformer / switchboard sizing (IEC 61439 / 60947)
☐	Cable ampacity, voltage drop, fault withstand
☐	Protection coordination; Type B RCD / RDC-DD as required
☐	Earthing, bonding, touch/step voltage
☐	Lightning risk (IEC 62305) and coordinated SPDs
☐	Harmonics, PF, flicker; PV/BESS anti-islanding and export approval
☐	Thermal management for high-power DC cabinets
☐	Emergency stop, isolation, and responder access independent of software

3.8 Civil & site checklist

☐	Item
☐	Safe entry/exit and queue storage for 12 m-class buses (drive-through preferred)
☐	Dispenser clearances, impact protection, cable management
☐	Canopy wind/seismic loads; PV mounting integrity
☐	Separated transformer, switchgear, charger and BESS compounds
☐	Drainage away from energized equipment; lighting, CCTV, fire access
☐	Passenger dwell offset from the electrical compound
☐	Spare ducts, foundations and switchboard ways for one expansion bay

4. Design basis — private campus / in-house station

ID	Requirement
C-01	Start from vehicle count, arrival SOC and dwell — not from a brochure kW
C-02	Prefer 11–22 kW Type 2 AC where vehicles park for hours; add DC only for short dwell
C-03	Building / estate import limit and landlord earthing govern charger count
C-04	Submetering for the host; OCPP if revenue-bearing or fleet-managed
C-05	Optional canopy PV + LiFePO ₄ using the same sizing methods as route hubs
C-06	Fire access, impact protection and isolation — campus does not mean light duty

5. Design basis — private house hybrid

ID	Requirement
H-01	Charger on customer property and meter — not a public hub
H-02	Start from duty cycle: typically 7.4 kW AC; DC only when justified
H-03	Optional solar + storage for overnight resilience
H-04	Same engineering discipline: survey, install, commissioning, support
H-05	App visibility for personal home charging when product supports it
H-06	Type A 30 mA plus 6 mA RDC-DD, or Type B, on a dedicated final circuit

6. Software & cybersecurity (station)

Topic	Baseline
Charger protocol	OCPP 2.0.1 (greenfield)
Upgrade path	OCPP 2.1 / ISO 15118-20
Edge	Offline auth snapshot, durable session queue, local load management
Cloud	Sessions, billing hooks, fleet windows, OTA, fault management
Security	Segmented OT/IT, least privilege, signed firmware
Safety	Software cannot override hardware E-stop, insulation monitoring, or import-limit trip

7. Kenya approvals and hold points

Hold capital and equipment orders until these are in the site pack (or explicitly waived in writing).

Gate	Owner	Evidence
Contracted demand	Commercial	Operator window / kWh commitment
Site control	Commercial + legal	Host agreement, tenure, access
Kenya Power enquiry	Electrical	Feasibility / connection offer, tariff, export rules
Licensed design	EBK-registered engineer	SLD, protection, earthing
EPRA / Energy Act	PM	Charging-infrastructure guideline checklist
NEMA / EIA	HSE	Screening decision or licence as triggered
County / fire	Civil + HSE	Building, fire, BESS separation
KEBS / IEC equipment	Procurement	Certificates matching the shipped SKU
Commissioning	Field + software	Acceptance tests signed

8. Engineering task sheet

Delivery tracker for a single site. Checkboxes are hold points.

Phase A — Feasibility

☐	ID	Task	Owner	Output
☐	A-01	Confirm contracted demand / duty cycle	Commercial + Eng	Demand note
☐	A-02	Site walkover, photos, access, host constraints	Field eng	Site pack
☐	A-03	Grid enquiry / connection study request	Electrical	Utility letter
☐	A-04	Concept single-line diagram	Electrical	SLD v0
☐	A-05	Concept layout (canopy, pedestals, storage, circulation)	Civil + Eng	Layout v0
☐	A-06	Capex/opex planning estimate	Eng + Finance	Cost sheet
☐	A-07	Capital gate: demand + site control + feeder path	PM	Go / no-go

Phase B — Design

☐	ID	Task	Owner	Output
☐	B-01	Detailed SLD and protection schedule	Licensed electrical	IFC pack
☐	B-02	Cable schedule and earthing design	Electrical	Schedules
☐	B-03	Canopy / PV structural design	Structural	Calcs + drawings
☐	B-04	BESS integration and fire separation	Electrical + HSE	Spec
☐	B-05	CSMS / OCPP configuration sheet	Software	Config pack
☐	B-06	Civil drainage, lighting, CCTV	Civil	Drawings
☐	B-07	Statutory submissions	PM	Approvals log

Phase C — Procurement

☐	ID	Task	Owner	Output
☐	C-01	RFQ against shortlist (bus/highway or house class)	Procurement	Vendor bids
☐	C-02	Factory acceptance criteria + OCPP live test	Eng + Software	FAT checklist
☐	C-03	Spares, warranty, local labour, ten-year parts	Procurement	Contract
☐	C-04	Confirm Kenya SKU: CCS2, 50 Hz, OCPP 2.0.1, environmental rating	Eng	Conformity matrix

Phase D — Construction & commission

☐	ID	Task	Owner	Output
☐	D-01	Civil and canopy install	Contractor	As-built
☐	D-02	Electrical install and torque records	Contractor	QA pack
☐	D-03	Charger / BESS / PV commissioning	Field eng	Commission report
☐	D-04	OCPP end-to-end session test	Software + Field	Test log
☐	D-05	Peak-load test against declared import limit	Electrical	Test sheet
☐	D-06	Safety sign-off and handover	PM + HSE	Handover certificate
☐	D-07	Operator training (T1–T3 as applicable)	Training	Attendance

Phase E — Operate

☐	ID	Task	Owner	Output
☐	E-01	Reserved window calendar live	Ops	Schedule
☐	E-02	Uptime and delivered-kWh dashboard	Ops	KPI weekly
☐	E-03	Preventive maintenance plan	Field	PM calendar
☐	E-04	Incident / exception process	Ops	Runbook
☐	E-05	Utilisation review before next cabinet / port	Eng + Finance	Expansion note

9. Acceptance criteria (route hub)

A site is **engineering-accepted** when:

1. Documented connection agreement and site import limit are respected under peak test load
2. At least one successful CCS2 session delivers metered energy to a representative vehicle
3. A reserved-window rehearsal completes the contracted kWh inside the timetable (or a documented exception path is proven)
4. OCPP session and meter values reconcile in CSMS
5. Emergency stop, isolation, and earthing verification are signed
6. PV anti-islanding and BESS fire/separation checks are signed where those systems are installed
7. As-built SLD and O&M pack are filed

Engineering acceptance is necessary; it is not traction. Commercial live-route proof remains a separate Canon proof gate.

10. Related references

- Precifarm Master EV Charging Engineering Handbook
- Kenya Deployment Plan 2026–2040
- Chinese Ready-Made EV Charger Shortlist
- Software, Communications and Cybersecurity Architecture
- Canon — Reserved Route Charging product boundaries

Precifarm

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