ALCAP EDUCATIONAL DOCUMENT | SOLAR PV

Designing a Solar PV System Correctly

Why a bankable PV system starts with the load, tariff, site, compliance, and lifecycle - not a panel count

A correctly designed photovoltaic system is an engineered energy asset. Its size, layout, inverter strategy, protection, monitoring, and commercial model must all match the site's real load, tariff, physical constraints, and operating goals.

WHAT YOU WILL LEARN

- Why load profile and tariff come before system size
- How roof, shading, orientation, structure, and environment affect design
- The role of inverter, string, cable, protection, and interconnection engineering
- How yield, degradation, availability, and O&M; shape lifecycle value

PRACTICAL. INDEPENDENT. DECISION-FOCUSED.
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01 | THE ESSENTIALS

Build the right mental model

Installed kWp is only one design output. A robust design joins electrical engineering, structural suitability, fire and access planning, energy simulation, grid requirements, construction quality, and long-term operations.

Match generation to value

Use interval load and tariff data to determine self-consumption, export, demand interaction, clipping, and curtailment. PV may reduce kWh without reducing a demand peak that occurs outside solar hours.

Design the physical asset

Survey usable area, structural capacity, shading, orientation, drainage, wind exposure, corrosion, access, waterproofing, fire routes, and future maintenance before final layout.

Engineer the electrical system

Check module and inverter compatibility across temperature, DC string limits, cable losses, isolators, overcurrent and surge protection, earthing, labelling, fault levels, and the AC connection.

THE DESIGN OBJECTIVE
Maximise **risk-adjusted lifecycle value**, not only first-year kWh. A lower-cost design that creates shading, chronic clipping, water ingress, unsafe access, weak monitoring, or difficult maintenance can destroy value over time.

A QUICK REFERENCE

Decision	Input	Output
System size	Load, tariff, export rules	kWp and inverter capacity
Array layout	Survey, shade, structure	Rows, access, orientation
Electrical design	Datasheets, climate, network	Strings, cables, protection
Business case	Yield, capex, O&M;, tariff	Cash flow and risk cases

02 | PUT IT TO WORK

Turn understanding into action

Use stage gates. Do not release procurement or construction until the energy model, site design, compliance path, technical schedules, and commercial assumptions agree.

1. **Define objectives and boundary**
   Clarify cost saving, resilience, export, ESG, demand, future storage, and ownership model.
2. **Collect reliable data**
   Use at least 12 months of bills, interval load, site survey, single-line, roof/land data, and approved tariff rules.
3. **Simulate alternatives**
   Compare layouts and DC/AC ratios using representative weather, losses, degradation, downtime, and curtailment.
4. **Complete detailed design**
   Coordinate structural, electrical, protection, civil, fire, access, metering, and monitoring requirements.
5. **Commission and hand over**
   Verify installation, protection, performance, documentation, data access, warranties, spares, and O&M; plan.

ILLUSTRATIVE EXAMPLE: THE OVERSIZED SALES PROPOSAL

A proposal fills the entire roof with modules but ignores a low weekend load and export restriction. Much of the potential generation is curtailed. A smaller or differently staged system may produce fewer kWh yet deliver a stronger return and lower operational risk.

A GOOD DECISION LOOKS LIKE

- The forecast separates gross generation, self-consumption, export, curtailment, and losses.
- The latest applicable SANS, NRS, utility, municipal, structural, and fire requirements are confirmed by qualified parties.
- The owner receives native monitoring access, as-built drawings, settings, test results, and an O&M; plan.

03 | CHECKLIST AND NEXT STEPS

Use this before you proceed

[ ]	Define objectives, ownership boundary, and future expansion plan.
[ ]	Validate bills, interval load, tariff, and export/interconnection rules.
[ ]	Complete shade, roof/land, structural, drainage, and access surveys.
[ ]	Review string design, cables, protection, earthing, labelling, and fault levels.
[ ]	Model realistic losses, degradation, availability, curtailment, and O&M.;
[ ]	Specify commissioning tests, data ownership, warranties, and handover documents.

RED FLAGS
- Sizing from annual kWh alone
- A yield model without stated assumptions and loss factors
- No structural sign-off, access plan, or waterproofing responsibility
- Monitoring available only through the installer's account

PLAIN-LANGUAGE GLOSSARY

kWp	Rated DC peak capacity of the PV modules under standard test conditions.
DC/AC ratio	PV array DC rating divided by inverter AC rating.
Clipping	PV power limited by inverter or connection capacity.
Curtailment	Intentional reduction of available generation.
PR	Performance ratio comparing actual output with a reference expectation.

SOURCES AND FURTHER READING

- NREL - PV and storage O&M; best practices
- U.S. DOE - Solar inverters and grid services
- Eskom - Generator connection reference information

IMPORTANT NOTE

This document is for general education only. It is not a substitute for a site assessment, electrical design, tariff review, safety study, or professional advice. Use the latest applicable standards, utility rules, municipal requirements, and manufacturer instructions. Work on electrical systems must be performed by suitably qualified and authorised persons.

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