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ENGINEERING RELIABILITY

The Hidden Power of Proper
Solar Cabling

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EXECUTIVE SUMMARY

Every solar project begins and ends with current flow through cables that rarely get attention. Yet cable integrity determines efficiency, safety, and long-term ROI.

This white paper explains how Solaren engineers design and install cabling systems that exceed international standards and deliver consistent performance across Philippine conditions. It presents the Ten Golden Rules of Cabling and the field insights behind them.

INTRODUCTION: WHY CABLING MATTERS

Panels and inverters get the credit, but cables carry the burden.

A single poor termination or under-sized conductor can waste energy, create hot spots, or void warranties.



Independent studies estimate that up to 15 % of all PV faults stem from wiring and connector issues.¹¹ For commercial systems, that translates to energy losses worth millions of pesos over a plant's lifetime.

At **Solaren**, cabling is treated as an essential, properly engineered item, not a cost-cutting exercise. Gathered from extensive installations nationwide.

TECHNICAL FOUNDATIONS

Electrical energy follows physical laws that never bend for budget shortcuts.

Key parameters include:

- Voltage Drop: Must stay below 1.5 % per string.
- Current Carrying Capacity: Determined by conductor cross-section, insulation rating, and ambient temperature.
- Thermal Rise: Every 1 °C above 25 °C increases resistance $\approx 0.4 \%$ ^[3]

For a DC circuit operating at 600 V and 140 A (≈ 84 kW continuous), a 1% voltage drop results in 840 W of continuous power loss, equivalent to $\sim 7,350$ kWh per year, or roughly ₱90,000 in lost yield.



THE PHILIPPINE ENVIRONMENT

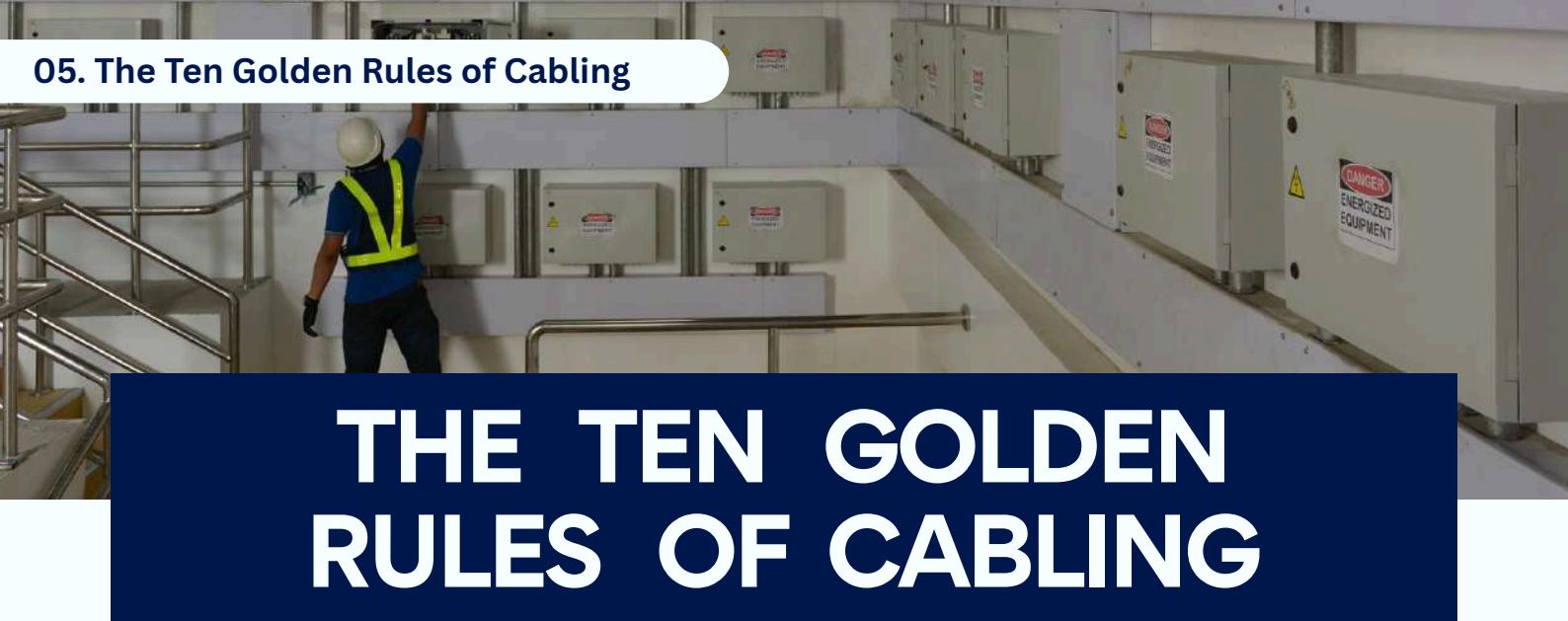
Tropical humidity, heat, and salt exposure accelerate cable aging. Roof surfaces often exceed 70 °C by midday; coastal plants face chloride corrosion and UV breakdown.^[4]



Solaren's field data shows that standard PVC-jacketed wire loses flexibility within 18 months outdoors.^[5]



That is why all Solaren designs specify cross-linked polyethylene (XLPE) insulation rated at 90 °C continuous, 120 °C peak, and UV-resistant.^[6]



THE TEN GOLDEN RULES OF CABLING

RULE 1: CERTIFIED SOLAR CABLE

Only TÜV-approved or IEC 62930-certified solar cable rated for 1,000 V or 1,500 V DC is used. Building wire and general-purpose cable are excluded.^[1]

Certified PV cable is designed for continuous DC voltage, elevated temperatures, and prolonged UV exposure. Non-rated cable accelerates insulation degradation and increases long-term risk.

RULE 2: CORRECT CABLE SIZING AND VOLTAGE DROP CONTROL

Cable cross-section is selected based on current, route length, ambient temperature, and installation method. Voltage drop is maintained below 1.5 % per string under full-load conditions.^[2]

Undersized conductors increase resistive loss and operating temperature. In many systems, upsizing by one gauge recovers cost through higher yield and reduced thermal stress.

RULE 3: UV AND HEAT RESISTANCE

All exposed cable jackets are rated for ≥ 90 °C continuous operation and certified UV-resistant for outdoor use.

Roof-mounted systems routinely operate beyond standard ambient assumptions. Reflective surfaces and adequate air gaps reduce conductor surface temperature and extend insulation life.

RULE 4: ROUTING, SUPPORT, AND MECHANICAL PROTECTION

Cable routes are planned to minimize length, loop area, and mechanical stress. All spans are supported at intervals not exceeding 300 mm.

Unrestrained cabling is subject to movement from wind and thermal cycling. Poor routing and edge contact are common causes of insulation abrasion and latent DC faults.

RULE 5: ROOF PENETRATIONS AND EDGE PROTECTION

All roof penetrations are protected using suitable glands or EPDM grommets. Cables crossing metal edges are sleeved or isolated with lined supports.

Unprotected edges create high-risk abrasion points. Minor jacket damage can progress into ground faults or arcing under sustained DC voltage

RULE 6: DC AND AC SEPARATION

DC and AC cabling routes are physically segregated, maintaining a minimum spacing of 150 mm when installed in parallel.

Separation reduces inductive interference, simplifies inspection, and lowers the risk of cross-system faults during maintenance.

RULE 7: FIXINGS AND FASTENERS

All outdoor fasteners are specified as AISI 304 or AISI 316 stainless steel.^[8] Cable ties are UV-stabilized PA12 with a design life exceeding 25 years.^[9]

Inferior metals and plastics embrittle rapidly in tropical conditions, leading to loss of support and secondary insulation damage.

RULE 8: LABELING AND POLARITY CONTROL

All DC conductors are clearly identified by polarity using UV-stable heat-shrink labels. Positive conductors are marked red; negatives black.

Durable labeling reduces commissioning errors and prevents reverse-polarity connections during maintenance or future system expansion.

RULE 9: TESTING BEFORE ENERGIZATION

Each string is tested prior to energization for polarity, continuity, and insulation resistance exceeding $40\text{ M}\Omega$.^[10]

Testing confirms installation integrity before load is applied. Protection devices limit consequences but do not correct poor workmanship.

RULE 10: DESIGN FOR MAINTENANCE ACCESS

Cable routes and terminations are designed to remain accessible without removing modules.

Accessible systems are inspected more consistently, reducing O&M cost and enabling early detection of degradation before failure occurs.

CASE STUDIES FROM THE FIELD



- * High-temperature aluminum roof.
- * Using bifacial modules and SMA inverters, Solaren specified XLPE $1 \times 10 \text{ mm}^2$ conductors in parallel.
- * Measured voltage drop: 1.22 %. After two years of operation, visual inspection and insulation resistance testing showed no measurable insulation degradation.

CASE 1: TARLAC MAC CHICKEN FARM (100 KWP GRID-TIED)

- * Legacy contractor used mixed wire gauges. Solaren re-terminated 148 strings, restoring inverter efficiency.



CASE 2: BIR RR4 PAMPANGA GOVERNMENT FACILITY



- * Salt mist corroded mild-steel saddles within 12 months. Replaced with 316 stainless supports; life extended > 25 years.

CASE 3: COASTAL HOTEL IN ZAMBALES

OBSERVED FIELD FAILURES (THIRD-PARTY INSTALLATIONS)

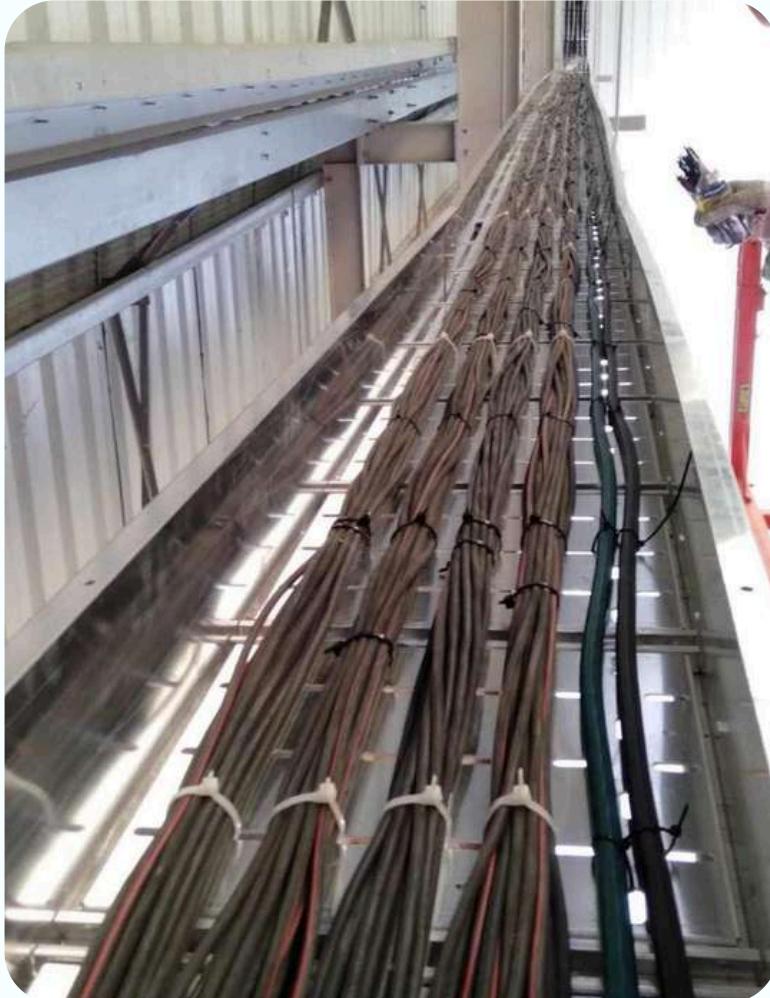


- CORRECTLY WIRED AND TAGGED RAPID SHUTDOWN SAFETY DEVICE



- TROUBLESHOOTING DEFECTIVE DC CABLING FOLLOWING A SERVICE CALLOUT TO AN OLD SYSTEM (THIRD PARTY)

DC-side thermal damage caused by improper termination and execution. Inadequate crimping, connector incompatibility, or poor mechanical support can create localized resistance, leading to overheating and arcing.



- WIREWAYS WITH CORRECTLY BUNDLED, ARRANGED AND TAGGED DC WIRING (COMMERCIAL PV SYSTEM). CREDIT SOLAREN

AC-side termination failure at a molded case circuit breaker. Loose or improperly torqued conductors resulted in overheating at the terminals. In this instance, the protective device operated correctly and tripped the circuit, preventing wider system damage.

These failures underscore that protection devices mitigate consequences but do not compensate for poor workmanship. Correct cabling design, execution, and verification remain the primary safeguards against fire and asset loss.

DC Cable Insulation Damage Due to Mechanical Abrasion

This image shows DC cabling routed beneath a photovoltaic module without adequate edge protection or mechanical clearance. Repeated thermal expansion and vibration caused abrasion against the metal support structure, leading to insulation damage.

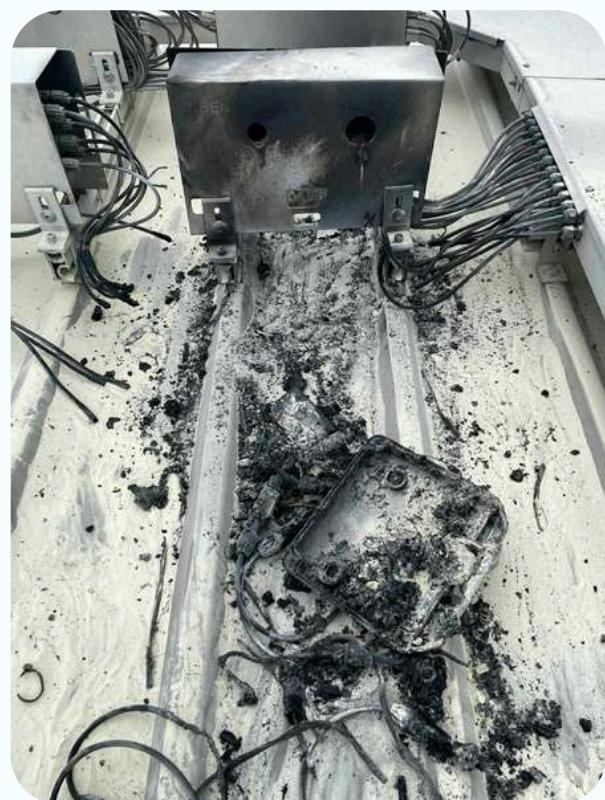
Such defects are typically hidden from routine visual inspection and may remain undetected until ground faults, arcing, or inverter protection events occur. Proper cable routing, support spacing, and protective sleeving are essential to prevent this failure mode.



- THE CONSEQUENCES OF INCORRECT TERMINATION OF AC CABLEING. THANKFULLY, THE CIRCUIT BREAKER DID ITS WORK EFFECTIVELY HERE, AND TRIPPED. LOW QUALITY OFTEN DO NOT TRIP.



- THE RESULT OF INCORRECT DC TERMINATION/INSTALLATION FOUND ON A THIRD PARTY CALLOUT VISIT



TESTING AND COMMISSIONING

Every Solaren project follows a verification checklist:

TEST	INSTRUMENT	ACCEPTABLE VALUE	PURPOSE
Polarity	Multimeter	Correct +/-	Prevent inverter damage
Insulation Resistance	Megger 1000 V	> 40 MΩ	Detect moisture ingress
Continuity	Ohmmeter	< 1 Ω	Confirm conductor integrity
IV-Curve	Tracer	> 95 % expected	Confirm array health
Thermal Scan	IR Camera	ΔT < 15 °C	Identify hot spots



Results archived in Solaren Engineering Handover File and part of warranty record. [11]

MAINTENANCE & INSPECTION

Under Solar Performance Care, cable inspections occur annually or semi-annually.

Tasks include visual check of conduits, torque testing, and thermal imaging during full load.

Loose MC4 connectors can cause arc faults > 1,000 °C; preventive inspection avoids failures.^[12]



SAFETY, COMPLIANCE AND WARRANTY

Standards observed:

- IEC 60364-7-712 – Solar PV Power Supply Systems.^[13]
- IEC 62930 – Electric Cables for PV Systems.
- NEC 690 – Solar Photovoltaic Systems.^[14]
- DOE Philippines Renewable Energy Guidelines.^[15]
- PCAB Safety Regulations.^[16]

Compliance ensures 25-year warranty validity.



CLIENT CHECKLIST

Inspection checklist for client reference:

- Correct cable type (TÜV/IEC rated)
- Voltage drop < 1.5 %
- Labels legible
- Roof penetrations sealed
- DC/AC paths separated
- Conduits intact
- Thermal scan complete



CONCLUSION

Cabling defines system reliability. Every Solaren installation applies engineering discipline: no shortcuts, no hidden faults.

Proper cabling is invisible when it works, unforgettable when it fails. Solaren's systems deliver safety, performance, and trust for decades.



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Photos and figures: Solaren Project Archive
(2018–2025)

MEDIA



Video showing DC cable arcing at a solar Farm. Credit: SparkyNinja

RELATED READING

1. Why Compliance Matters for Your Commercial Solar Installation in the Philippines?