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The Invisible Infraestructure of Solar Energy:

safety, efficiency and service life of Photovoltaic Projects in Latin America.



Nexans



A new Scale for Solar Energy

The energy transition in Latin America has reached a turning point: photovoltaic projects have evolved from pilot initiatives and small plants into utility-scale installations with capacities of hundreds of megawatts, many of which are already integrated with battery energy storage systems (BESS). Thanks to its abundant solar radiation—particularly in the Atacama Desert, northeastern Brazil, northern Mexico, and the Peruvian coast—Latin America is exceptionally well positioned to lead clean energy generation on a global scale.

However, this rapid maturation presents a technical and economic paradox: while the pressure to reduce the Levelized Cost of Energy (LCOE) and maximize returns focuses attention on panels and inverters, the direct-current and alternating-current (DC/AC) electrical infrastructure—the plant's "nervous system"—is often treated as a commodity, selected primarily on the basis of cost per meter.

Although it accounts for only 1% to 2% of CAPEX, a failure in photovoltaic cabling can disrupt the entire operation, reduce the performance ratio, increase OPEX, and cause critical hazards such as electrical arcs or fires.

This paper argues that the success, safety, and profitability of a solar project over 25 to 30 years depend not only on solar irradiation or the modules themselves, but also on robust electrical infrastructure supported by safety and ergonomic solutions, designed from the outset to meet the actual conditions of the site.

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1. Solar Expansion in Latin America and New Technical Requirements

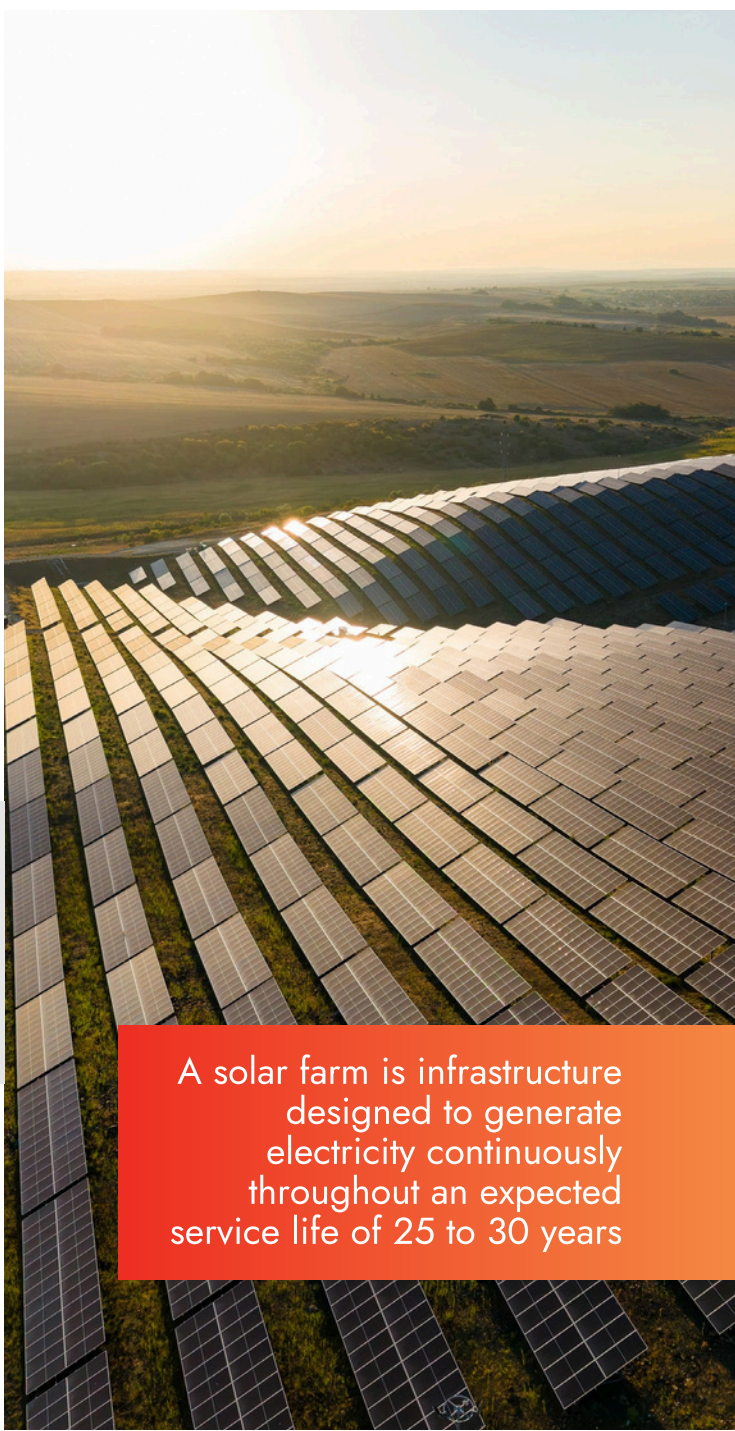
Solar photovoltaic energy in Latin America is no longer merely a complementary alternative; it has become a pillar of socioeconomic development and industrial decarbonization. According to the International Renewable Energy Agency (IRENA), installed solar photovoltaic capacity in Latin America and the Caribbean grew rapidly over the past decade, exceeding 50 GW of cumulative capacity, driven by large-scale developments in Brazil, Chile, Mexico, Peru, and Colombia[1].

This expansion has reshaped the electrical architecture of photovoltaic plants, driving two prevailing technical trends:

- **Transition from 1,000 V DC to 1,500 V DC architectures.** This shift improves efficiency and reduces electrical transmission costs within solar fields by enabling longer strings, fewer combiner boxes[2], less parallel cabling, and lower Joule-effect losses.

- **Use of high-power modules and single-axis trackers.** Bifacial and large-format modules (>600 Wp) increase string currents, requiring greater current-carrying capacity and thermal performance. At the same time, trackers subject cables to torsion, dynamic bending, and abrasion for more than two decades.

In this context, a project's financial indicators (IRR or NPV) no longer depend solely on the initial cost of components, but also on the system's resilience over time.



A solar farm is infrastructure designed to generate electricity continuously throughout an expected service life of 25 to 30 years

[1]IRENA (International Renewable Energy Agency): Renewable Capacity Statistics 2024. Data on the growth of installed photovoltaic capacity in Latin America and the Caribbean.

[2]Strings: groups of solar panels connected in series. Combiner boxes: enclosures that combine several strings to consolidate cabling before the inverter.

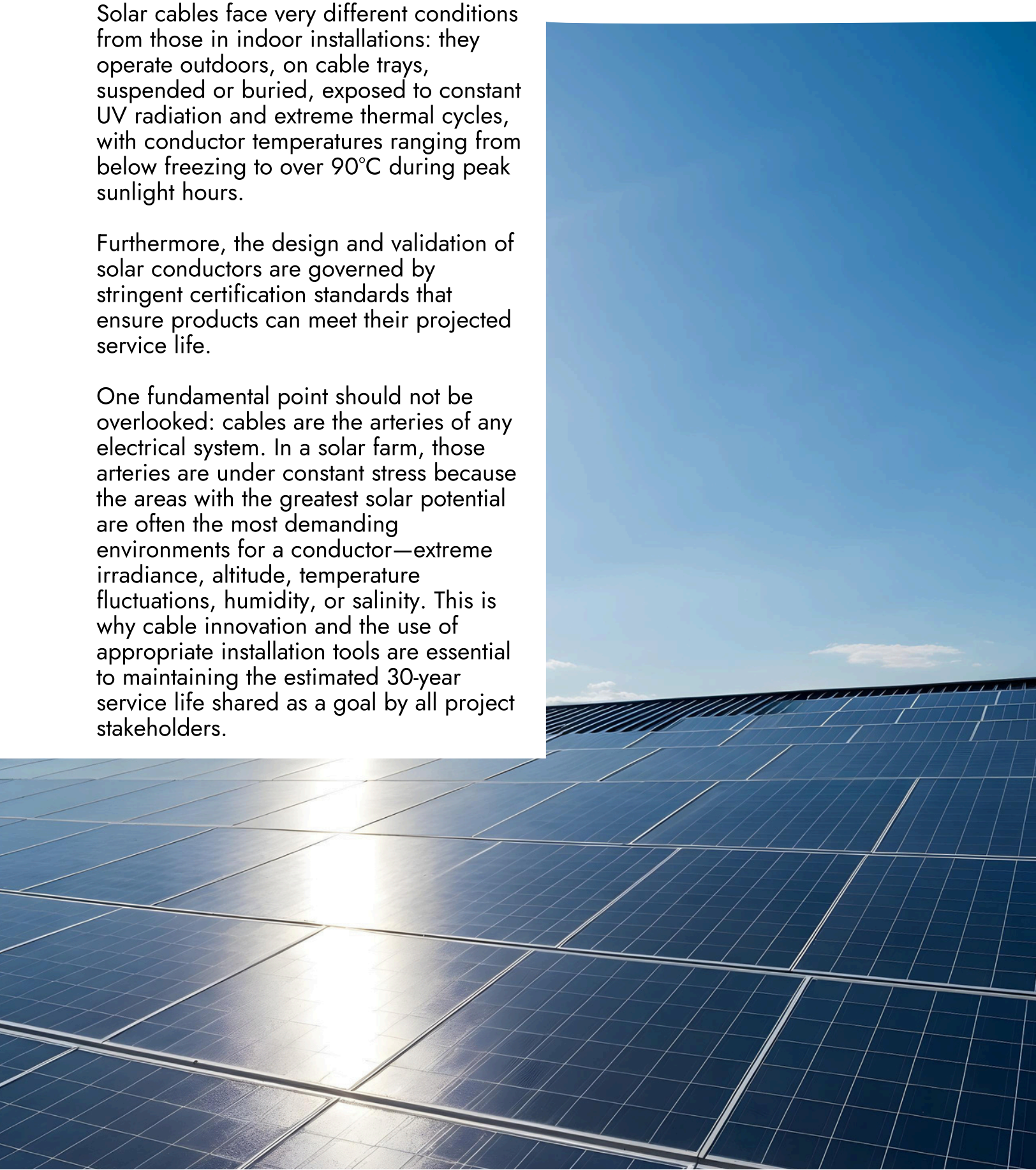
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2. Solar Cables: Photovoltaic Connectivity

Solar cables face very different conditions from those in indoor installations: they operate outdoors, on cable trays, suspended or buried, exposed to constant UV radiation and extreme thermal cycles, with conductor temperatures ranging from below freezing to over 90°C during peak sunlight hours.

Furthermore, the design and validation of solar conductors are governed by stringent certification standards that ensure products can meet their projected service life.

One fundamental point should not be overlooked: cables are the arteries of any electrical system. In a solar farm, those arteries are under constant stress because the areas with the greatest solar potential are often the most demanding environments for a conductor—extreme irradiance, altitude, temperature fluctuations, humidity, or salinity. This is why cable innovation and the use of appropriate installation tools are essential to maintaining the estimated 30-year service life shared as a goal by all project stakeholders.



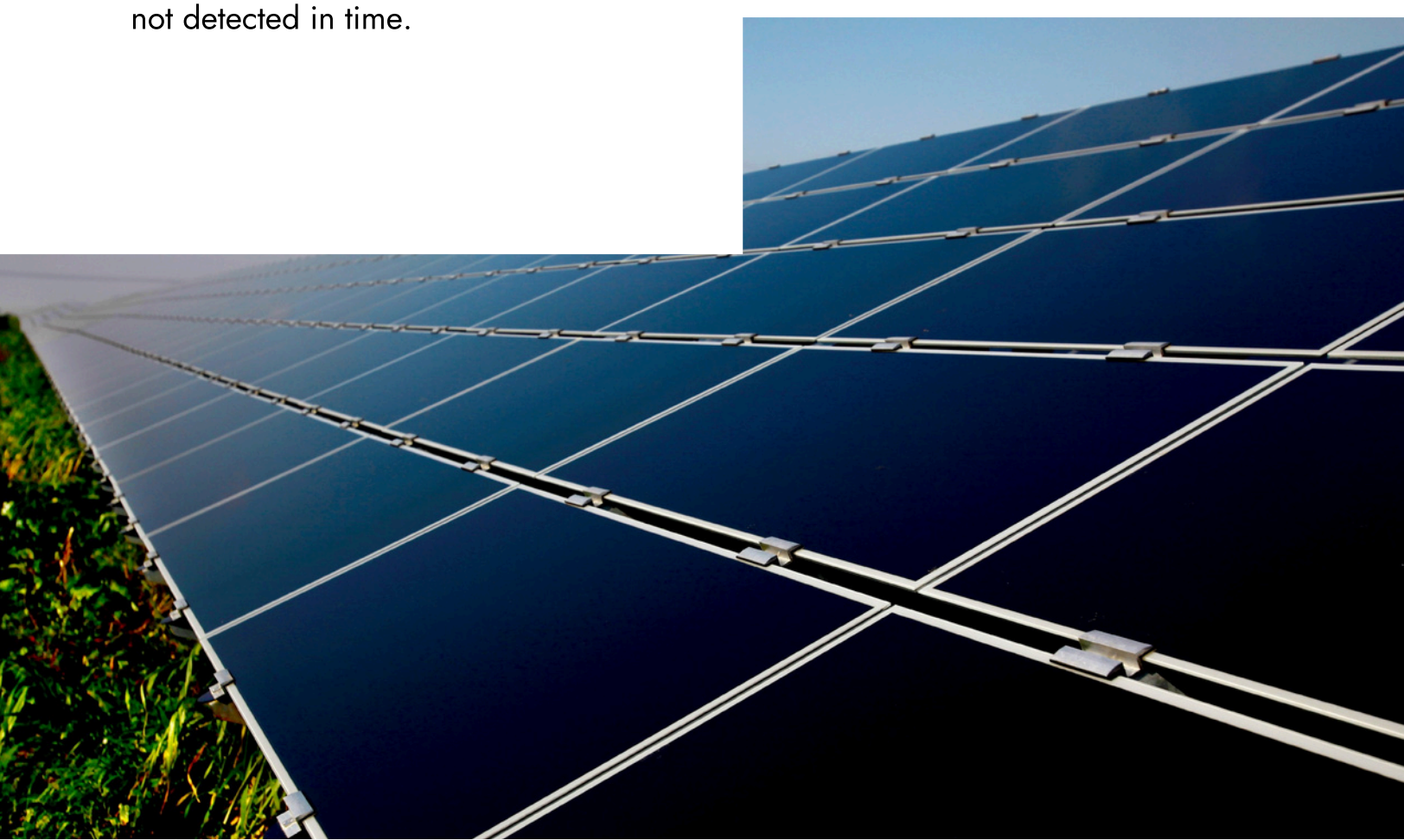
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3. The True Cost of "Underdesign": Risks, Failures, and Unplanned Losses

In the financial assessment of a solar plant, the savings gained by purchasing uncertified conductors or sizing cable cross-sections at the minimum allowable limit often disappear rapidly after the first operational failure.

Studies by TÜV Rheinland and the National Renewable Energy Laboratory (NREL)[3] associate a large share of serious photovoltaic failures and fires with the electrical Balance of Plant: faulty connections, deterioration of DC insulation, and electrical arcs that are not detected in time.

Non-cross-linked cables or cables with PVC/thermoplastic sheaths age prematurely under UV exposure and heat. Cracks allow water ingress, cause ground-insulation faults, and trigger the protective systems of centralized inverters, disconnecting sections of the solar farm during periods of high solar irradiation.



4. Climate, Geography, and Extreme Operating Conditions in Latin America

Latin America is home to some of the world's most challenging environmental conditions for electrical engineering. Generic specifications developed for moderate climates are inadequate when applied to the region's microclimates.

4.1. Atacama Desert and Andean Altiplano (Chile, Peru, Bolivia)

Extreme UV radiation and record irradiance. The Atacama Desert records some of the world's highest levels of global horizontal irradiance (GHI) and direct normal irradiance (DNI), exceeding 3,500 kWh/m^2 per year[4]. This intense photon radiation rapidly degrades polymers that lack advanced chemical additives.

High altitude (>3,000 meters above sea level).
At high elevations, lower air density decreases the heat-dissipation capacity of conductors and reduces insulation clearances intended to prevent corona discharge and dielectric breakdown in equipment.

Daily temperature fluctuations.
Extreme day–night cycles cause longitudinal expansion and contraction in solar cables; without adequate flexibility or expansion loops, they can disconnect panel connectors or place stress on inverter terminals.



[3]TÜV Rheinland / NREL (National Renewable Energy Laboratory): Risk Management for Photovoltaic Power Plants. Technical reports on root-cause analyses of mechanical failures, electrical arcs, and fires in utility-scale photovoltaic plants.

[4]Global Solar Atlas / World Bank Group: Solar Resource Data for Latin America. Data on global horizontal irradiance (GHI) and direct normal irradiance (DNI) for the Atacama Desert and Andean highland regions.

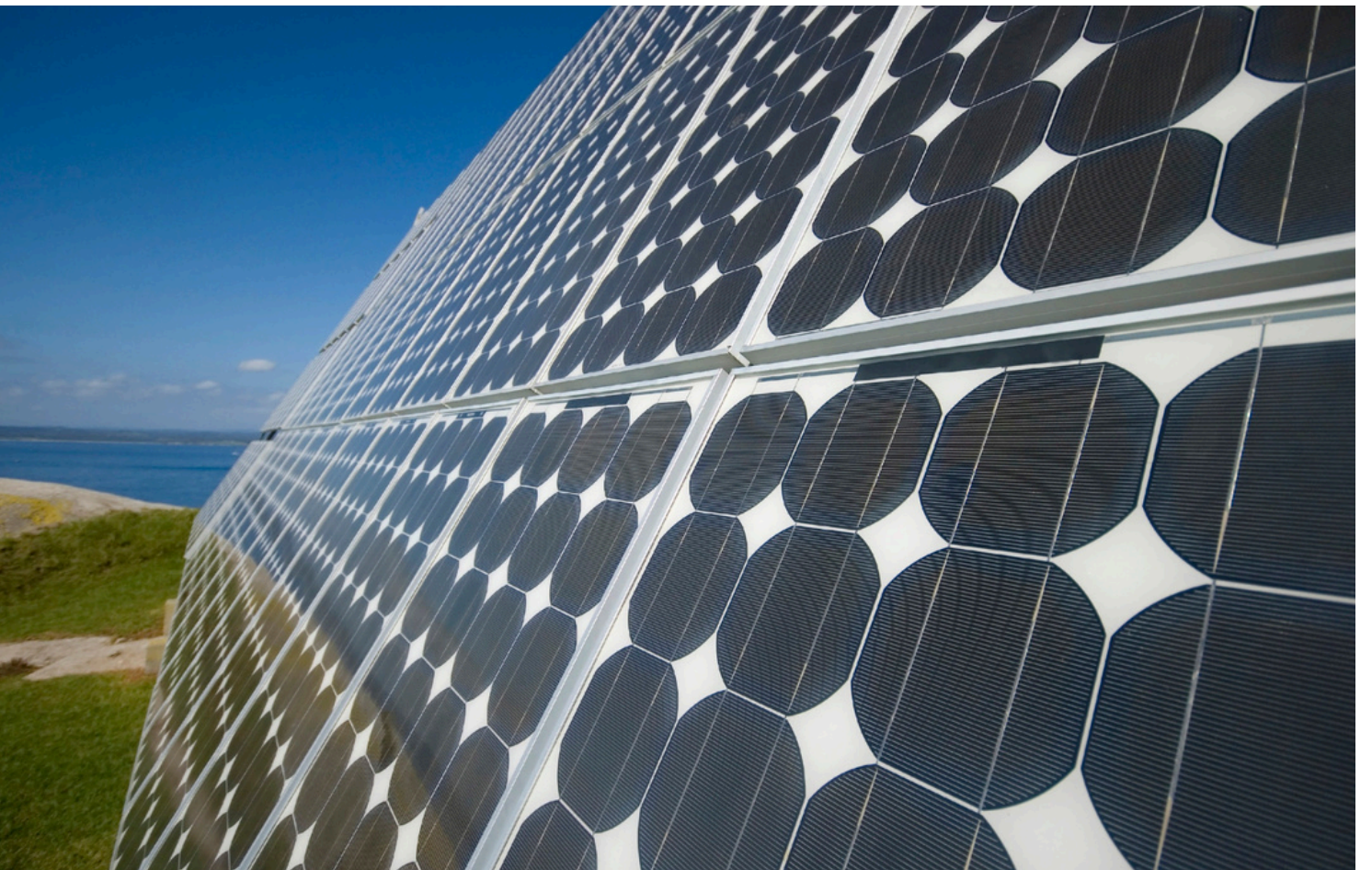
4.2. Tropical, Humid, and Continental Environments (Brazil, Colombia, Central America, Mexico)

Hydrolysis and prolonged immersion. In high-humidity climates, condensation in trenches and cable trays requires cables with AD8 water resistance to withstand permanent immersion without degradation of their mechanical or dielectric properties.

Microbiological attack and rodents. Polymeric sheath materials must incorporate additives that resist fungal and bacterial attack as well as damage caused by local wildlife, which often uses cable conduits for nesting or as a food source

4.3. Coastal and Industrial Areas

Saltwater and industrial corrosionl. Moisture, sea salts, and chemical agents degrade unprotected copper connections. High-purity tinned copper conductors are therefore critical to preventing sulfation and electrochemical degradation.



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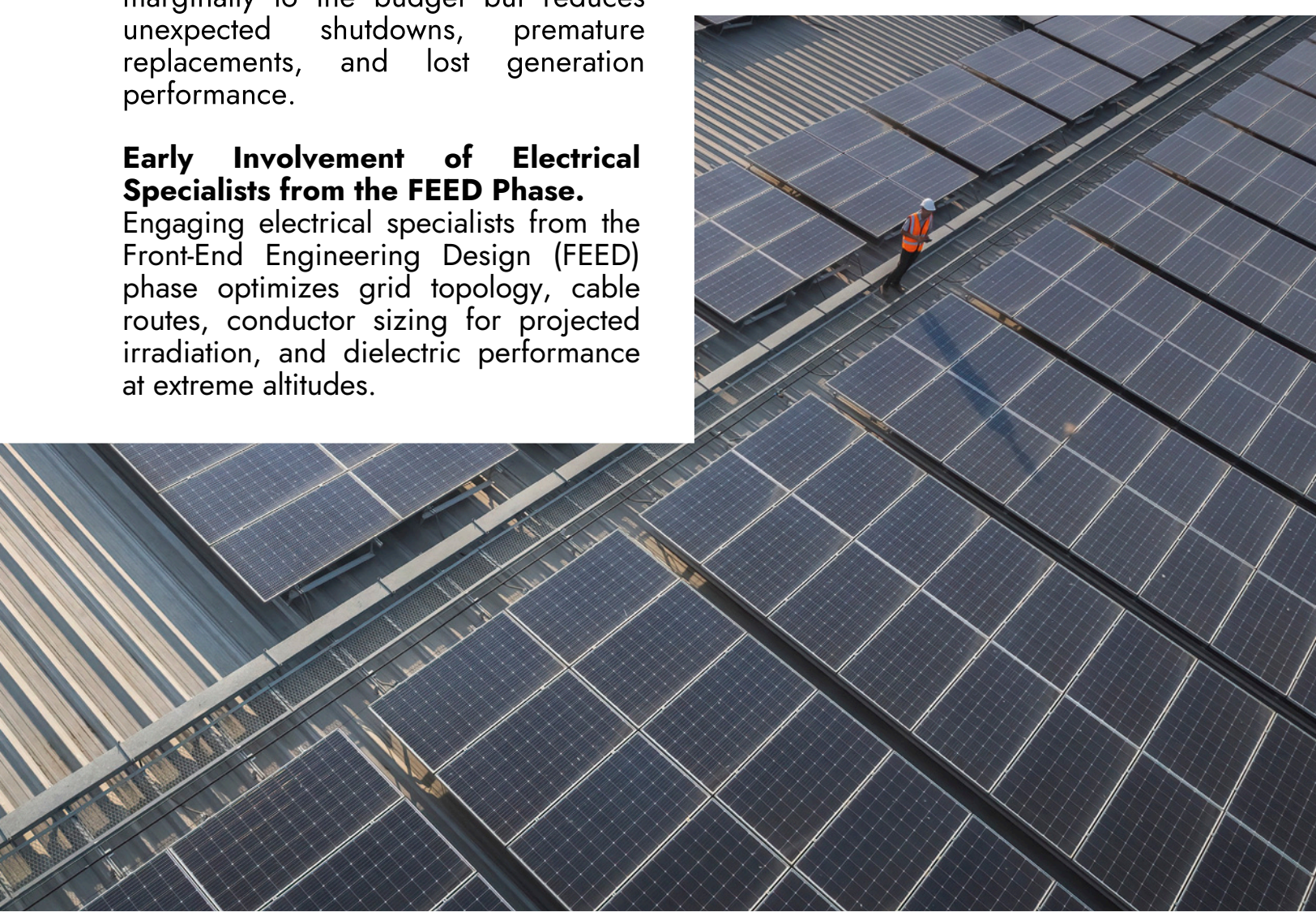
5. Safe, Efficient, and Financially Viable Photovoltaic Projects

To move beyond reactive purchasing based solely on the initial price per meter, project developers, independent consultants (Lender's Engineers), and EPC contractors must rethink their contractual and technical strategies for the electrical Balance of Plant.

Specifications Based on Total Cost of Ownership and Operational Efficiency
Procurement must shift from an exclusive focus on CAPEX to Total Cost of Ownership (TCO) through life-cycle costing: optimizing DC conductor cross-sections or using more highly cross-linked thermoset insulation adds only marginally to the budget but reduces unexpected shutdowns, premature replacements, and lost generation performance.

Early Involvement of Electrical Specialists from the FEED Phase.
Engaging electrical specialists from the Front-End Engineering Design (FEED) phase optimizes grid topology, cable routes, conductor sizing for projected irradiation, and dielectric performance at extreme altitudes.

Safety and Ergonomics for Technical Personnel.
With this approach, Nexans has developed four key solutions designed to enhance ergonomics, safety, and efficiency during solar farm installation:



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All-Terrain Mobile Workstation

The Mobiway™ Solar Kart L makes the installation of Nexans Solar Premium cable for DC connections safer and more efficient. It simplifies transport from the warehouse, eliminates the need to cut and lay cable on the ground—helping prevent damage—and speeds up installation. It boosts productivity by incorporating a charging point, tool storage, a safety kit, a hydration system, and lighting for nighttime work





Physical Assistance Exoskeleton

As part of the safety kit, the exoskeleton helps reduce fatigue and improve efficiency in repetitive activities involving work with the arms raised above shoulder level, such as lifting, transporting, and connecting panels and installing metal structures.

Protective Shoulder Pads

These reduce fatigue and the risk of injuries to the neck, shoulders, and face. They also help limit potential cable damage when pulling-tension limits are exceeded and improve installation efficiency.





Cable-Guide Roller Kit for Optimized Cable Laying

This kit facilitates the installation of low- and medium-voltage cables in solar farms by keeping them off the ground, reducing friction and potential damage. It increases installation efficiency, reliability, and productivity while minimizing future failures and the costs associated with downtime and maintenance.

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Conclusion: The Strategic Decision in the Balance of Plant

Solar photovoltaic generation is reaching technological and industrial maturity in Latin America. In a market where panels and inverters deliver only marginal efficiency improvements, neglecting the electrical Balance of Plant undermines the reliability of the entire facility.

DC cables, interconnection harnesses, medium-voltage lines, and safety and ergonomic solutions are not expendable costs: they are strategic assets for availability, efficiency, and safety. Their reliability turns 30 years of projected generation into actual financial returns and safeguards the region's clean electricity supply.

Nexans aims to be a comprehensive partner in solar electrification—with global technology and six industrial plants in the region, operating through INDECO by Nexans in Peru, MADECO by Nexans in Chile, CENTELSA by Nexans in Colombia, and Nexans in Brazil—to ensure financial viability and competitiveness from conceptual engineering through long-term operations.

That is why we highlight three strategic decisions that will shape the solar farm of the future:



1 Specify electrical infrastructure based on its impact on LCOE and life-cycle costs (TCO).

Moving beyond selection by purchase price per meter and incorporating 30-year analyses of voltage drop and polymer aging helps ensure operational continuity.

2 Industrialize on-site installation through pre-connectorized, safety, and ergonomic solutions

Adopting factory-proven, plug-and-play innovations to shorten construction timelines and eliminate on-site failures helps protect return margins.

3 Involve electrical specialists from the early engineering stages (FEED).

Designing 1,500 V DC architectures with rigorous consideration of site microclimates, altitude, UV radiation, and sustainability requirements helps prevent shutdowns and operational failures.

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References:

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[4]Global Solar Atlas / World Bank Group: Solar Resource Data for Latin America. Data on global horizontal irradiance (GHI) and direct normal irradiance (DNI) for the Atacama Desert and Andean highland regions.

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Martha Sepúlveda
martha.sepulveda@nexans.com