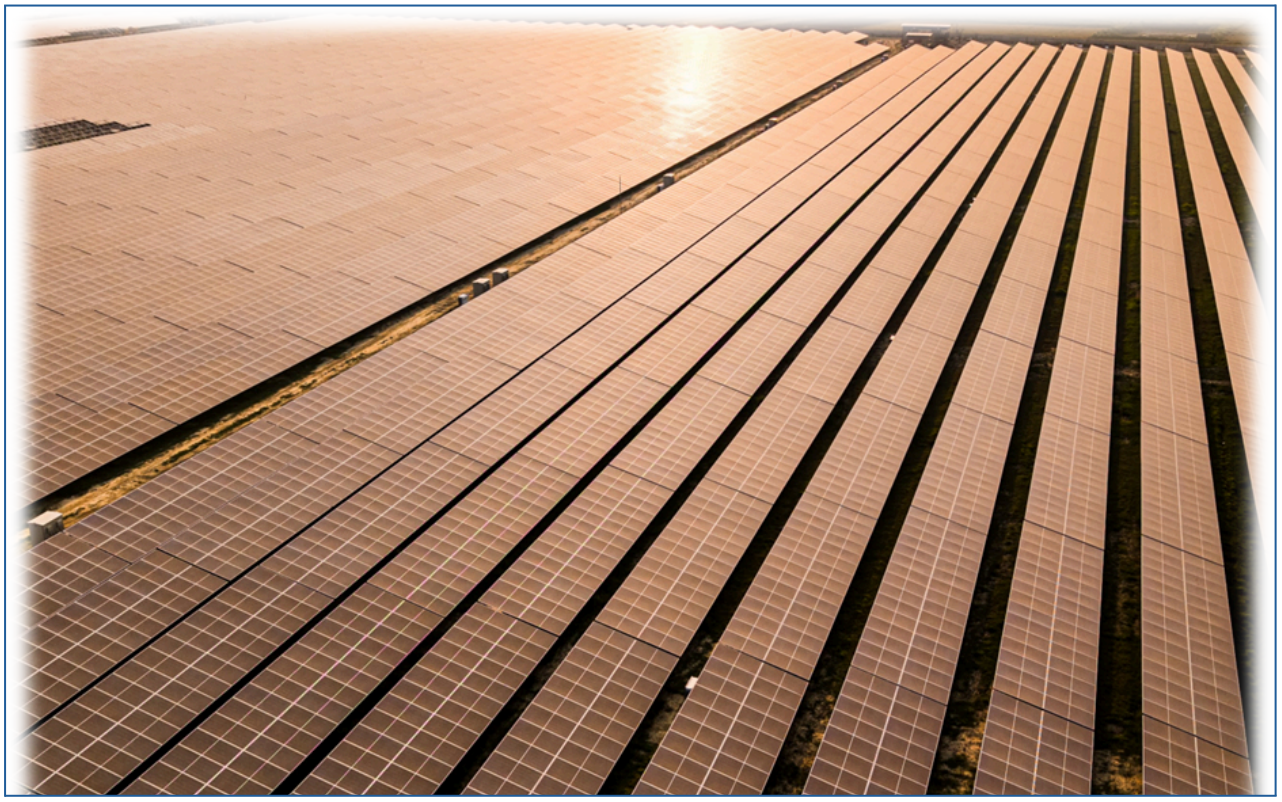
SOLAR POWER IN NEPAL:
THE NEXT PILLAR OF ENERGY SECURITY, RESILIENCE & ECONOMIC TRANSFORMATION

*By **Dr. Sandip Shah** – President, **Solar Power Producers Association Nepal (SOPPAN)***



1. Nepal's Solar Sector: A Turning Point in the National Energy Narrative

Nepal's power system has historically been shaped—and constrained—by its near-total dependence on hydropower. While hydropower remains the backbone of the Integrated Nepal Power System (INPS), the last decade has revealed a structural vulnerability: climate volatility is now directly influencing national energy security. Floods, landslides, GLOFs, and prolonged dry spells have repeatedly disrupted run-of-river and peaking plants, exposing the fragility of a single-resource system.

Against this backdrop, solar power has moved from the periphery to the center of Nepal's energy conversation. Today, **154 MW** of grid-connected solar is already operational, and nearly **1,000 MW** is under active development by Independent Power Producers (IPPs). More than **USD 150 million** has already been invested in Tier-I solar assets, with an additional **USD 1.5 billion** expected within the next three years.

This is no longer a pilot phase. It is the beginning of a structural shift in Nepal's electricity supply architecture.

2. SOPPAN: The Institutional Backbone of Nepal's Solar IPPs

The **Solar Power Producers Association Nepal (SOPPAN)**, established in January 2023, has rapidly become the authoritative voice of Nepal's grid-connected solar industry. SOPPAN represents the collective interests of solar IPPs, advocates for predictable and transparent regulation, and champions the adoption of Tier-I technologies and global best practices.

SOPPAN's mandate extends beyond advocacy. It is shaping the strategic direction of Nepal's energy diversification, supporting the country's net-zero commitments, and ensuring that solar development is technically robust, financially viable, and environmentally responsible. Through continuous engagement with MoEWRI, NEA, ERC, DoED, AEPC, NPC, and development partners, SOPPAN is helping define the contours of Nepal's future energy system.

3. Nepal's Solar Potential: A Resource of Continental Scale

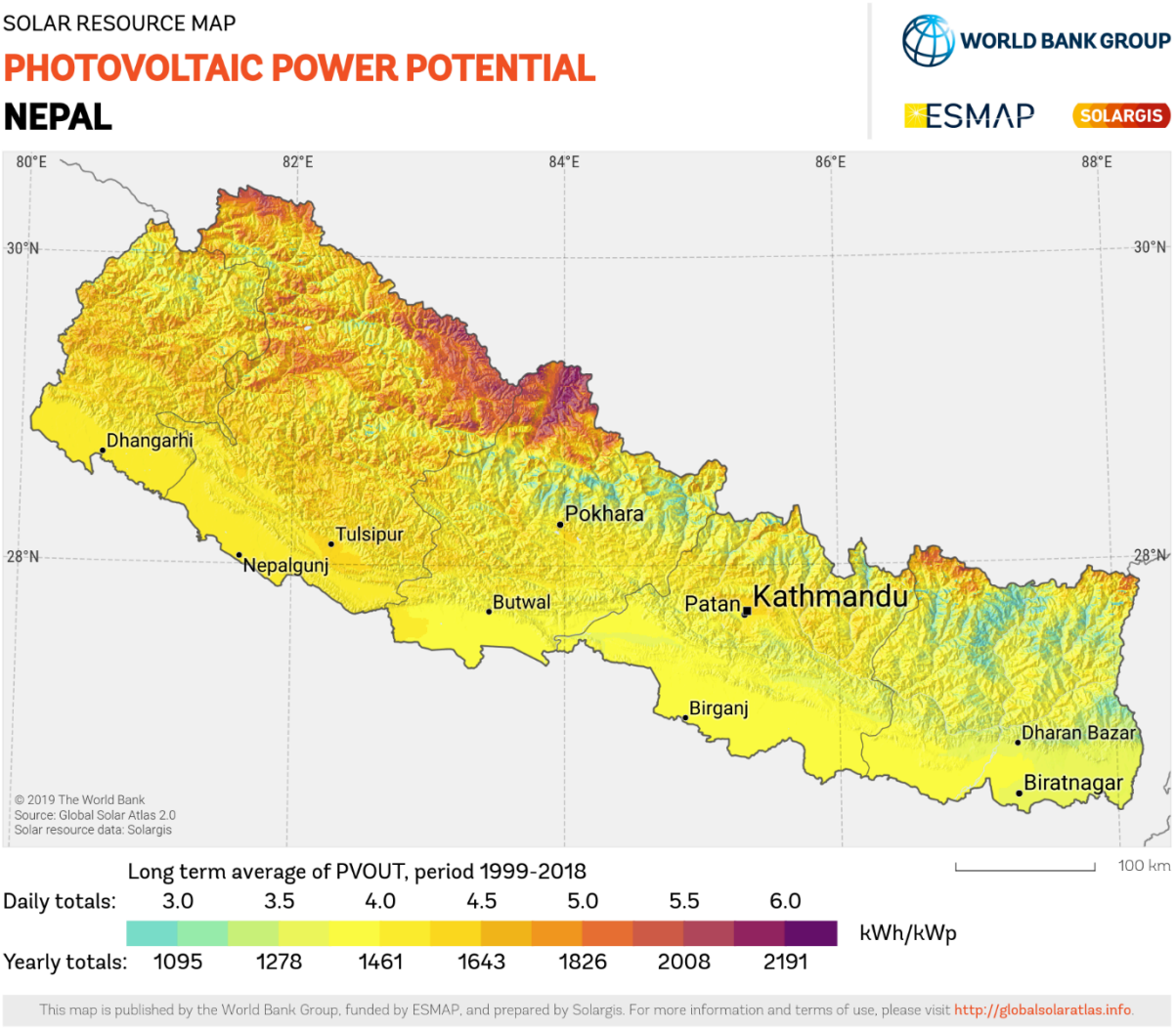


Figure 2: Nepal's average insolation of 4.7 kWh/m²/day positions it among South Asia's most solar rich geographies.

Nepal's solar resource is extraordinary. With **4.7 kWh/m²/day** of average insolation and nearly **300 sunny days** annually, Nepal possesses one of the most favorable solar profiles in the region. A GIZ-supported study estimates Nepal's theoretical technical solar potential at **432 GW**—ten times greater than its techno-economically viable hydropower potential of 42 GW.

SOPPAN's analysis indicates that **at least 10 GW** of solar can be developed without compromising food security. This can be achieved through barren land utilization, degraded land rehabilitation, agri-PV integration, canal-top and reservoir-top solar, and distributed generation across industrial rooftops.

Nepal's solar potential is not just abundant—it is transformative.

4. Solar + Hydro: The Hybrid System Nepal Needs

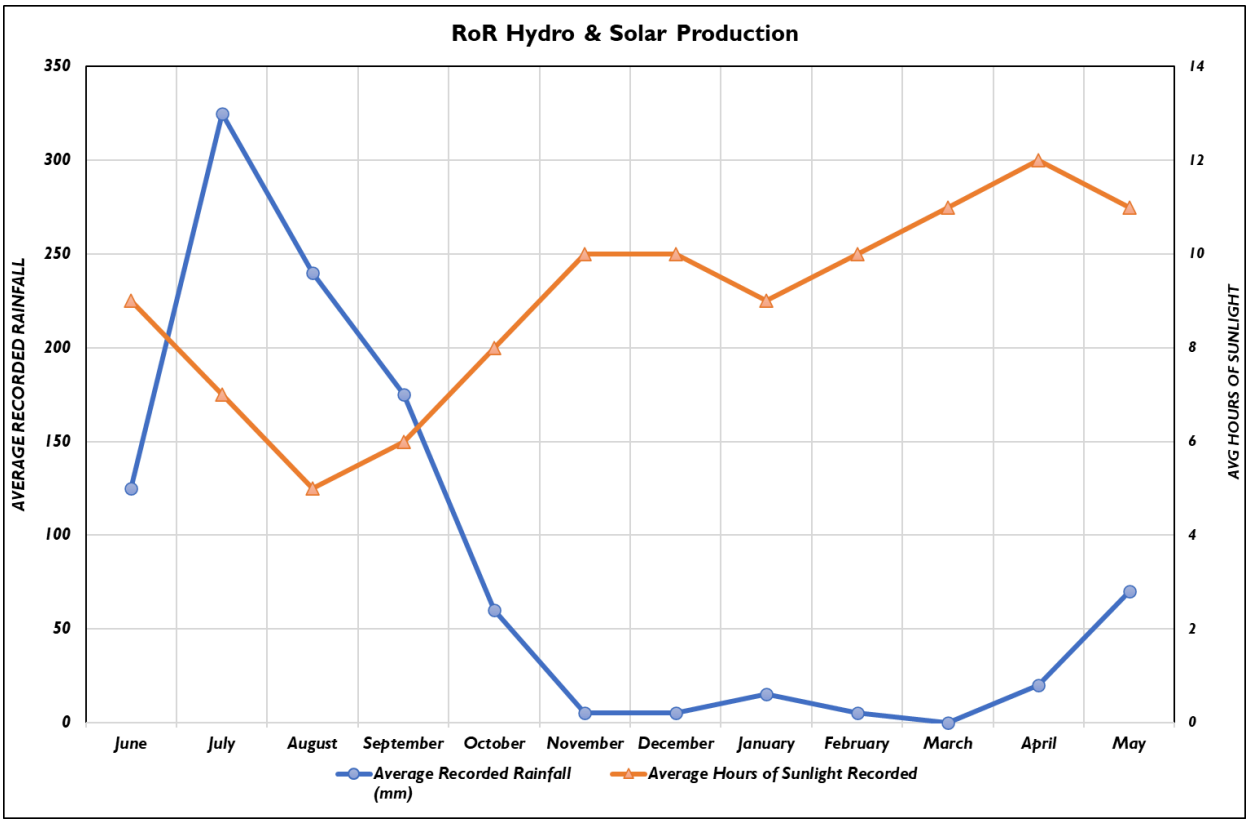


Figure 3: Solar generation peaks during the dry season, precisely when RoR hydropower output declines.

Hydropower and solar are not competing technologies; they are complementary assets in a modern grid. Hydropower suffers from seasonal variability, climate-driven outages, and long construction timelines. Solar, by contrast, delivers its highest output during the dry season, can be deployed within 12–18 months, and operates with zero fuel cost.

Simple RoR Plants can be complimented with Solar Plants on an annual basis as shown in Figure 3. PRoR Plants in tandem with solar plants can generate more firm power in the system since they can shut down or reduce generation during the daytime when the solar plants are operational, thus, providing much required energy in the evening peak hours (see Figure 4).

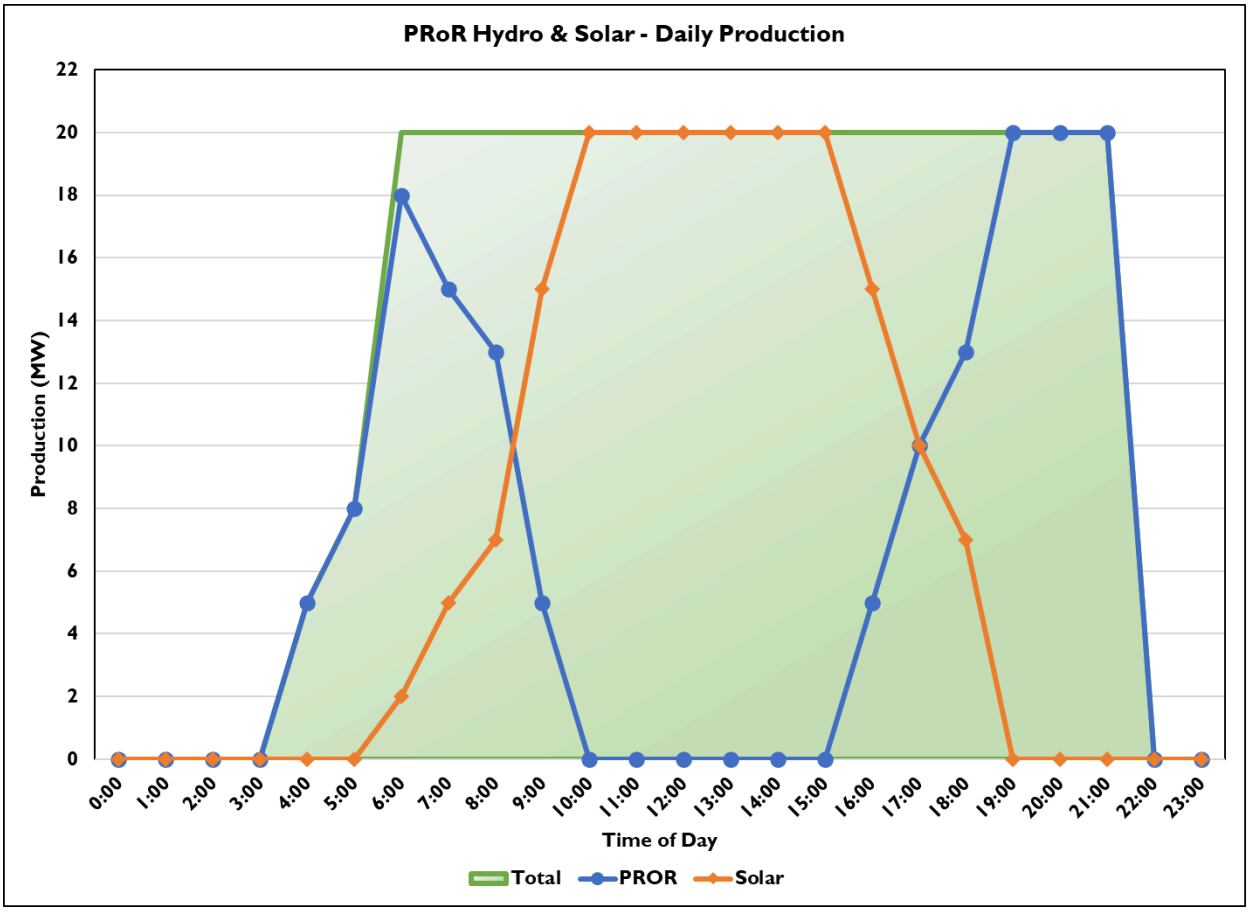


Figure 4: PRoR hydropower plants and solar plants can work in tandem to generate firm power throughout the day

A hybrid system offers profound advantages. Solar reduces daytime pressure on PRoR plants, allowing reservoirs to conserve water for evening peaks. This synergy enhances grid stability, reduces system stress, and increases Nepal's cross-border export potential.

Nepal's future is not "hydro vs solar." It is **hydro + solar + storage**, operating as a unified, resilient system.

5. Agri-PV: Dual-Use Land, Dual-Stream Value

Figure 5: Ginger and turmeric cultivation beneath solar modules in Western Nepal's Terai—an emerging model for dual use land.

Agri-PV represents one of Nepal's most promising innovations in land-use optimization. By enabling simultaneous agricultural production and electricity generation, Agri-PV increases farmer income, reduces irrigation evaporation, improves soil moisture retention, and enhances climate resilience.

SOPPAN members have already demonstrated successful cultivation of ginger, turmeric, and vegetables beneath solar modules. With appropriate policy support, Agri-PV can unlock thousands of hectares for productive dual use, turning land-use debates into land-use opportunities.

6. Battery Energy Storage Systems (BESS): The Missing Link in INPS Modernization

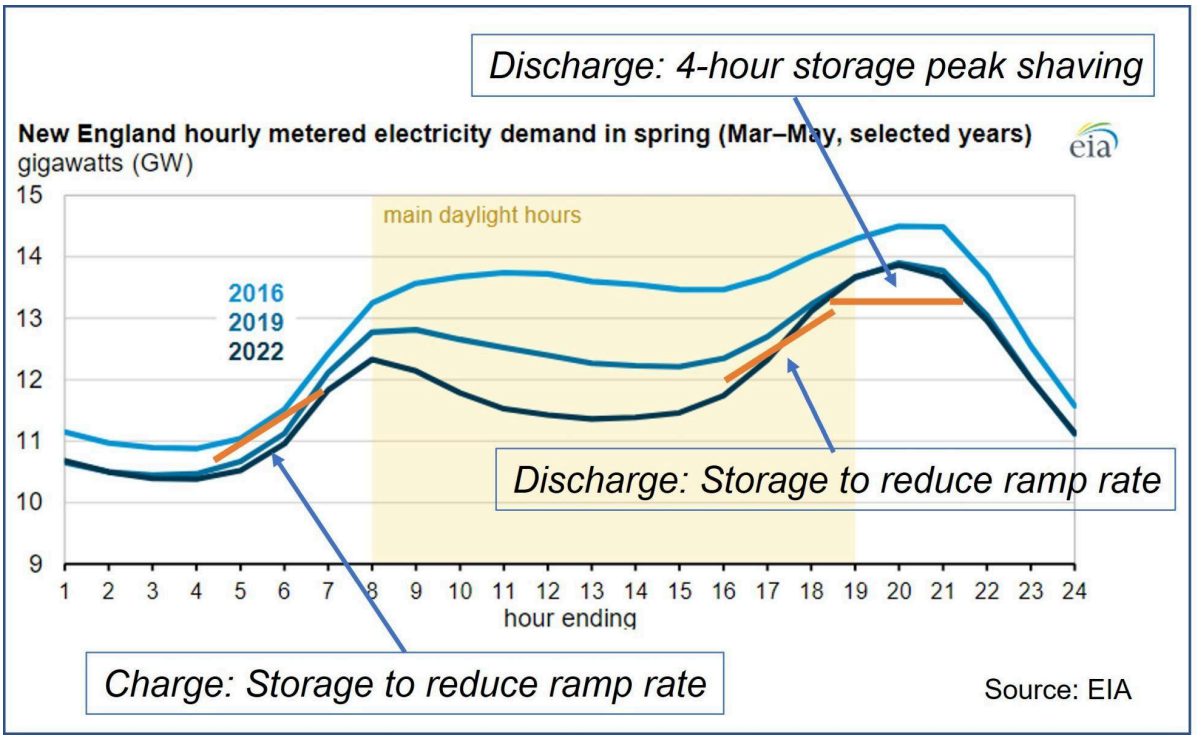


Figure 6: BESS enables peak shaving, ramp control, frequency regulation, and black start capability.

Battery Energy Storage Systems (BESS) are no longer optional—they are essential for a flexible, reliable, and future-ready INPS. BESS enables peak shaving, stabilizes solar output, provides frequency and voltage regulation, reduces curtailment, and enhances the value of cross-border electricity trading.

SOPPAN advocates that all new solar projects above a defined threshold incorporate BESS, supported by a financially viable tariff framework that reflects capital cost recovery, battery degradation, round-trip efficiency, and grid-service value.

With BESS, Nepal can transition from a hydro-dependent grid to a **hydro-optimized** grid.

7. Technical and Operational Risks in Solar Projects

Solar PV carries significantly lower catastrophic risk than hydropower, but it is not risk-free. Solar projects face risks such as module degradation, micro-cracks, inverter failures, transformer faults, hail and windstorm damage, lightning strikes, land disputes, right-of-way challenges, grid unavailability, and curtailment.

These risks can be effectively mitigated through Tier-I components, robust EPC standards, predictive maintenance, and a stable regulatory environment.

8. Structural Issues Constraining Nepal's Solar Sector

The solar sector continues to face several systemic challenges. Regulatory constraints include the 10 percent cap on solar in the national energy mix, the short 25-year PPA and generation license period, VAT inconsistencies, SCADA integration fees imposed on IPPs, inconsistent EIA thresholds, and delays in obtaining No-Objection letters from irrigation authorities.

Financial constraints arise from reverse-tariff auction pressures, high insurance premiums, the absence of a BESS tariff framework, and limited grid evacuation capacity. Technical constraints include curtailment during low-demand periods and the slow adoption of forecasting and scheduling protocols.

These issues are not merely administrative—they directly affect project viability and investor confidence.

9. Insurance: A Critical Barrier to Solar Bankability

Solar IPPs currently face insurance premiums that are misaligned with actual risk exposure. Property Damage (PD) premiums are set at 0.3 percent of CAPEX, and Loss of Profit (LOP) premiums at 0.375 percent of annual revenue. Hydropower projects, despite facing far greater catastrophic risks, pay significantly lower premiums.

SOPPAN has formally requested the Nepal Insurance Authority to revise these premiums to 0.15 percent for PD and 0.20 percent for LOP. A rational, evidence-based insurance regime is essential for improving project bankability and accelerating Nepal's clean-energy transition.

10. Environmental & Social (E&S) Considerations

Solar PV has one of the smallest environmental and social footprints among all energy technologies. Nevertheless, responsible development requires meaningful community engagement, equitable benefit-sharing, thoughtful land-use planning, biodiversity protection, and robust waste-management strategies. Solar projects also offer opportunities for gender-inclusive employment and local economic development.

SOPPAN promotes global best practices to ensure that solar development remains socially inclusive and environmentally sustainable.

11. The Future of Solar in Nepal's Energy Mix

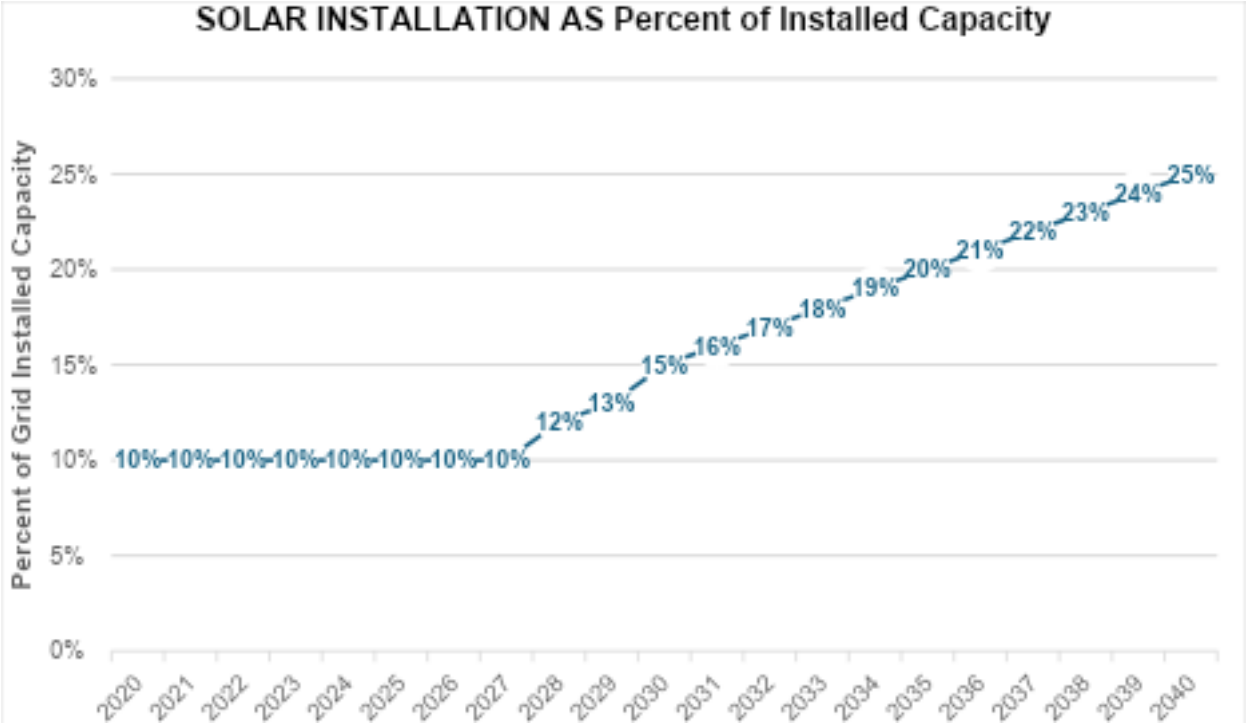


Figure 7: Projected contribution of solar to Nepal's Energy mix through 2030 and 2040.

Nepal's energy future will be shaped by hydropower for baseload and storage, solar for daytime and dry-season generation, BESS for flexibility and reliability, and cross-border trade for economic optimization. SOPPAN envisions solar contributing at least 10 percent of Nepal's energy mix by 2030 and 20–25 percent by 2040, supported by a long-term potential of 10 GW. This hybridized system will create a resilient, diversified, and affordable power supply for Nepal.

Conclusion: A New Energy Paradigm for Nepal

Nepal stands at a pivotal moment in its energy transition. Hydropower built the foundation of our electricity system, but solar will define its future. With the right policies and investments, Nepal can build a diversified, resilient, and affordable power system that strengthens the economy, enhances energy security, and positions the nation as a regional leader in clean energy.

SOPPAN remains committed to working closely with NEA, MoEWRI, ERC, DoED, AEPC, IPPAN and all stakeholders to realize this vision.