

No. NEPRA/SA(M&E)/LAD-11/ 3622 - 34

February 18, 2026

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Chief Executive Officer, Hazara Electric Supply Company (HAZECO), 426/A, PMA Link Road, Jinnahabad Abbottabad	Chief Executive Officer K-Electric Limited (KEL), KE House, Punjab Chowrangi, 39-B, Sunset Boulevard, Phase- II Defence Housing Authority, Karachi

Subject: Directions of the Authority – Study on the Technical/Financial Impacts of Distributed Solar Photovoltaic (PV) Integration on Distribution Utility Operations and Infrastructure

Owing to factors such as higher electricity tariffs from grid supply and load shedding caused by AT&C losses, Pakistan has witnessed a rapid increase in the adoption of on-grid and off-grid distributed generation (DG), particularly rooftop solar photovoltaic (PV) systems. While this trend advances energy access, affordability, and sustainability goals, it also presents significant financial and technical challenges for electric power distribution companies.

2. To facilitate the continued integration of solar distributed generation while safeguarding the financial viability and technical stability of distribution utilities, the Authority considers it necessary to conduct a comprehensive study on the technical and financial impacts of distributed solar photovoltaic (PV) integration on utility operations and infrastructure. The study will, among other aspects, focus on the following key areas:

- a) **Financial Impact** – Assessment of the impact of distributed solar generation on utility revenues, cost recovery mechanisms, cross-subsidies, and implications for the existing tariff structure.
- b) **Technical Impact** – Evaluation of the effects of DG penetration on distribution network performance, system reliability, power quality, protection schemes, and the condition and lifespan of distribution assets.
- c) **Policy and Regulatory Review** – Review of existing policies, regulations, and guidelines governing distributed generation, identification of gaps or inconsistencies, and formulation of actionable recommendations to enable the safe, reliable, and sustainable integration of DG.

The study shall aim to identify key challenges and propose practical, evidence-based solutions that ensure a balanced and mutually beneficial outcome for all stakeholders, including utilities, consumers, and the power system at large.

3. In this regard, while determining the Quarterly Adjustment for the 3rd Quarter of FY 2024-25, the Authority, vide its decision dated May 09, 2025, directed all DISCOs and K-Electric to undertake a comprehensive assessment of the financial and technical impacts of distributed solar PV integration on their respective distribution networks, operations, and infrastructure. Consequently, detailed Terms of Reference (ToRs) were drafted and shared with all stakeholders, and a consultative session was convened, during which all DISCOs and K-Electric provided their comments and inputs.

4. After thorough consideration of the feedback received from stakeholders, the Authority has approved the ToRs (copy enclosed) and has prescribed a timeframe of one hundred eighty (180) days for completion of the study. The Authority has further decided that each DISCO and K-Electric shall conduct the study independently, taking into account their respective network topology, load characteristics, and operational realities, by engaging a consultant of international repute in accordance with applicable procurement procedures.

5. In view of the above, the Chief Executive Officers of all DISCOs and K-Electric are hereby directed to take the lead in initiating the exercise without delay. All DISCOs and K-Electric shall submit a monthly progress report to this office by the 10th day of each succeeding month until the study is completed.

6. In case of any clarification regarding the ToRs or matters related to the subject study, the Additional Director (Distribution) may be contacted via email at (h.irfan@nepra.org.pk) or by phone: at 051-2013200(410) / cell: 0300-0664010.

7. The matter may be treated as Most Important.

Enclosure: As above


18.02.26
(Syed Zawar Haider)
Director

Copy to:

Secretary,
Ministry of Energy (Power Division),
Pak Secretariat, Islamabad [for information]

Study on the Technical/Financial Impacts of Distributed Solar Photovoltaic (PV) Integration on Distribution Utility Operations and Infrastructure

Preamble:

Due to multiple factors, including higher electricity tariffs from grid supply and unreliable service caused in part by Aggregate Technical & Commercial (AT&C) losses, there has been a rapid increase in the adoption of distributed generation (DG), particularly solar panels, across Pakistan. While this trend supports energy access and sustainability goals, it also presents significant financial and technical challenges for electric power distribution companies.

To support the continued integration of solar distributed generation (DG) systems without undermining the financial viability or technical stability of distribution companies, the company intends to commission a comprehensive study through an independent consultant or consulting firm. The study will focus on:

- a) **Financial Impact** – assessing the effects on utility revenues, cost recovery mechanisms, and the implications for the current tariff structure;
- b) **Technical Impact** – evaluating the influence of DG on network performance, reliability, and the condition of distribution assets; and
- c) **Policy and Regulatory Review** – examining existing policies and regulatory frameworks, identifying gaps, and providing actionable recommendations to enable the safe, reliable, and sustainable integration of distributed generation.

This study should aim to identify key challenges and propose actionable solutions that create a win-win scenario for all stakeholders involved.

A. Technical Assessment

Analyse the current penetration levels and spatial distribution of distributed generation (DG) systems across different consumer categories (residential, commercial, industrial).

Identify and evaluate technical challenges associated with DG integration, including:

- o Hosting capacity at feeder, transformer and phase levels
- o Creation of maps for future DG Installations
- o Voltage fluctuations and limit violations
- o Reverse power flow and associated protection coordination issues
- o Increased transformer loading and accelerated asset aging
- o Power quality disturbances (e.g., harmonics, voltage flicker, etc.)
- o Impacts on load forecasting accuracy and dispatch planning
- o Current interconnection practices and recommend revisions following IEC Standards
- o Real time generation tracking and system diagnostics

Assess the adequacy and effectiveness of existing interconnection standards and protocols for DG systems, and propose necessary updates or revisions to align with current and projected integration levels.

Propose practical and cost-effective technical solutions to support seamless DG integration, such as advanced inverter functionalities, targeted grid reinforcements, deployment of energy storage systems, and implementation of smart grid technologies.

B. Financial & Economic Impact Analysis

Evaluate the financial impact of increasing DG penetration on utility revenue streams and assess challenges related to cost recovery and fixed cost allocation.

Analyse the effects of DG integration on existing tariff structures, including the dynamics of cross-subsidization among consumer categories and the financial implications of mechanisms such as net metering.

Estimate potential revenue losses under multiple DG penetration scenarios (low, medium, high), taking into account projected growth in consumer adoption and technology costs.

Propose innovative financial tools and policy instruments to facilitate equitable cost-sharing of DG-related infrastructure upgrades and to monetize grid-support services provided by distributed energy resources.

C. Policy and Regulatory Framework Review

Examine current policies, regulations, and licensing conditions related to DG integration, including those established by NEPRA, PPIB, and individual distribution licensees. Identify areas of alignment, gaps, and inconsistencies.

Benchmark global best practices in DG integration, including interconnection standards, net metering, compensation mechanisms, and utility business model adaptations, with a focus on applicability to the local context.

Propose targeted revisions to interconnection codes, net metering regulations, and tariff design frameworks to enhance the safe, equitable, and financially viable integration of distributed generation within the national grid.

D. Off-Grid Solar PV Installations and Utility Impact

The study shall also assess the challenges associated with off-grid solar PV installations and their broader impact on utility operations, planning, and revenue.

The final report shall be developed with a balanced approach that safeguards the interests of all stakeholders, including utilities, consumers, regulators, and private sector participants—while promoting efficiency, transparency, and fair competition in the energy market.

E. Stakeholder Impact Assessment of Solar PV Penetration

The study shall comprehensively identify and evaluate the advantages and disadvantages of increased Solar PV penetration for all key stakeholders. These include the utility, distributed generation (DG) system owners/installers, non-DG consumers, the national exchequer, and other relevant market participants.

The assessment will adopt a balanced and objective approach, ensuring that the benefits and potential drawbacks are fairly analysed from multiple perspectives.

The goal is to provide actionable insights that support informed decision-making while promoting equitable outcomes, grid stability, and long-term sustainability of the power sector.

F. Duration:

The study shall be completed within 180 calendar days from the date of commencement

G. The consultant or firm must have:

- Proven experience in electricity market modelling, tariff design, and load forecasting.
- Past work in the energy sector studies, preferably in developing economies.
- Multidisciplinary team comprising power system analysts, economists, tariff specialists, and data scientists.