OFFICE OF THE REGISTRAR

NATIONAL ELECTRIC POWER REGULATORY AUTHORITY
ISLAMIC REPUBLIC OF PAKISTAN
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Subject: **Directions of the Authority – Feasibility Study for Replacing or Supplementing High AT&C Loss Rural Feeders with Off-Grid Renewable Energy Solutions**

Pakistan's power distribution sector, particularly in Sindh, Baluchistan, Khyber Pakhtunkhwa, and southern Punjab (MEPCO), continues to experience high Aggregate Technical and Commercial (AT&C) losses. In urban areas, these losses are primarily due to weak governance, poor management, and inadequate enforcement by DISCOs. In rural areas, losses are compounded by governance challenges, outdated infrastructure, long feeders, electricity theft, and low population density, rendering many feeders commercially unviable.

2. Despite directives prohibiting AT&C loss-based load shedding, DISCOs, including K-Electric, continue indiscriminate load shedding, adversely affecting paying consumers and increasing financial burdens on the sector.

3. To address this, a differentiated approach is required, one that ensures continuous electricity supply for consumers while maintaining the financial viability of DISCOs. Off-grid renewable energy solutions, such as solar and/or wind mini-grids or standalone systems, provide a viable alternative, especially in rural, high-loss areas where grid extension is economically impractical. These solutions can enhance energy access, reduce technical and commercial losses, improve service quality, and alleviate financial pressures on DISCOs.

4. Accordingly, the Authority has mandated a comprehensive feasibility study to be conducted by QESCO, HESCO, SEPCO, PESCO, TESCO, and MEPCO (with K-Electric participation optional) to evaluate the technical, financial, and socio-economic viability of off-grid renewable solutions for high-loss rural feeders. The finalized Terms of Reference (ToRs) (copy enclosed), developed after stakeholder consultations, prescribe a 180-day timeframe for completion.

5. CEOs of the respective DISCOs are directed to lead the study, engage an internationally reputed consultant in accordance with procurement rules, and submit monthly progress reports by the 10th day of each month until the study's completion.

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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

18.12.26

(Syed Zawar Haider)
Director

Copy to:

Secretary,
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Feasibility Study for Replacing or Supplementing High AT&C Loss Rural Feeders with Off-Grid Renewable Energy Solutions

Preamble:

Pakistan's electric power distribution and supply sector—particularly in the provinces of Sindh, Balochistan, Khyber Pakhtunkhwa (KP), and parts of southern Punjab served by the Multan Electric Power Company (MEPCO)—continues to face significant challenges due to high Aggregate Technical and Commercial (AT&C) losses.

2. While AT&C losses are present in both rural and urban areas, their root causes differ. In urban areas, these losses are primarily driven by weak governance, poor management, and inadequate enforcement by Distribution Companies (DISCOs). In contrast, rural areas suffer from a combination of poor governance and technical limitations, such as outdated, lengthy infrastructure and low population density. Rural feeders typically experience long distribution lines, elevated technical losses, frequent electricity theft, and low revenue recovery, rendering them commercially unviable for DISCOs.

3. All Distribution Companies (DISCOs), including K-Electric (KE), continue to implement load shedding based on Aggregate Technical and Commercial (AT&C) losses, despite clear directives from the National Electric Power Regulatory Authority (NEPRA) explicitly prohibiting this practice. NEPRA has not only issued binding orders against AT&C loss-based load shedding but has also concluded legal proceedings in several cases by imposing penalties on DISCOs and initiating further action for repeated non-compliance.

4. NEPRA's rationale is grounded in the fact that DISCOs enforce feeder-level load shedding without differentiating between non-paying consumers involved in electricity theft and those who pay their bills regularly and are not involved in electricity theft. Consequently, a large number of honest, law-abiding consumers are unfairly subjected to power outages due to the poor governance and operational inefficiencies of the DISCOs, despite having no role in the losses.

5. This indiscriminate approach severely undermines the quality of service, erodes public trust, and increases consumer dissatisfaction. It also exacerbates the broader financial and operational challenges plaguing the power sector. A further adverse consequence of this practice is the suppression of electricity demand growth, which worsens the underutilization of surplus 'Take-or-Pay' generation capacity—leading to inefficiencies and increased financial burdens on the sector and consumers alike.

6. In accordance with the Government of Pakistan policy, the duration of load shedding is proportionate to the level of AT&C losses. The table below outlines the prescribed hours of load shedding relative to various levels of AT&C losses:

AT&C Loss Level (%)	Load Shedding Duration (Hours/Day)
0–10%	0 hours
11–20%	2 hours
21–30%	4 hours
31–40%	6 hours
41–60%	8 hours
Above 60%	10 hours or more

7. Under the current AT&C loss-based load management policy, even law-abiding, bill-paying consumers in high-loss areas—regardless of their geographic location—are subjected to prolonged and

frequent load shedding. This indiscriminate approach not only hampers local economic development but also reinforces social and regional inequalities. It highlights the urgent need for targeted, data-driven solutions that promote fairness, improve service delivery, and ensure a more equitable and efficient power distribution system.

8. To eliminate the menace of AT&C (Aggregate Technical and Commercial) loss-based load shedding, a multipronged approach is required. This approach should differentiate between two categories of areas:

- Areas where AT&C losses stem primarily from poor governance, inefficient management, and underperformance by DISCOs (Distribution Companies).
- Areas where, in addition to DISCO inefficiencies, external and uncontrollable factors render electricity sales commercially unviable.

9. In the first category—where the supply from the national grid may be beneficial to DISCOs, but the inefficiency of the DISCO makes it unsustainable—there is a pressing need to strengthen governance. This can be achieved through targeted investments, strict monitoring, and performance-based accountability. Monthly targets should be set to bring down AT&C losses to acceptable levels, with regular evaluation of the performance of officers posted in these areas.

10. The performance of the Sub-Division In-charge should be directly linked to the AT&C loss levels on the feeders under their jurisdiction during their tenure. If an officer's record shows an increase in AT&C losses during their postings, strict penalties—up to and including termination from service—should be considered. Conversely, if the record reflects a significant reduction in AT&C losses, the officer should be duly recognized and rewarded. This performance-based accountability framework will incentivize better management and ensure greater responsibility at the field level.

11. In the second category—where power supply from the national grid is commercially unviable—alternative distribution strategies should be considered. With the rapid evolution and declining costs of renewable energy technologies, particularly solar and wind, there is a unique opportunity to explore decentralized, off-grid energy solutions as a sustainable alternative to grid-connected supply in these high-loss areas.

12. Off-grid solar or wind-based mini-grids, as well as standalone systems, can significantly improve energy access, reduce technical and commercial losses, enhance service quality, and ease the financial burden on DISCOs. These systems are especially suited for remote rural areas where extending or maintaining the grid is economically impractical.

13. To support a data-driven and strategic policy shift toward off-grid electrification of such loss-prone feeders, a comprehensive feasibility study is essential. This study should evaluate the technical viability, financial sustainability, and socio-economic impact of deploying off-grid renewable energy solutions in regions currently served by high-loss, commercially non-viable rural feeders. The results will provide a critical foundation for informed investment decisions, regulatory frameworks, and public-private partnership initiatives in the power sector.

Terms of Reference (ToR)

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Feasibility Study for Replacing or Supplementing High AT&C Loss Rural Feeders with Off-Grid Renewable Energy Solutions

1. Objective of the Study

To evaluate the technical, commercial, and socio-economic feasibility of replacing or supplementing grid-based electricity supply on high AT&C loss rural feeders with off-grid renewable energy systems. The goal is to provide reliable and affordable electric power to the consumers, minimize technical and distribution losses, eliminate electricity theft, ensure payment for electricity consumed, improve the financial health of DISCOs, foreign exchange savings to the national exchequer, and last but not least, to clean the environment by enhancing the usage of clean energy.

2. Scope of Work

2.1 Identification of High-Loss Rural Feeders

Each DISCO shall:

- Prepare a comprehensive list of rural feeders with high Aggregate Technical & Commercial (AT&C) losses over the past three years. Conduct a detailed trend analysis to evaluate the year-on-year AT&C loss patterns for each feeder, with a focus on identifying persistently high-loss areas and potential causes.
- Classify feeders based on rural/remoteness using geographical, demographic, and accessibility criteria.
- Document technical specifications for each feeder, including:
  - Total feeder length and branch-wise segmentation.
  - Number, location, and rating of distribution transformers.
  - GIS mapping of the complete feeder route and infrastructure.
- Compile village/town-level electricity details for each feeder:
  - Number of consumer connections by category.
  - Aggregate connected load and annual energy sales.
  - Recovery rate, billing efficiency, and commercial viability.
- Include any additional data required for a robust techno-commercial analysis.

2.2 Technical and Commercial Viability Assessment

- Quantify technical losses, commercial losses, and total AT&C losses.
- Assess energy input versus billed energy.
- Analyze operational and maintenance (O&M) costs, system downtime, and inefficiencies.
- Document applicable subsidies and cross-subsidies.

2.3 Consumer Profiling

- Conduct detailed consumer surveys across categories (residential, agricultural, commercial).
- Identify energy usage patterns, peak loads, willingness to pay, and affordability constraints.

2.4 Evaluation of Off-Grid Renewable Energy Options

- Assess the potential of solar, wind, hybrid systems, and battery storage using GIS and site-specific resource data.
- Develop feasible system configurations:

- Mini-grids
- Standalone solar systems
- Solar + battery systems
- Centralized battery charging stations
- Other innovative solutions based on local conditions

- Estimate:
  - Capital expenditure (CAPEX)
  - Operational expenditure (OPEX)
  - Levelized Cost of Electricity (LCOE)

2.5 Socio-Economic Impact Analysis

- Assess improvements in education, healthcare, livelihood, and local enterprises due to better electricity access.
- Evaluate job creation potential from the deployment and maintenance of renewable systems.

2.6 Stakeholder Engagement

- Engage with:
  - Local communities
  - Provincial and local governments
  - Regulatory authorities (e.g., NEPRA)
  - Renewable energy developers and investors
- Identify regulatory and institutional constraints.

2.7 Cost-Benefit Analysis

- Compare current grid-based supply costs (including losses) with proposed off-grid solutions.
- Include environmental, social, and economic externalities in the analysis.

2.8 Implementation Framework

- Develop a phased implementation roadmap for transitioning selected feeders to off-grid systems.
- Propose models for:
  - Public-private partnerships (PPPs)
  - Community-based operations
  - Financing (grants, loans, subsidies)
- Recommend necessary regulatory and policy interventions.

3. Methodology

- Utilize:
  - Data analytics and statistical tools
  - GIS and remote sensing
  - Consumer and stakeholder surveys
  - Field-level technical audits
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- Employ financial modelling for detailed cost-benefit and viability assessments.
  - Collaborate with all relevant stakeholders, including but not limited to the Government entities, Private sector entities, and development partners

4. Expected Outcomes

- A detailed feasibility report for each high-loss rural feeder.
- Recommendations on optimal off-grid solutions with associated technical and financial parameters.
- An actionable implementation plan with stakeholder roles, timelines, and investment requirements.

5. Way forward/Roadmap:

- A clear roadmap for transitioning from high-loss rural feeders to cost-effective off-grid solutions.
- Identification of priority feeders for pilot projects.
- Policy and regulatory recommendations to facilitate off-grid deployment.
- Enhanced service delivery and financial sustainability for DISCOs.

6. Duration:

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

7. 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.