

Terms of Reference (ToRs)

Part A)

1. Objectives:

The key objectives of the assignment are to:

- i. Determine technical losses at 132 kV, 66 kV, 33 kV, 11 kV, and 400/230 V levels using simulation-based load flow studies and validated field data.
- ii. Segregate technical and non-technical losses for accurate accountability.
- iii. Assess the impact of Distributed Energy Resources (DERs)/Solar PV Net Metering on loss estimation and energy accounting.
- iv. Develop validated network models, assumptions and benchmarks including benchmarking against peer and regional utilities as well as relevant international standards and best practices
- v. Recommend least-cost, technically feasible loss reduction measures, with quantified impacts over the investment horizon.
- vi. Provide analytical outputs and documentation suitable for regulatory review and approval by NEPRA.

2. Scope of Work

General Requirements

- i. The Firm shall employ internationally recognized engineering standards, validated methodologies, and industry-standard software tools (eg, PSS®E, Power-Factory, Synergi Electric, or equivalent).
- ii. All assumptions, data sources, adjustments, and limitations shall be clearly documented.
- iii. The Firm shall coordinate closely with HESCO and relevant system entities, the Independent System and Market Operator (ISMO), the National Grid Company (NGC), and other concerned organizations, for data validation and reconciliation.
- iv. The study shall be completed and submitted in accordance with timelines prescribed, including presentation and defense before the NEPRA.

3. Transmission Loss Evaluation

3.1. Data Provision by HESCO: shall provide, inter alia:

- i. Load and Energy Data:
 - Hourly Load Profile of selected feeders.
 - Month-wise Peak and Off-Peak load data
 - Energy import/export data at all Common Delivery Points (CDPs)
- ii. System Operational Snapshots: Required System snapshots (Peak & Off-Peak for each month) obtained from RCCs covering:
 - Line flows, transformer loadings, bus voltages, loads, etc.
 - Generator dispatch connected at ≤ 132 kV,
 - Capacitor status for peak/off peak conditions and ambient temperatures data
 - Recorded Transmission Losses
 - Any other essential operational data and record
- iii. Network and Asset Information:

- Network topology, single-line diagram, GIS grid coordinates/maps
 - transformer nameplate data, meter accuracy classes,
 - list of CDPs,
 - Any other essential data as required
- iv. Reference Network Model:
- Reference PSS&E or equivalent base case reflecting the actual network topology of the HESCO 132 kV transmission network and up to 11 kV buses of 132/11 KV grid substations for the relevant study year.
 - The base case shall incorporate and reflect all network changes occurring during the study year.

Note: The aforementioned transmission loss evaluation data shall be provided by the O/O DG (MIRAD). Furthermore, the scrutiny, authentication, and vetting of the transmission losses shall be ensured by O/O DG (MIRAD) on behalf of HESCO.

3.2 Responsibilities of the Firm:

The Firm shall

- i. Validate and reconcile all data and resolve inconsistencies.
- ii. Develop matched power-flow cases (Peak & Off-Peak for each month) for the 132 kV, 66 kV and 33 kV transmission network, including transformers up to 11 kV bus-bars.
- iii. Ensure accurate modeling of all system conditions in the load flow study cases including but not limited to:
 - Circuit status, transmission line flows, transformer parameters, taps positions, etc.
 - Voltage profiles, power factor, capacitor configurations,
 - Generator dispatch and load representation.
- iv. Determine monthly and annual transmission losses
 - MW losses from matched cases (Peak and Off peak) for each month,
 - Annual average MW loss (mean and standard deviation) based on the 24 values,
 - Annual Average Energy Loss (GWh) using
 - Regression-based best-fit curve ($R^2 \geq 0.90$), or
 - An equivalent superior methodology.
- v. Compare simulated losses with recorded losses and analyze variances.
- vi. Assess the impact of net-metering injections at grid stations and CDPs.
- vii. Recommend technically and economically viable loss reduction measures,

4. Distribution Loss Evaluation:

4.1 Data Provision by HESCO: HESCO shall provide

- i. Network Models and GIS Data:
 - GIS-mapped HT network models.
 - Synergi Electric (mdb) files along with latest supported data warehouse, consistent with the study year 2025-2026
- ii. Feeder Load and Performance Data
 - Actual load factors, and power factor of every feeder for study year
 - Feeder-wise loading data, including maximum and minimum current (Amps)

- Feeder categorization (Urban/Rural) for field validation.
- iii. Distribution Transformer (DT) Data
 - DT database with capacity, type, applicable standards, tagging/identification, and feeder wise allocation.
 - Any other essential data, files, or operational information required by the Firm for accurate modelling, field surveys, validation, and reconciliation of study results.

Note: The aforementioned Distribution loss evaluation data shall be provided by the O/O Chief Engineer (P&E). Furthermore, the scrutiny, authentication, and vetting of the Distribution losses shall be ensured by O/O Chief Engineer (P&E) on behalf of HESCO.

4.2 Responsibilities of the Firm:

The Firm shall conduct load flow analysis for calculation of distribution loss assessment covering HT lines, DTs, LT lines, and service cables by using the Synergi Electric software & GIS mapped models, while considering below but not limited to following:

i. HT Network Losses

- ❖ Validate and reconcile all GIS based data and resolve inconsistencies
- ❖ Use updated GIS mapped models of all 11 kV feeders showing main branches or T-offs with node-to-node connectivity
- ❖ Models shall include load currents peak hours for summer and winter for the base years as per recorded data at grids.
- ❖ Use total length of the feeders main, branches and inter-lengths between transformer with size and type of conductor and impedance per km.
- ❖ Use actual load factors of the feeders for the base years shall be considered along with actual load factors of the distribution transformers (where metering available).
- ❖ For benchmarking purposes, a few feeders' representative of the company-wide feeder mix shall be selected, preferably those with a complete metering tree available. These feeders will be used to ascertain the actual load factors and associated losses, compared against calculated values.
- ❖ The Firm shall review load loss factor (LLF) empirical formula and same shall be verified and validated with the latest research as well as field data back with any mathematical model. The validated LLF shall be applied on sample feeders along with comments, analysis and results submitted as part of study for review.
- ❖ Technical losses will be assessed and determined using LLF methodology and or any other better alternative option.

ii. Distribution Transformer Losses

- For the purpose of DT loss assessment, a separate assessment model shall be adopted to independently determine Iron (No-Load) Losses and Copper (Load) loss
- The Distribution Company shall establish and maintain a comprehensive and authenticated Distribution Transformer Database, incorporating, inter alia, the following classifications.
 - Transformer capacity ratings and tagging

- Type/category (Independent, General Duty) and tagging,
 - Feeder-wise allocation and tagging, and
 - Any other technical parameters
- Furthermore, the database shall distinctly categorize all distribution transformers into the following two groups for analytical and reporting purposes
 - Transformers procured and installed in accordance with valid and approved Standards and Specification, and
 - Transformers manufactured under earlier Standards and Specifications
- No-Load (Iron) losses based on applicable standard loss values corresponding to the above groups shall be assigned to each transformer. and off-loading factors/adjustment factor (planned and unplanned) shall be applied to reflect the actual off-loading status.
- Load (Copper) losses first priority shall be accorded to the actual recorded peak load obtained using AMI/APMS/Scanning meters data where available for the respective transformer, otherwise, the nameplate peak load as per applicable specifications shall be utilized, subject to reasonable downward adjustment based on justified and prudent engineering estimates.
- Use of measured or sales-based load factors for determining the loading, arbitrary assumptions are not permitted. The actual load factor recorded at the transformer shall be used for loss calculations. Where such data is not available, DT loading shall be evaluated in correlation with the corresponding feeder loading data and installed capacity of D.Ts and corresponding Coincidence Factor (CF), Load allocation must be carried out based on the actual installed capacity and connected load of each DT
- The annual energy loss shall be computed by incorporation of Coincidence Factor (CF) determined on the basis of justified and documented assumptions, through its integration within validated Loss Factor formula

iii. LT Network Losses

- Use 100% GIS-based LT network mapping for load-flow analysis by utilizing Synergi Electric software or any equivalent standard analytical tool.
- Validate and reconcile all GIS based data and resolve inconsistencies
- The actual transformer-wise Load Factor (LF) shall be applied, through an appropriate Loss Factor, for determining the Annual Energy Loss (AEL) attributable to the LT network associated with the respective distribution transformer. Or,
- Feeder-wise load factors along with justified and appropriate CFs will be applied for determining the Annual Energy Loss (AEL) attributable to the LT network associated with the respective distribution transformer.

iv. Service Cable Losses:

- For the purpose of evaluating losses in service cables, these cables shall either be incorporated into the LT GIS network or, alternatively, a dedicated analytical model shall be developed to represent the actual electrical parameters of various categories of service cables, based on the specific nature of the connected load.
- The length of the service cable shall be determined on a prudent and technically justified basis, reflecting the representative average service-lengths. Segregation may be carried out for urban and rural areas, as well as for domestic, commercial, industrial,

and agricultural consumers, to ensure accurate representation of the existing network topology.

- The applicable Load Factor (LF) of the respective distribution transformer shall be used.
- For loss calculations; where transformer specific LF is not available, the corresponding feeder LF shall be applied For determining the AEL, an appropriate LF shall be applied, with proper technical justification, in deriving the LLF for service-cable loss evaluation

- 4.3** Consolidated Distribution Loss Assessment Losses shall be computed and reported at:
- i. Company, Circle, Division, Sub-Division, and Feeder levels.
 - ii. Components
 - HT line losses
 - DT losses (category and capacity-wise)
 - LT line and service cable losses
 - Impact of DER/Net Metering on losses
 - Total Technical Distribution Losses (HT Line + Distribution Transformer + LT Line+ Service Cable)
 - iii. Reconciliation of the calculated losses with CP-22 and CP-22(T) losses for corresponding period to segregate administrative losses.
 - iv. The feeder wise losses shall be reconciled with the CP 22 losses. Any material variance identified during this comparison shall be highlighted and substantiated with appropriate technical justification and supporting evidence.
 - v. For the purpose of validating LT network loss calculations against the CP 22 (1) losses, a complete and verifiable database shall be maintained. A representative sample analysis shall also be furnished to demonstrate the correlation and justification of the simulated LT network results with the recorded performance data.

5. Investment Plan Review and Loss Reduction Strategy

- i. Provide recommendation and identify feeders and areas requiring rehabilitation, compensation, or reconfiguration is required
- ii. Review and validate HESCO investment plans for technical soundness and the anticipated five-year loss reduction trajectory, and to establish a validated baseline for future system
- iii. and loss-reduction planning Quantify expected loss-reduction trajectory over the next five years on a least-cost basis

6. Deliverables: The Firm shall submit:

- i. Validated transmission and distribution simulation models.
- ii. Detailed technical reports with
 - Methodology
 - Assumptions
 - Results
 - Benchmarking
 - Variance analysis
 - Any other essential aspects
- iii. Loss-reduction recommendations with cost-benefit analysis.

- iv. Regulatory-ready documentation and presentations.
- v. Support for presentation, clarification, and defense before NEPRA and any consequential revisions thereof until approval.

Part B)

1. INFORMATION TO CONSULTANT

- In the case of a joint venture, consortium, or association, all members shall be jointly and severally liable for the Contract's execution under the Contract's terms and conditions. The joint venture, consortium or association shall nominate a Lead Member who shall have the authority to conduct all business for and on behalf of all the members of the joint venture, consortium, or association during the Bidding process, and in case of award of contract, during the execution of the contract.
- The appointment of the Lead Member in the joint venture, consortium, or association shall be confirmed by submission of a valid Power of Attorney to the Procuring Agency:
- Maximum number of members in the joint venture, consortium or association shall be **three (03)**.
- A verifiable copy of the agreement that forms a joint venture, consortium or association shall be required to be submitted as part of the Bid.
- Technical forms from Tech-1 to Tech-8 shall be filled by consultant as well as financial forms Fin-1 and Fin-2 (attached).

2. LOCATION OF THE PROJECT:

13 Districts under the jurisdiction of Hyderabad Electric Supply Company HESCO viz. Hyderabad, Matiari, Tando Allah Yar, Nawab Shah, Tando Mohammad Khan, Sanghar, Badin, Mirpur Khas, Sujawal, Umerkot, Thatta, Tharparker and Jamshoro

3. FOCUSED FIELDS:

To carry out load flow studies of STG Network, 11kV Feeders, LT Network, Distribution Transformers and Service mains.

4. OVERVIEW OF HESCO'S DISTRIBUTION SYSTEM

Detail of Offices:

- Circles = 04 No.
- Divisions = 17 No.
- Sub Divisions = 72 No.

5. TECHNICAL INFORMATION OF HESCO AS ON 30.06.2026

5.1 Grid Stations:

220 KV Source Grid Stations of NTDC	02	Nos.
Total Grid Stations Under GSO HESCO	91	Nos.
132KV Grid Stations	66	Nos.
66KV Grid Stations	14	Nos.
132KV Consumer Grid Stations	11	Nos.

5.2 Transmission Line:

No. of 132 KV Circuits	106	No.
No. of 66 KV Circuits	16	No.
Total Circuits	122	No.
132KV Transmission Lines (S/C) = 1729 KM	3020	KM
132KV Transmission Lines (D/C) =1291 KM		
66KV Transmission Lines (S/C) = 630 KM	630	KM
66KV Transmission Lines (D/C) = ----- KM		
Total	3650	KM

5.3 Power Transformers:

Description	No.	MVA
132 / 11.5 KV Power Transformers	120	3228.60
66 / 11.5 KV Power Transformers	14	116.40
Sub Total:-	134	3345.00
132 / 66 KV Power Transformers	04	103.50
Total:-	138	3,448.50

5.4 Circle wise No. of Feeders and Length:

Circles	No. of Feeders	Measured Length in km
Hyderabad	180	3,300
Laar	245	9,550
Nawabshah	187	11,100
Mirpurkhas	98	7,550
Total	710	31,500

5.5 Circle wise No. of Transformers, LT Line's Length and Consumers:

Circles	Total No. of Transformers	LT Length (km)	No. Consumers
Hyderabad	10,300	3,912	352,805
Laar	15,940	4,978	279,993
Nawabshah	20,960	2,780	386,961
MirpurKhas	11,300	3,530	252,103
Total	58,500	15,200	1,271,862

Note:

- In case of any increase in data due to network extension and rehabilitation during the performance of contract, the Consultant firm will be bound to carry out the loss evaluation study without any additional cost.
- The study shall be carried out in accordance with the Terms of Reference (TOR) and regulatory requirements of HESCO and NEPRA.

6. Other Requirements from Consultant

6.1 Monthly Progress Reports

The Consultant shall submit detailed monthly progress reports outlining activities performed, data collected, analysis conducted, issues encountered, and planned activities for the following month.

6.2 Deliverables

All deliverables as specified in the ToRs shall be submitted within the agreed timelines.

6.3 Draft Study Report

The Consultant shall submit Draft Study Reports covering all components of the project for review and comments by HESCO.

6.4 Final Study Report

The Final Study Report shall be submitted after incorporation of comments received from HESCO.

6.5 GIS Mapping

The Consultant shall map and analyze 100% of the LT Network of HESCO across all categories.

6.6 Data Submission Requirements

The Consultant shall submit all study data and models in compatible digital formats including 11kV mdbs., warehouse, LT Data Entry access file (Field_Data and GPS_Points), GPS Points, Text file, GDBs), KMLs and Synergi electric mdbs. of LT Network. All submitted data shall be fully functional, editable, and compatible with HESCO existing systems.

7. REPORTING REQUIREMENT FOR TRANSMISSION LOSS:

- The report will be based on the study of 132KV, 66KV Transmission network.
- Monthly progress report & all Deliverable and studies of the project.
- Draft study report and final study report be submitted after addressing the comments from HESCO.

8. REPORTING REQUIREMENT FOR DISTRIBUTION LOSS:

First Four Months Initial Study & Submission

It has been proposed that the consultant will submit an initial study report comprising upon 50% of the network to HESCO within first Three Months of the study. This report will be based on the study of Transmission, HT, L.T Networks including Distribution Transformers, and service main of HESCO.

NOTE:

The Consultant shall, at the completion of the project, provide all GIS data of the HESCO Distribution Network (HT/LT), including Synergi Electric models (CSV/MDBs), Warehouse, Geo Database (.gdb) files, Data Entry Access databases (MDBs), GPS points (.txt, .gdb), KML files, and all other distribution reporting formats. All such deliverables shall be fully compatible

with HESCO's existing systems and requirements. The data formats shall be finalized at the commencement of the contract in coordination with HESCO.

9. MODE OF PAYMENT

In consideration of the services performed by the consultant under this contract, the client shall make to the consultant such payments and in such a manner as stated herein.

<i>Activity</i>	<i>% Payment</i>
1: <i>Upon completion of 50% of Loss Study</i>	15%
2: <i>Upon Submission of initial Loss Study Report (after addressing comments from HESCO)</i>	30%
4: <i>Upon submission of the Final Report and, if required, submission of the revised Final Report after duly addressing HESCO's comments.</i>	35%
5: <i>Upon approval of loss evaluation study by NEPRA</i>	20%
Total	100%

Payments will be made by Chief Financial Officer HESCO on production of following documents.

- i. Submission of Invoices of official letter head in triplicate.
- ii. The payments against above will be made on the submission of duly certified/ verified reports from Steering Committee/focal Persons nominated by HESCO.

10. FOCAL PERSON ON BEHALF OF THE CLIENT

The following Steering Committee of HESCO shall act as focal person for the client:

- | | |
|---|----------|
| 1. Chief Technical Officer | Convener |
| 2. S.E (GSO) | Member |
| 3. Dy: Director (Tech:) of concerned Circle | Member |
| 4. Representative of (P&E) | Member |
| 5. Representative of (MIRAD) | Member |

11. PLACE / LOCATION OF PERFORMANCE OF SERVICES:

- The services shall be performed at the Consultant's offices, HESCO offices, and various sites of 132/66 kV HESCO Grid Stations, as well as different sites of 11 kV feeders, LT lines, and service mains within the jurisdiction of HESCO.
- HESCO shall not provide any office accommodation, computers or related accessories official vehicles, or TA/DA to the Consultant's staff.

12. KEY PERSONNELS

Position (for load flow studies)
Principal System Study Engineer (Elect. / Team Leader)
Support System Study Engineer (Elect.)
Junior Engineer (Elect.) / SynerGEE Electric Software expert
Position (For Physical Assessment /study)
Principal Engineer (Elect.)
Support Engineer (Elect.)
Junior Engineer (Elect.)

13. INFORMATION TO BE PROVIDED BY THE CLIENT FOR TRANSMISSION & DISTRIBUTION LOSS ANALYSIS:

HESCO will assist the Consultant by providing all necessary and relevant information required for carrying out the Transmission & Distribution Loss Analysis as given above.

14. CONTRACT FOR ENGINEERING CONSULTANCY SERVICES

The contract for Engineering Consultancy Services will be based on Pakistan Engineering Council's "Standard form of Contract for Engineering Consultancy Services (for Large Projects)" for Lump sum Assignments. However, necessary special condition included in the contract according to HESCO's financial and legal matters.

15. FINANCING:

The consultancy services shall be financed through HESCO's own budgetary resources.

16. TRAINING:

The Consultant shall provide hands-on training to **five (05)** HESCO Engineers/Officials on T&D technical loss evaluation through PSS/E, Synergi Electric, ArcGIS, and related methodologies.

17. Defect Liability Period:

The period during which consultant's responsibility to rectify any error / observation or amendment in the data already provided to HESCO as desired. The defect liability period is 12 months after the completion of the project and issuance of completion certificate by HESCO.