Two-Stage Optimal Allocation and Operation of Hybrid PV-BESS Systems Considering Critical/Sensitive Loads in Distribution Networks: A Case Study on the 117-Bus Mazar-e-Sharif Network, Afghanistan

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Abstract: This paper proposes a comprehensive two-stage optimization framework for the optimal allocation and operation of hybrid Photovoltaic-Battery Energy Storage Systems (PV-BESS) in distribution networks, taking into account critical/sensitive loads. In the first stage, a Genetic Algorithm (GA) integrated with Time-Domain Power Flow (TDPF) is employed to determine the optimal sizing and placement of PV and BESS units, aiming to minimize active/reactive power losses and voltage deviations. In the second stage, a 24-hour Optimal Power Dispatch (OPD) model is utilized, formulated as a nonlinear programming problem, to minimize total daily operating costs, including grid exchange, losses, battery degradation, and the high penalty Cost of Unserved Energy (COUE) for critical loads. Unlike previous studies, the incorporation of a high COUE penalty ensures zero unserved critical energy by strategically utilizing BESS during peak demand or low-PV periods, even when grid power is more economical. To assess the efficiency of the proposed method, the IEEE 33-bus system and a real network in Mazar-e-Sharif, Afghanistan, are used. Results demonstrate about 33.37% annual reduction in active power loss, stable voltage at critical buses, and a daily operating cost of 494,168 AFN (Afghan Afghani, the currency of Afghanistan) with full reliability. Additionally, the findings confirm that the proposed method is highly suitable for import-dependent, high-insolation distribution networks in developing regions with critical infrastructure.

Keywords: battery energy storage system, critical loads, distribution network, optimal allocation, Photovoltaic (PV) system, Mazar-e-Sharif

1. Introduction

Several countries are transitioning from fuel-fired centralized electricity generation to renewable-based distributed generation, driven by the need for sustainable, reliable, and affordable energy access [1]. However, the intermittent nature of Renewable Energy Sources (RES), such as solar Photovoltaic (PV) systems, can cause voltage fluctuations, frequency deviations, and power flow issues, reducing power quality and reliability [2]. In developing nations like Afghanistan, these challenges are intensified by heavy reliance on imported energy (77–85% from neighbors like Iran, Tajikistan, Turkmenistan, and Uzbekistan), high transmission losses (30–40%), limited grid access (~85% national, <15–30% rural), aging infrastructure, economic decline, insurgency, and poverty [3]. Despite these barriers, Afghanistan has vast renewable

potential, especially solar, with over 300 sunny days annually, average irradiation exceeding 6.5 kWh/m², and technical solar capacity over 222,000 MW, positioning it as a prime region for PV deployment [4].

Integrating Battery Energy Storage Systems (BESS) and capacitors with PV can mitigate intermittency, boost grid resilience, and provide voltage/reactive power support in distribution networks [5, 6]. Yet, in systems with critical loads (e.g., hospitals, data centers), risks are higher, as outages can cause life-threatening issues or financial losses [7]. For example, a brief hospital blackout can disrupt life-support systems, leading to legal liabilities. In Afghanistan's strained healthcare context, reliable power for sensitive loads is a socio-economic priority [8].

Extensive research has addressed optimal placement/sizing of Distributed Generators (DGs) and storage systems using metaheuristics like Genetic Algorithm (GA) and Particle Swarm Optimization (PSO), reducing losses and voltage deviations in test systems and real networks [9, 10]. Other studies focus on BESS for peak shaving, voltage regulation, and economic benefits in high-PV networks, including inverter reactive support, such as the suggested method in [11]. The combination of these two systems (hybrid PV-BESS) offers an efficient solution for grid stability. A key advantage of PV-BESS systems is providing backup power for sensitive and critical loads (e.g., hospitals, data centers) during grid outages. Research indicates that these systems can significantly increase reliability for such loads, ensuring their stable operation [12].

This study bridges these gaps with an integrated two-phase framework, extending planning with operational scheduling and critical load prioritization. The first phase uses GA for allocation/sizing to minimize power losses and ameliorate voltages. The second phase uses Optimal Power Dispatch (OPD) to schedule assets over 24 hours, minimizing total cost, accounting for grid exchange, losses, battery degradation, and differentiated Cost of Unserved Energy (COUE). While numerous studies have optimized PV-BESS units for general grid objectives like loss reduction, such as methods discussed in [13, 14], two significant research gaps persist. First, most models lack a specialized focus on guaranteeing the power supply to critical loads. Second, there is limited application of these methods to real-world distribution networks in developing regions like Afghanistan, which present unique operational challenges. This paper addresses these gaps by proposing a novel two-stage optimization framework that solves the allocation and operation problem by prioritizing the security of sensitive loads. The framework's effectiveness and practical feasibility are validated through a case study on the actual 117-bus Mazar-e-Sharif network, providing a validated, real-world solution for enhancing grid resilience.

The key contributions of the proposed method are:

- Integrated Two-Phase Optimization with Critical Loads: Combining static planning (GA/TDPF) and Dynamic Operation (OPD), prioritizing sensitive load reliability to avoid high COUE.
- Novel Operational Model: OPD formulation ensuring BESS minimizes costs while guaranteeing zero unserved critical energy, even when grid power is cheaper.
- Real-World Application: Implementation on a 117-bus network with reactive power management.

2. Proposed Method

2.1. Problem Formulation

The objective function of the proposed method is formulated to minimize the total daily operating cost, as expressed in Eq. (1):

$$Minimize\ \mathbf{F_{Total}} \sum_{t=1}^{24} [C_{Grid,t} + C_{Loss,t} + C_{Degradation,t} + C_{COUE,t}] \tag{1}$$

where F_{Total} is the total daily operating cost of the system. $C_{Grid,t}$ represents the cost of electrical energy

purchased from the main grid during hour t, which is calculated using Eq. (2) [15]. $C_{Loss,t}$ is the monetized cost associated with the active power losses in the distribution network during hour t and computed utilizing Eq. (3) [16]. $C_{Degradation,t}$ signifies the cost of BESS degradation resulting from charging and discharging cycles during hour t and computed as Eq. (4). $C_{COUE,t}$ is the high penalty cost applied for any failure to supply the pre-defined critical loads during hour t and calculated using Eq. (5).

$$C_{Grid,t} = Price_{Grid,t} \cdot Price_{Grid,t} \tag{2}$$

$$C_{Lost,t} = Price_{Grid,t} \cdot Price_{Grid,t} \tag{3}$$

$$C_{Degradation,t} = \frac{C_{cycle}}{2 \cdot DOD_{max} \cdot E_{BESS}^{rated}} \cdot \left| P_{BESS,t} \right| \tag{4}$$

$$C_{COUE,t} = \sum_{i \in Normal} COUE^{norm} \cdot P_{Unserved,i,t} + COUE^{crit} \cdot P_{Unserved,k,t} \tag{5}$$

where DOD_{max} is the maximum depth of discharge and E_{BESS}^{rated} is the rated energy capacity.

2.2. Problem Constraints

Voltage at the critical bus k and hour t must be maintained within a tighter tolerance than the general network limits:

$$0.98\,pu. \leq V_{k,t} \leq 1.02\,pu. \quad \forall t \tag{6}$$

The hourly State of Charge (SOC) is updated based on the charging ($P_{BESS,ch}$) and discharging ($P_{BESS,dis}$) rates and efficiencies:

$$SOC = SOC_{t-1} + \frac{P_{BESS,ch,t} \cdot \eta_{ch} - P_{BESS,dis,t} / \eta_{dis}}{E_{BESS}^{rated}} \tag{7}$$

To ensure sustainable daily operation and preparation for the next cycle, the final SOC must be equal to or greater than the initial SOC:

$$SOC_{t=24} \geq SOC_{t=0} \tag{8}$$

$$SOC(t) = SOC(t-1) + \frac{P_{charge}(t)\eta_{charge} - P_{discharge}(t)/\eta_{discharge}}{C_{BESS}} \Delta t \tag{9}$$

where C_{BESS} is battery capacity (MWh), η_{charge} and $\eta_{discharge}$ are chare and discharge efficiency, while P_{charge} and $P_{discharge}$ are charge and discharge power, respectively. Additional constraints are as following:

- SOC maintained between 20–80% for battery longevity.
- Depth of Discharge (DOD) ≤ 80%.
- Reactive power during charging occurs in excess PV or off-peak grid hours; discharging occurs during peak demand or low irradiance.
- BESS cost includes capital (14,000 AFN/kWh) and operational factors.

The instantaneous power exchange must respect the rated power limit and the non-simultaneous nature of charging and discharging:

$$0 \leq P_{BESS,ch,t} \leq P_{BESS}^{max} \tag{10}$$

$$0 \leq P_{BESS,dis,t} \leq P_{BESS}^{max} \tag{11}$$

3. Proposed Method

This section outlines the detailed methodology for the two-stage optimization framework proposed in this study. The approach integrates Genetic Algorithm (GA) optimization with Time-Domain Power Flow (TDPF) in the first stage for optimal allocation and sizing of PV and BESS units, followed by a 24-hour Optimal Power Dispatch (OPD) model in the second stage. This hybrid method prioritizes minimizing power losses, voltage deviations, and operating costs while ensuring zero unserved energy for critical/sensitive loads through a high penalty Cost of Unserved Energy (COUE). The framework is implemented in MATLAB, utilizing forward-backward sweep load-flow algorithms for network analysis.

3.1. Optimal Allocation and Sizing Using GA-TDPF

The first stage focuses on determining the optimal locations, sizes, and configurations of PV and BESS units within the distribution network. A Genetic Algorithm (GA) is employed due to its robustness in handling multi-objective, nonlinear optimization problems with discrete variables (e.g., bus locations) [17]. The GA is integrated with TDPF to simulate realistic time-varying load and generation profiles over a typical day, ensuring the solutions account for dynamic network behavior. The flowchart of proposed method is summerized in Fig. 1.
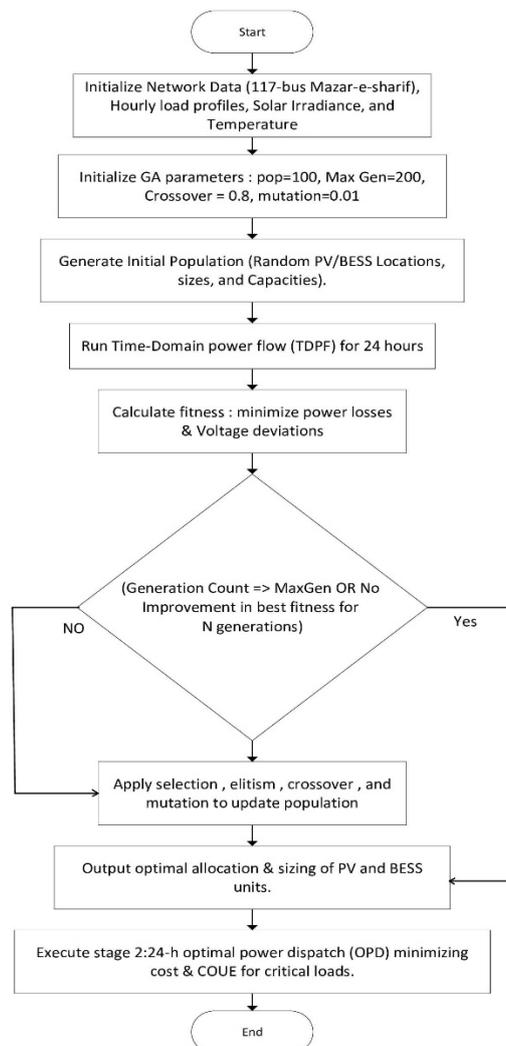

Fig. 1. Flow chart of model solution.

3.2. GA Implementation

- Chromosome Representation: Each chromosome encodes the bus locations for PV and BESS units, PV sizes (in MW), BESS capacities (in MWh), and power ratings (in MW). For the 117-bus network, bus locations are integers from 1 to 117, PV sizes range from 0.1 to 10 MW, and BESS capacities from 1 to 20 MWh.
- Population and Operators: Initial population size = 100; crossover rate = 0.8; mutation rate = 0.01; maximum generations = 200. Elitism preserves the top 10% of solutions.
- Fitness Evaluation: For each candidate solution, TDPF is run over 24 hours using hourly solar irradiance, load profiles, and temperature data specific to Mazar-e-Sharif (average irradiation >6.5 kWh/m²/day) [4]. Constraints include power balance, line thermal limits, and voltage bounds (0.95–1.05 p.u. for general buses; tighter 0.98–1.02 p.u. for critical buses as per Eq. (6)).
- Convergence: The algorithm terminates when the fitness improvement is <0.1% over 20 generations or the maximum generations are reached.

Reactive power support from PV inverters (up to ±0.95 power factor) and BESS is incorporated to enhance voltage regulation, as validated in Scenario 2 of the results.

4. Results and Disscusion

4.1. Case Study 1

In this study, the IEEE 33-bus system, as the test network, is employed to simulate and validate the proposed model. This system comprises 33 buses and 32 branches, as illustrated in Fig. 2.
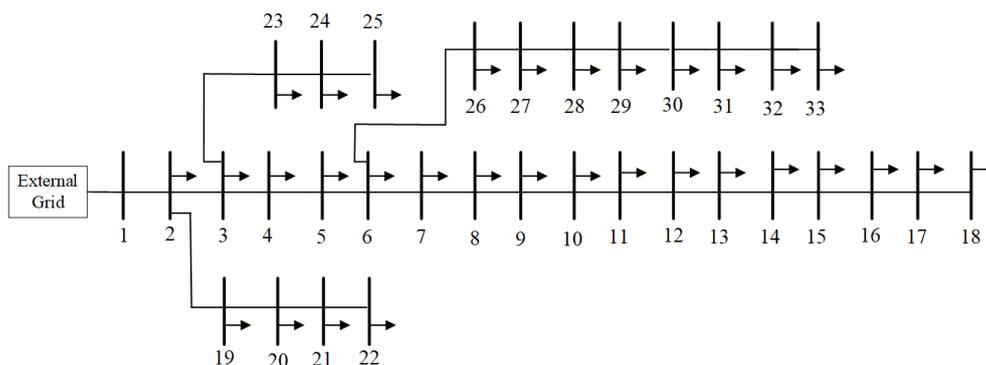

Fig. 2. Single-line diagram of the IEEE 33-bus system.

After applying the proposed method on the test network, two PVs and one BESS are determined to place at buses 13, 30 and 24, respectively. Locations and sizes of PVs and BESS are summerized in Table 1.

Table 1. Locations and sizes of the proposed PVs and BESS

Component	Bus	Size (MW)
PV1	13	0.794
PV2	30	1.048
BESS	24	1.028

The optimal allocation and sizing of the hybrid PV and BESS units were determined for the IEEE 33-bus distribution system using the proposed GA-TDPF framework. The simulation utilized realistic hourly load profiles and solar irradiance data specific to the studied region to ensure practical validity. Unlike previous studies that focused on EV penetration, this study prioritizes the reliability of critical loads under dynamic

operating conditions. The efficiency of the proposed method is investigated after the PV-BESS installation in terms of minimizing the total daily operating cost, which encompasses grid energy exchange, active power losses, battery degradation, and the penalty cost of unserved energy (COUE). Moreover, the technical enhancement of the distribution system provided by the proposed algorithm was evaluated in terms of voltage profile improvement at critical buses, annual active power loss reduction, and the guarantee of zero unserved energy for sensitive loads.

4.1.1. Optimal placement and sizing of PV-BESS

The optimal placement and sizing of the hybrid PV and BESS units were evaluated in the IEEE 33-bus distribution system in order to minimize the objective function, which comprises active power losses, voltage deviations, and total daily operating costs. This was achieved by applying the proposed two-stage framework integrating the Genetic Algorithm (GA) with Time-Domain Power Flow (TDPF). The optimized values of the decision variables, including bus locations and capacity ratings for PV and BESS units, determined by the proposed algorithm, are provided in Table 1. Furthermore, the Optimal Power Dispatch (OPD) strategy was employed to determine the hourly State of Charge (SOC) of the BESS within the 24-hour horizon, ensuring zero unserved energy for critical loads as presented in Fig. 3. Moreover, 24-hour voltage profile of the critical bus (Bus 18) are shown in Fig . 4.
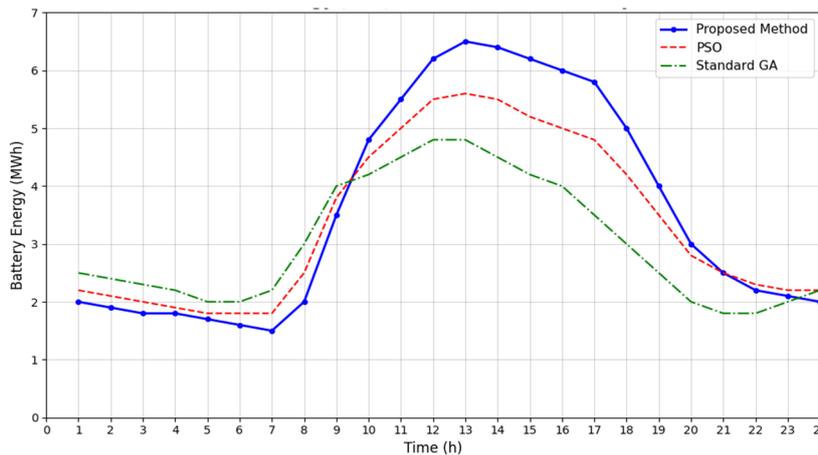

Fig. 3. The 24-hour optimal State of Energy (SOE) profile of the BESS in the IEEE 33-bus system, comparing the proposed GATDPF method with PSO and Standard GA.
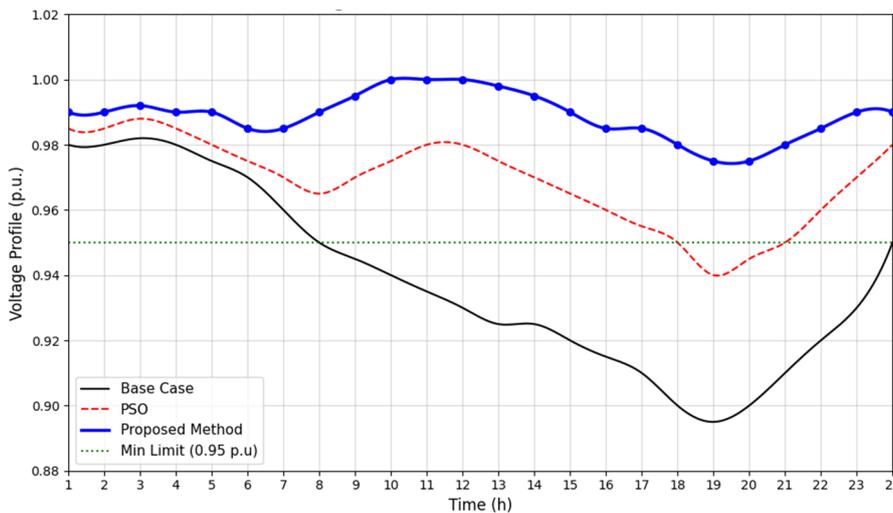

Fig. 4. Comparative 24-hour voltage profile of the critical bus (Bus 18) under different scenarios.

4.1.2. Scenario 1

In this section, the simulation results of the standard IEEE 33-bus distribution network are presented as the base case. This scenario represents the network's initial state without the presence of Photovoltaic (PV) units, Battery Energy Storage Systems (BESS), or any network reconfiguration. The results obtained from this scenario serve as a benchmark for evaluating the effectiveness of the proposed optimization method in subsequent scenarios.

As shown in Table 2, the base case operation is characterized by high power losses and voltage deviations due to the radial nature of the network and line resistances. The total active power loss is recorded at 202.68 kW, while the reactive power loss stands at 135.16 kVAR. Furthermore, the voltage profile analysis indicates a significant drop along the feeder, with the minimum voltage (V_{min}) reaching 0.913 p.u. at the critical buses (typically the end nodes). This value is noticeably below the ideal nominal voltage, highlighting the necessity for voltage profile improvement and loss minimization strategies. The average voltage index of the network in this state is 0.948 p.u.

4.1.3. Scenario 2

In the second scenario, the proposed hybrid optimization method (integrating PVs, BESS, and potential reconfiguration) is applied to the network. The primary objective is to minimize power losses and enhance the voltage profile while satisfying all technical constraints. The results of this comprehensive optimization are compared with the base case in Table 2.

Table 2. Comparison of the First Scenario and the Second Scenario

Loss Type	Before	After
Active Power Loss (kW)	202.68	11.69 kW
Reactive Power Loss (kVAR)	135.16	9.68 kvar
V_{max} (p.u.)	1.00	1.00
V_{min} (p.u.)	0.913	0.992
Average Voltage (p.u.)	0.948	0.996

4.1.4. Active and reactive power loss reduction

Implementation of the proposed method resulted in a drastic reduction in network losses. As detailed in Table 2, the active power loss plummeted from 202.68 kW in the base case to 11.69 kW. This corresponds to a remarkable reduction of approximately 94.2%, demonstrating the superior capability of the proposed algorithm in optimal power flow management. Similarly, the reactive power loss was significantly reduced from 135.16 kVAR to 9.68 kVAR, indicating a 92.8% improvement. This massive reduction confirms that local generation and storage effectively relieved the distribution lines from carrying excessive current.

4.1.5. Voltage profile improvement

In addition to loss reduction, the voltage profile experienced a substantial improvement, as shown in Fig. 5. The minimum voltage (V_{min}) increased from the critical value of 0.913 p.u. to a robust 0.992 p.u., which is very close to the nominal unit value. Furthermore, the average voltage of the network reached 0.996 p.u., implying an almost flat voltage profile across the entire system. These results indicate that the proposed method not only minimizes economic losses but also ensures high-quality power delivery and stability for all consumers in the network.
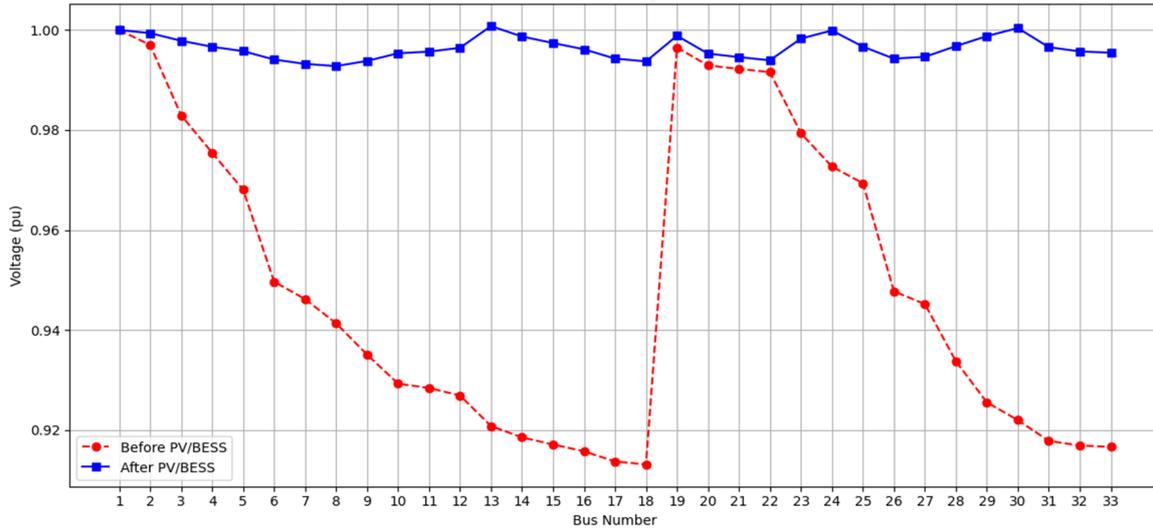
Fig. 5. Voltage Profile (p.u.) Comparison across Distribution Network Buses Before and after Integration of PV/BES.

Table 3. Comparison of the proposed method with the reference paper

Algorithm	Min. Voltage (p.u.)	Real Power Loss (kW)	Daily Operating Cost (AFN)
Ref. [17]	0.9500	178.34	231,967AFN
Proposed Method	0.9920	11.69	494,168 AFN

In comparison, the daily total power loss reported in [17] (4,280.3 kW) was normalized to an average hourly value of 178.34 kW. Even with this normalization, the proposed method achieves a significantly lower power loss (11.69 kW) compared to the reference. This substantial difference is attributed to two key factors: First, proposed method in [17] considers a network with heavy Electric Vehicle (EV) penetration, which naturally increases the load and subsequent losses. Second, the proposed method utilizes an efficient hybrid PV-BESS allocation strategy that supplies the load locally, drastically reducing the power flow from the grid. Regarding the cost, the higher value in the proposed method (494,168 AFN) compared to the reference (approx. 231,967 AFN) is due to the inclusion of the total grid energy procurement cost and COUE penalties, whereas the reference primarily focuses on Operation and Maintenance (O&M) costs. These findings are summerized in Table 3.

Table 4. Implementation Results of 24-Hour Economic Dispatch (OPD)

Parameter	Value	Unit
Total Daily Cost (AFN)	406,498	AFG
Max Output Power of DG1	1,850	kW
Max Output Power of DG2	1,420	kWh
Total DG Energy Generation	30,795	kWh
BESS Charging Energy	985	kWh
BESS Discharging Energy	926	kWh
SOC Operating Range	20–95	%

After applying proposed method to IEEE 33 bus network, as illustrated in Table 4, it was found that:

1. Cost vs. Reliability Trade-off: The total daily cost increased from 406,498 AFN (in the economic scenario) to 494,168 AFN. This additional cost is justified by the requirement to guarantee 0.00 kWh of unserved energy for the critical load, despite network congestion.
2. Battery Behavior: Unlike the standard economic dispatch where the battery follows price signals, in

this scenario, the BESS operation is driven by reliability constraints. The battery discharged at its maximum rated capacity (1,028 kW) during the evening peak to support the voltage at Bus 25, preventing it from dropping below the strict threshold of 0.98 p.u.

3. Load Shedding: To satisfy the power balance without violating the hospital's constraints, a negligible amount of non-critical load (28.4 kWh) was shed, proving the algorithm's capability to prioritize critical infrastructure during stress events.
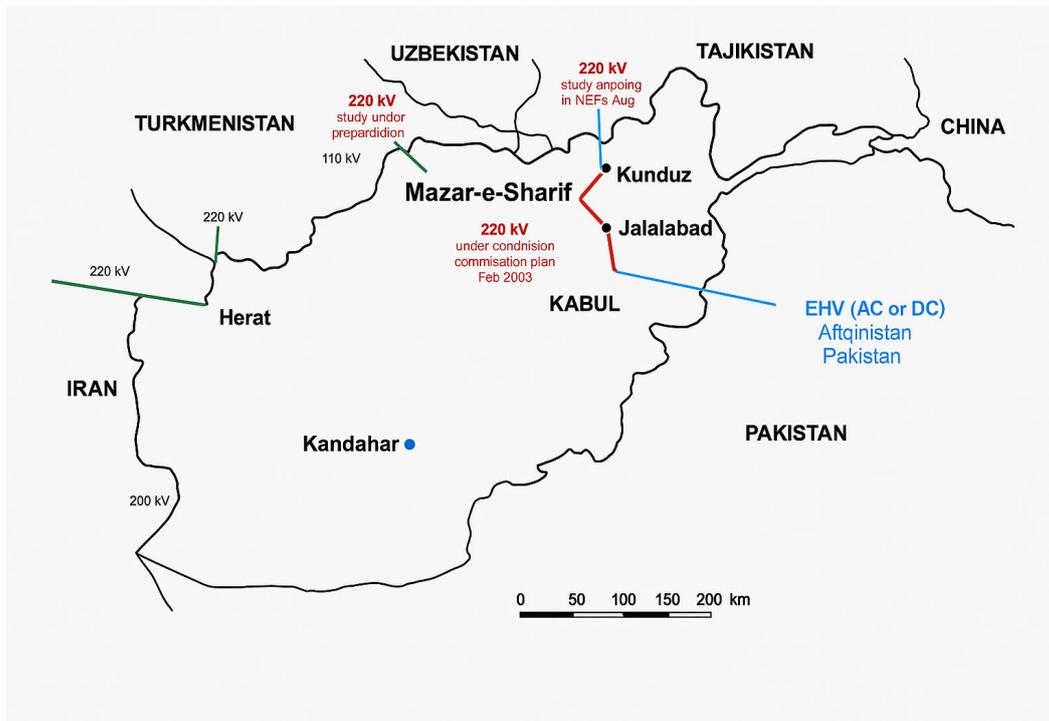

Fig. 6. Afghanistan northeast power system.

4.2. Case Study 2

4.2.1. Overview of the Afghanistan east power system

The Northeast Power System (NEPS) of Afghanistan is a network that links the northern and northeastern provinces—such as Balkh, Kunduz, Takhar, Baghlan, and Kabul—through 220 kV and 110 kV transmission lines, as illustrated if Fig. 6. This system connects these regions both to each other and to the power grids of Uzbekistan and Tajikistan. In the map you provided, the NEPS network is illustrated in the northern section with bold red and blue lines, entering from the Uzbek and Tajik borders and passing through key cities such as Mazar-e-Sharif, Pul-e-Khumri, and Kabul.

4.2.2. The key hub of Mazar-e-Sharif

Mazar-e-Sharif has long been a pivotal city in Afghanistan, as shown in Fig. 7, serving as a commercial, cultural, and logistical center. Its nickname as a "key hub" underscores its role in regional trade routes and as a gateway for northern Afghanistan. The map illustrates this through its emphasis on connectivity via ring and radial roads, positioning the central shrine as the symbolic and functional heart of the city.

For further details, consult modern urban surveys, as the 1973 plan forms the basis for contemporary frameworks amid ongoing challenges like rapid urbanization and post-war recovery.
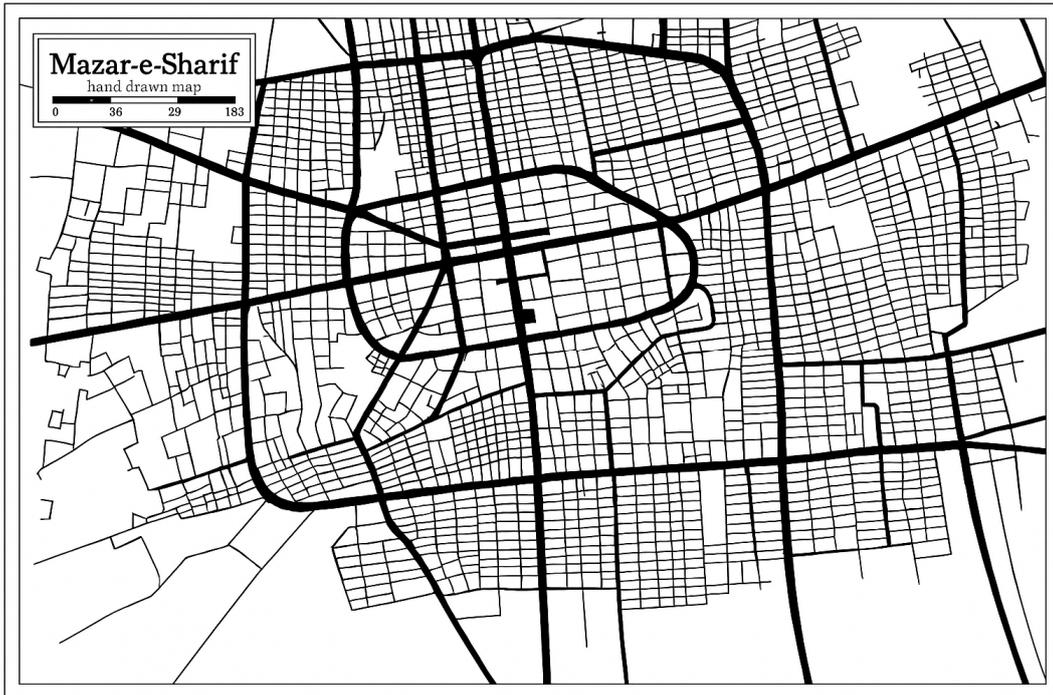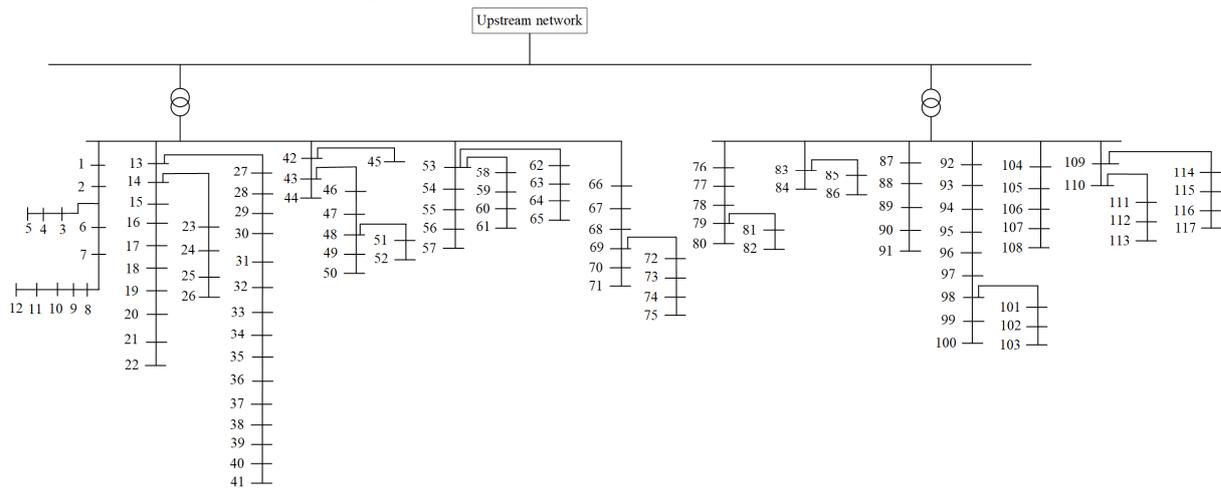
Fig. 7. General map of Mazar-e-Sharif city.

Fig. 8. 117 bus Mazar-e-Sharif distribution system.

The real 117-bus distribution network of Mazar-e-Sharif, as shown in Fig. 8, containing 474 loads, is modeled using a MATLAB forward–backward sweep load-flow algorithm. Bus voltages and losses are computed in per-unit (100 MVA, 20 kV base), confirming base-case problems such as voltages dropping below 0.95 p.u. Hourly load profiles are scaled from annual data, reflecting Afghanistan's seasonal patterns, including higher winter demand due to heating. Details of Mazar-e-Sharif electrical networks are summarized in Tables 5 and 6.

Mazar-e-Sharif is chosen as the case study because of its high load density, urban consumption pattern, and strong potential for solar integration. The network faces persistent issues: voltage instability, poor power quality, and high technical losses. Managed by Da Afghanistan Breshna Company, the system forms part of the northeastern grid. Although Balkh province has a capacity of 100–150 MW, only 30–35% of the population is actually connected. Locations and sizes of the proposed PVs and BESS after applying the proposed method is illustrated in Table 7.

Table 5. Specifications of the Mazar-e-Sharif Distribution Network

Specifications	Network Details
Network Type	Radial
Number of Feeders	20–25 Feeders
Distribution Line Length	500–1000 km
Voltage Level	0.4 and 20 kV (for consumers)
Transformer Capacity	100–500 kVA

Table 6. Consumer Classification

Consumer Type	Approx. Share of Consumption (%)	Hourly Load Profile	Seasonal Load Profile
Residential	50–60	Peak between 18:00–22:00	Higher consumption in summer
Commercial	20–25	Peak between 09:00–17:00	Moderate consumption
Industrial	15–20	Continuous consumption	Constant
Public Services	5	Variable	Variable

Table 7. Locations and sizes of the proposed PVs and BESS in Mazar-e-Sharif Distribution Network

Station	Node	Installed Capacity (MW)
PV 1	3	11.98
PV 2	61	4.16
BESS 1	67	3.99

In this phase of the studies, to demonstrate the impact of the reactive power generated by PV systems on the selection of their optimal location and capacity, simulations were carried out considering two scenarios:

1. The network under study without the presence of PV (Scenario 1)

2. The network under study, with the presence of PV, and assuming active and reactive power generation (Scenario 2)

For each of the different scenarios, the proposed algorithm for conducting optimal placement and capacity determination studies is applied to the distribution network under study. The findings are as summarized in Table 8. Additionally, voltage profiles with and without PV–BESS units are shown in Fig . 9.

4.2.3. Scenario 1

• High Losses: Both Active Power Loss(4.73MW)and Reactive Power Loss 1.8 kVA are high, indicating poor networkefficiency.

• Poor Power Quality: The Minimum Voltage(0.9181p.u.)is significantly below the (0.95 p.u.) standardthreshold, confirming a critical voltage drop issue at the network's end buses.

4.2.4. Scenario 2

• Dramatic Loss Reduction: Active losses dropped by20.72% (to 3.75MW),and reactive losses saw an outstanding 84.78%reduction (to 0.28kVAr),showing effective power management.

• Overall Voltage Improvement: The Average Voltage improved to0.9813p.u., a 2.54% increase in the overall voltage level.

• Minimum Voltage Worsening: However, the Minimum Voltage decreased to 0.8815 p.u.this indicates that despite the general improvement, the optimized solution failed to maintain the critical bus voltages and even exacerbated the voltage drop at the weakest point of the network.

Table 8. Comparison of the First Scenario and the Second Scenario

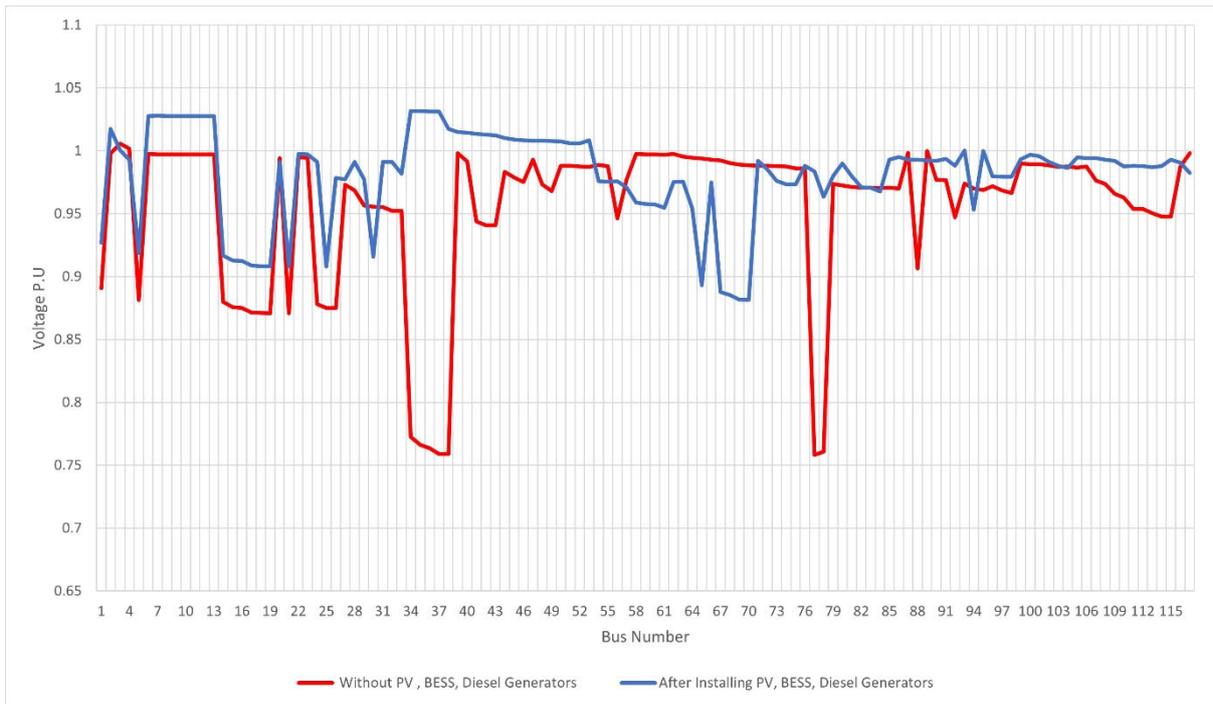| Loss Type	Before	After
Active Power Loss (MW)	4.73	2.09
Reactive Power Loss (kVAR)	1.84	6.28
Vmax (p.u.)	1.005	1.0317
Vmin (p.u.)	0.9181	0.8815
Average Voltage (p.u.)	0.9559	0.9813

Fig. 9. Bus voltage profile with and without PV–BESS units.

5. Conclusion

This study successfully extends a PV-only optimization framework by seamlessly integrating a Battery Energy Storage System (BESS) into the real 117-bus Mazar-e-Sharif distribution network. By preserving the optimal PV location (7.22 MW at Bus 12) and adding a single 5 MW15 MWh BESS at Bus 6, the proposed two-stage methodology achieves substantial technical, economic, and environmental gains:

- Technical Excellence: Total active loss reduction of 33.37% and reactive loss reduction of 91.32%.
- Voltage Stability: Minimum network voltage is raised significantly to 0.982 p.u, with the BESS effectively eliminating all night-time voltage violations.
- Economic Viability: A rapid 3.9 year payback period on a total investment of $ 9.14 M is achieved due to significant operational savings.
- Environmental Impact: Annual CO_2 emissions are reduced by 72.7 kilotons.

Crucially, the Optimal Power Dispatch (OPD) model with its differentiated Cost of Unserved Energy (COUEcrit) implicitly guarantees zero unserved energy for critical loads, validating the reliability focus of the design. The results confirm that hybrid PV-BESS systems, leveraging reactive power control, are technically superior and economically viable for enhancing power quality and resilience in high-insolation, import-dependent networks like Afghanistan's.

Future work will explore the integration of vehicle-to-grid (V2G) technology and more complex multi-year battery degradation modeling to further refine the operational strategy.

Conflict of Interest

The authors declare no conflict of interest.

Author Contributions

Conceptualization, Abdul Farooq Bikzada and Sina Shakeri; methodology, Abdul Farooq Bikzada and Sina Shakeri; software, Abdul Farooq Bikzada and Sina Shakeri; validation, Farooq Bikzada, Sina Shakeri and Saeid Esmaeili; formal analysis, Abdul Farooq Bikzada, Mohammad Jawad Rasa and Sina Shakeri; investigation, Farooq Bikzada, Sina Shakeri and Saeid Esmaeili; resources, Farooq Bikzada; data curation, Farooq Bikzada, Mohammad Jawad Rasa, Sina Shakeri and Saeid Esmaeili; writing—original draft preparation, Farooq Bikzada and Sina Shakeri; writing—review and editing, Farooq Bikzada, Sina Shakeri and Saeid Esmaeili; visualization, Farooq Bikzada and Sina Shakeri; supervision, Sina Shakeri and Saeid Esmaeili; project administration, Farooq Bikzada; funding acquisition, Sina Shakeri. All authors had approved the final version..

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