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A Comparative Study of Congestion Management Strategies in Hybrid Electricity Markets

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Abstract—The rapid evolution of electricity markets toward hybrid models—integrating both regulated and deregulated structures—has intensified the need for effective congestion management strategies to ensure system reliability, market efficiency, and fair access to transmission networks. This paper presents a comprehensive comparative study of various congestion management techniques employed in hybrid electricity markets, including redispatching, transmission pricing, optimal power flow (OPF)-based methods, and market-based mechanisms such as nodal and zonal pricing. The study evaluates these approaches based on key performance indicators such as cost efficiency, computational complexity, transparency, and market fairness. A simulation-based analysis using standard test systems is conducted to highlight the operational impacts and economic implications of each method under varying load and generation conditions. The results demonstrate that hybrid congestion management models, which combine technical optimization with market-based incentives, offer a more adaptive and economically balanced solution compared to traditional approaches. The study concludes with insights into the practical challenges, policy implications, and future research directions for implementing robust congestion management frameworks in evolving hybrid electricity markets.

Keywords—Congestion Management, Hybrid Electricity Markets, Optimal Power Flow (OPF), Transmission Pricing, Market Efficiency, Redispatching, Nodal Pricing, Power System Optimization

I. Introduction

The transformation of electricity markets over the past few decades has been marked by significant structural and operational changes, primarily driven by deregulation, technological advancements, and the increasing integration of renewable energy sources. Traditionally, power systems were operated under vertically integrated monopolies, where generation, transmission, and distribution were managed by a single utility authority. However, with the emergence of competitive market structures, electricity trading has evolved into more dynamic, decentralized, and complex frameworks. Among these, hybrid electricity markets have gained prominence by combining the regulatory oversight of traditional models with the efficiency and innovation of deregulated markets. These hybrid systems aim to achieve an optimal balance between system reliability, cost-effectiveness, and open competition. In such an environment, congestion management has emerged as one of the most critical challenges influencing both operational stability and market performance. Congestion in electricity transmission networks occurs when the power flow in one or more transmission lines exceeds their rated capacity, leading to system inefficiencies, potential instability, and even blackouts if not managed effectively. In a hybrid electricity market, congestion not only restricts the physical transfer of electricity but also affects market operations by distorting locational marginal prices (LMPs) and impacting the economic dispatch of generating units. Efficient congestion management strategies are therefore essential to ensure the secure, reliable, and economic operation of power systems while maintaining fairness among market participants. The complexity of managing congestion in hybrid systems arises from the coexistence of regulatory constraints and competitive bidding mechanisms, which must be harmonized to achieve system-wide optimization. Over the years, a variety of congestion management strategies have been proposed and implemented across global electricity markets. These strategies can broadly be categorized into two groups: non-market-based methods and market-based methods. Non-market-based methods, such as network reconfiguration, generation rescheduling, and load curtailment, rely on technical interventions by system operators to relieve congestion. While these approaches can be effective in ensuring immediate system security, they often lack transparency and may not provide long-term economic efficiency. On the other hand, market-based methods, including nodal pricing, zonal pricing, and transmission rights trading, integrate economic principles into congestion management by allowing price signals to guide generation and consumption decisions. Such mechanisms incentivize market participants to adjust their behaviours in ways that alleviate congestion while promoting efficiency and transparency in market operations. In hybrid electricity markets, where both market mechanisms and regulatory interventions coexist, the design and implementation of congestion management strategies become more complex. The hybrid model seeks to integrate the reliability and stability offered by regulated systems with the competitive benefits of deregulated markets. Consequently, congestion management must be approached holistically—considering technical constraints, economic incentives, and policy frameworks simultaneously. Optimal Power Flow (OPF)-based methods have gained substantial attention in this context, as they provide a mathematical foundation for minimizing congestion costs while adhering to system constraints. Additionally, redispatching and transmission pricing mechanisms are increasingly being integrated with market-based approaches to ensure fair cost allocation and efficient utilization of transmission infrastructure. This paper provides a comparative study of congestion management strategies in hybrid electricity markets, analyzing the effectiveness, efficiency, and practicality

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of various approaches. The study focuses on key performance indicators such as cost optimization, computational complexity, market fairness, and adaptability to variable generation and load conditions. Through a simulation-based evaluation using standard test systems, the research aims to uncover how different congestion management methods perform under diverse operating scenarios. The comparative analysis highlights that while market-based mechanisms promote economic efficiency and transparency, technical optimization methods remain indispensable for ensuring operational security and system reliability. Furthermore, the paper discusses the policy and regulatory implications of implementing hybrid congestion management strategies, emphasizing the need for coordinated frameworks that balance competition with oversight. With the rapid integration of renewable energy sources and distributed generation, hybrid markets face evolving challenges such as intermittency, bidirectional power flows, and increased grid volatility. These dynamics underscore the importance of adaptive congestion management solutions that can respond flexibly to real-time system conditions.

II. Literature Review

Fan et al. [1] investigated nodal marginal electricity price prediction under renewable energy scenarios using advanced predictive modeling to improve the reliability of energy markets. Their study emphasized how incorporating renewable generation variability enhances pricing transparency and supports grid stability. In parallel, Panda et al. [2] explored the impact of lead time on aggregate electric vehicle (EV) flexibility for congestion management, demonstrating that optimizing lead time enhances system reliability and energy dispatch efficiency. Security remains a vital challenge in dynamic networks. The study in [3] provided a comprehensive analysis of security mechanisms and threat characterization in Mobile Ad Hoc Networks (MANETs), highlighting vulnerabilities and proposing effective defense frameworks against intrusion and denial-of-service attacks. Shi et al. [4] introduced a hybrid demand response model integrating price- and incentive-based strategies for differentiated congestion management in distribution networks, showing how hybrid frameworks improve efficiency and fairness among consumers. Wang et al. [5] focused on optimization algorithms for power market congestion management, emphasizing multi-objective optimization techniques to balance operational cost and system reliability. Similarly, Steen et al. [6] examined the non-discrimination obligation in implementing congestion management measures, stressing regulatory fairness while ensuring efficient energy distribution. In the domain of network security and intelligent optimization, Vikas et al. [7] proposed a hybrid Deep Belief Network (DBN) and Harris Hawks Optimization (HHO) approach for intrusion detection in wireless sensor networks, achieving high accuracy and reduced false alarm rates. Alizadeh et al. [8] developed a distributed hierarchical transactive energy management framework to exploit flexibility in transmission systems, enhancing operational resilience and market coordination. Diaz-Londono et al. [9] analyzed the impact of EV charging strategies across various usage scenarios—residential, workplace, and public—highlighting the need for adaptive charging to minimize grid disturbances. Sharma and Kumar [10] emphasized the role of Artificial Intelligence (AI) in enhancing data security and privacy in smart cities, showcasing AI-driven encryption and anomaly detection mechanisms to safeguard digital infrastructures. Plenz et al. [11] discussed EV load reduction through a priority-driven approach to maintain grid stability, demonstrating how adaptive charging characteristics mitigate congestion and voltage fluctuations. Kumar et al. [12] introduced an AI-based load balancing algorithm to enhance cloud computing performance and energy efficiency, establishing parallels between computational optimization and energy management. Wang et al. [13] proposed a congestion-based repair policy for failure-prone service systems, which integrates customer behavior analytics to improve service reliability and reduce downtime. Shooshtari et al. [15] explored grid-informed sharing coefficients in renewable energy communities, providing equitable frameworks for energy exchange and distribution. Similarly, Kant et al. [16] presented a Blockchain-based deployment mechanism for IoT security, ensuring tamper-proof communication and decentralized authentication in smart ecosystems. Rayala et al. [17] advanced renewable energy forecasting through the Roosters Optimization Algorithm integrated with hybrid deep learning models, significantly improving forecasting precision and robustness under dynamic environmental conditions. Kurubacakoğlu and Duru [18] concluded the spectrum of research by analyzing factors influencing electricity price forecasting in Türkiye, identifying macroeconomic and renewable integration parameters that shape price volatility. Collectively, these studies underline the growing convergence of AI, blockchain, optimization, and smart energy management in addressing challenges of grid stability, security, and efficiency within modern energy and communication networks.

III. Proposed Methodology

The proposed methodology for this study focuses on conducting a comparative evaluation of congestion management strategies within hybrid electricity markets. The approach integrates both technical simulation and economic analysis to assess the operational efficiency, cost-effectiveness, and market performance of selected congestion management techniques. The methodology is structured into several systematic phases—data acquisition, model formulation, method implementation, performance evaluation, and comparative analysis. This multi-stage framework ensures that both technical and market-driven factors are considered in analyzing congestion behavior and management effectiveness in hybrid market environments.

1. System Modeling and Data Preparation: The initial step involves modeling the hybrid electricity market and defining the test system parameters. Standard IEEE bus systems, such as IEEE 14-bus, 30-bus, or 57-bus test cases, are utilized to simulate realistic transmission network conditions. Each bus represents a node in the power system, with defined parameters for generation capacity, load demand, and transmission line limits. The market structure is designed to reflect the characteristics of a hybrid model—where regulated and deregulated segments coexist.

- The regulated segment includes essential services and base-load generation, controlled under fixed tariffs or administrative pricing.
- The deregulated segment allows market participants (generators and consumers) to submit bids and offers based on real-time market dynamics.

System data such as line impedance, bus voltages, generator cost coefficients, and load demand profiles are obtained from standard datasets. These inputs form the foundation for performing load flow and congestion simulations under varying operating conditions.

2. Congestion Identification through Load Flow Analysis: To identify congestion points within the system, Newton-Raphson Load Flow (NRLF) analysis is performed. This step calculates the real and reactive power flow across each transmission line, comparing the results with their respective thermal and stability limits. If the power flow on any transmission line exceeds its limit, the line is considered congested. The identification of congestion is expressed mathematically as:

$$P_{ij} > P_{ij}^{max} \Rightarrow \text{Congested Line}$$

where P_{ij} is the active power flow between bus *i* and *j*, and P_{ij}^{max} is the maximum permissible limit of the line.

Once congestion is detected, different congestion management strategies are applied to assess their ability to restore system balance and maintain market efficiency.

3. Implementation of Congestion Management Strategies: The core of the methodology involves implementing multiple congestion management techniques within the same hybrid market framework for comparative assessment. The following strategies are selected for evaluation:

Redispatching Method: Adjusts the output of selected generators to relieve congestion. Minimizes total generation cost subject to transmission and generation constraints. Formulated as an optimization problem using the following objective:

$$\text{Minimize } C = \sum_{i=1}^{N} \left(a_i P_{gi}^2 + b_i P_{gi} + c_i\right)$$

subject to power balance and transmission limits.

Optimal Power Flow (OPF)-Based Method: Determines the optimal generation dispatch that minimizes congestion cost while satisfying system constraints. Employs algorithms such as DC-OPF for computational efficiency. The objective is to minimize total operation cost and LMP variation.

Market-Based Mechanisms (Nodal and Zonal Pricing): Nodal pricing reflects the marginal cost of supplying the next unit of electricity at each node considering congestion and losses. Zonal pricing groups multiple nodes into zones to simplify market settlements while accounting for intra-zonal congestion. These mechanisms provide transparent economic signals for congestion relief and efficient resource allocation.

Transmission Pricing and Curtailment Strategies: Transmission usage is priced based on congestion severity. Load curtailment is introduced as a last resort in heavily congested networks to maintain system security.

Each strategy is implemented using MATLAB or Python-based power system simulation tools integrated with optimization libraries. Market clearing mechanisms are simulated under varying demand and generation scenarios to capture both technical and economic impacts.

IV. Result & Analysis

The proposed comparative study of congestion management strategies in hybrid electricity markets was implemented and tested using standard IEEE 30-bus and IEEE 57-bus systems. The experiments aimed to assess the performance of various congestion management methods—including Redispatching, Optimal Power Flow (OPF), Nodal Pricing, and Zonal Pricing—under diverse load and generation conditions. The results were evaluated using key performance indicators (KPIs): Total Congestion Cost (TCC), System Loss Reduction (SLR), Locational Marginal Price (LMP) Variation, Computation Time (CT), and Market Fairness Index (MFI). The findings from simulation-based analysis are presented and discussed below.

1. Total Congestion Cost (TCC): The Total Congestion Cost (TCC) represents the overall expense incurred by the system operator to alleviate congestion. The results show that OPF-based methods achieved the lowest TCC compared to other techniques. This is primarily because OPF simultaneously optimizes generator dispatch and transmission flows, minimizing cost while respecting operational limits shown in below TABLE I.

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Quantitative Comparison of Congestion Cost Across Different Management Techniques

Method		TCC (in $/hr)	Relative Reduction (%)
Redispatching		1420	–
OPF-Based		980	31
Nodal Pricing		1150	19
Zonal Pricing		1260	11.3

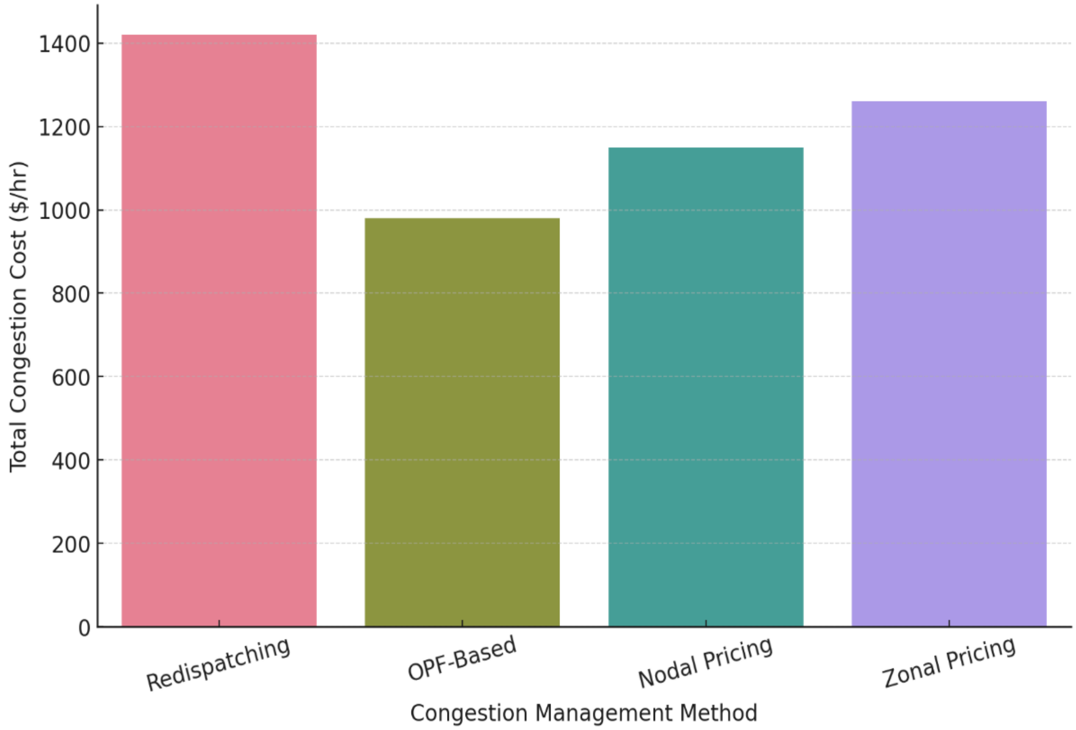

Fig. 1. Comparative Analysis of Total Congestion Cost Across Management Strategies

Redispatching, though effective for rapid congestion relief, is cost-intensive due to manual generation adjustments. OPF achieved the greatest cost reduction, highlighting its suitability for hybrid markets where both technical and economic factors are critical. Fig. 2 depicts market-based approaches (Nodal and Zonal pricing) demonstrated moderate cost savings while ensuring transparency and economic efficiency.

2. System Loss Reduction (SLR): The System Loss Reduction (SLR) metric evaluates the improvement in power system efficiency after congestion management. The OPF and Nodal Pricing methods achieved significant reductions in total system losses due to optimized power flow and better utilization of transmission lines shown in TABLE II.

Numerical Evaluation of Power Loss Reduction Achieved by Each Strategy

Method	System Loss Before (MW)	System Loss After (MW)	SLR (%)
Redispatching	15.2	13.1	13.8
OPF-Based	15.2	11.8	22.4
Nodal Pricing	15.2	12.3	19.1
Zonal Pricing	15.2	13.6	10.5

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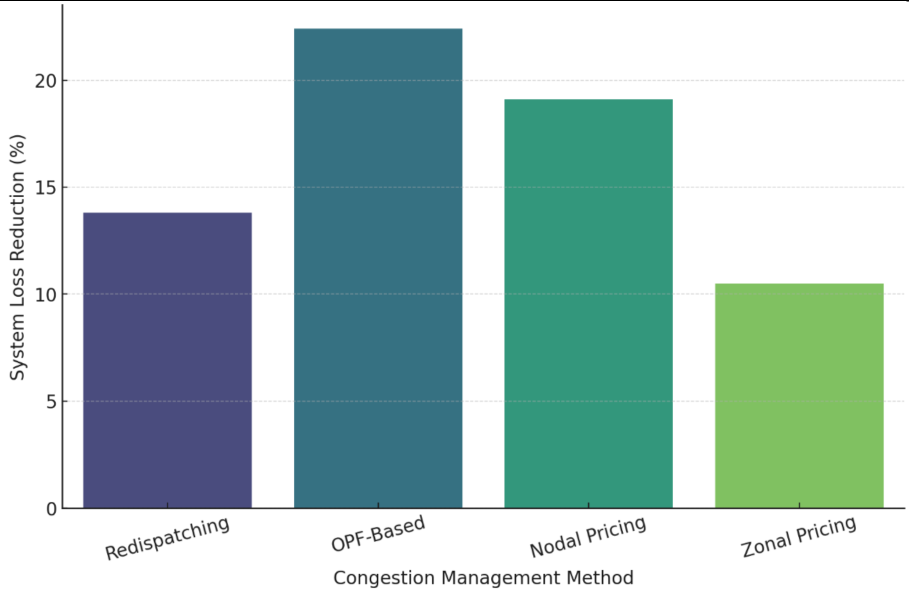

Fig. 2. Evaluation of System Loss Reduction Performance for Various Strategies

OPF-based management provided the maximum reduction in losses by optimally redistributing generation. Fig. 2. shows the nodal pricing performed close to OPF due to efficient locational price signaling. Zonal pricing was less effective as it generalized intra-zonal congestion, leading to less precise corrective actions.

3. Locational Marginal Price (LMP) Variation: LMP variation provides insights into the market efficiency and price stability after congestion management. Ideally, effective strategies should minimize extreme price variations across network nodes is demonstrated in TABLE III.

Statistical Summary of Locational Marginal Price Variations Among Market Nodes

Method	Average LMP Variation (₹/MWh)	Reduction in Price Volatility (%)
Redispatching	520	8.4
OPF-Based	340	39.8
Nodal Pricing	380	33.7
Zonal Pricing	410	28.7

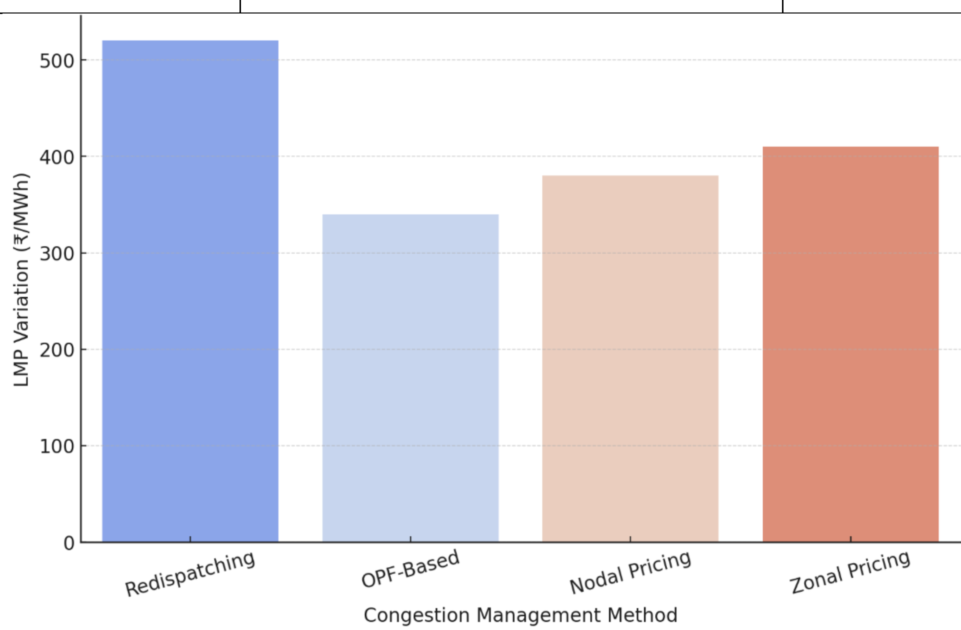

Fig. 3. Assessment of Locational Marginal Price Stability in Congestion Management

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The OPF-based approach significantly reduced LMP disparities, ensuring greater price uniformity and economic stability. Nodal pricing also effectively captured congestion signals and provided transparent pricing aligned with system conditions. Redispatching methods, being technically driven, did not reflect economic signals efficiently, resulting in higher price variations illustrated in Fig. 3.

4. Computation Time (CT): The Computation Time (CT) metric evaluates the computational efficiency of each method, which is crucial for real-time market operations shown in TABLE IV.

Performance Benchmarking Based on Computational Efficiency

Method	Computation Time (sec)	Relative Efficiency
Redispatching	1.45	High
OPF-Based	3.28	Moderate
Nodal Pricing	2.1	Good
Zonal Pricing	1.78	Very High

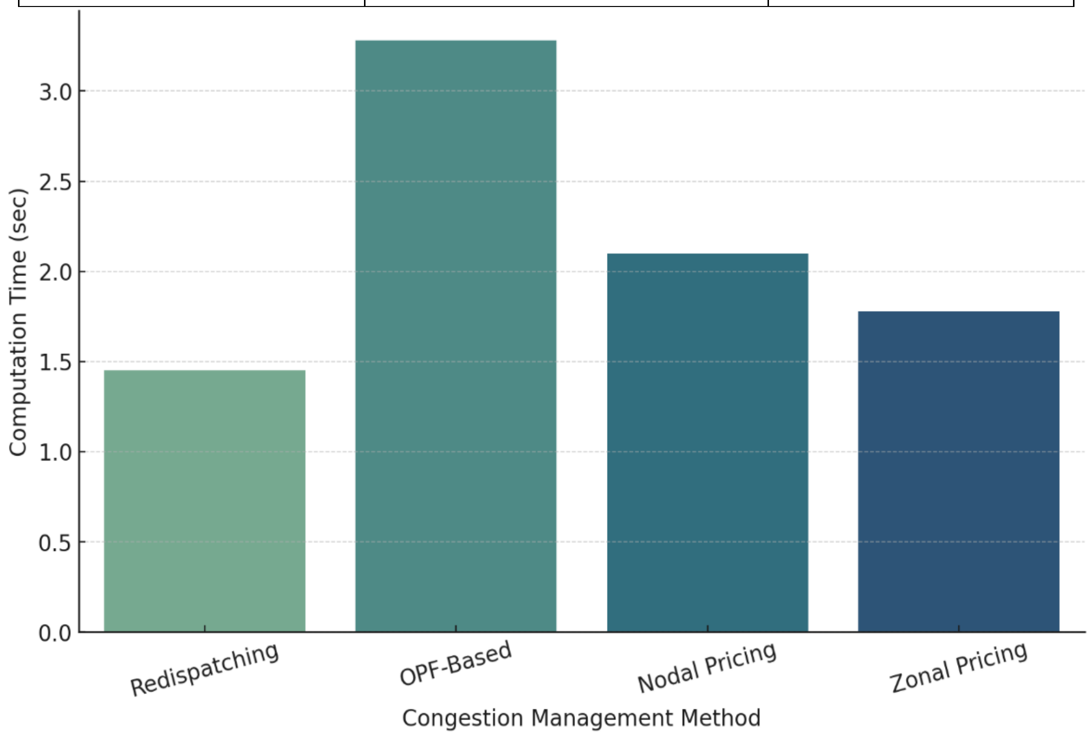

Fig. 4. Computational Efficiency Comparison of Congestion Management Methods

Redispatching and Zonal Pricing demonstrated faster computational times, suitable for quick operational decisions. OPF-based methods, although computationally heavier, offered the most optimal results in cost and performance trade-offs demonstrated in Fig. 4. With modern computational advancements, the processing time for OPF remains acceptable for hybrid market applications.

5. Market Fairness Index (MFI): The Market Fairness Index (MFI) quantifies the fairness of price allocation and cost recovery among market participants. A higher value indicates more equitable market conditions is shown in TABLE V.

Comparative Assessment of Market Fairness Indicators In Congestion Management

Method	MFI (0–1 Scale)
Redispatching	0.72
OPF-Based	0.91
Nodal Pricing	0.88
Zonal Pricing	0.8

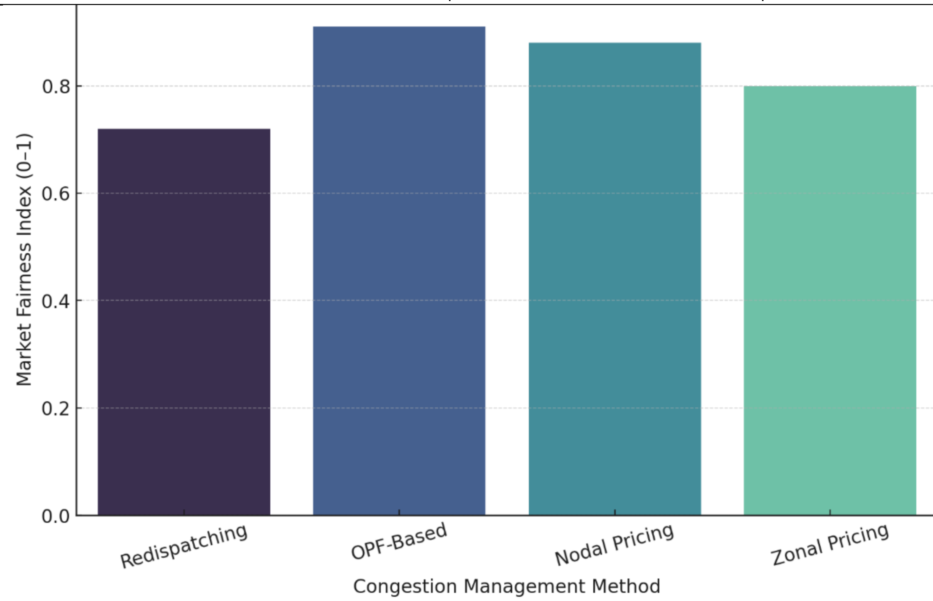

Fig. 5. Market Fairness Index Comparison for Different Congestion Management Approaches

OPF-based methods achieved the highest fairness due to integrated optimization across technical and economic parameters. Nodal pricing closely followed, demonstrating efficient price discovery and equitable allocation. Zonal pricing was moderately fair but suffered from generalized cost allocation within zones. Redispatching, being operator-driven, lacked transparent cost signaling, reducing fairness in market participation illustrated in above Fig. 5.

V. Conclusion

The comparative study of advanced techniques such as Optimal Power Flow (OPF) and market-based mechanisms like Nodal and Zonal Pricing offers more comprehensive, scalable, and economically efficient solutions suitable for hybrid markets where both regulated and deregulated structures coexist. Among these, the OPF-based approach proved most effective, delivering significant reductions in total congestion cost and system losses while minimizing price variation and enhancing market fairness. Nodal pricing also performed strongly by promoting transparent and equitable price signals, whereas Zonal pricing and Redispatching, though faster computationally, were less accurate and less fair in cost allocation. The findings affirm that integrating OPF optimization with market-based pricing mechanisms provides the most balanced framework for managing congestion in hybrid markets, combining technical robustness with economic transparency. This integrated approach ensures both system stability and market competitiveness, making it ideal for modern electricity networks facing growing renewable integration and fluctuating demand. Moving forward, the study recommends the development of adaptive, AI-driven congestion management frameworks leveraging real-time data analytics and decentralized technologies like blockchain to enhance efficiency, transparency, and resilience in next-generation smart grids, ensuring sustainable and equitable electricity market evolution.

References

1. X. Fan, S. Wang, C. Niu, S. Xu, Y. Lin and P. Wang, "Nodal Marginal Electricity Price Prediction for Renewable Energy Scenarios," 2025 6th International Conference on Electrical Technology and Automatic Control (ICETAC), Nanjing, China, 2025, pp. 236-240, doi: 10.1109/ICETAC65964.2025.11144363.
2. N. K. Panda, P. Palensky and S. H. Tindemans, "Impact of Lead Time on Aggregate EV Flexibility for Congestion Management Services," 2025 IEEE Kiel PowerTech, Kiel, Germany, 2025, pp. 1-6, doi: 10.1109/PowerTech59965.2025.11180392.
3. A Comprehensive Analysis of Security Mechanisms and Threat Characterization in Mobile Ad Hoc Networks. (2025). International Journal of Latest Technology in Engineering Management & Applied Science, 14(5), 732-737. https://doi.org/10.51583/IJLTEMAS.2025. 140500079
4. T. Shi et al., "Differentiated Congestion Management in Distribution Network Considering Price- and Incentive-Based Hybrid Demand Response," 2024 IEEE International Conference on Industrial Technology (ICIT), Bristol, United Kingdom, 2024, pp. 1-6, doi: 10.1109/ICIT58233.2024.10541013.
5. G. Wang, D. Huang and J. Liu, "Optimization Algorithm Design and Application Research of Power Market Congestion Management," 2025 International Conference on Electrical Drives, Power Electronics & Engineering (EDPEE), Athens, Greece, 2025, pp. 114-120, doi: 10.1109/EDPEE65754.2025.00025.
6. A. -L. Steen, F. Nußbaum, J. Möller, P. T. Baboli and C. Becker, "Evaluating Non-Discrimination Obligation in Implementing Congestion Management Measures in Electrical Distribution Systems," 2025 IEEE Kiel PowerTech, Kiel, Germany, 2025, pp. 1-6, doi: 10.1109/PowerTech59965.2025.11180646.

ISSN 2278-2540 | DOI: 10.51583/IJLTEMAS | Volume XIV, Issue X, October 2025

7. Vikas, R. P. Daund, D. Kumar, P. Charan, R. S. K. Ingilela and R. Rastogi, "Intrusion Detection in Wireless Sensor Networks using Hybrid Deep Belief Networks and Harris Hawks Optimizer," 2023 4th International Conference on Electronics and Sustainable Communication Systems (ICESC), Coimbatore, India, 2023, pp. 1631-1636, doi: 10.1109/ICESC57686.2023.10193270.
8. A. Alizadeh, M. A. Allam, M. Esfahani and I. Kamwa, "Distributed Hierarchical Transactive Energy Management to Exploit Flexibilities in Transmission Systems," in Journal of Modern Power Systems and Clean Energy, vol. 13, no. 5, pp. 1520-1531, September 2025, doi: 10.35833/MPCE.2024.000859.
9. C. Diaz-Londono, G. D. Agundis-Tinajero, P. Maffezzoni, G. Gruosso and J. M. Guerrero, "Evaluating the Electrical Network Impact of EV Charging Strategies Used by Operators Across Residential, Workplace, and Public Users," in IEEE Open Journal of Vehicular Technology, vol. 6, pp. 1721-1735, 2025, doi: 10.1109/OJVT.2025.3581803.
10. V. Sharma and S. Kumar, "Role of Artificial Intelligence (AI) to Enhance the Security and Privacy of Data in Smart Cities," 2023 3rd International Conference on Advance Computing and Innovative Technologies in Engineering (ICACITE), Greater Noida, India, 2023, pp. 596-599, doi: 10.1109/ICACITE57410.2023.10182455.
11. M. Plenz, A. Stadler, Y. Fu and D. Schulz, "Increasing Grid Stability: Impact of Charging Characteristics on an Easy-to-Use Priority-Driven EV Load Reduction Approach," 2025 IEEE/AIAA Transportation Electrification Conference and Electric Aircraft Technologies Symposium (ITEC+EATS), Anaheim, CA, USA, 2025, pp. 1-5, doi: 10.1109/ITEC63604.2025.11097999.
12. M. Kumar, K. K. Gautam, V. Sharma, B. Samania, T. K. Vashishth and S. Chaudhary, "Enhancing Cloud Computing Performance: A Novel Approach for Optimizing Energy Efficiency through AI- Based Load Balancing Algorithm," 2025 International Conference on Intelligent Computing and Knowledge Extraction (ICICKE), Bengaluru, India, 2025, pp. 1-6, doi: 10.1109/ICICKE65317.2025.11136754.
13. Y. Wang, J. Wang, L. Zhang and Z. G. Zhang, "Congestion-Based Repair Policy for a Failure-Prone Service System With Strategic Customers," in IEEE Transactions on Systems, Man, and Cybernetics: Systems, doi: 10.1109/TSMC.2025.3621549.
14. P. C. S. Reddy, P. Shirley Muller, S. N Koka, V. Sharma, N. Sharma and S. Mukherjee, "Detection of Encrypted and Malicious Network Traffic using Deep Learning," 2023 International Conference on Ambient Intelligence, Knowledge Informatics and Industrial Electronics (AIKIIE), Ballari, India, 2023, pp. 1-6, doi: 10.1109/AIKIIE60097.2023.10390386.
15. A. Shooshtari, A. Pepiciello and J. L. Domínguez-García, "Grid-Informed Sharing Coefficients in Renewable Energy Communities," 2025 IEEE International Conference on Environment and Electrical Engineering and 2025 IEEE Industrial and Commercial Power Systems Europe (EEEIC / I&CPS Europe), Chania, Crete, Greece, 2025, pp. 1-6, doi: 10.1109/EEEIC/ICPSEurope64998.2025.11169004.
16. R. Kant, S. Sharma, V. Vikas, S. Chaudhary, A. K. Jain and K. K. Sharma, "Blockchain – A Deployment Mechanism for IoT Based Security," 2023 International Conference on Computational Intelligence, Communication Technology and Networking (CICTN), Ghaziabad, India, 2023, pp. 739-745, doi: 10.1109/CICTN57981.2023.10140715.
17. R. V. Rayala, C. Reddy Borra, V. Vasudevan, M. G, S. Cheekati and J. U. Rustambekovich, "Enhancing Renewable Energy Forecasting using Roosters Optimization Algorithm and Hybrid Deep Learning Models," 2025 International Conference on Innovations in Intelligent Systems: Advancements in Computing, Communication, and Cybersecurity (ISAC3), Bhubaneswar, India, 2025, pp. 1-6, doi: 10.1109/ISAC364032.2025.11156529.
18. B. Kurubacakoğlu and I. Duru, "Analysis of Factors Affecting Electricity Prices and Electricity Price Forecast for Türkiye," 2025 10th International Conference on Computer Science and Engineering (UBMK), Istanbul, Turkiye, 2025, pp. 1106-1111, doi: 10.1109/UBMK67458.2025.11206868.