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Name of the topic: Mitigation Congestion in Deregulated Power Systems

Findings:

Key Words: Congestion Management, Deregulated Power Systems, Renewable Energy Integration, Available Transfer Capacity (ATC), Flexible AC Transmission Systems (FACTS), Optimization Techniques (GA, PSO, GWO, SSA, JAYA), Generator Rescheduling, Sensitivity Factors (ACPTDF, GSF), Voltage Stability, IEEE 30 Bus System Simulation

This study identifies congestion as a major challenge in deregulated power systems, especially with high renewable energy integration. It investigates mitigation strategies using both cost-free and non-cost-free approaches.

The cost-free method enhances Available Transfer Capacity (ATC) through the optimal placement of Flexible AC Transmission Systems (FACTS) devices. Using a sensitivity factor-based approach with AC Power Transfer Distribution Factor (ACPTDF), the study determines ideal FACTS placement. Optimization techniques such as Genetic Algorithm (GA), Particle Swarm Optimization (PSO), Grey Wolf Optimization (GWO), Sine Cosine Algorithm (SSA), and JAYA significantly improve ATC, reduce congestion, and enhance voltage profiles without additional operational costs.

The non-cost-free method involves generator rescheduling using the Generator Sensitivity Factor (GSF). Optimization techniques like GWO, Social Spider Optimization (SSO), Teaching-Learning-Based Optimization (TLBO), and JAYA ensure cost-effective rescheduling. Integrating wind energy into rescheduling further reduces congestion costs while promoting sustainability.

Simulations on IEEE 30 Bus and Modified IEEE 30 Bus systems validate the effectiveness of these strategies. Combining sensitivity factors with optimization techniques significantly improves power loss reduction, voltage stability, and system reliability. Parameter-less optimization methods like JAYA and TLBO prove to be particularly robust and efficient.

This research establishes a strong foundation for future studies, suggesting energy storage, demand response, and advanced optimization techniques for enhanced congestion management in evolving power systems.