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Name of the topic: Load Frequency Control Strategies for Integrated Power Systems with Renewable Energy Sources

Findings:

Key Words: AGC/LFC; Power system; Renewable energy sources; Energy storage system; FOTID Controller; salp swarm algorithm (SSA); soft computing techniques;

The dynamic nature of power demand and generation poses challenges to power system stability, particularly evident in undesirable frequency deviations. Load Frequency Control (LFC) faces these challenges due to fluctuating load demands and the integration of renewable energy sources (RES). To mitigate frequency deviations, a robust LFC scheme and energy storage system are essential in realistic interconnected multi-source power systems (IMSPS) heavily penetrated by RES.

This study explores various LFC strategies including PID, fractional order PID (FOPID), two degrees of freedom-PID (2DOF-PID), and tilt integrated derivative (TID) controllers. The salp swarm algorithm (SSA) optimizes these controllers to effectively manage frequency deviations across single-area thermal-hydro (TH), TH-gas (THG), and nonlinear THG configurations. Results demonstrate SSA-tuned controllers significantly enhance LFC performance, with TID controllers showing superiority in stability and reliability metrics.

Additionally, fractional order controllers like FOPID and the proposed fractional order tilt integral derivative (FOTID) controller optimized by SSA exhibit improved control dynamics in MATLAB simulations of two-area multi-source power systems. Moreover, a new cascade fractional order TID (CFOTID) controller integrated with capacitive energy storage (CES) enhances performance in a pragmatic RES-based IMSPS, surpassing existing controllers and SSA-based CFOTID in minimizing overshoot, undershoot, and settling time.

Furthermore, a cascade tilt integral derivative-fractional ordered proportional TID (TID-FOPTID) controller refined by SSA demonstrates superior LFC in a three-area power system with integrated CES, effectively managing frequency and voltage deviations due to load variations and RES integration.

In conclusion, this study underscores the efficacy of SSA-based control techniques and the integration of CES in bolstering LFC performance and enhancing power system stability in the face of dynamic load demands and RES integration challenges.