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An ADMM-enabled robust optimization framework for self-healing scheduling of smart grids integrated with smart prosumers

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Abstract-

Enhancing the reliability of energy networks and minimizing downtime is crucial, making self-healing smart grids indispensable for ensuring a continuous power supply and fortifying resilience. As smart grids increasingly incorporate decentralized prosumers, innovative coordination strategies are essential to fully exploit their potential and improve system self-healing capabilities. To address this need, this paper presents a novel bi-level strategy for managing the self-healing process within a smart grid influenced by Hydrogen Refueling Stations (HRSs), Electric Vehicle Charging Stations (EVCSs), and energy hubs. This approach taps into the combined potential of these prosumers to boost system self-healing speed and reliability. In the initial stage, the Smart Grid Operator (SGO) conducts self-healing planning during emergencies, communicating required nodal capacities to prevent forced load shedding and outlining incentives for smart prosumers. Subsequently, prosumers schedule their activities and contribute flexible capacities to the SGO. Bridging the first and second stages, an adaptive Alternating Direction Method of Multipliers (ADMM) algorithm ensures convergence between the SGO and prosumer schedules within a decentralized framework. This strategy underwent implementation on a 118-node distribution system using GAMS. Results demonstrate that the proposed concept reduces Forced Load Shedding (FLS) by 32.04% and self-healing costs by 17.48% through effective utilization of smart prosumers' flexible capacities. Furthermore, outcomes indicate that the SGO reduces FLS by 6.69% by deploying Mobile Electrical Energy Storages (MEESs) and Mobile Fuel Cell Trucks (MFCTs) to critical nodes.

Index Terms- Smart gridsSelf-healingEnergy hubsHydrogen energyVehicle-to-grid servicesAlternating direction method of multipliers

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