

Internet data centers and industrial parks as flexibility providers in modern power systems: An ADMM-based coordination mechanism

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Abstract-

Smart prosumers with Distributed Generation (DGs) and controllable loads can provide cost-effective grid services. However, realizing this potential requires distributed optimization mechanisms that ensure market efficiency, participant privacy, and compliance with electricity market regulations. This paper presents a bi-level distributed optimization mechanism to maximize flexibility services from industrial parks and Internet Data Centers (IDCs) in distribution-level Congestion Management (CM) markets. The upper-level models the Distribution System Operator (DSO), which identifies congested lines using linear AC power flow analysis on pre-settled energy market results and sends corrective signals to prosumers. The lower level allows prosumers to adjust their operations accordingly and communicate updated transactions back to the DSO. A novel proxy-driven algorithm is proposed to facilitate service-sharing among geo-distributed IDCs, considering congestion issues. Additionally, an adaptive Alternating Direction Method of Multipliers (ADMM) algorithm enables decentralized coordination among market agents, achieving 74.52 % faster convergence than the standard ADMM. A real-world case study from Spain demonstrates that the proposed mechanism enables the grid operator to maximize grid services from prosumers, reducing congestion alleviation costs by 35.27 %. Moreover, IDCs reduced daily costs by 11.07 % through service-sharing and task-shifting aligned with CM market signals, while industrial parks achieved a 13.68 % cost reduction by aligning material production processes with CM market signals, both enabled by the proposed bi-level mechanism.

Index Terms- Industrial parks; Internet data Centers; Congestion management; Distributed optimization; Smart prosumers; Smart grids

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