Guest editorial: special section on managing electricity demand

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The interest in managing electricity demand surfaced in earnest during the 1970s as economic, political, social, technological, and resource supply factors combined to change the electricity sectors' operating environment and its outlook for the future. Ever since then, a successive series of concepts have evolved as an effective way of mitigating these risks including: demand-side management (DSM), demand response (DR), and transactive energy.

In the paper entitled "Evolving practice of demand-side management", the evolution of demand-side management is reviewed. Then, the technologies, programs and activities of demand-side management are described with U.S. data as examples. Finally, the future evolution path of DSM is discussed.

In the paper entitled "From demand response to transactive energy: state of the art", the state of the art in the research and industrial practice in demand response is reviewed. In particular, the design of demand response programs, performance of pilot projects and programs, consumer behaviors, and barriers are discussed. Also discussed include characteristics, the state of the art, schemes, promises and challenges of transactive energy.

In the paper entitled "Demand response for frequency control of multi-area power system", the authors propose a frequency control strategy using demand response for a multi-area power system. The tie-line power flow is utilized as an additional input signal for demand response control. Then, the frequency regulation is formulated as a multi-objective optimization problem to obtain the optimal control parameters. Numerical results on a three-area system verify the proposed method.

In the paper entitled "Hierarchical and distributed demand response control strategy for thermostatically controlled appliances in smart grid", the authors point out that thermostatically controlled loads are excellent DR resources because of their thermal inertia to maintain the tie-line power flows, which has been a challenging job under the high penetration of renewable energy resources. A hierarchical and distributed control strategy of thermostatically controlled appliances is proposed. Also, the model prediction strategy and customers' responsive behavior model are integrated in the proposed approach. Case studies are reported to verify the proposed control strategy.

In the paper entitled "Controllability and stability of primary frequency control from thermostatic loads with delays", the authors study the impact from response delays and lockout constraints on the controllability of aggregated refrigerators, i.e., thermostatic loads, when they offer primary frequency control (PFC). A framework to systematically address frequency measurement and response delays is proposed. Extensive simulation studies are conducted to investigate the effects of measurement delay, ramping times, lockout durations and rotational inertia on the controllability of the aggregation and system stability.

In the paper entitled "Optimal air-conditioning load control in distribution network with intermittent renewables", a MILP (mixed integer linear programming) based approach to schedule interruptible air-conditioning loads is proposed to

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improve the wind power utilization level in distribution networks. The rolling horizon optimization (RHO) strategy is employed to continuously update the real-time information and proceed the control window. Then, to ensure the thermal comfort of customers, a two-parameter thermal model is proposed to calculate the indoor temperature variation.

In the paper entitled “Congestion management with demand response considering uncertainties of distributed generation outputs and market prices”, a DR-based congestion management strategy is proposed with a bi-level optimization model for the day-ahead congestion management. Subsequently, robust optimization is introduced to alleviate negative impacts introduced by the uncertainties of distributed generator output and market prices. The economic efficiency and robustness of the proposed congestion management strategy are demonstrated with an actual 0.4 kV distribution system in Denmark.

In the paper entitled “Nodal user’s demand response based on incentive based programs”, the authors describe a practical approach to identify nodal price compensation payment for nodal consumers who are willing to reduce their energy consumption via consumers’ DR programs. The implementation of a nodal reliability service pricing approach is based on contingency assessment of $N-2$ transmission line contingencies. A representative annualized demand curve is used to evaluate the nodal reliability impact during an entire year such that the back payments (incentive payments) to users for service interruption can be assessed. The IEEE RTS 24-node system is used to implement and verify the proposed approach.

In the paper entitled “Residential end-uses disaggregation and demand response evaluation using integral transforms”, the authors point out the importance to analyze the load decomposition for better utilization of DR. Then, the authors present an approach based on the Integral (Hilbert) Transform as a tool to analyze non-stationary signals, and then discuss the information extracted from load measurements and end-use filtering. Case studies are carried out to analyze real demand profiles and customers.

In the paper entitled “Green neighbourhoods in low voltage networks: measuring impact of electric vehicles and photovoltaics on load profiles”, a UK experience in low-carbon technologies (LCTs) is discussed. In this paper, the authors proposed an agent based model that estimates the growth of LCTs within local neighbourhoods, where social influence is imposed. Real-life data from a low-voltage network is used that comprises of many socially diverse neighbourhoods. Then, a probabilistic approach is described to determine lower and upper bounds for the model response at every neighbourhood. Finally, the authors discuss the potential applications of these bounds in future network planning.

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