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Optimization and control in smart grids

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Abstract:

The increased use of renewable energy, the emergence of distributed generation and storage systems, and, in general, the concept of "smart grids", necessitate new decision and control schemes for planning and management of energy resources. The proposed Open Invited Track has the objective of collecting contributions related to optimization and control methods for the planning and management of smart grids that include renewable energy, storage systems, distributed generation, buildings with demand response capabilities, microgrids, etc. The application and testing of the proposed approaches to real case studies and research infrastructures are encouraged.

Detailed description:

The continued growth and promotion of Renewable Energy Systems (RESs) as a sustainable replacement for diminishing and carbon-intensive fossils fuels for electricity generation is a key priority for the European Union. Typically, renewable electricity generation systems are intermittent and geographically distributed. Additionally, RESs enable traditional electricity consumers to become prosumers who actively engage in energy markets through renewable production, storage and demand-side management. In this framework, novel and transformative smart grid management and optimization technology solutions must become reality in the coming years. Currently, a major challenge is represented by the lack of a unified mathematical framework including

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robust tools for modeling, simulation, control and optimization of time critical operations in complex multicomponent and hierarchical networks [1], [2]. The difficulty of defining effective real-time optimal control schemes is due to several physical and mathematical issues, including: renewable and traditional power production, bidirectional power flows, dynamic storage systems, demand response requirements, and stochastic aspects (such as uncertainties in renewable, prices, and demand forecasting). This results in optimization problems which are generally intractable within a real-time optimal control scheme when detailed models of every system component are required. Moreover, new regulation related to new market entrants and schemes requires a revision and improvement of distributed energy management systems planning and management, as well as their coordination in order to optimize self-consumption and energy distribution.

Microgrid research fits very well with ongoing smart grid activities throughout the world and several challenges need to be investigated [3]. Microgrids are able to integrate different distributed and heterogeneous sources, either programmable or stochastic (these latter, typically, are the renewables like wind and solar), and require intelligent management methods and efficient design in order to meet the needs of the area they are located in ([4–6]). Generally, microgrids are low voltage distribution networks installed in confined geographical areas (like university campuses or districts), but also buildings or industrial plants can themselves be viewed as microgrids. Energy Management Systems (EMSs) are vital tools used to optimally operate and schedule microgrids [7]. Experimental tests and demonstration projects are fundamental to derive new methods and tools for the optimal planning and management and for simulation purposes.

The topics of the proposed Open Invited Track are specifically related (but not limited to) to the following methods and application areas:

- Model predictive control
- Distributed control
- Decentralized control
- Hierarchical control
- Stochastic optimization
- Chance constrained optimization

- Identification of models for power forecasting
- Microgrids (grid-connected and islanded)
- Polygeneration grids
- Demand response
- Energy Management Systems
- Building Automation Systems
- Integration of electrical vehicles in smart grids
- Distributed storage planning and management
- Coordination of microgrids

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