Smart Algorithmic design For Enhanced Frequency Response In Distributed Storage Systems

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Abstract

Due to the lack of large-scale energy storage for extended periods of time, supply and demand in power systems need to be balanced at all times. With the increasing proportion of intermittent and variable renewable energy generation in the energy mix and the existence of more volatile types of load, as well as the lack of cost competitive energy storage, there is an increased interest in the demand side management and especially in Demand Response (DR).

Demand Response programs have the capability to lower electricity prices, as well their volatility, and improve the reliability of the energy system. By improving the reliability of the power system and shaving peak demand in the long term, DR helps to reduce overall plant and capital cost investments and postpones the need for network upgrades and reinforcements. This need of DR services can be provided by companies (Aggregators) that provide aggregation services and act as intermediaries between the distribution network operators (DNOs) and the electricity end-use consumers.

The challenges of Demand Response can be tackled using knowledge and techniques from various domains, not just power systems. Different techniques from the AI "toolbox" such as Machine Learning, Deep Learning, Reinforcement learning (or a combination of these) are used to try and solve various problems such as finding the optimal set of end-use consumers to perform coordinated demand response in the short as well as in the long run, learning latent information of the consumers from observable data, dynamic monitoring of the State of Health of battery assets, and optimisation of assets' usage based on price signals. Game theory is used to address a different set of problems e.g. how to incentivise end-use consumers to participate in this scheme, as well as how to reward them for their services in a fair and stable way. Furthermore, there is a need for automated negotiations because of the volume and timeframe in EFR.

References

[1] Palensky, P. & Dietrich, D. (2011), 'Demand Side Management: Demand Response, Intelligent Energy Systems, and Smart Loads', IEEE Transactions on Industrial Informatics 7(3), 381–388.