OPTIMIZATION OF SMART ENERGY MANAGEMENT IN SMART GRID

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Optimizations in power grids are difficult because of fluctuating demand and *uncertainty* in the supply, especially due to penetration of distributed renewable energy sources. Even though efforts are on to increase generation capacity, there is significant potential and need to improve the existing infrastructure by utilizing intelligent grid-state-aware optimal generation, distribution, and loads. Fine grain level of monitoring and controlling till the appliance level is possible with the advances in sensing systems, smart appliances and smart meters, which give rise to *new optimization problems* in this space. Smart Energy Management (SEM) and Demand Response (DR) programs are getting more attention due to *sustainability* and green environment considerations. The DR programs can be more interactive and automatic for the benefit of both utilities and customers. *We present a snapshot of related work with the overview of existing literature in DR, energy management and optimization techniques to solve those problems. We discuss the challenges, identified gaps and our approach to solve the problems including the dynamics of the system. We enhanced the previous results in literature by including real time control in seconds. The LP model solved using "Cplex" had 100,000 variables and performed data analysis to understand the solution.*

Our work involves the ways to model large scale smart grid system optimization problems, solution methods for such models, and results and interpretation of these solutions. Typical scenario of *1000-customer problem each has 10 appliances with hourly varying time slots and 10 supply side options results in a mixed integer linear program (MILP) with millions of variables (*with 40,000 integer and 950,000 real variables). Our model is an extension of standard MILP formulations, to incorporate aggregation *for computational tractability, and extensions to handle constraints such as* user *comfort, emission limits, and appliance level constraints*. Another feature in our model is the incorporation of *uncertainty*, in an intuitive fashion, using substitutive, complementary and general constraints as an extension of *robust optimization* framework. Convexification and hierarchical model are used to make the problems tractable, with targeted real-time response (few seconds to mins). The convexified model is solved by nested simulation and optimization using "Cplex" both at consumer and utility levels. We observed benefits of up to 60% of energy saving during practical implementation of our model at a campus level network. The analysis of initial results indicates that our model is mutually beneficial to the customers and utility companies by flattening the demand curve over a day either by shifting or reducing the load and automating the energy management.