Title of thesis:
The Cloud Based Energy Management: Design, Analysis and Realization

Abstraction:
Reducing greenhouses gasses by promoting renewable energy has become an important goal for many countries in recent years to ease the severe climate changes. How to encourage companies and residents to adopt both large-scale renewable generators (such as solar parks, wind farms) and distributed rooftop photovoltaic (PV) power, and be able to simultaneously enhance the integration of these non-dispatchable distributed energy resource (DER) without bringing challenges (such as reserve capacity, scheduling, and load management) caused by the fluctuations and uncertainties to the entire power grid becomes a critical issue. It is achievable with proper managements and novel trading strategies that could provide incentives to involved customers and efficient control to the entire power grid.

In this thesis, we firstly proposed a cloud-based framework to provide a customer-oriented energy management as a service (EMaaS) for "*green communities*," which are formed as virtual retail electricity providers (REP) by involved DERs providers. While the green communities are formed as virtual REP, customers (i.e., involved DERs providers) are able to *virtually trade* their produced renewable to each other, and be able to benefit mutually. EMaaS is an extensive framework and also a business model for renewable energy integration. Incentives are maximized as the global costs are minimized and renewable energy integration is enhanced as the renewable energy consumption is stabilized by the proposed EMaaS for each green community. A linear programming model is formulated for EMaaS.

This thesis secondly introduced the demand response and the charging scheduling of electric vehicles (EVs) for the cloud-based energy management service. With the combination of electricity usage choices and trading choices, the proposed fair demand response with electric vehicles (F-DREV) is able to further minimize the global cost for each community while distributing incentives fairly to the individual customer via a binary linear programming model. The fairness in F-DREV is proposed as "customers with higher participation level can reduce individual cost more than other customers with lower participation level." It is attainable by customizing trading prices for each customer base on his/her fairness index. F-DREV attracts customers not only to involve in controlling their consumption patterns but also participate actively, and allows EVs and DERs within the community operate grid-friendly by smoothing the fluctuated penetration of EV loads and production capacities from DER.

The distributed large-scale interaction and adjustment are proposed for the cloud-based energy management in the third part of the thesis. The cross-community interaction (XCI) minimizes the global costs as maximizing the incentives for customers within all the collaborated communities over the given time period. XCI is performed in the distributed fashion to overcome the privacy concern and the ability, scalability, and efficiency of the allocated computing resources for handling the large-scale data. It can be solved efficiently via the alternating direction method of multiplier (ADMM). The cross-community adjustment is also proposed to enhance the efficiency of XCI for the cloud-based energy management service under uncertainty. The overwhelmed data exchanging and the computations can be significantly reduced without rerunning the management frequently.