

Title: Semiconductor Research Center (SRC) Energy Research Initiative (ERI) Smart Grid Research Center (SGRC) Task 2111.001 **Adaptive Load Management**

Duration: September 2011 to September 2013

Sponsor: Semiconductor Research Center (SRC)

Contributing faculty: Marija Ilic (PI)

Contributing students: Jhi-Young Joo

Description:

Adaptive Load Management (ALM) provides a framework and structure for demand response strategies, by formulating them as optimization problems of different demand entities in the system over multiple time horizons. We provide a comprehensive point of view, in both temporal and spatial aspects, emphasizing the relationships of the decisions made by different entities in the system. The spatial scope of the framework ranges from the system/market operator, load serving entities to the individual end-users. The temporal scope includes decision-making processes for long-term investment into demand efficiency to near real-time adjustment of loads with respect to the volatile real-time price.

In terms of multi-temporal aspect of demand optimization, we propose multiple clearances and adjustments of demand and supply along the time horizon as more information becomes available approaching the actual generation and consumption. When the time comes close to the real-time operation, if the loads can be adjusted for balancing and stabilizing the system with the right signal represented by the real-time price, the decision making procedure of the system operator, the load serving entities and the end-users can be supported by Lagrange dual decomposed optimization. We define the problem of decision-making by each entity at different time stages, with illustration of how these ideas could work within a large system. We especially explore methodology for solving the dual decomposition problem of economic dispatch by the system operator, and the conditions for the decisions to converge to the system optimum. The main contribution of this work is in identifying the mathematical relationships between the multi-temporal and multi-spatial objectives of the electric energy system, and defining the effective methods of balancing the different objectives at different time horizons.

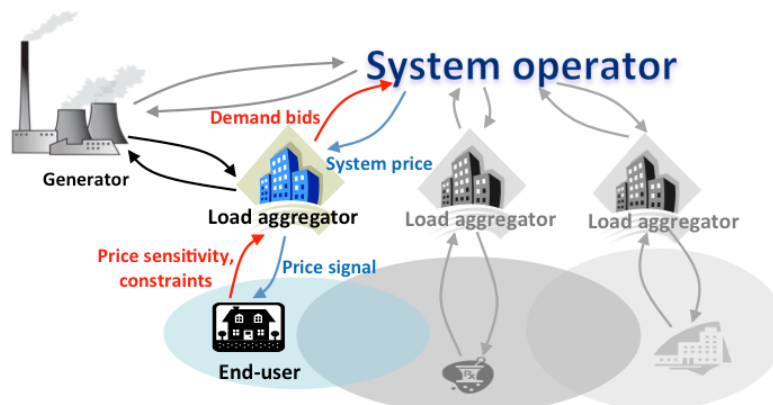


Figure 1. Information exchange in Adaptive Load Management

Related publications:

• **Journal Papers**

1. **Jhi-Young Joo**, and Marija Ilić, "A Tutorial On Decentralized Economic Dispatch Including Demand Resources In Power Systems," *IEEE Transactions On Education, in progress*
2. **Jhi-Young Joo**, and Marija Ilić, "Multi-Layered Optimization Of Demand Resources Using Lagrange Dual Decomposition," *IEEE Transactions On Smart Grid*, Special Issue on Real-Time Demand Response, Volume 4, Issue 4, 2013
3. Marija Ilic, **Jhi-Young Joo**, Le Xie, Marija Prica, and Niklas Rotering, "A Decision Making Framework and Simulator for Sustainable Electric Energy Systems," *IEEE Transactions on Sustainable Energy*, Volume 2, Issue 1, January 2011
4. Marija Ilic, Le Xie, and **Jhi-Young Joo**, "Efficient Coordination of Wind Power and Price-Responsive Demand, Part I: Theoretical Foundations," *IEEE Transactions on Power Systems*, Volume 26, Issue 4, November 2011
5. Marija Ilic, Le Xie, and **Jhi-Young Joo**, "Efficient Coordination of Wind Power and Price-Responsive Demand, Part II: Case Studies," *IEEE Transactions on Sustainable Energy*, Volume 26, Issue 4, November 2011
6. **Jhi-Young Joo**, Sang-Ho Ahn, and Yong Tae Yoon, "Enhancing Price-Responsiveness Of End-Use Customers' Loads: Dynamically Administered Critical Peak Pricing," *European Transactions on Electrical Power*, Volume 19, Issue 1, John Wiley and Sons, Ltd., 2009

• **Book Chapters**

1. **Jhi-Young Joo**, Jonathan Donadee, and Marija Ilic, "Assessing the Ability of Different Types of Loads to Participate in Adaptive Load Management," *Engineering IT-Enabled Electricity Services; The Case Of Low-Cost Green Azores Islands*, Ed. Marija Ilic, Le Xie, and Qixing Liu, Springer, 2013
2. **Jhi-Young Joo**, Yingzhong Gu, Le Xie, Jonathan Donadee, and Marija Ilic, "Look-ahead Model-Predictive Coordinated Generation and Demand Dispatch Methods for Managing Uncertainties," *Engineering IT-Enabled Electricity Services; The Case Of Low-Cost Green Azores Islands*, Ed. Marija Ilic, Le Xie, and Qixing Liu, Springer, 2013

• **IEEE Conference Proceedings**

1. **Jhi-Young Joo**, and Marija Ilić, "Distributed Scheduling Of Demand Resources In A Congested Network," *2014 IEEE Power and Energy Society General Meeting, revision under review*
2. Marija Ilić, **Jhi-Young Joo**, Pedro M.S. Carvalho, Luís A.F.M. Ferreira, and Bernardo Almeida, "Dynamic Monitoring and Decision Systems (DYMONDS) Framework for Reliable and Efficient Congestion Management in Smart Distribution Grids," *Bulk Power System Dynamics and Control, iREP Symposium*, August 2013
3. **Jhi-Young Joo** and Marija Ilic, "Distributed Multi-Temporal Risk Management Approach to Designing Dynamic Pricing," *IEEE Power and Energy Society General Meeting*, July 2012
4. **Jhi-Young Joo** and Marija Ilic, "Multi-Temporal Risk Minimization Of Adaptive Load Management In Electricity Spot Markets," *IEEE Power and Energy Society Innovative Smart Grid Technologies Europe*, December 2011
5. Marija Ilic, Nipun Popli, **Jhi-Young Joo**, and Yunhe Hou, "A Possible Engineering and Economic Framework for Implementing Demand Side Participation in Frequency Regulation at Value," *IEEE Power and Energy Society General Meeting*, July 2011

6. **Jhi-Young Joo** and Marija Ilic, "A Multi-Layered Adaptive Load Management (ALM) System: Information exchange between market participants for efficient and reliable energy use," *2010 IEEE Power and Energy Society Transmission and Distribution Conference*, April 2010
7. **Jhi-Young Joo** and Marija Ilic, "Adaptive Load Management (ALM) in Electric Power Systems," *2010 IEEE International Conference on Networking, Sensing and Control*, April 2010
8. Le Xie, **Jhi-Young Joo**, and Marija Ilic, "Integration of Intermittent Resources with Price-Responsive Loads," *2009 North American Power Symposium*, October 2009
9. **Jhi-Young Joo**, Sang-Ho Ahn, Yong Tae Yoon, and Jong-Woong Choi, "Option Valuation Applied to Implementing Demand Response via Critical Peak Pricing," *IEEE Power and Energy Society General Meeting*, June 2007