



Power Systems Engineering Research Center

The Key Role of Network Systems Engineering in Meeting the Energy and Environment Dream

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Public Tele-Seminar
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Energy and the environment are once again on everyone's mind. The primary energy producers have entered a race for making the traditional energy resources cleaner and safer, as well as for developing scientific principles in support of entirely novel energy resources. At the same time, we do not have the infrastructure to transport the energy effectively. The infrastructure for converting our primary energy resources and delivering energy in the form required by the end users was designed with qualitatively different objectives from the functions of today; it is aging and far from what it should and could become.

This talk concerns the basic challenge of transforming today's passive electric power grids into active enablers of efficient and reliable utilization of emerging unconventional energy resources. Our conservative estimate for the electric energy system alone is that a 25% increase in efficiency can be obtained today by such transformation without degrading reliability of services. However, while much of the hardware exists, meeting this goal still poses a fundamental challenge to the current state-of-the-art in systems and network sciences. Any large-scale penetration of intermittent resources is practically impossible without equally large-scale sensing, actuation and on-line data-assisted decision making by various industry participants, ranging from Independent System Operators (ISOs), Load Service Entities (LSEs), power producers/aggregators, to end users. In short, these resources cannot succeed without significant improvements to the control of the infrastructure.

We pose the problem of future electric energy systems as the problem of network design, monitoring, and control for enabling implementation of multiple objectives by the actors embedded at various network layers. Typical tradeoffs of interest are efficiency, cost, emissions, network congestion, profits, differentiated reliability, long-term sustainable services, etc. We present our new cyber-physical modeling framework as a possible way to represent future electric energy systems. The emphasis is on model structure needed for effective deployment of distributed sensing and decision tools. Finally, we describe the fundamental role of fast-switched electric network control for shaping effective system energy dynamics. We argue that while on the average no real work is done, very fast distributed switching of stored energy in wires (inductors and capacitors) enables stable delivery of energy which would otherwise be impossible. Such active wire control may become key to balancing highly stochastic supply according to desired quality of service.

Biography: Marija Ilic is a professor in the Electrical and Computer Engineering and Engineering Public Policy Departments, Carnegie-Mellon University. Marija is a researcher in MIT's Affiliate Systems Engineering Division (SED). Her interest is in control and design of large-scale systems. She has co-authored several books on the subject of large-scale electric power systems. From September 1999 until March 2001, she was a Program Director for Control, Networks and Computational Intelligence at the National Science Foundation. She was a Senior Research Scientist at the EECS Department at MIT. Prior to her years at MIT, she was a faculty at the University of Illinois at Urbana-Champaign, Cornell University, and Drexel University. She is a recipient of the First Presidential Young Investigator Award for Power Systems. She is an IEEE Fellow and an IEEE Distinguished Lecturer. She received her M.Sc. and D.Sc. degrees in Systems Science and Mathematics from Washington University in St. Louis, and her Dipl. Ing. and M.E.E. degrees from her native Yugoslavia, University of Belgrade.

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Shmuel welcomes feedback on the tele-seminars and suggestions for future ones.