Stanford University

TomKat Center for Sustainable Energy
Precourt Institute for Energy
SLAC National Accelerator Laboratory
Energy and Environment Affiliates Program
Civil and Environmental Engineering
Department of Electrical Engineering

Stanford SmartGrid Seminar

Spatiotemporal Marginal Costing on T&D Electricity Networks for distributed Load/Generation/Resource Synergy

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1:15pm-2:15pm, Thursday, Nov 6th, Y2E2 101

Abstract: Interconnected/synchronized Power Grids are the largest and at the same time most critical man-made systems. As such, they:

- enable *interaction/interoperation of millions of hardware assets* (traditional bricks, mortar, steel etc. as well as modern sensors, computer controlled actuators, communication antennas etc.) *with human agents/actors/energy service users supported by software-based-decision-support assets*, and
- reveal *challenging opportunities* for efficient, sustainable and reliable operation, and also reveal *formidable vulnerabilities* associated with an inefficient energy sector, or with unfriendly damage of critical grid components.

Centralized management of the grid through regional control centers served us well during the 20th century. However, more recently (1990 in England, late 1990s in the US), benefits of coordinated-

decentralized-control were realized through dynamic spatiotemporal marginal costing of electricity service. This *marginal costing on high voltage networks* was obtained as the mutually acceptable consensus amongst grid participants interacting in well-designed wholesale markets. Extension of *consensus marginal cost estimation* to distribution networks while addressing the evolving gamut of electricity products transacted on the grid can exploit the grid's promises and mitigate its vulnerabilities. This talk will present key issues that must be addressed to achieve this extension, including market reform, socially optimal coordination of distributed decision making and associated *open* optimization, control and communication research problems.

Bio: Michael Caramanis, Boston University Systems and Mechanical Engineering Professor, (BS Stanford 1971, MS/PhD Harvard 1976) has been active in research on electricity generation expansion, manufacturing and service network supply chain optimization, and spatiotemporal marginal costing on electricity T&D networks. He co-investigated Power Market design in the 80s and participated in pioneering implementations in Brittan, US, Spain and Italy. From 2004 to 2008, while on leave from Boston University, he chaired the Energy Charter's Investment group (Brussels) and the Regulatory Authority for Energy (Athens). His disciplinary background lies in Mathematical Economics, Optimization, and Stochastic Dynamic Decision Making. His recent focus on smart electricity grids is centered around (*i*) the Power Market reform required to integrate Distribution/Retail participants and (*ii*) the dynamic reconfiguration of power transmission networks for congestion cost mitigation and infrastructure resilience to renewable generation. He has authored/coauthored more than 100 refereed publications and is coauthor of Spot Pricing of Electricity, Kluwer Academic Publishers, 1987. URL: www. bu.edu/pcms/caramanis