Harnessing the Power of Distributed Energy Resources: Quantifying Transactive Energy Economics

Thursday October 20, 2016

Rotary Summit Center, 88 S. 4th St, San Jose, CA 95112

Time	Activity
8:00 am	**Registration and Networking**
8:30 am	**Welcome, Overview from NIST** • *Avi Gopstein, Smart Grid Program Manager – NIST*
8:35 am	**Keynote Address: The role of distributed resources in California's future** • *Mike Gravely, Assistant Deputy Director for Energy Research & Development – California Energy Commission*
8:55 am	**NIST TE Challenge** • *David Holmberg, TE Challenge Lead – NIST*
9:10 am	**Breakout Session Instructions and Charge to Participants** • *Chris Kelley, Vice President – Energetics Incorporated*
9:15 am	**Plenary Session 1: Technologies, Tools, and Techniques that Impact the Grid in a Transactive Energy Environment** • *Don Reeves, CTO – Silver Spring Networks* • *Steve Bushby, Mechanical Systems and Controls Lead – NIST*
10:00 am	**Break**
10:15 am	**Breakout Session 1** Technologies, Tools, and Techniques that Impact the Grid in a DER Environment
11:15 am	**Break**
11:30 am	**Plenary Session 2: Ensuring the Availability and Delivery of Transactive Energy Services across Markets** • *Lorenzo Kristov, Principal, Market & Infrastructure Policy – CAISO* • *Avi Gopstein, Smart Grid Program Manager – NIST*
12:15 pm	**Lunch** (on your own)
1:30 pm	**Breakout Session 2** Ensuring the Availability and Delivery of Transactive Energy Services
2:30 pm	**Break**
2:45 pm	**Plenary Session 3: Validating the Models for Transactive Energy** • *Audrey Lee, VP of Analytics and Design—Advanced Microgrid Solutions* • *Marty Burns, Associate Director for Cyber Physical Systems – NIST*
3:30 pm	**Breakout Session 3** Validating the Models for Transactive Energy
4:30 pm	**Break** and return to Plenary *Prep for report outs*
4:45 pm	**Report Outs** (*5-10 min debrief from each group, with Q&A*)
5:15 pm	**Closing Remarks from NIST**
5:30 pm	**Adjourn Meeting**

Transactive Energy (TE) Use Cases

TE has the ability to allow real-time markets to solve challenges as they arise and address some of the most complex challenges facing future utility operations. Defining Use Cases with specific objectives allows the effectiveness of TE solutions to be analytically compared against business-as-usual or baseline scenarios. To facilitate meaningful comparison across strategies, use cases must include common reference grids, environmental conditions, and objectives.

Transactive Energy is the combination of control and pricing techniques to balance supply and demand of electricity across the electric grid.

The following use cases represent some of the driving forces behind TE development and articulate why TE has such great potential. Each case contains a summary that defines the scenario and an objective that identifies the use and benefit of TE in response to this scenario.

Use Case 1: Peak Heat Day and Energy Supply

Summary: The grid is severely strained in capacity and requires additional load shedding/shifting or storage resources. Electricity bulk generation resources have all been tapped and first-tier demand response (DR) resources have already been called. The grid operator still has back-up DR resources, including curtailing large customers on interruptible contracts.

Objective: Build upon DR by using TE's ability to support dynamic price structures that respond to current or anticipated grid conditions. This approach incents loads and distributed energy resources (DER) to participate in overall lowering demand on the grid. Additional capacity is incentivized through compensation that appropriately values the reliability provided by DR participation.

Use Case 2: Wind Energy Balancing Reserves

Summary: DERs are engaged based on economics and location to balance wind resources. Balancing is needed for both wind ramps (when wind is expected to blow more strongly across an extended period) and for fast regulation of wind variability (when wind blows at variable speeds within a designated forecasted high wind time).

Objective: To use TE to match wind variability closely enough that base load generation can provide fine levels of balancing through automatic generator controls. The bulk power system operator engages the DER via distribution level aggregators. A TE mechanism is needed for aggregators to (1) recognize the location and number of DER units available to provide these services, (2) recognize the incentive (value) to the grid and to the owners to engage the resources, and then (3) to select from among DERs that can be engaged, while including impact on distribution level. The decision on which balancing reserve to engage (base load, spinning reserves, or DER) is likely to be made based on most effective cost.

Use Case 3: High-Penetration PV and Voltage Control

Summary: High-penetration of rooftop solar photovoltaics (PV) causes swings in voltage on distribution grid. On a sunny day with low load conditions, the generation of energy on a feeder may be greater than the load resulting in reverse power flows. Voltage levels will also increase.

Objective: Rather than curtailing PV generation, TE methods would be used to incentivize additional load or storage, and the transactive signals should be localized to the feeder level to respond to voltage fluctuations. Consideration of grid infrastructure life cycle impact must be included in the TE market design. A particular TE approach may use different forms of negotiation and transaction, control actions, measurement/validation and finally settlement/reconciliation. A specific use case may only address a subset of these process steps.

Use Case 4: EVs on the Neighborhood Transformer

Summary: A distribution network operator receives significant wind power. When the wind power is available, the utility incentivizes electric vehicle owners to charge their vehicles. However, overloading at a specific transformer serving several homes that each have fast-charging electric vehicles (EVs) has the potential to decrease the service life of the transformer.

Objective: A TE solution that can prevent unneeded wear and tear on the distribution transformer and differentiate incentives in a highly localized, distributed approach. In addition to EVs, other customer loads/DER may be incentivized to respond to decrease load or supply power to reduce localized overloading. This TE application influences distribution system operations as well as bulk power generation. Negotiation and responses are needed within minutes. Transformer load cycling needs to occur more rapidly.

Use Case 5: Islanded Microgrid Energy Balancing

Summary: When power fails on the main grid, the microgrid controller switches to islanded mode with local generation and load control. In this microgrid, all of the grid domains are contained in miniature with a smaller number of participants. The participating entities must balance generation and load in a more contained grid that creates reliability concerns and the possibility for full failure. Isolated problems that could be absorbed easily on the distribution grid could greatly affect the smaller, less tolerant microgrid operation. Voltage sags could be produced by a single cloud interrupting solar PV generation.

Objective: TE approaches are used to balance the interests of various microgrid participants (e.g., buildings with different owners, homes, commercial and industrial facilities), DR and DER resources (generators, batteries). The primary application of TE is in balancing the costs of solar against the incremental fuel costs associated with running supply such as from a combined heat and power (CHP).

Use Case 6: System Constraint Resulting in Mandatory Curtailment

Summary: A sudden transmission system constraint results in mandatory load reductions. The distribution system network operator does not have local generation available to offset the bulk power system curtailment. They must drop 40MW of load within the coming 15 minutes and maintain the curtailment for two hours. Absent sufficient DR, they must blackout customers to meet the curtailment.

Objective: Use transactive incentives or markets to allow customers to participate and self-select the duration of involvement based on the incentive or market activity. This approach allows some precision in meeting the curtailment target. This scenario focuses primarily on the distribution grid and looks at the ability of a TE approach to get significant and sustained load reductions on short notice, while allowing customers to prioritize their service reliability. The scenario can manifest in multiple future iterations, but allows first for DER resources to participate in near-emergency circumstances.

Additional Resources

The Transactive Energy Modeling and Simulation Challenge for the Smart Grid ("TE Challenge") brings researchers and companies with simulation tools together with utilities, product developers, and other grid stakeholders to create and demonstrate modeling and simulation platforms while applying TE approaches to real grid problems.

For information about the goals and participants of the NIST Transactive Energy Modeling and Simulation Challenge, please visit:

- TE Challenge Collaboration Site
- TE Challenge Tool Chest
- Teams involved in the TE Challenge, including details on the types of simulations being developed.

The U.S. Department of Energy Gridwise Architecture Council has published a Transactive Energy Framework that defines TE broadly as, “a system of economic and control mechanisms that allows the dynamic balance of supply and demand across the entire electrical infrastructure using value as a key operational parameter.” The TE community gathered this spring for the third Transactive Energy Systems Conference and Workshop (Portland, Oregon, May 17-19, 2016) – view proceedings.

Background Questions to Consider for the Workshop

Customer Research

1. What value proposition is needed to induce customer participation in TE while still being economic for electricity consumers?
2. Which customer segmentation model best fits the response to TE? (Today utilities segment as residential, commercial, and industrial because that is what the regulations required.)
3. What incentive sizes are required to reach participation levels?
4. What format(s) should TE take for each customer segment?
5. For each customer segment, what payment/incentive/cost format has the most impact?

Tariff Research

6. What is a reasonable interval for each TE transaction (e.g. 5, 15, 60 minutes, etc.)?

Operations Research

7. How is performance measured?
8. What level of verification is required?
9. How much of the grid model does operations need to have correct to manage TE and maintain grid stability?

Regulatory Research

10. What is allowable for verification and performance?

Technology Research

11. What performance metrics are required to meet TE operational technology goals?