TE Challenge Basic Scenarios

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In the NIST March 2014 TE Challenge Preparatory Workshop, the idea of some reference scenarios was proposed. These scenarios would provide the following:

1. Coverage of many of today’s grid challenges for which TE may provide some solution.
2. A reference set that allows different teams to look at the same problems and consider how their simulation platform/tool might be useful for simulating a given scenario.
3. Likewise, a reference set that will allow different TE approaches to be compared when looking at the results relative to a common scenario.

The scenarios describe some general grid situations, but do not provide details of what is happening for every device connected to some specific grid. The goal is to guide direction of team efforts and promote interactions and opportunities for further efforts. Later efforts might define more detailed scenarios to allow head-to-head comparisons of different grid management approaches. Therefore, these basic scenarios in their present form do not allow two groups to use different tools or different TE approaches to model exactly the same problem on the same grid model. We do not know at this point what are the problems of most interest to different teams, nor the specific grid configurations that some teams may want to consider. Therefore, we do not make it a goal to define very detailed scenarios with defined grid resources and grid infrastructure that would allow exact comparison. Rather,

### Scenario 1: Peak Heat Day and Energy Supply

Description: On a hot July afternoon, generation resources have nearly all been tapped. Wind has died and first-tier DR resources have already been called. Afternoon thunderstorms are expected to cut solar power generation. Wholesale energy prices are hitting a peak.

Boundary conditions: The week has been hot already. There has been time to plan ahead (e.g., DR event notices the day before). Scope covers generation, wholesale and retail markets, and residential, commercial and industrial customers.

Objectives: Use TE approaches to reduce the load on the system and encourage customers to shift loads and draw on local generation/storage resources. Consider transactions on delivery (T&D constraints). Demonstrate co-simulation platform capabilities to tie together simulation tools for different parts of the grid (generation, T&D, markets, customer, etc.).

### Scenario 2: Wind Peak/Calm and Ramp Rate

Description: Coincident with the sun setting, the wind falls off rapidly. In total, 30 % of supply is dropped in one hour even as load is increasing as people return from work.

Boundary conditions: Some grid storage exists as does behind-the-meter customer resources (thermal and electrical storage, sheddable/shiftable load) that might help to reduce the ramp rate.

Objectives: Use TE approaches to reduce the ramp rate. Forward markets as well as real-time markets should be included.

### Scenario 3: High-Penetration Wind/PV and Voltage Control

Description: A high percentage of electricity supply comes from wind and solar PV. Controlling voltage on feeders with high penetrations of PV has been problematic given intermittency and reverse power flows.

Boundary conditions: Distribution feeder-level. There are some grid-scale batteries as well as customer energy storage, load management and generation resources (behind the meter, not utility controlled).

Objectives: Use TE approaches to manage voltage, both energy as well as regulation service.

### Scenario 4: EVs on the Neighborhood Transformer

Description: Five houses are fed from a single transformer. Each house buys an EV.

Boundary conditions:

Objectives: Use TE approaches to manage power flowing through the transformer so as to remain below the transformer rating. Consider signals upstream from transformer to power provider/market. Consider human interactions.

### Scenario 5: Islanded Microgrid Energy Balancing

Description: When power fails on the main grid, the microgrid controller switches to islanded mode with local generation and load control.

Boundary conditions: campus size microgrid, 10 MW typical load, CHP generator plus batteries and PV. Commercial buildings plus some multi-unit residential and industrial loads.

Objectives: Use TE approaches to help manage equitable distribution of power to campus building loads when supply is less than required for normal operation. Consider impact of transactions on microgrid stability.

### Scenario 6: Power Quality Management

Description: Distribution grid power quality is influenced by customer loads and DER. But the same loads and DER might be used for power quality improvement.

Boundary conditions: Distribution system from substation to customer meter. Time scales can be short (seconds) up to hours or longer for forward contracts.

Objectives: use TE to manage different elements of power quality (e.g., power factor, waveform distortion/harmonics, voltage regulation). Interactions may involve communications with smart inverters, thermal storage, renewable and dispatchable generators, and smart loads (able to reduce/shift demand), as well as building control systems which may handle interactions with some of these devices behind the meter. Consider market stability if short time-scale transactions are involved.

### Scenario 7: NY REV model for distribution grid operation

Description: TBD

Boundary Conditions: TBD

Objective: Model the grid architecture proposed by the NY REV proceedings, and model the proposed grid management approaches. Use TE approaches if possible.

### Scenario 8: Create your own

Description: TBD

Boundary Conditions: TBD

Objective: Look at some grid challenge, grid segment (domain) that has not been looked at and needs study, etc. Work with other partners. Do good simulation research and present exciting results.

## Additional possible threads

* How does TE address loss of assets (generation, storage, line)?
* Percentage of demand/load which TE can be applied to
* Demonstrate the use of specific standards ability to meet TE needs.
* Identify failure modes.
* Bring in the human element and human decisions.

## Metrics and common reporting of results (discuss at the Kickoff meeting)

* Consider metrics around a “reference scenario” that have to be documented, e.g., temps, peak above average load ratio (%), supply portfolio (% coal, nuclear, gas, hydro, wind, solar, other), scale of problem (#nodes, parts of grid modeled, special characteristics), etc.
* Summary of potential metrics (descriptors) for a team using some tools:
  + Metrics for tool
    - Grid challenges (scenarios) addressed
    - Installed base of each tool
    - Which TE approaches were used
    - Characterize tool set footprint
    - Scalability of tool set -- 10 nodes or 1M nodes
  + Metrics for a given team effort:
    - Number of organizations on team
    - Number of stakeholders involved in simulation and approach
    - Scale of each scenario (test case)
  + Metrics for a given TE approach:
    - Timing characteristics of simulations / performance
    - Flexibility, extensibility, observability, scalability
    - Complexity of deployment of solutions (cellphone app or forklift upgrade)
    - Market segmentation that results
    - Return on investment if deployed at scale
    - Impact on reliability, system efficiency, emissions
    - Economic activity created