Quantifying reliability and resilience impacts of energy efficiency: Examples and opportunities

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Agenda

Motivation

Reliability and resilience

EE and reliability in three planning domains
  - Long-term planning in bulk-power systems (BPS)
  - Distribution system planning
  - Demand-side management planning

Challenges

Opportunities
Motivation

- Energy efficiency (EE) has **reliability and resilience benefits** for the power system.

- **Electric system planning processes** are used to ensure that **future needs are reliably met** with cost-effective supply- and demand-side resources.

- **Traditional reliability metrics and planning methods** and **emerging resilience metrics** may not fully capture the benefits from distributed energy resources (DER), in particular EE.

- Our work seeks to:
  - **Understand** how (1) current planning processes, (2) and reliability/resilience assessment methods and metrics capture the reliability and resilience benefits of EE.
  - **Identify challenges** to capture reliability and resilience benefits of EE.
  - **Propose opportunities** to address these challenges.
What are reliability and resilience?

**Reliability**
- “The ability of the system to deliver power in the face of routine uncertainty in operation conditions” (Eto et al. 2020)
- Metrics and methods are standardized and widely accepted
- Different metrics and methods depending on domain:
  - Resource adequacy and operational reliability (Generation)
  - Transmission stability (Transmission)
  - Distribution reliability (Distribution)

**Resilience**
- “Ability to prepare, adapt, withstand, and recover rapidly from disruptions” (PPD 21, 2013)
- No widely accepted metrics or methods yet
- Focused on high impact, low frequency events
- Proposed metrics at the customer, community, grid, and economy-wide levels

Source: ESIG 2021 “Redefining Resource Adequacy for Modern Power Systems”
Three planning domains

Bulk Power System

Distribution System

Demand side management

Long-term planning

Distribution System Planning

DSM Planning
Three planning frameworks

- **BPS planning**
  - Resource adequacy assessments
  - The impact of EE on the reserve margin
  - Examples of NERC and NWPCC assessments

- **Distribution planning**
  - EE can be used to defer grid upgrades in non-wires alternative (NWA) projects
  - Examples of Xcel Energy, ConEdison, and NV Energy performing NWA

- **Demand side management planning**
  - Benefit-cost analysis of EE that include reliability benefits
  - Uses the value of lost load (VOLL) to monetize impacts
  - Examples of the five states that require consideration of EE reliability benefits (Arizona, Connecticut, Massachusetts, New York, and Rhode Island)
Challenges – Reliability metrics

- In distribution planning and NWS, traditional reliability metrics (e.g. SAIDI, SAIFI) are really **availability** metrics. They do not reflect:
  - The **actual impact of interruptions** on the consumption or fulfillment of end-use services
  - The reliability experienced by each **individual customer**

- IEEE Standard 1366-2012 introduced **two customer-centric metrics**: Customers Experiencing Long Interruption Durations (CELID) and Customers Experiencing Multiple Interruptions (CEMI)
  - These standards **count customers suffering certain types of interruptions**
  - Standards do not reflect the reliability experience of each customer

- **Customer-level** metrics would:
  - Identify **highly-valued or critical** end-uses
  - Ensure that these **end-uses can be consumed** at least at minimum sustainable levels
  - Ensure that service for each customer meets a **minimum reliability standard** with recognition of their level of vulnerability and adaptability.
Challenges – The Value Of Lost Load in BCA

- The VOLL typically reflects the **cost of energy not served** to customers, instead of **costs of the consequences that accrue to customers** during interruptions. It is needed to monetize the reliability benefits of EE due to energy reductions.

- VOLL is limited to a **single value** per customer segment using traditional segments of residential, commercial, and industrial, which does not capture **heterogeneity across customers** and interruption types.

- Current VOLL approaches are generally **not time sensitive**, assigning the same value to load lost at any time of day and season.

- The calculation of VOLL is often based on **short-duration** interruption data, limiting its application to resilience that studies long duration interruptions.
Opportunities

- **Performance metrics**
  - Develop and use customer-level metrics to measure reliability and resilience
  - Measure and value voluntary energy efficiency and conservation (e.g., load shedding) as a resilience strategy and compensate it accordingly
  - Track improvement in restoration time as a reliability benefit of energy efficiency and potentially other DER

- **Monetary metrics: VOLL**
  - Use better data and methods to monetize reliability
  - Improve traditional VOLL approaches through development and use of a framework to quantify DER resilience benefits to the Bulk Power System

- **Methods**
  - Strengthen BCA frameworks and expand their application
  - Treat energy efficiency as a resource, and consider its time-sensitive value, in long-term BPS planning
  - Integrate energy efficiency with other DERs