Investing In Electric Reliability and Resiliency

PRESENTED TO

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Joint Electricity and Critical Infrastructure Committees

PRESENTED BY

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Reliability and Electric Rates

- Historic investments in reliability are currently included in electric rates.
  - Founded in basic economics:

    Marginal Benefit (MB) = Marginal Cost (MC)
  - In practice, based on experience and regulatory dialogue.

- Primary issue has been how to estimate MB.
  - Reflects a partial "disconnect" between the Cost Bearer (of the investment) and the Benefit Recipient(s).
  - Costs can be traced to investment borne by the electric utility.
  - Major areas of benefits are realized directly by customers in the form of reduced frequencies and durations of outages, and are more difficult to measure.

Measuring Value to Customers

- Methods used: Value of Lost Load (VOLL) / Willingness to Pay (WTP).
- **VOLL** = survey-based estimate of value to various categories of customers by duration of outage event. (Berkeley National Lab / DOE, 2009)
- VOLL is a form of Contingent Valuations (CV), largely based on customer surveys.
  - CVs are not as precise as market based data.
  - Criticisms include e.g., survey design / scope and CV concept.
- But not a new concept for the electricity industry.
  - Used in determining generating reserve requirements.
  - (Calabrese, 1947; Watchorn, 1950, Telson-MIT, 1973; PGE 1990).

MB = MC
Utility Infrastructure Applications

- Receiving increasing attention, as utilities are expected to make significant investments in ***Reliability*** and ***Resiliency***.
- Distinction Worth Noting: Both fall within the broad scope of electric system "Reliability."
- Investments in *Reliability* typically involve minimizing service interruptions under routine ("blue sky") conditions.
- Investments in *Resiliency* tend to be aimed at mitigating outages – bringing service back on line following unavoidable outages (typically caused by extreme weather events).
- Not always a bright line difference; may overlap.
- <u>Important note:</u> Resiliency investments *"work"* when severe weather strikes, and generally do not play a role in improving blue sky reliability.

Cost-Benefit Analysis

- Assessments of benefits and costs are frequently combined into a cost-benefit analysis (CBA).*
  - Costs and benefits presented as net present values (NPVs).
  - Probabilities are applied to account for uncertainties, which produces an Expected Value (EV).

- Investments in (Blue Sky) **Reliability** - Utilities are able to project outcomes (i.e., resultant levels of outages) to some extent.

→ Possible to estimate probabilities for use in EV type CBA.

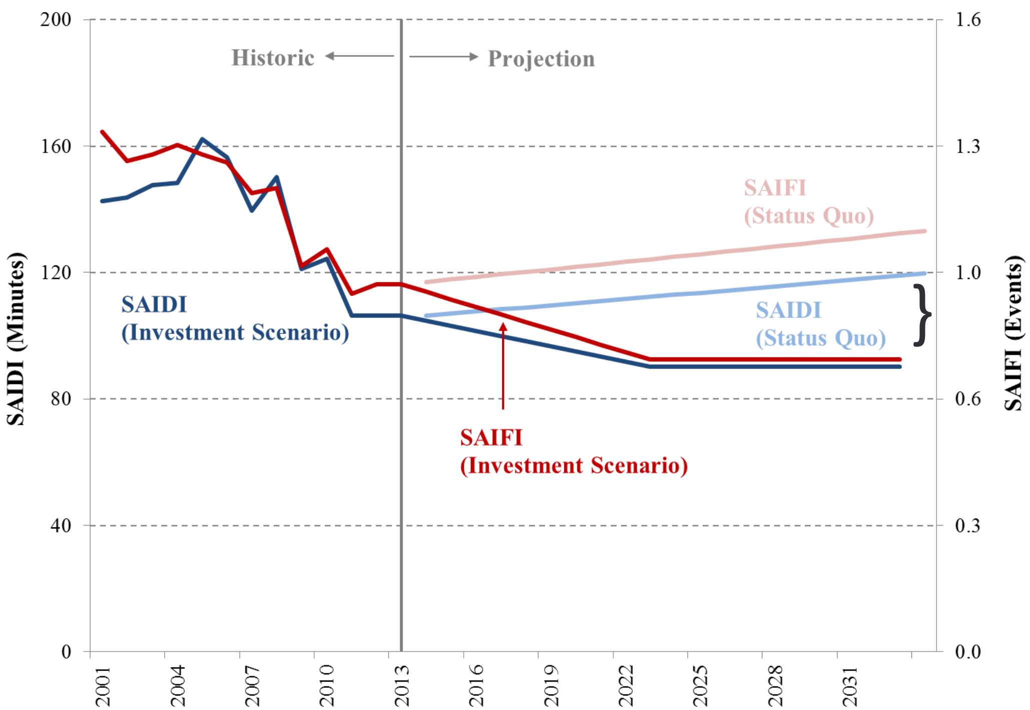
- Outcomes from investments in **Resiliency** are dependent upon occurrence of extreme weather event + impact of such on utility infrastructure.

→ Difficult or impossible to develop probabilities to use in EV CBA.

* CBA differs from cost effectiveness analysis, which compares the relative costs of alternative investments that each seek to accomplish the same outcome.

CBA of *Reliability* Investment

Projected SAIDI-x and SAIFI-x
Status Quo Case vs. Incremental Investment Case
Midwestern Electric Utility



Source:
Based on analysis for Midwestern U.S. electric utility.

$$\text{SAIDI} = \frac{\text{Sum of customer minutes of interruption}}{\text{Number of customers served}}$$

Δ SAIDI $\rightarrow$ Δ CMI

- Outage duration profile
- Allocation among customer classes
- VOLL per class and outage duration

Monetized value of improved SAIDI and SAIFI to customers

NPV when compared to investment schedule

Can apply probabilities to derive EV

Adjusting For High Degree of Uncertainty

- The difficulties in estimating and applying probabilities associated with the combination of the occurrence of severe weather and the impact such will have on utility infrastructure:

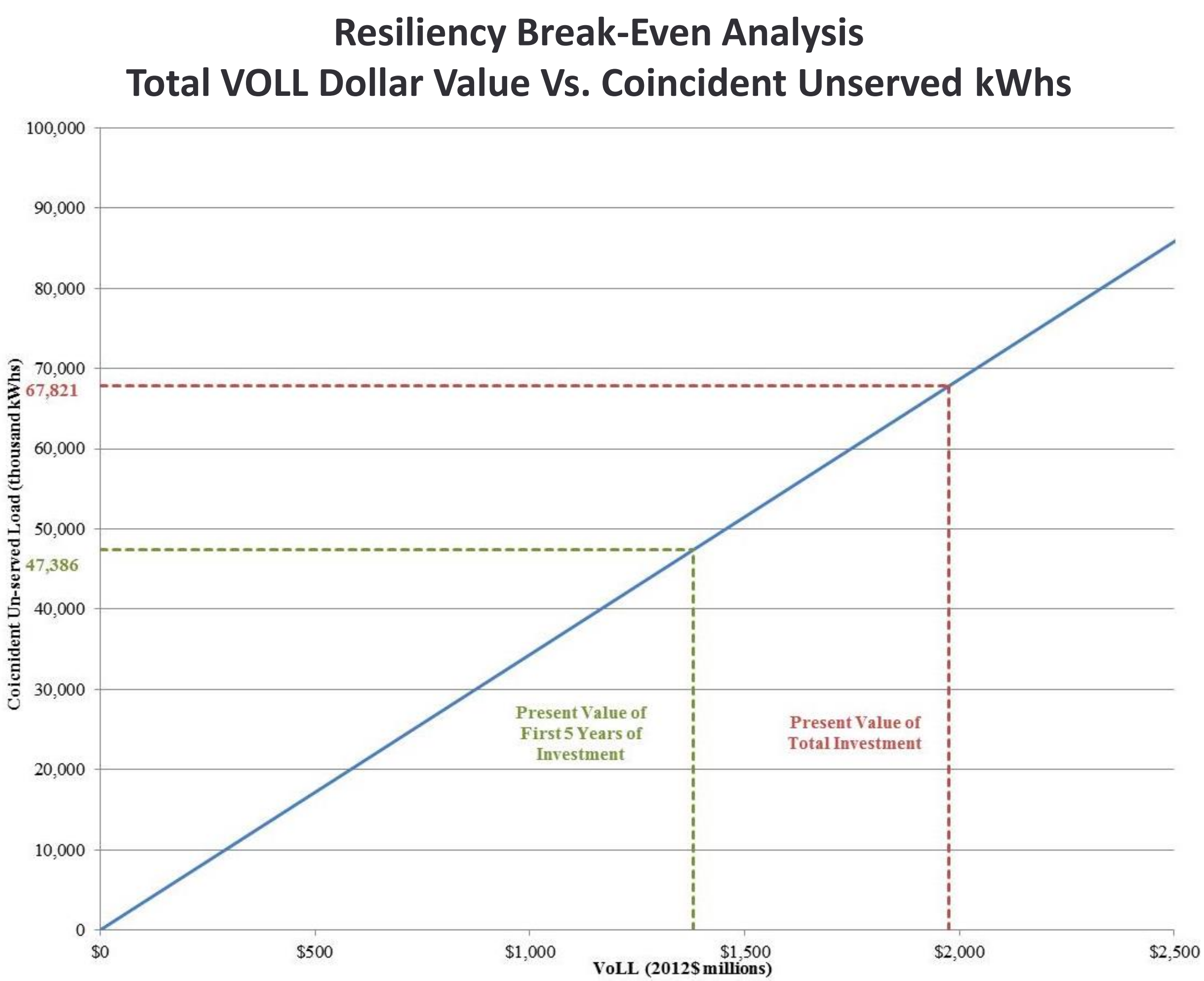
→ Makes the application of an EV CBA challenging, if not impossible.

→ Necessitates an alternative approach.

- Break-Even Analysis
  - More hypothetical: Applies VOLL framework to projections of outage mitigations to estimate unit value to customers (e.g., avoiding a 1 day system-wide outage).
  - Indicates the cumulative duration of outages that are required such that the PV of benefits to customers (of mitigated outages) equals the PV of Resiliency investments. (i.e., when the investments "pays" for itself).

- Break-even cumulative outage duration can then be compared to outage history, projections, and judgment to determine if outages would likely occur (over the course of investment asset lives) absent the Resiliency investment.

Value of *Resiliency* Investment



- Solve for cumulative CMIs, so that PV VOLL = PV Inv.
- *Not without criticism*:
  - Not definitive EV.
  - Outages may take many different forms.
  - Should be able to develop probabilities (weather / insurance data).
- Ultimately requires regulator to determine whether the break-even cumulative outage duration (*over course of asset lives*) is realistic.

Perspective: Electric Delivery Investments

- Connections to the electric grid will most likely continue to be the norm, even as distributed generation gains traction.
- High quality electric service is increasingly critical (and valuable) to silicon-based applications.
- The vast majority of outages and voltage issues (>95%) stem from disruptions to the distribution system (in normal and severe weather).
- Expectations of more frequent severe weather events (and its impact on utility infrastructure) appear to be generally accepted.
- Governments and regulators are asking / mandating that utilities ensure that their infrastructures are current, safe and resilient.

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- Increasing levels of capital spending on electric system replacements and upgrades, and on system resiliency.

Concluding Comments

- Regulators will continue to use cost-benefit analysis to assess the appropriateness of major utility investments in infrastructure…
- …And should recognize that investments in resiliency involve:
  - “Disconnects” between cost bearers from benefit recipients – more so than with most prior forms of utility infrastructure investments.
  - Higher levels of uncertainties that make application of an EV CBA framework challenging.
- VOLL serves to bridge the disconnect, at least in part.
  - Some areas of measurement and methodology may be improved (e.g., “private” vs. “social” VOLLs).
  - May be refined to reflect more discrete geographic and/or customer values.
- Important to have approach that recognizes difficulties in developing probabilities (weather/system).
  - Break-even (or Pay-back) approach, + history and best projections.
  - May evolve to EV CBA as weather / system impact models evolve.

Presenter Information

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Bill Zarakas is an economist specializing in the economics and regulation of utility infrastructure and the evolving factors that are affecting utility business models, including the impact of distributed generation. He has worked on a wide range of projects concerning cost-benefit analyses relating to utility investments in distribution systems, including investments in smart grid, asset hardening, and enhancements to system resiliency.

Bill also works on matters pertaining to the valuations of utility assets and businesses and the comparative analyses of utility operational and financial performances. He has examined the impacts of investment levels, operational performance, operating cost levels, and rates on utility equity prices and on customer satisfaction.

Bill has also worked extensively on issues pertaining to telecommunications infrastructure and costs. He has led and directed projects involving spectrum valuation, investment feasibility, demand and market forecasting, and regulation of incumbents, among other areas, in the U.S., Europe, Asia, the Middle East, and Africa.