Using Customer Reliability Benefits to Support Business Cases for Smart Grid Investments

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IEEE Smart Grid Webinar
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Presentation overview

- New challenges for utility planners
- Methods for estimating customer interruption costs
- 2015 interruption cost meta-study
- Interruption Cost Estimate (ICE) Calculator
- Two distribution automation case studies
- Remaining knowledge gaps
Utility planners are facing several new challenges

<table>
<thead>
<tr>
<th>Reliability</th>
<th>Resiliency</th>
</tr>
</thead>
<tbody>
<tr>
<td>▪ While smart grid technologies improve reliability and help integrate renewable resources, operational benefits to the utility may not be sufficient to justify investment cost</td>
<td>▪ Climate change is leading to increased severity and frequency of extreme weather in densely populated areas</td>
</tr>
<tr>
<td>▪ Many regulatory jurisdictions do not have an established amount of funding for new smart grid technologies</td>
<td>➢ Seven of the ten costliest storms in U.S. history occurred between 2004 and 2012</td>
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<tr>
<td></td>
<td>▪ Utilities must provide strong justification for resiliency investments that exceed typical standards and funding levels</td>
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</tbody>
</table>
Utilities are increasingly evaluating customer reliability benefits

- Primary customer reliability benefit is the **avoided customer interruption costs** that result from a reduction in outage frequency and/or duration.
- These benefits can be used to **support business cases** for smart grid investments (and grid hardening).
Surveys are preferred method for estimating customer interruption costs

<table>
<thead>
<tr>
<th>Method</th>
<th>Strengths</th>
<th>Weaknesses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Macroeconomic</td>
<td>▪ Inexpensive</td>
<td>▪ Unrealistic assumptions</td>
</tr>
<tr>
<td>Surveys</td>
<td>▪ More accurate</td>
<td>▪ Costly</td>
</tr>
<tr>
<td></td>
<td>▪ Applicable to many geographical areas and interruption scenarios</td>
<td>▪ Responses are based on hypothetical scenarios</td>
</tr>
<tr>
<td>Case Study</td>
<td>▪ Responses are based on actual interruptions</td>
<td>▪ Costly</td>
</tr>
<tr>
<td></td>
<td></td>
<td>▪ Major blackouts not representative</td>
</tr>
<tr>
<td>Market-based</td>
<td>▪ Less costly than surveys</td>
<td>▪ Unrealistic assumptions</td>
</tr>
</tbody>
</table>
Preferred type of survey question varies by customer class

**Commercial & Industrial**

Interruption cost =
Direct cost =
  Lost Production
  − Recovered Production
  + Outage-related Costs
  − Savings

**Residential**

Interruption cost =
  *Willingness to pay to avoid power interruption*

Hypothetical outage scenarios refer to a specific season, time of week, start time and interruption duration
Addressing the cost-issue for survey-based estimates

- Due to the cost of conducting customer interruption cost surveys, reasonable estimates were not readily available for most utilities.
- The U.S. Department of Energy, Lawrence Berkeley National Laboratory and Nexant have been working together for over a decade to address this issue for U.S. utilities:
## Results of 2015 meta-analysis

Source: [http://eetd.lbl.gov/sites/all/files/lbnl-6941e_0.pdf](http://eetd.lbl.gov/sites/all/files/lbnl-6941e_0.pdf)

<table>
<thead>
<tr>
<th>Interruption Duration</th>
<th>5 Minutes</th>
<th>30 Minutes</th>
<th>1 Hour</th>
<th>4 Hours</th>
<th>8 Hours</th>
<th>16 Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Medium and Large C&amp;I (Over 50,000 Annual kWh)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cost per Event</td>
<td>$12,952</td>
<td>$15,241</td>
<td>$17,804</td>
<td>$39,458</td>
<td>$84,083</td>
<td>$165,482</td>
</tr>
<tr>
<td>Cost per Average kW</td>
<td>$15.9</td>
<td>$18.7</td>
<td>$21.8</td>
<td>$48.4</td>
<td>$103.2</td>
<td>$203.0</td>
</tr>
<tr>
<td><strong>Small C&amp;I (Under 50,000 Annual kWh)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cost per Event</td>
<td>$412</td>
<td>$520</td>
<td>$647</td>
<td>$1,880</td>
<td>$4,690</td>
<td>$9,055</td>
</tr>
<tr>
<td>Cost per Average kW</td>
<td>$187.9</td>
<td>$237.0</td>
<td>$295.0</td>
<td>$857.1</td>
<td>$2,138.1</td>
<td>$4,128.3</td>
</tr>
<tr>
<td><strong>Residential</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cost per Event</td>
<td>$3.9</td>
<td>$4.5</td>
<td>$5.1</td>
<td>$9.5</td>
<td>$17.2</td>
<td>$32.4</td>
</tr>
<tr>
<td>Cost per Average kW</td>
<td>$2.6</td>
<td>$2.9</td>
<td>$3.3</td>
<td>$6.2</td>
<td>$11.3</td>
<td>$21.2</td>
</tr>
</tbody>
</table>
Evaluating interruption costs with the ICE Calculator

www.icecalculator.com

Customer Survey Meta-database
- 34 surveys
- 10 utilities
- 1989-2012
- N=105,000

Econometric Meta-analysis
- Med/large C&I
- Small C&I
- Residential
- Other factors

Forecast of Reliability
- SAIFI (frequency)
- SAIDI (mins. interrupted)
- w/ and w/o investment

ICE Calculator

Customer Characteristics
- Customer class
- Usage (kWh)
- Industry

Forecast of Customer Outage Costs
- ICE Calculator output
- w/ and w/o investment

www.icecalculator.com
Avoided interruption costs can help build business cases for smart grid

Benefits

- Avoided Customer Interruption Costs (NPV)
- Other Societal Benefits (e.g., Environmental)
- Utility Benefits (e.g., Avoided O&M Costs)

Investment Costs

- Fixed Investment Costs (e.g., Infrastructure Upgrades)
- Ongoing Investment Costs (e.g., Incremental O&M Costs)
Automated feeder switching technology:
- Equipment cost $51 million
- In this storm, avoided $23 million in damages to customers, eliminated 500 truck rolls, and reduced restoration costs to the utility by $1.4 million by restoring 1.5 days early

Avoided customer outage minutes are translated into avoided customer costs by the ICE Calculator

Courtesy of EPB of Chattanooga and Oak Ridge National Laboratory
CMP: Distribution automation avoids substantial interruption costs

- CMP proposed $30M for distribution automation to improve reliability
- Reliability benefits served as primary justification, based on econometric models underlying the ICE Calculator

<table>
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<th>CAIDI</th>
<th>↓0.04 hours</th>
</tr>
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<tbody>
<tr>
<td>Customer outage savings</td>
<td>$20.7M over 5 years or $97/reduced outage hour</td>
</tr>
<tr>
<td>Investment</td>
<td>$47/reduced outage hour</td>
</tr>
</tbody>
</table>

Benefit/Cost ratio > 2
Key knowledge gaps remain

- **Geographic** – Survey data not available for Northeast/mid-Atlantic region, limited in Midwest

- **Age of data** – Around half of the data from the meta-database is 15 or more years old

- **Scenarios** – Interruption scenarios are typically for peaking conditions (summer afternoons and winter mornings)

- **Long duration interruptions** – Econometric model estimates interruption costs up to 16 hours
Key takeaways

- Utilities can help address reliability/resiliency challenges by using customer reliability benefits to support business cases for smart grid and grid hardening investments.

- Although key knowledge gaps remain, utilities can supplement existing studies and tools with their own efforts to address specific needs.

- These efforts can draw upon the growing number of surveys, analyses and case studies from several jurisdictions.
Utilities may also consider applying interruption costs to operations

- At the **2016 IEEE/PES T&D Expo** in Dallas on May 3-5, LBNL and Nexant will present a paper on
  - Integrating customer interruption costs more closely with operations, including prioritization of outage restoration and scheduling of planned outages
  - Tracking value-based reliability metrics, such as a System Average Interruption Value Index (SAIVI)

**Paper title** – *Integrating Customer Interruption Costs into Outage Management Systems*
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QUESTIONS?

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