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

Josh Schellenberg
Principal, Nexant

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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

Reliability

- While smart grid technologies improve reliability and help integrate renewable resources, operational benefits to the utility may not be sufficient to justify investment cost
- Many regulatory jurisdictions do not have an established amount of funding for new smart grid technologies

Resiliency

- Climate change is leading to increased severity and frequency of extreme weather in densely populated areas
  - Seven of the ten costliest storms in U.S. history occurred between 2004 and 2012
- Utilities must provide strong justification for resiliency investments that exceed typical standards and funding levels

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

Method	Strengths	Weaknesses
Macroeconomic	▪ Inexpensive	▪ Unrealistic assumptions
Surveys	▪ More accurate ▪ Applicable to many geographical areas and interruption scenarios	▪ Costly ▪ Responses are based on hypothetical scenarios
Case Study	▪ Responses are based on actual interruptions	▪ Costly ▪ Major blackouts not representative
Market-based	▪ Less costly than surveys	▪ Unrealistic assumptions

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
  - Meta-analysis of survey-based customer interruption cost studies in 2004, 2009 and 2015
  - Release of Interruption Cost Estimate (ICE) Calculator in 2011 and update in 2015

Results of 2015 meta-analysis

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

Interruption Cost (U.S. 2013$)	Interruption Duration					
	5 Minutes	30 Minutes	1 Hour	4 Hours	8 Hours	16 Hours
Medium and Large C&I (Over 50,000 Annual kWh)						
Cost per Event	$12,952	$15,241	$17,804	$39,458	$84,083	$165,482
Cost per Average kW	$15.9	$18.7	$21.8	$48.4	$103.2	$203.0
Small C&I (Under 50,000 Annual kWh)						
Cost per Event	$412	$520	$647	$1,880	$4,690	$9,055
Cost per Average kW	$187.9	$237.0	$295.0	$857.1	$2,138.1	$4,128.3
Residential						
Cost per Event	$3.9	$4.5	$5.1	$9.5	$17.2	$32.4
Cost per Average kW	$2.6	$2.9	$3.3	$6.2	$11.3	$21.2

Evaluating interruption costs with the ICE Calculator

www.icecalculator.com

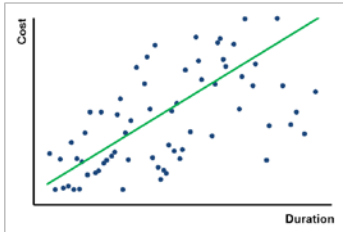
Forecast of Reliability

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

Customer Survey Meta-database

- 34 surveys
- 10 utilities
- 1989-2012
- N=105,000

Econometric Meta-analysis



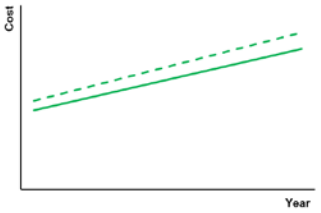
- Med/large C&I
- Small C&I
- Residential
- Other factors

ICE Calculator

Customer Characteristics

- Customer class
- Usage (kWh)
- Industry

Forecast of Customer Outage Costs



- ICE Calculator output
- w/ and w/o investment

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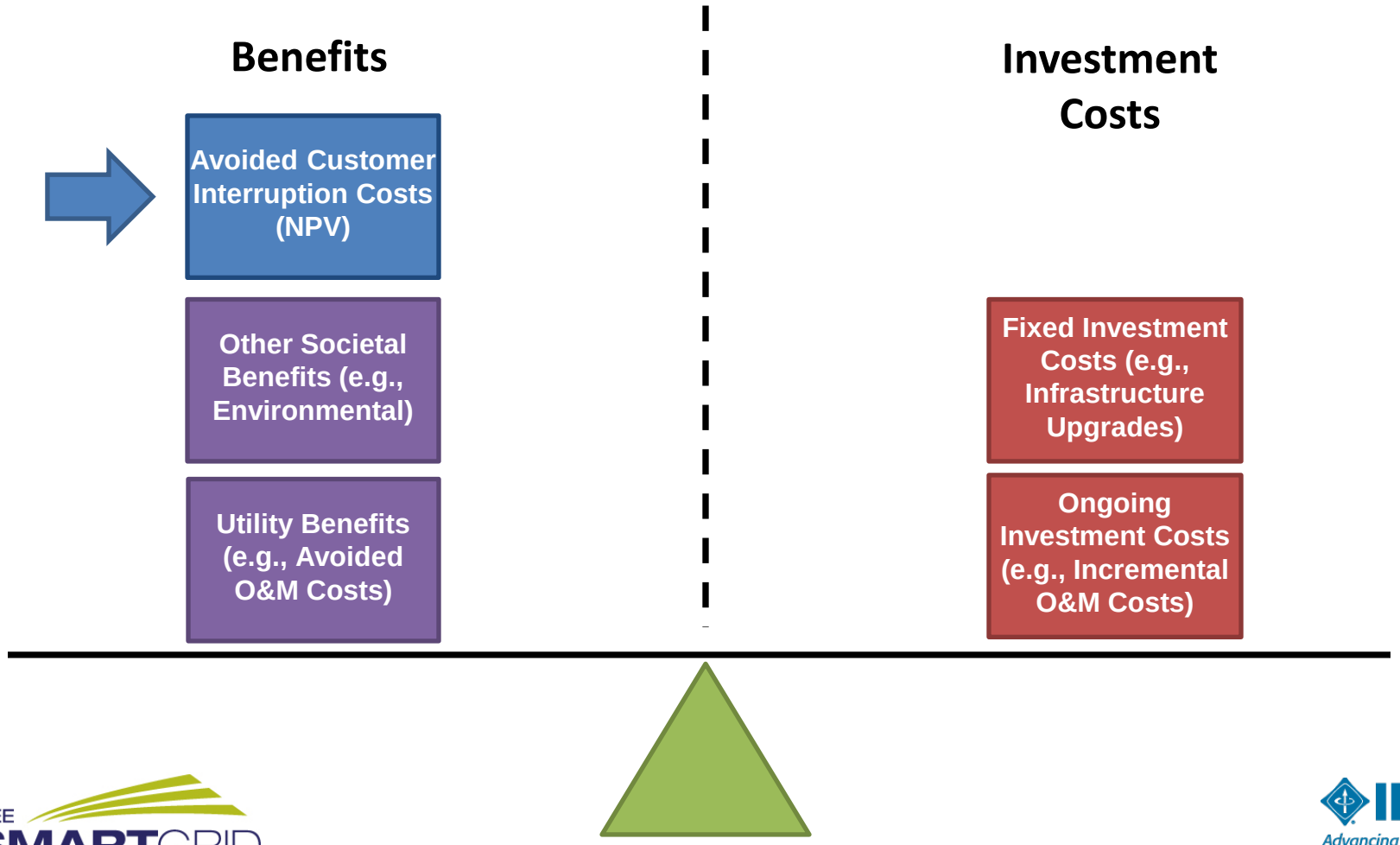
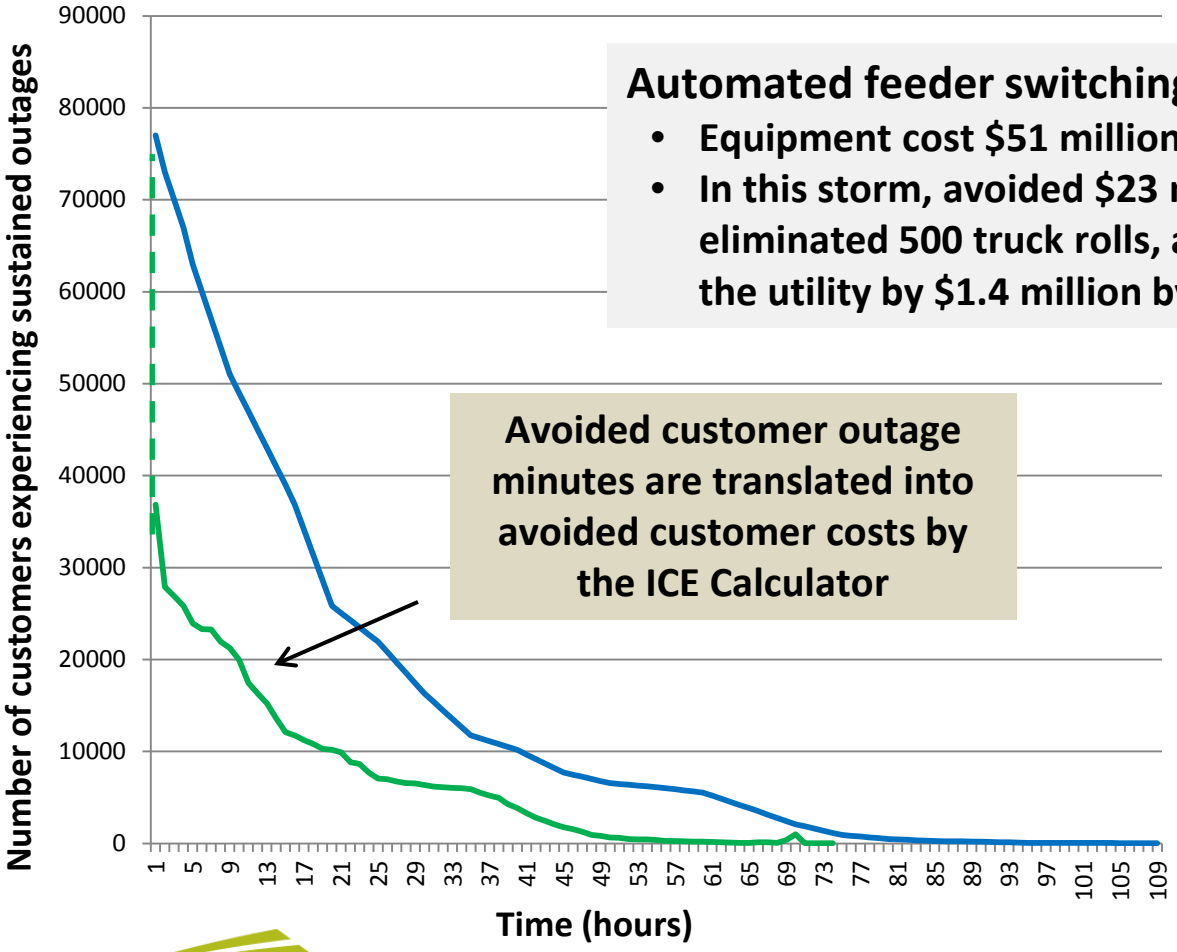
Avoided interruption costs can help build business cases for smart grid



EPB: July 5, 2012 storm response in Chattanooga



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

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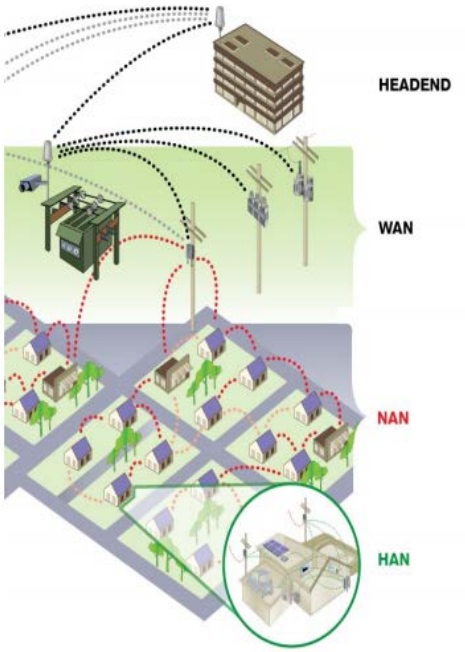
CMP: Distribution automation avoids substantial interruption costs



CMP's new IT and communications infrastructure supports follow-on smart grid investments.

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

CAIDI	↓0.04 hours
Customer outage savings	$20.7M over 5 years or $97/reduced outage hour
Investment	$47/reduced outage hour

Benefit/Cost ratio > 2

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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*

Contact information

Josh Schellenberg
Principal Consultant
Nexant
JSchellenberg@nexant.com
415-777-0707

QUESTIONS?

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