Utility Reliability Performance Objectives: Theoretical and Practical Considerations

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LBNL Reliability Research

Reliability Performance Data and Metrics

Review of reliability data reported to PUCs (2008)
Review of reliability data reported to NERC/EIA (2012)
Support for EIA collection of reliability data (2013, 2016)
Analysis of Major Event definitions (2016)
Analysis of Distribution vs. Bulk Power System Reliability (submitted for publication)
GMLC task 1.1 – develop new bulk power system metric for NERC State of Reliability report (in progress)

Reliability Analysis

Econometric analysis of trends in reliability (2012, 2014, update in progress)
Customer adoption of stand-by generation/UPS (2016)
Review of reliability information posted in real-time by utilities (in progress)

The Economic Value of Reliability

Interruption Cost Estimate (ICE) Calculator (2005, 2010, 2015)
Review of regional economic modeling to estimate cost of long-duration, widespread interruptions (2016)
Insurance industry perspectives (2016)

Value-based Reliability Planning

National cost of power interruptions (2004, submitted for publication)
Utility case studies (2015)
PUC experiences with utility filings (2016)
GMLC task 1.1 - incorporate ICE Calculator into APPA web portal (in progress)

https://emp.lbl.gov/research-areas/electricity-reliability

Opening Remarks

- The pace of electricity grid modernization efforts will be determined by decisions made by electric utilities, their customers, and local communities/states to adopt new technologies and practices
- An important motivation for these actions will be maintaining or improving the reliability and resiliency of electric service
- From an economic perspective, the justification for these actions will therefore, depend, *at least in part*, on:
  - The cost of the actions under consideration (including who pays for them);
  - The impact they are expected to have on reliability or resilience; and
  - The value these impacts have to the utility, its customers, and the community/state
- Better information will enable, but does not guarantee, better decisions …and we will never have perfect information

Value-Based Reliability Planning (VBRP) takes into account the cost of interruptions in guiding reliability decisions

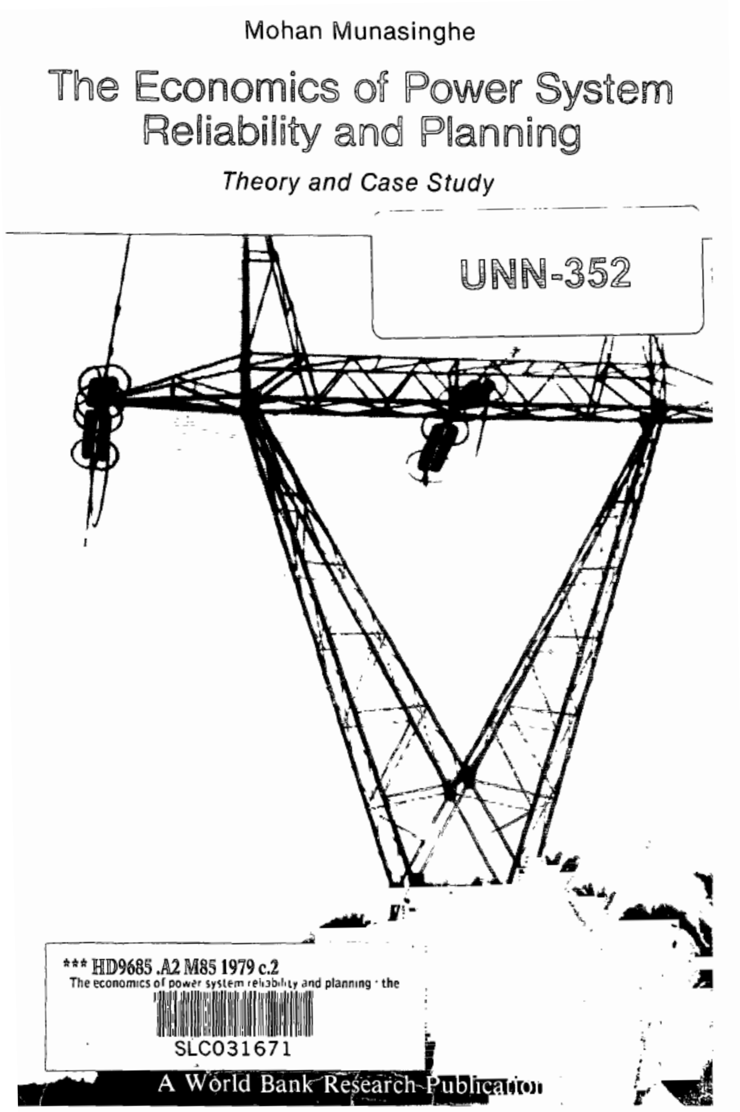
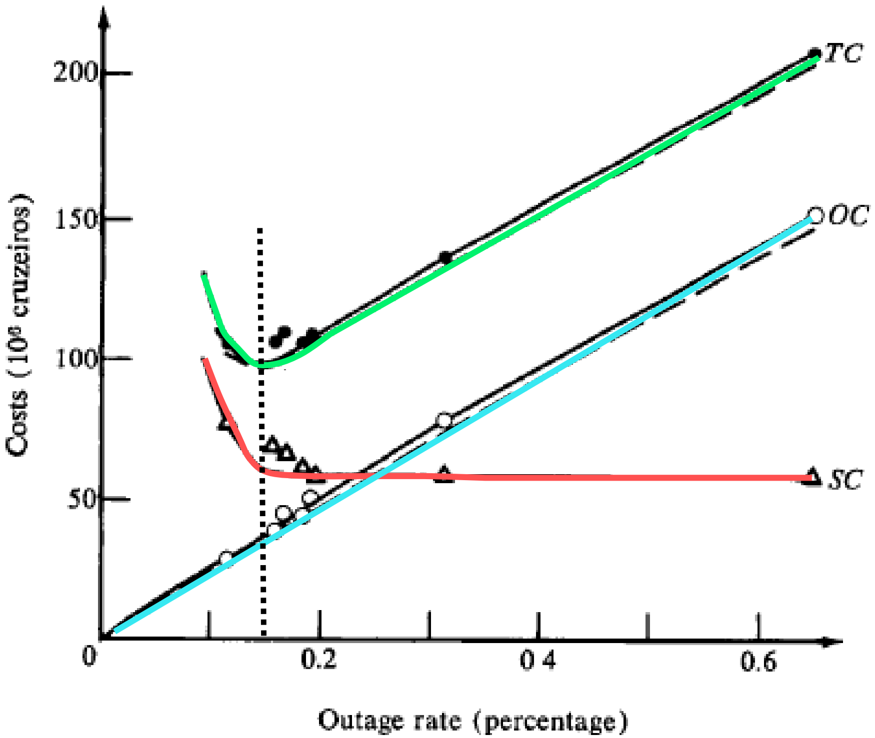


Figure 13.1. *Optimization of the Outage System: Costs Versus Outage Rate*



Note: *SC* = distribution system supply costs; *OC* = global outage costs; and *TC* = total costs. The plotted data points and solid lines refer to efficiency priced costs; the broken lines indicate the costs in terms of social prices.

DOE/LBNL developed the Interruption Cost Estimate (ICE) Calculator to support VBRP applications

ICECalculator.com

Interruption Cost Estimate Calculator

U.S. DEPARTMENT OF ENERGY

The Interruption Cost Estimate (ICE) Calculator is a tool designed for electric reliability planners at utilities, government organizations or other entities that are interested in estimating interruption costs and/or the benefits associated with reliability improvements.

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Use the ICE Calculator to:

- Estimate Interruption Costs
  Estimate the cost per interruption event, per average kW, per unserved kWh and the total cost of sustained electric power interruptions.
- Estimate Value of Reliability Improvement in a Static Environment
  Estimate the value associated with a given reliability improvement. The environment is "static" because the expected reliability with and without the improvement does not change over time.
- Estimate Value of Reliability Improvement in a Dynamic Environment
  Estimate the value associated with a given reliability improvement. The environment is "dynamic" because the expected reliability with and without the improvement changes over time based on forecasts of SAIFI, SAIDI and CAIDI.

This tool was funded by the Lawrence Berkeley National Laboratory and Department of Energy. Developed by Freeman, Sullivan & Co.

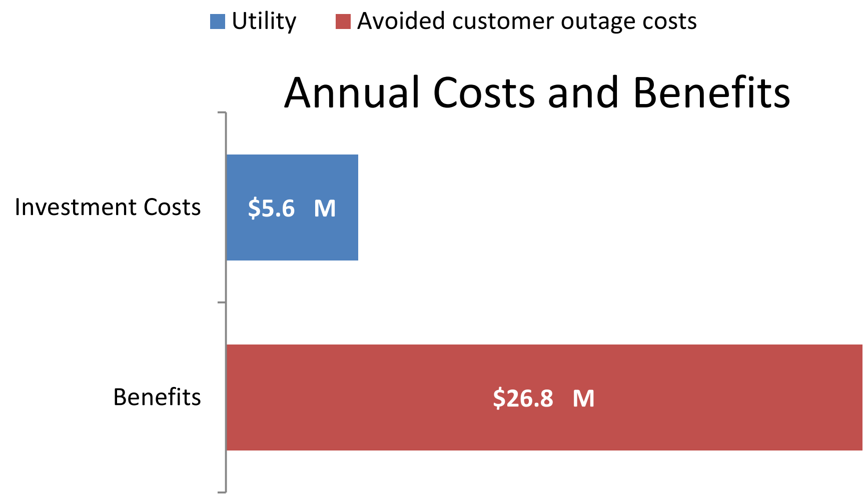
Learn more about the federal initiatives that support the development of the technologies, policies and projects transforming the electric power industry on SmartGrid.gov.

http://icecalculator.com

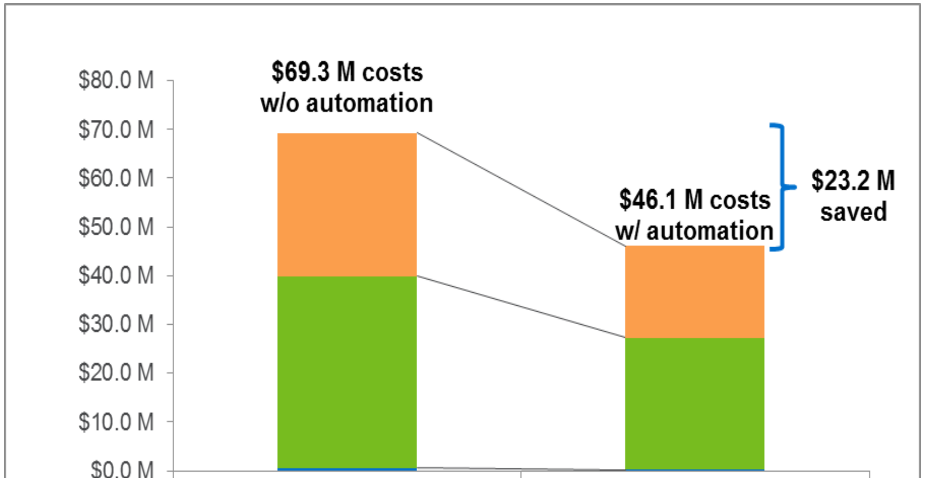
VBRP Example: Electric Power Board of Chattanooga

From Distribution Automation at EPB Chattanooga:

- **Customers Impacted:** 174,000 customers (entire territory)
- **Investment:** 1,200 automated circuit switches and sensors on 171 circuits
- **Reliability Improvement Achieved between 2010 and 2015:**
  - SAIDI ↓45%
    from 112 to 61.8 minutes / year
  - SAIFI ↓51%
    from 1.42 to 0.69 interruptions / year



Avoided Cost of Severe Storm



	Pre-Automation	Post-Automation
Large C&I	$29.4 M	$18.8 M
Small C&I	$39.3 M	$27.1 M
Residential	$0.6 M	$0.2 M

Electric utility industry reliability metrics, by themselves, are not well-suited for supporting VBRP

System Average Interruption Duration Index (SAIDI)

$$\text{SAIDI} = \frac{\text{total duration of sustained customer interruptions } (\geq 5\text{min each})}{\text{number of customers served}}$$

System Average Interruption Frequency Index (SAIFI)

$$\text{SAIFI} = \frac{\text{frequency of sustained customer interruptions } (\geq 5\text{min each})}{\text{number of customers served}}$$

SAIDI and SAIFI aggregate/mask information on the types of customers affected by power interruptions, as well as information on how long and when their lights are out

The economic cost of power interruptions

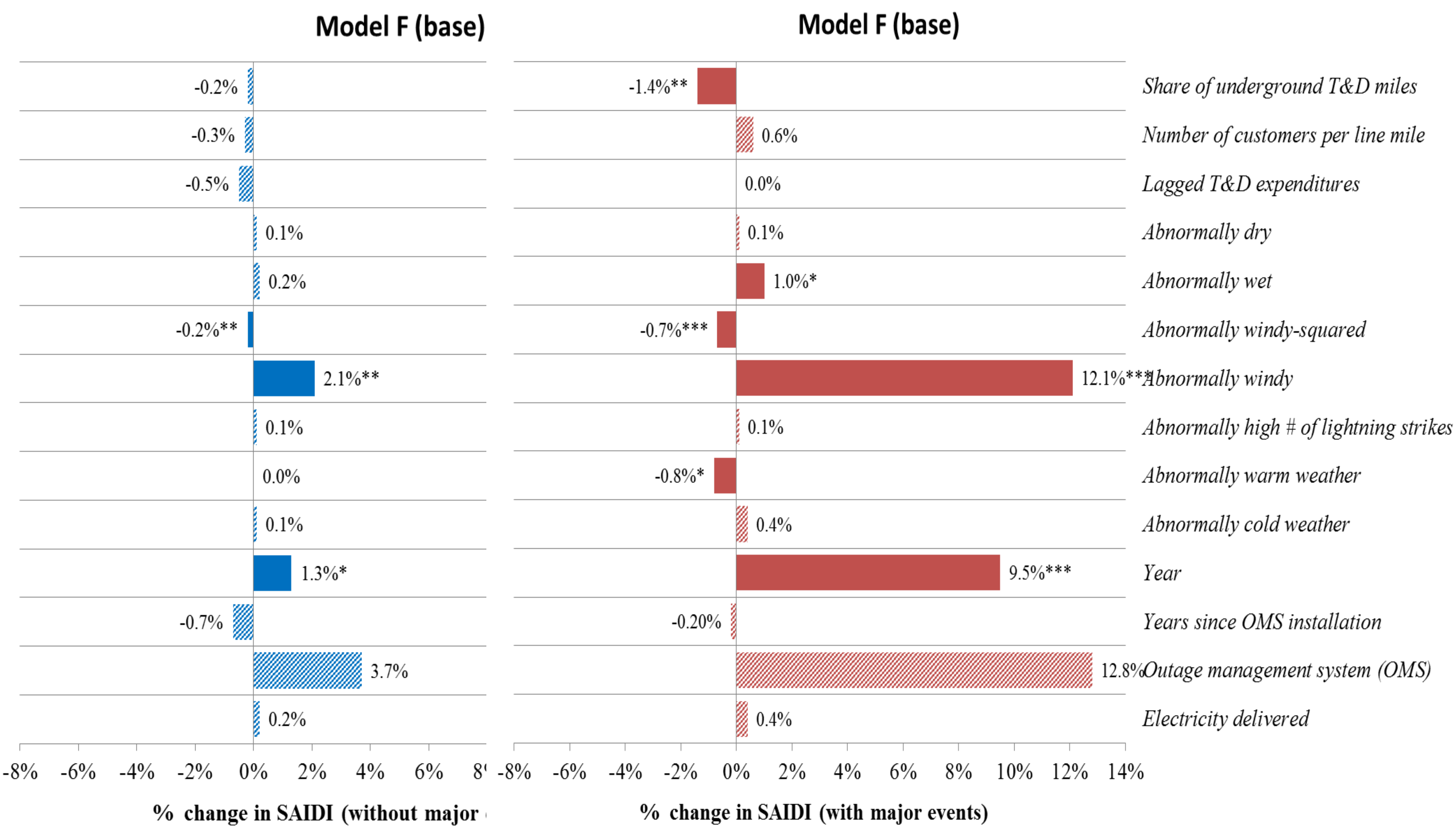
Varies by type of customer and depends on when and for how long their lights are out

Interruption Cost	Interruption Duration				
	Momentary	30 minutes	1 hour	4 hours	8 hours
Medium and Large C&I					
Morning	$8,133	$11,035	$14,488	$43,954	$70,190
Afternoon	$11,756	$15,709	$20,360	$59,188	$93,890
Evening	$9,276	$12,844	$17,162	$55,278	$89,145
Small C&I					
Morning	$346	$492	$673	$2,389	$4,348
Afternoon	$439	$610	$818	$2,696	$4,768
Evening	$199	$299	$431	$1,881	$3,734
Residential					
Morning	$3.7	$4.4	$5.2	$9.9	$13.6
Afternoon	$2.7	$3.3	$3.9	$7.8	$10.7
Evening	$2.4	$3.0	$3.7	$8.4	$11.9

Reliability data collected by the US Energy Information Administration for calendar year 2015

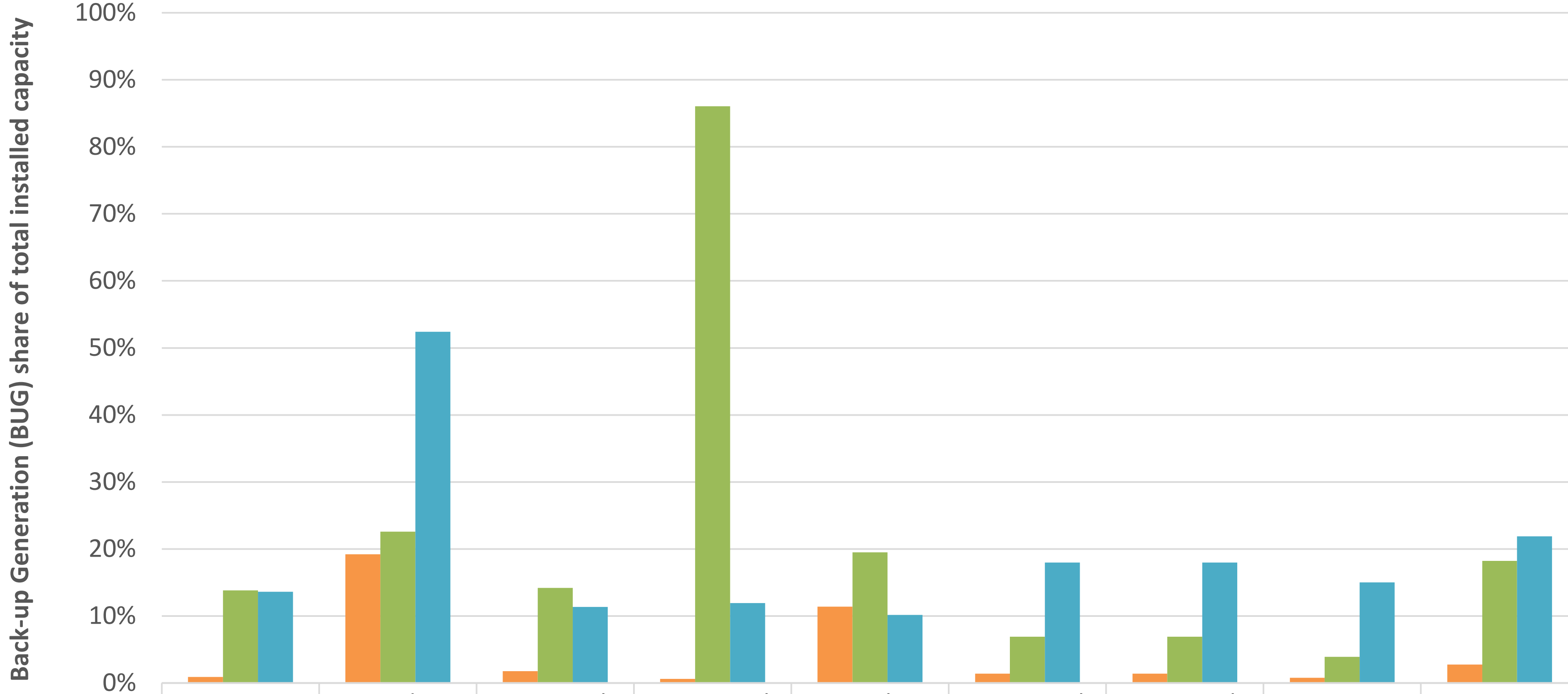
IEEE Standard 1366	Investor Owned	Cooperative	Municipal
Number of utilities reporting	137	296	117
% of U.S. sales by type of utility	51%	47%	43%
SAIDI with Major Events	237	302	115
SAIDI without Major Events	136	159	50
SAIFI with Major Events	1.4	2.8	0.9
SAIFI without Major Events	1.2	2.1	0.7

LBNL finds that reliability is getting worse due to increased severity/frequency of major events



Source: Larsen, P. K LaCommare, J. Eto, J. Sweeney. Recent Trends in Power System Reliability and Implications for Evaluating Future Investments in Resiliency. Energy 117 (2016) 29-46. http://dx.doi.org/10.1016/j.energy.2016.10.063

Customers are augmenting utility-provided reliability by purchasing back-up generation



	New England	Mid-Atlantic	East North Central	West North Central	South Atlantic	West South Central	East South Central	Mountain	Pacific
Residential	1%	19%	2%	1%	11%	1%	1%	1%	3%
Commercial	14%	23%	14%	86%	19%	7%	7%	4%	18%
Industrial	14%	52%	11%	12%	10%	18%	18%	15%	22%

Source: Frost and Sullivan. 2015. "Analysis of the US Power Quality Equipment Market." Berkeley California: Lawrence Berkeley National Laboratory. LBNL-1003990. August. Accessible at: http://eetd.lbl.gov/sites/all/files/lbnl-1003990.pdf

Some themes to keep in mind

"What's measured improves"
— Peter F. Drucker

"Delegating your accountabilities is abdication"
— Michael E. Gerber

"Not everything that can be counted counts,
and not everything that counts can be counted"
— Albert Einstein