Assessing Costs and Benefits to Justify Future Utility Investments in Resilience

~ National Council on Electricity Policy Workshop ~

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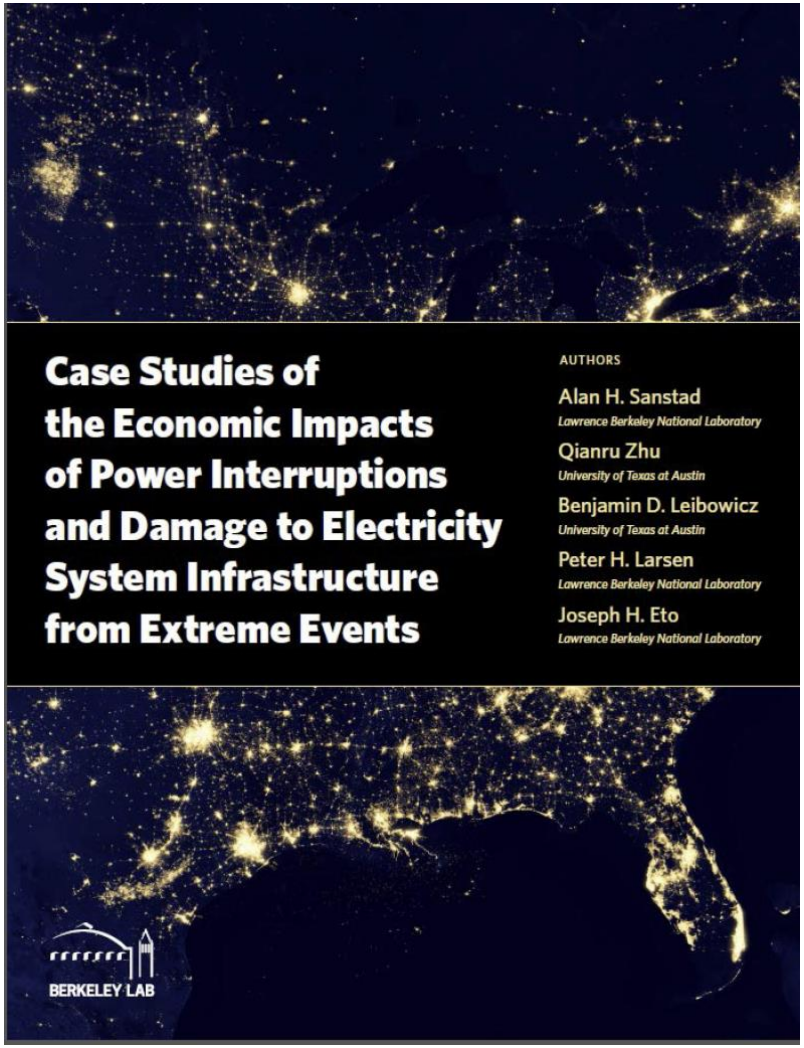
New Berkeley Lab study connection to NSPM

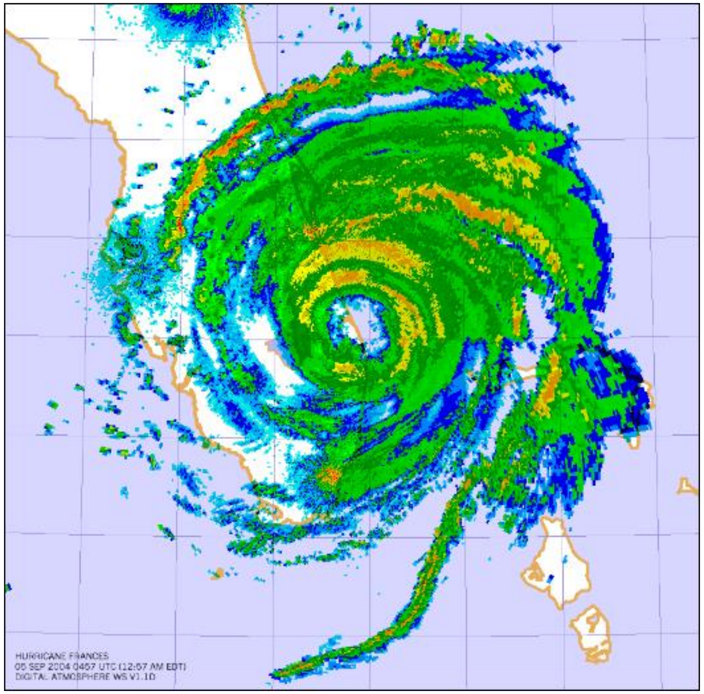


- New Berkeley Lab study investigates impacts to utilities from extreme events—as well as how utilities try to justify future investments in resilience

- Relates to NSPM through a discussion around:
  1. *Utility impacts* (e.g., cost recovery on damaged infrastructure)
  2. *Ratepayer impacts* (e.g., avoided power interruption costs)
  3. *Societal impacts* (e.g., avoided regional economic impacts)

Study motivation

- *Long-duration, widespread power interruptions* (LDWIs) are those lasting days, weeks or longer, and affecting entire utility service territories or larger regions—often caused by extreme weather.



- There is a growing need on the part of utilities and regulators for information on the:

1. Economic impacts of LDWIs
2. Costs and benefits of investments to mitigate such impacts

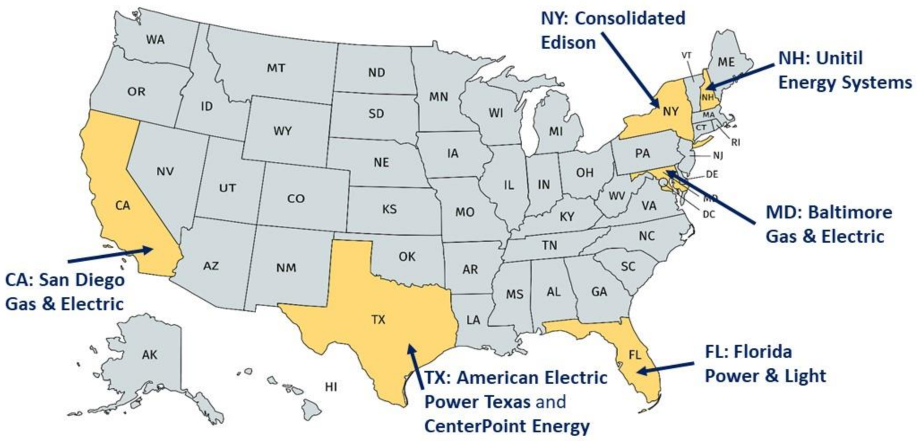
Research questions

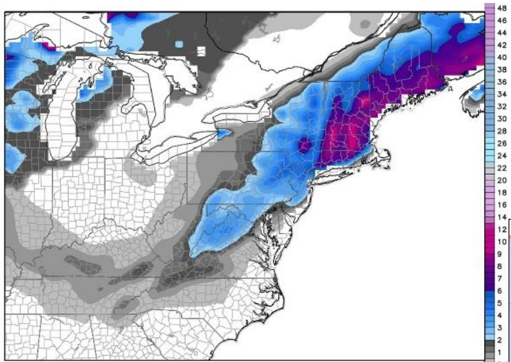
We investigated the following questions:

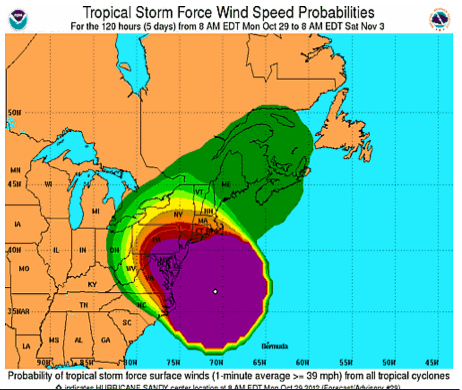
- *How do utilities…*
  1. *Assess the costs of system damage caused by extreme weather and the costs of recovering from this damage?*
  2. *Estimate customer costs of past power interruptions?*
  3. *Estimate the costs and benefits of investments to reduce power system vulnerabilities to future extreme weather events?*
  4. *Use the concept of "resilience" when making economic assessments of extreme weather impacts and the value of preventive investments?*
- *How do regulatory processes influence utilities' economic analyses related to power interruptions?*

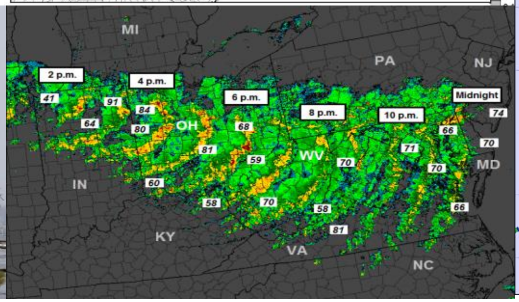
Approach and scope

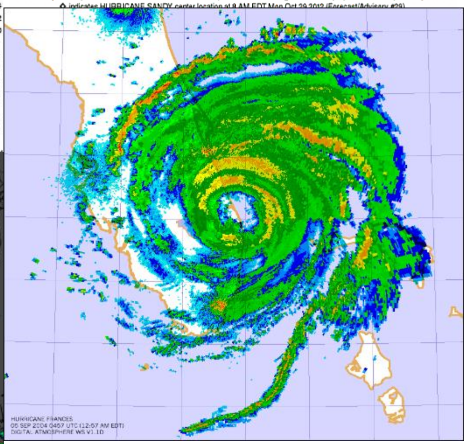
- We conducted case studies of investor-owned utilities and regulatory processes in six jurisdictions—selected for geographic, regulatory, utility-practice, and extreme event-type variation.











Method

Jurisdiction	Precipitating event
Florida	Hurricanes of 2004-2005
New York	Tropical Storm Sandy, 2012
Texas	Hurricanes of 2005, 2008, 2017
California	2007 Southern California wildfires
New Hampshire	Severe fall and winter storms in 2008, 2011, and 2014
Maryland	Derecho (severe wind event) in 2012

- Primary source of information was state public utilities commissions' online regulatory archives
- Secondary sources included reports by other state government agencies and academic literature

Method (cont.)

Availability of information on categories of economic impacts summarized in tables…	
Symbol	Key
●	Extensive publicly-available documentation
◒	Moderate amount of publicly-available documentation
○	Little/no publicly-available documentation

- Economic information related to utility ***cost recovery*** including:

1. Transmission system costs
2. Distribution system costs
3. Generation system costs
4. Increased customer service costs
5. Other costs

- Economic information related to ***mitigating future impacts*** including:

1. Avoided customer interruption costs
2. Avoided regional economic impacts
3. Other avoided societal impacts
4. Other
5. Cost-effectiveness or cost-benefit analysis conducted?

Summary of available information, cost recovery

Availability of economic information related to cost recovery…

Utility	Precipitating Event	Trans. System Costs	Dist. System Costs	Gen. System Costs	Increased Customer Service Costs	Other Costs
Florida Power & Light (FL)	Hurricanes of 2004-2005	●	●	●	●	●
Consolidated Edison (NY)	Tropical Storm Sandy	●	●	●	●	●
AEP Texas (TX)	Hurricanes of 2005, 2008, and 2017	●	●	N/A	◒	●
San Diego Gas and Electric (CA)	2007 Southern California wildfires	○	○	○	○	○
Unitil Energy Systems (NH)	Severe fall and winter storms	N/A	●	N/A	○	○
Baltimore Gas & Electric (MD)	June 2012 Derecho	●	●	●	○	○

Utility System Impacts

Summary of available information, mitigating future impacts

Availability of economic information related to mitigating future customer and regional impacts…

Organization	Precipitating Event	Avoided Customer Interruption Costs	Avoided Regional Economic Impacts	Other Avoided Societal Impacts	Other	Cost-Effectiveness Analysis?	Cost-Benefit Analysis?
Florida Power & Light (FL)	Hurricanes of 2004-2005	○	○	○	○	Yes	No
Consolidated Edison (NY)	Tropical Storm Sandy	●	○	○	○	Yes	Yes
City of New York (NY)	Tropical Storm Sandy	○	◒	○	○	Yes	Yes
CenterPoint Energy (TX)	Hurricanes of 2005, 2008, and 2017	◒	○	○	○	Yes	Yes
San Diego Gas and Electric (CA)	2007 Southern California wildfires	◒	○	○	○	Yes	No
Unitil Energy Systems (NH)	Severe fall and winter storms	○	○	○	○	Yes	No
Grid Resiliency Task Force (MD)	June 2012 Derecho	●	○	○	○	Yes	Yes

Ratepayer Impacts (Avoided Customer Interruption Costs)

Societal Impacts (Avoided Regional Economic Impacts, Other Avoided Societal Impacts, Other)

Cost-Effectiveness Analysis: $\frac{\$\ Cost}{Qualitative\ Benefit}$

Cost-Benefit Analysis: $\frac{\$\ Cost}{\$\ Benefit}$

Summary of key findings

- ***How do utilities assess the costs of system damage caused by extreme weather and the costs of recovering from this damage?***
  - Utilities conduct detailed physical and engineering assessments of damages
  - They estimate costs of replacement and repair as well as response and recovery operations

- ***How do utilities estimate customer costs of past power interruptions?***
  - Utilities often report statistics, including the counts, locations, and durations of customers without power, but generally did not monetize these customer impacts

- ***How do utilities or others estimate the costs and benefits of investments to reduce power system vulnerabilities to future extreme weather events?***
  - Costs of preventive investments can be estimated with reasonable accuracy, but the economic benefits are very uncertain
  - Cost-effectiveness analysis is the most common method
  - Berkeley Lab's ICE Calculator was used, but there was no evidence of avoided cost information being developed specifically for LDWI applications
  - No utility or regulator used regional economic modeling to estimate either direct or indirect costs of power interruptions

Summary of key findings (cont.)

- ***How do utilities and regulators use the concept of resilience in economic assessments of extreme weather impacts and the value of preventive investments?***
  - Utilities and regulators referred to "resilience" extensively in two of the case studies, a moderate amount in two others, and very little in the remaining two
  - "Resilience investments" were typically related to traditional storm hardening, for example, but at greater scale and cost
  - The challenge is not what "resilience metrics" should be used, but rather how to value proposed investments using these metrics within a cost-benefit framework
- ***How do regulatory processes influence utilities' economic analysis related to power interruptions?***
  - Laws, regulations, and regulatory practices can significantly influence utilities' preparation for, and response to, long-duration widespread power interruptions
  - New economic tools and methods are usually developed and/or adopted through collective decision-making involving utilities as well as other stakeholders, rather than unilaterally by utilities

Key recommendations

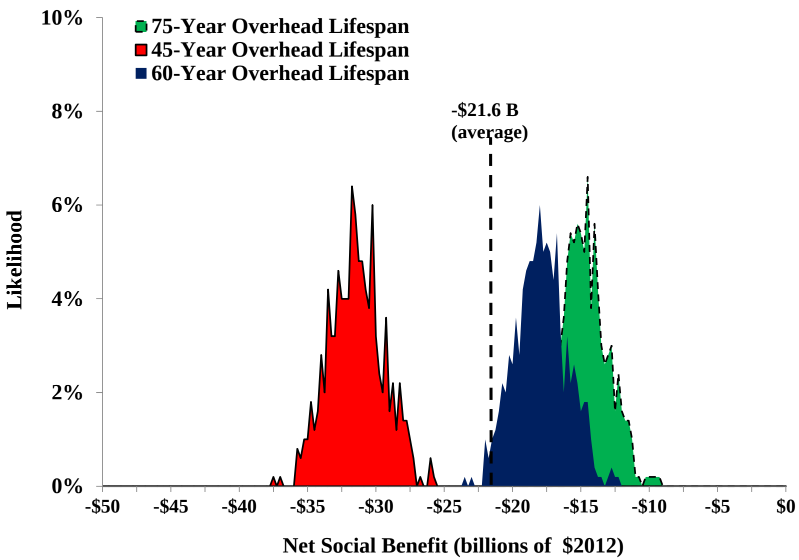
1. ***Investigate the value of consistently collecting information on past extreme events***

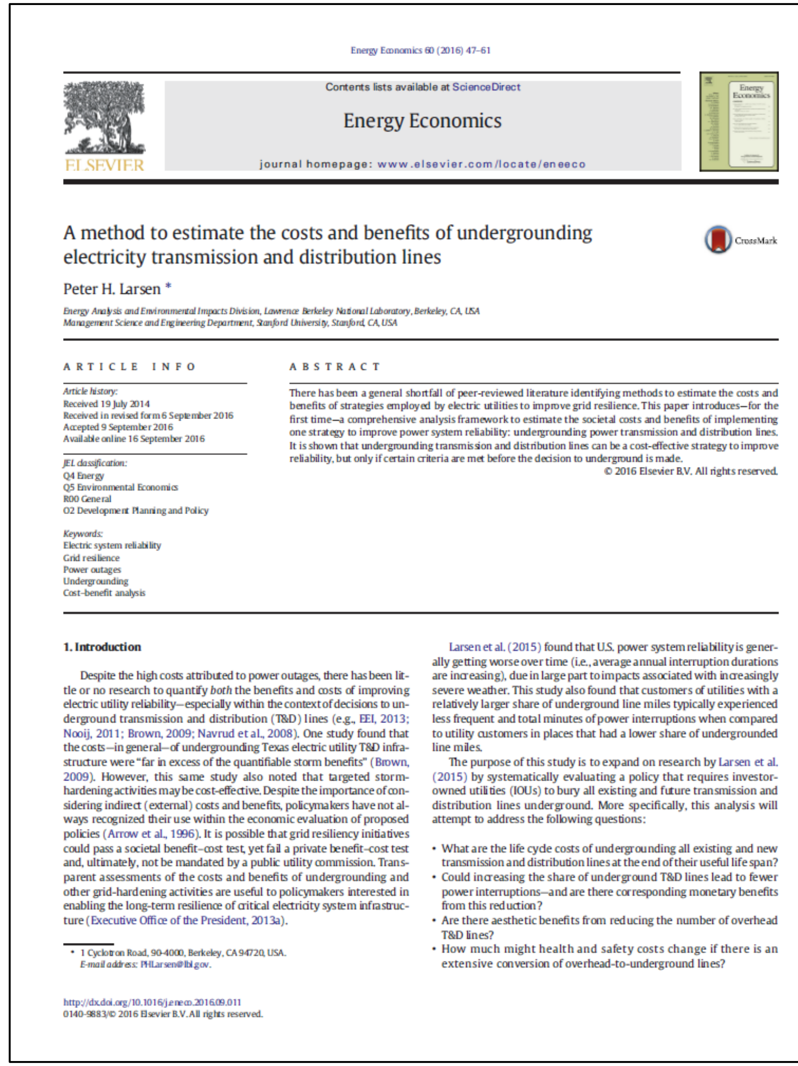
2. ***Improve economic analysis of avoided costs associated with preventing long-duration, widespread power interruptions***

3. ***Determine factors that influence regulatory/utility willingness to incorporate, into planning and other processes, economic information about long-duration, widespread power interruptions***

Looking for example of societal cost-benefit analysis?

Impact Category	Undergrounding	Status Quo	Net Cost ($billions)
Environmental restoration	$2.8	$1.0	$1.8
Health & safety	$0.56	$0.31	$0.2
Lifecycle costs	$52.3	$26.1	$26.3
Total net costs (Undergrounding)			$28.3
Impact Category	**Undergrounding**	**Status Quo**	**Net Benefit ($billions)**
Interruption cost	$182.7	$188.4	$5.8
Avoided aesthetic costs	$12.1	$10.6	$1.5
Total net benefits (Undergrounding)			$7.3
Net Social Benefit (Undergrounding)			
Net social benefit (billions of $2012)			**-$21.0**
Benefit-cost ratio			**0.3**





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A method to estimate the costs and benefits of undergrounding electricity transmission and distribution lines

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ABSTRACT

There has been a general shortfall of peer-reviewed literature identifying methods to estimate the costs and benefits of strategies employed by electric utilities to improve grid resilience. This paper introduces—for the first time—a comprehensive analysis framework to estimate the societal costs and benefits of implementing one strategy to improve power system reliability: undergrounding power transmission and distribution lines. It is shown that undergrounding transmission and distribution lines can be a cost-effective strategy to improve reliability, but only if certain criteria are met before the decision to underground is made.

1. Introduction

Despite the high costs attributed to power outages, there has been little or no research to quantify *both* the benefits and costs of improving electric utility reliability—especially within the context of decisions to underground transmission and distribution (T&D) lines (e.g., EEI, 2013; Nooij, 2011; Brown, 2009; Navrud et al., 2008). One study found that the costs—in general—of undergrounding Texas electric utility T&D infrastructure were "far in excess of the quantifiable storm benefits" (Brown, 2009). However, this same study also noted that targeted storm-hardening activities may be cost-effective. Despite the importance of considering indirect (external) costs and benefits, policymakers have not always recognized their use within the economic evaluation of proposed policies (Arrow et al., 1996). It is possible that grid resiliency initiatives could pass a societal benefit–cost test, yet fail a private benefit–cost test and, ultimately, not be mandated by a public utility commission. Transparent assessments of the costs and benefits of undergrounding and other grid-hardening activities are useful to policymakers interested in enabling the long-term resilience of critical electricity system infrastructure (Executive Office of the President, 2013a).

Larsen et al. (2015) found that U.S. power system reliability is generally getting worse over time (i.e., average annual interruption durations are increasing), due in large part to impacts associated with increasingly severe weather. This study also found that customers of utilities with a relatively larger share of underground line miles typically experienced less frequent and total minutes of power interruptions when compared to utility customers in places that had a lower share of undergrounded line miles.

The purpose of this study is to expand on research by Larsen et al. (2015) by systematically evaluating a policy that requires investor-owned utilities (IOUs) to bury all existing and future transmission and distribution lines underground. More specifically, this analysis will attempt to address the following questions:

- What are the life cycle costs of undergrounding all existing and new transmission and distribution lines at the end of their useful life span?
- Could increasing the share of underground T&D lines lead to fewer power interruptions—and are there corresponding monetary benefits from this reduction?
- Are there aesthetic benefits from reducing the number of overhead T&D lines?
- How much might health and safety costs change if there is an extensive conversion of overhead-to-underground lines?

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Putting a dollar value on resilience…

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