Risk Modeling for Energy Utility Investments

Tools for achieving safe and affordable energy service: risk modeling approaches for electric utilities in California

NASUCA

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Synapse Energy Economics

- Founded in 1996 by CEO Bruce Biewald
- Leader for public interest and government clients in providing rigorous analysis of the electric power and natural gas sectors
- Staff of 40+ includes experts in energy, economic, and environmental topics

Agenda and Background

- This presentation provides an introduction and overview of the approach to risk modeling in California that has been developed over the last decade.

- It is intended to provide a high-level introduction to risk modeling that can help states and regulatory Commissions quantify any type of risk to address it in a deliberate, transparent, and rigorous manner.

- As with all modeling tools, development of reasonable and analytically supported inputs, assumptions, and calculations is critical to inform sound policy decision-making.

    - *Modeling results are only as good as modeling inputs and assumptions.*

Agenda and Background

- Goals of Risk Modeling
- History of Risk Modeling Developments in California
- Risk Modeling Framework Overview
- Illustrative Example of Calculating Risk – Hurricanes in Florida
- Uses of Risk Modeling in Policy Decision-Making
- Implementation Issues and Constraints

What is the Goal of Utility Risk Modeling?

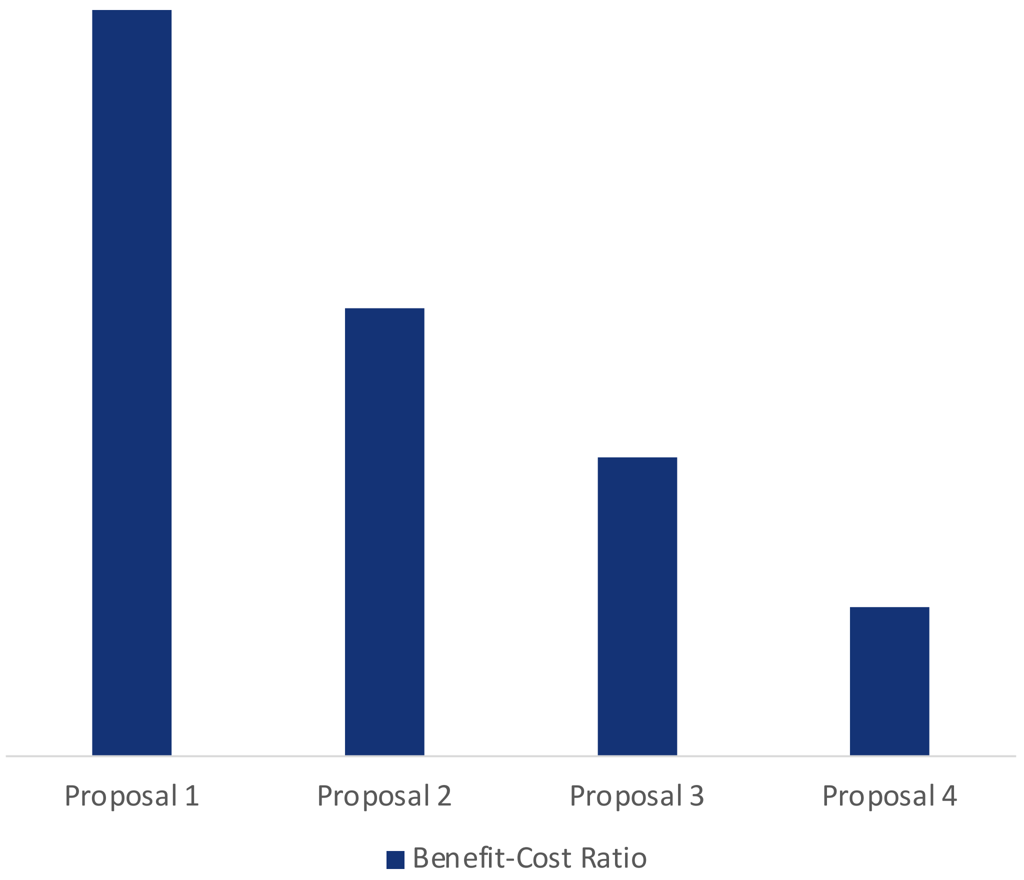
The goal is to better inform utility Commissions on how to achieve **safe** *and* **affordable** energy.

Can help utilities, intervenors and Commissions to better understand how to deploy limited ratepayer funds to achieve the greatest level of safety benefits.

Risk modeling enables a **cost-effectiveness analysis** with enhanced focus on safety or other types of benefits not always quantified.

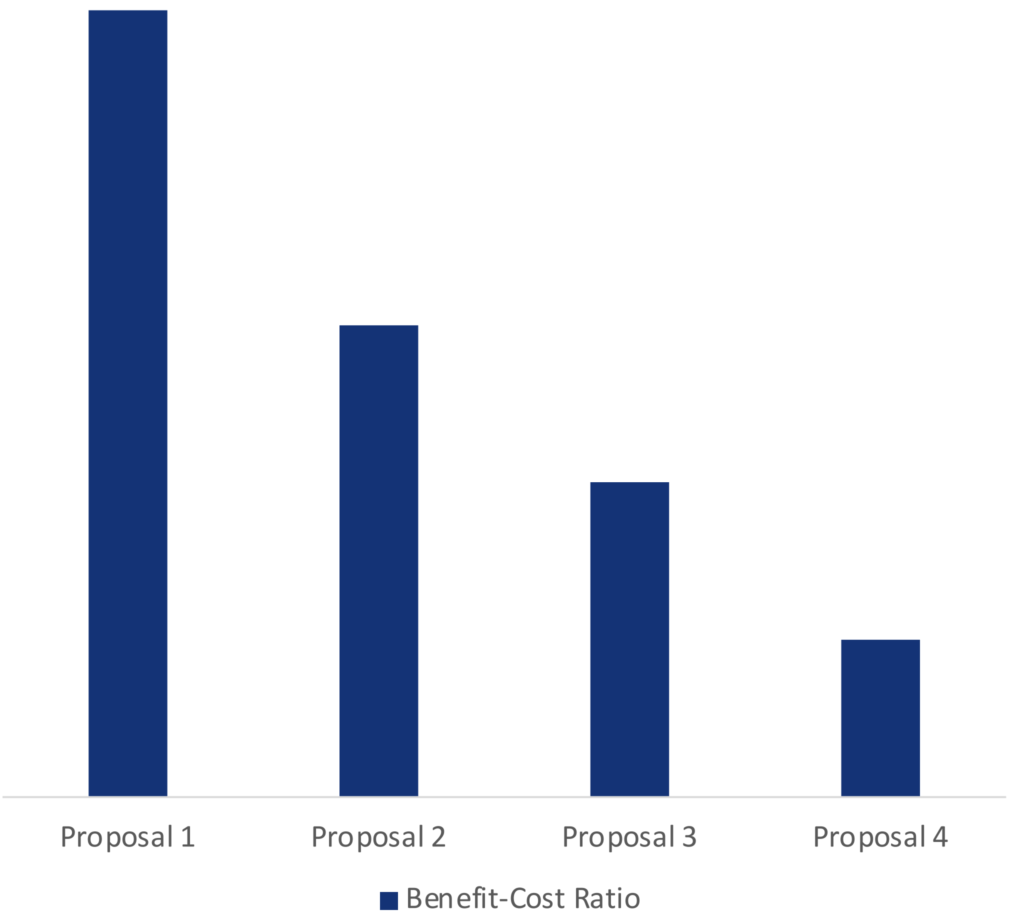
Advantages of Risk Modeling

- Allows for the direct comparison of risk reduction benefits to costs for various approaches to address safety issues
    - A lot of similarities with benefit-cost tests, but here only risk reduction is accounted for
- Rigorous, quantitative assessment of proposals often described qualitatively.
- Can provide data to quantitatively demonstrate how to best target funding
- Understand tradeoffs of safety and affordability
- Examine causes and effects of a risk in a data-driven way.



Limitations of Risk Modeling

- Requires quality data and a history of data collection
- Utilities and Commission must be committed to constant improvement
- Sharing of confidential and critical information
- Does not directly address affordability
    - *Rate and bill impacts must be analyzed separately*
- Does not address what is an acceptable level of risk
    - *Provides information to understand implications of various risks for a utility*



Regulatory Framework – History

2013	Spurred by San Bruno natural gas explosion caused by PG&E in 2010, and related legislation thereafter, Rulemaking R.13-11-006 is opened to develop and consider issues related to a risk-based decision framework for all utilities.
2014	Commission codifies an initial set of requirements to incorporate a *Risk-Based Decision-Making Framework* into the process for General Rate Cases (GRCs). Describes RAMP (Risk Assessment Mitigation Phase) filing before GRCs.
2015	Commission addresses additional safety and risk management issues, including several recommendations put forward by Commission consultant experts.
2016	Commission adopts the Joint Intervenor "Multi-Attribute Approach" and ordered a "test drive" of the approach. This calculates a risk reduction per dollar or risk spend efficiency (RSE) statistic in a probabilistic way.
2018	Commission adopts a settlement agreement between intervenors and large IOUs that defines key terms and provides a step by step guide to building a multi-attribute value function.
2019-2020	Additional refinements to RAMP process and refined utility risk and safety performance requirements.
2021	PG&E files first GRC that incorporates risk framework.
2022	CPUC modifies risk methodology moves away from multi-attribute value function to methodology based in dollars.

Regulatory Framework – Proceedings

Safety Model Assessment Proceeding (SMAP)

This is an open Rulemaking to identify and address overarching risk modeling issues which affect RAMP and GRC filings

Risk Assessment Mitigation Phase (RAMP)

An application filed ~one year before GRCs to review, assess, and make recommendations for utility risk modeling that will be incorporated into GRC

General Rate Cases (GRCs)

Multi-year forecast for most investor owned utility investments

Overview of Risk

What is Risk?

- Quantitatively, defined by the formula:

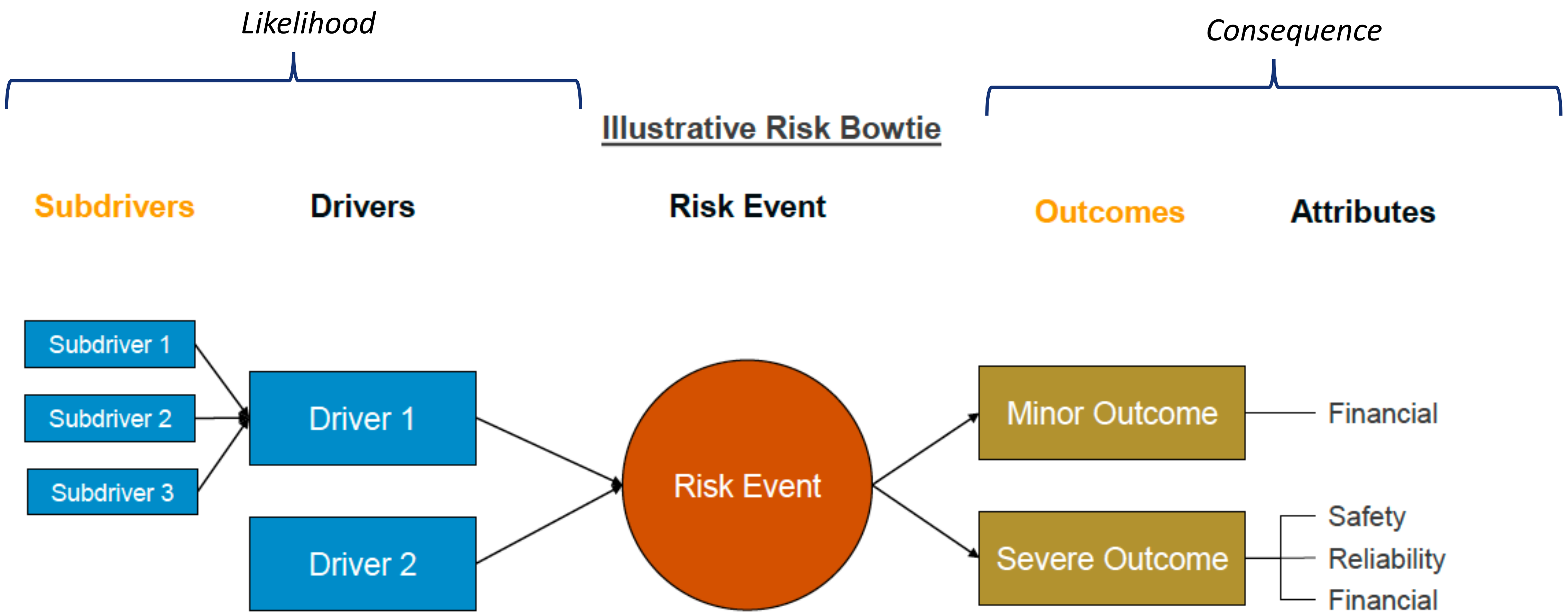
Likelihood x Consequence = Risk

Likelihood	Consequence
• Probability of event occurring over a certain time period • Often defined by *frequency* - e.g. average number of historical events per year	• The impacts of a risk event • Multiple impacts may be considered – e.g. safety, reliability, financial.

5% Probability x $100M Consequence = $5mm Risk

“Bowtie”

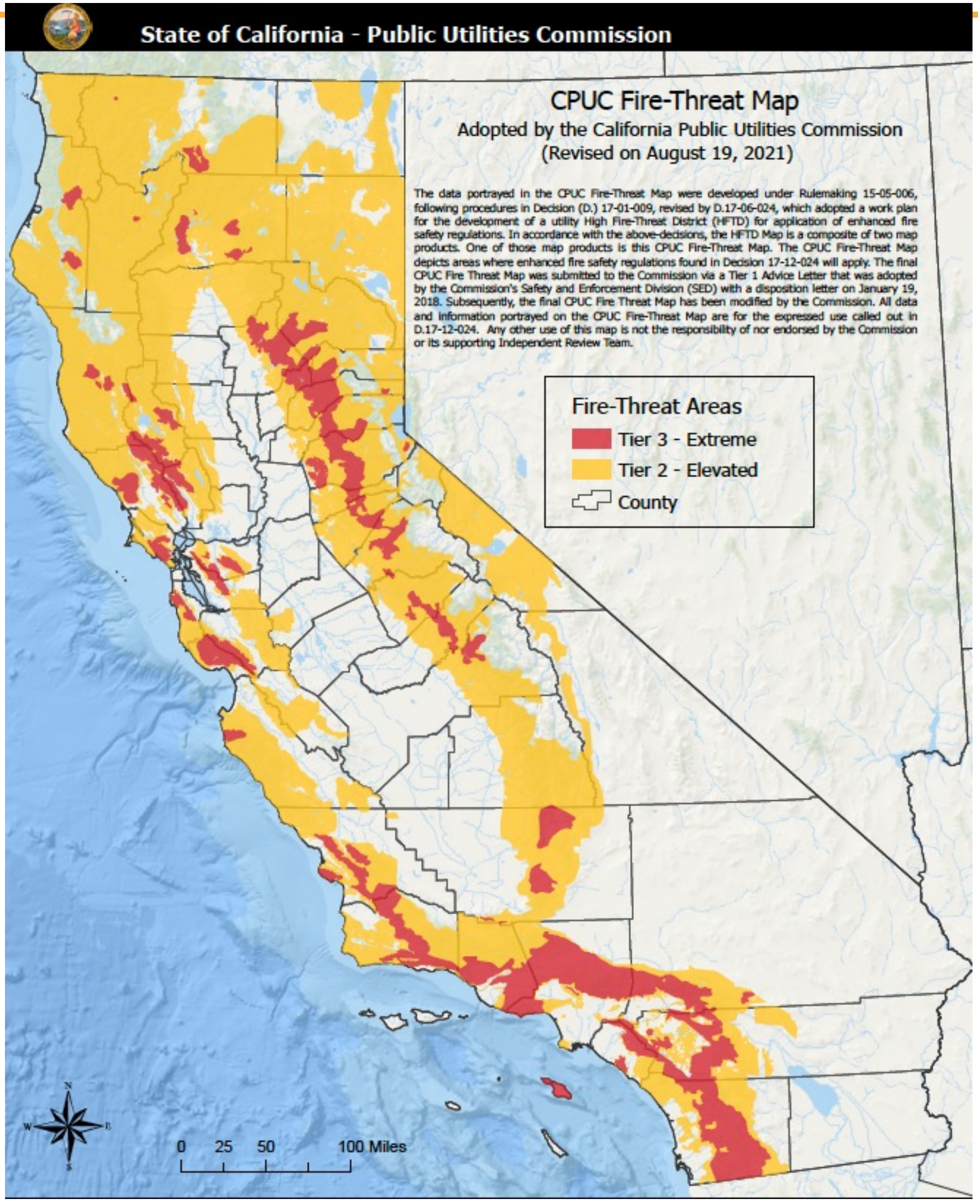
- Graphically illustrates a risk.



Risk "Tranches"

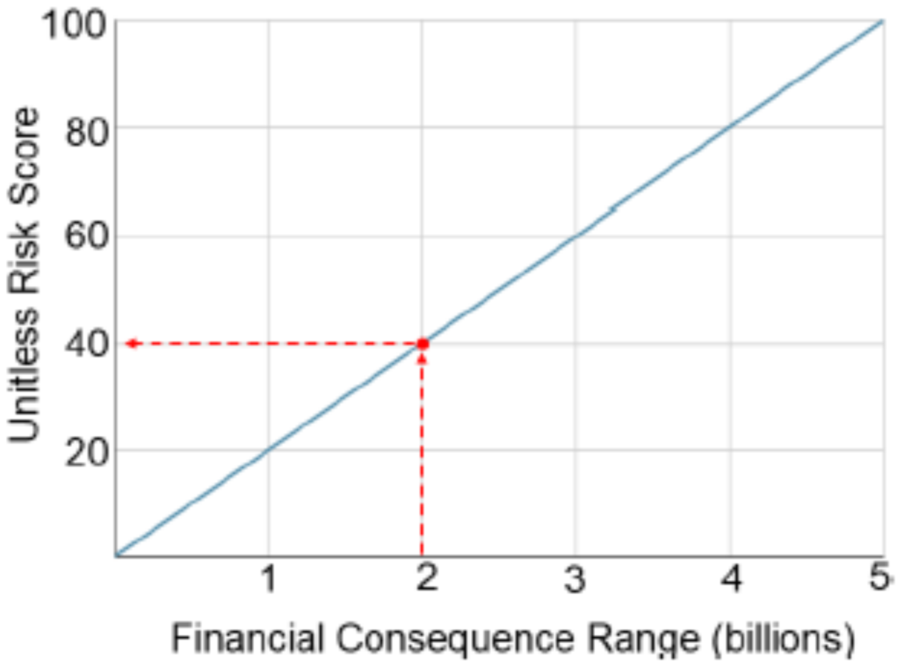
- Risk is unlikely to be uniform across a utility system or asset classes.

- Risk tranches – areas, assets, or other components of utility systems with homogenous risk



Consequence: Initial Approach – Multi-Attribute Value Function (MAVF)

- A MAVF allows for the combination multiple “attributes” into one quantitative score, in this case related to risk.
  - Combine various types of units (dollars, lives saved, minutes of outage) into a unitless risk number that can be directly compared.



Action	Value
Identify Consequence Value	$2 billion
Determine Scaled Score	40
Identify Attribute Weight (Financial)	25%
Apply Weight to Scaled Score	10 = 25% * 40
Financial Risk Score	**10**

Consequence: Current Approach – Calculate Consequences Using Dollar Equivalencies

- Promoted by CPUC over MAVF approach to increase transparency and ability to compare dollar benefits with dollar costs.
  - Pros: Transparency, greater alignment of calculations among utilities, easier to understand
  - Con: Not all attributes have readily understood/available dollar equivalencies
- Safety: Statistical Value of Life (e.g. U.S Department of Transportation)
- Reliability: Value of Lost Load (e.g. LBNL ICE calculator)

Attributes	Natural Units	Value[a]	Scaling Function	Dollar Value of Attributes*	Monetized Risk Value**
Safety	Fatalities	20	Linear	$10 M/fatality	$200 M
Reliability	CMI	500 minutes	Linear	$2.50 M/CMI	$1.25 B
Financial	Dollars ($)	$1 billion	Linear	$1	$1 B
				Total Monetized Risk Value	**$2.45 B**

* The Dollar Value of Attributes is also referred to as the Trade-off Value.

** Monetized Risk Value = Value x Dollar Value of Attributes.

Risk Modeling at a High Level*

1. Calculate *baseline risk* (likelihood x consequence).
2. Calculate or assume based on subject matter expertise the “mitigation effectiveness” of a program – how much it reduces risk.
3. Develop cost estimates for each utility investment or program – e.g. undergrounding, vegetation management, covered conductor.
4. Subtract pre-mitigation risk and post-mitigation risk (risk x (1-mitigation effectiveness))
5. Divide present value of risk reduction by present value of costs.
   - Results in cost-effectiveness or “Risk Spend Efficiency” (RSE) statistic

**Each risk calculation done at the “tranche” level*

Illustrative Example – Hurricanes in Florida

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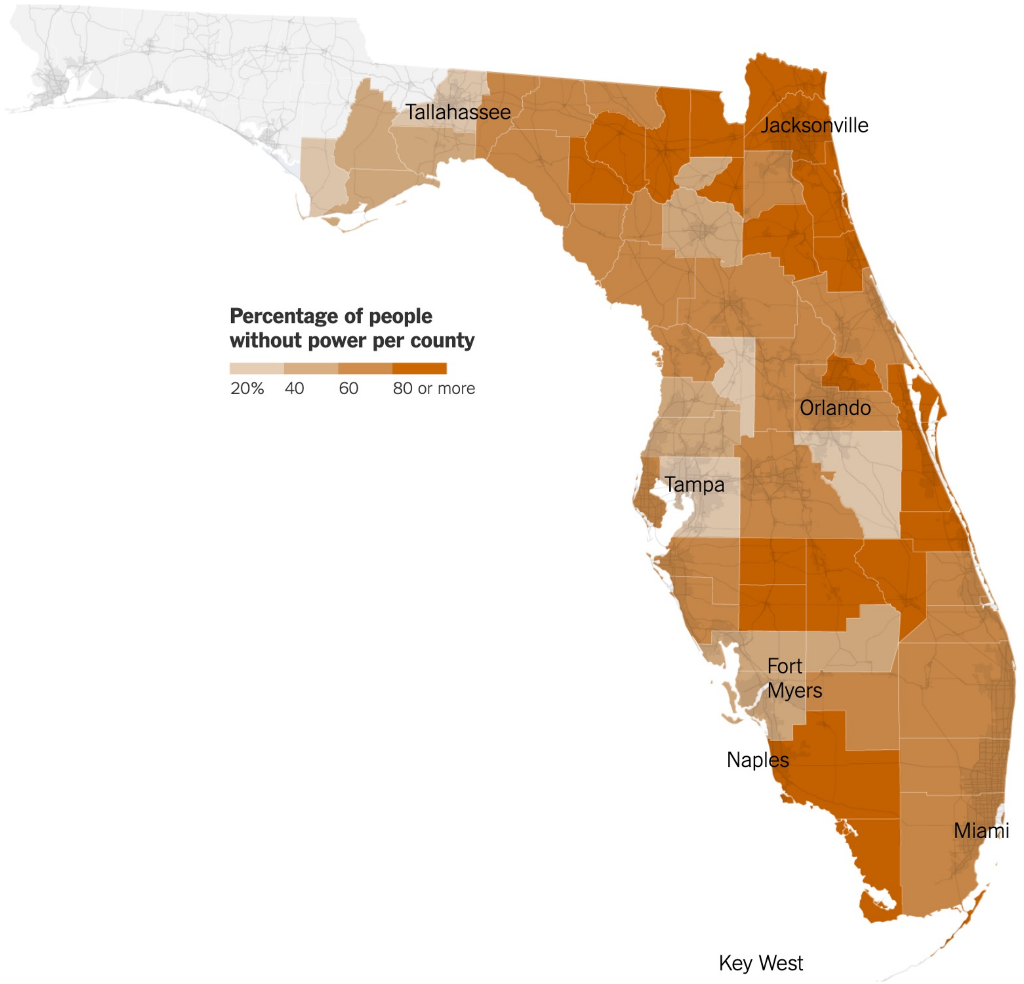
1. **What is the likelihood of a hurricane?**
   - **This varies by location**
   - **As granular as possible – e.g. it's less useful to calculate the likelihood of a hurricane in Florida vs. the likelihood of a hurricane in Miami.**
2. **What is the consequence of a hurricane?**
   - **Safety**
     - **Injuries**
     - **Fatalities**
   - **Power outages**
     - **Business disruption**
     - **Access to medical equipment**
   - **Property damage**
     - **Buildings destroyed**
     - **Debris and cleanup costs**



Illustrative Example – Hurricanes in Florida*

- Let’s assume we expect 1 large hurricane every 5 years in a given location.
    - 1/5 = 20% probability of hurricane in a given year.
- Let’s assume we expect each time a hurricane occurs, there will be, on average:
    - 5 outages at a cost of $1 million per outage based on value of lost load
- We have two “mitigations” to help reduce risk*
- 1. Underground utility lines
    - Cost: $15 million
    - Mitigation effectiveness = 100%
    - 10 years before have to rebuild

Represents high-cost, high mitigation effectiveness solution

- 2. Install steel poles
    - Cost: $1 million
    - Mitigation effectiveness: 30%
    - 15 years before have to replace

Represents lower cost, lower mitigation effectiveness solution

**Note: The numbers in this example are meant to be entirely illustrative and do not represent actual likelihood or consequence values.*

Illustrative Example - Hurricanes in Florida – Calculate Risk Reduction

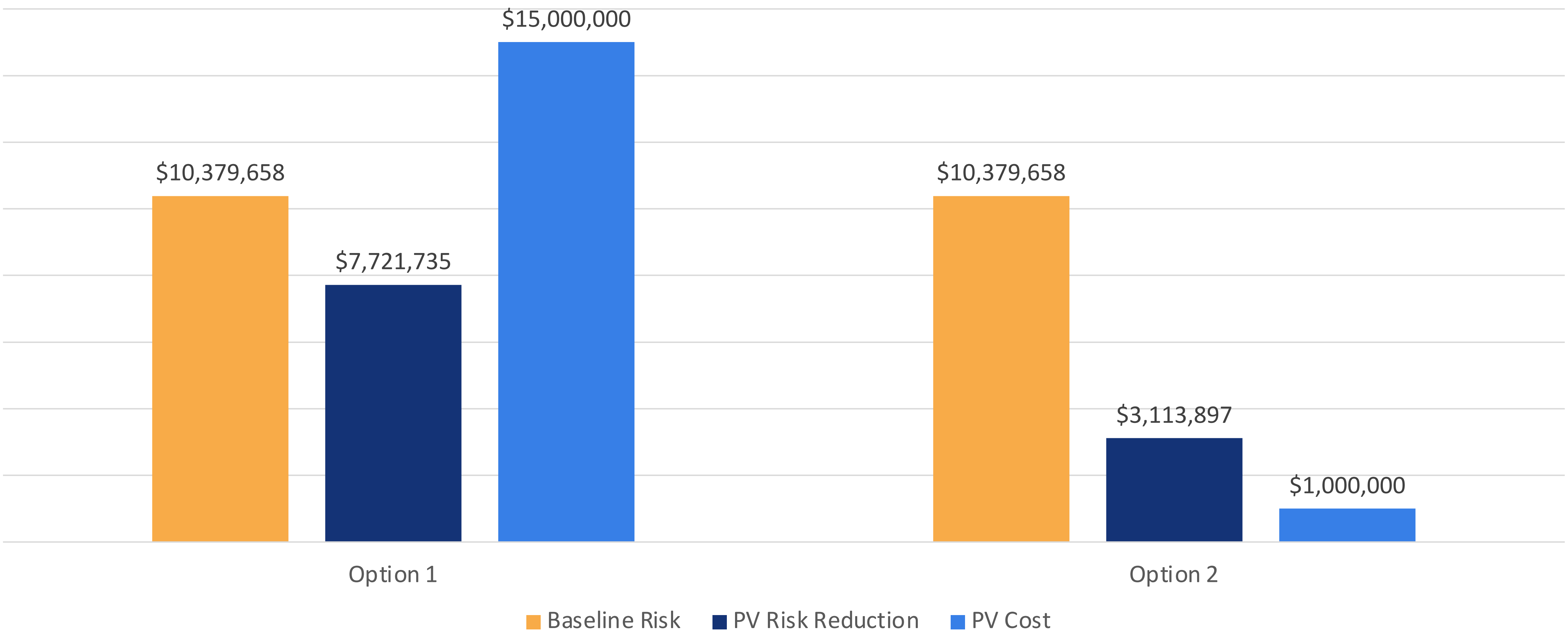
	Likelihood	Consequence (Reduction)	Annual Risk (Reduction)
Risk of Hurricane	20%	$5,000,000	$1,000,000
Option 1	20%	$(5,000,000) = $5,000,000 * 100% *Reduction to Consequence = CoRE * Mitigation Effectiveness*	$(1,000,000)
Option 2	20%	$(1,500,000) = $5,000,000 * 30% *Reduction to Consequence = CoRE * Mitigation Effectiveness*	$(300,000)

Illustrative Example - Hurricanes in Florida – Calculate Risk Reduction

	Option 1	Option 2
Present Value Risk Reduction	$\sum_{n=1}^{10} \frac{(Annual\ Risk\ Reduction)}{(1+i)\hat{}n} = \$7.7mm$	$\sum_{n=1}^{15} \frac{(Annual\ Risk\ Reduction)}{(1+i)\hat{}n} = \$3.1mm$
Present Value Cost	$15 million	$1 million

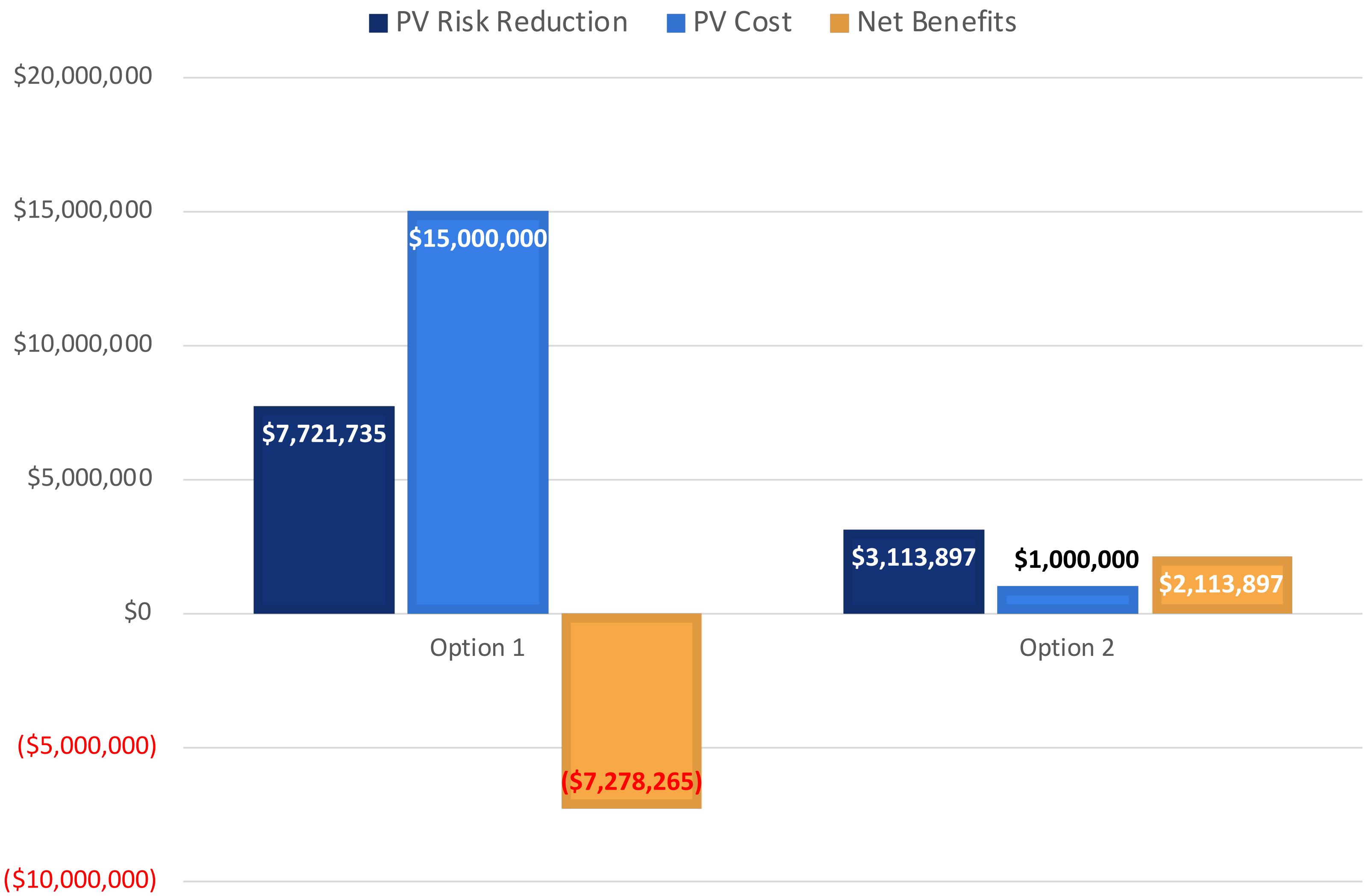
Illustrative Example - Hurricanes in Florida - Results

- Option 2 has a positive benefit-cost ratio – benefits are greater than costs
- Option 1 mitigates more overall risk but at higher expense



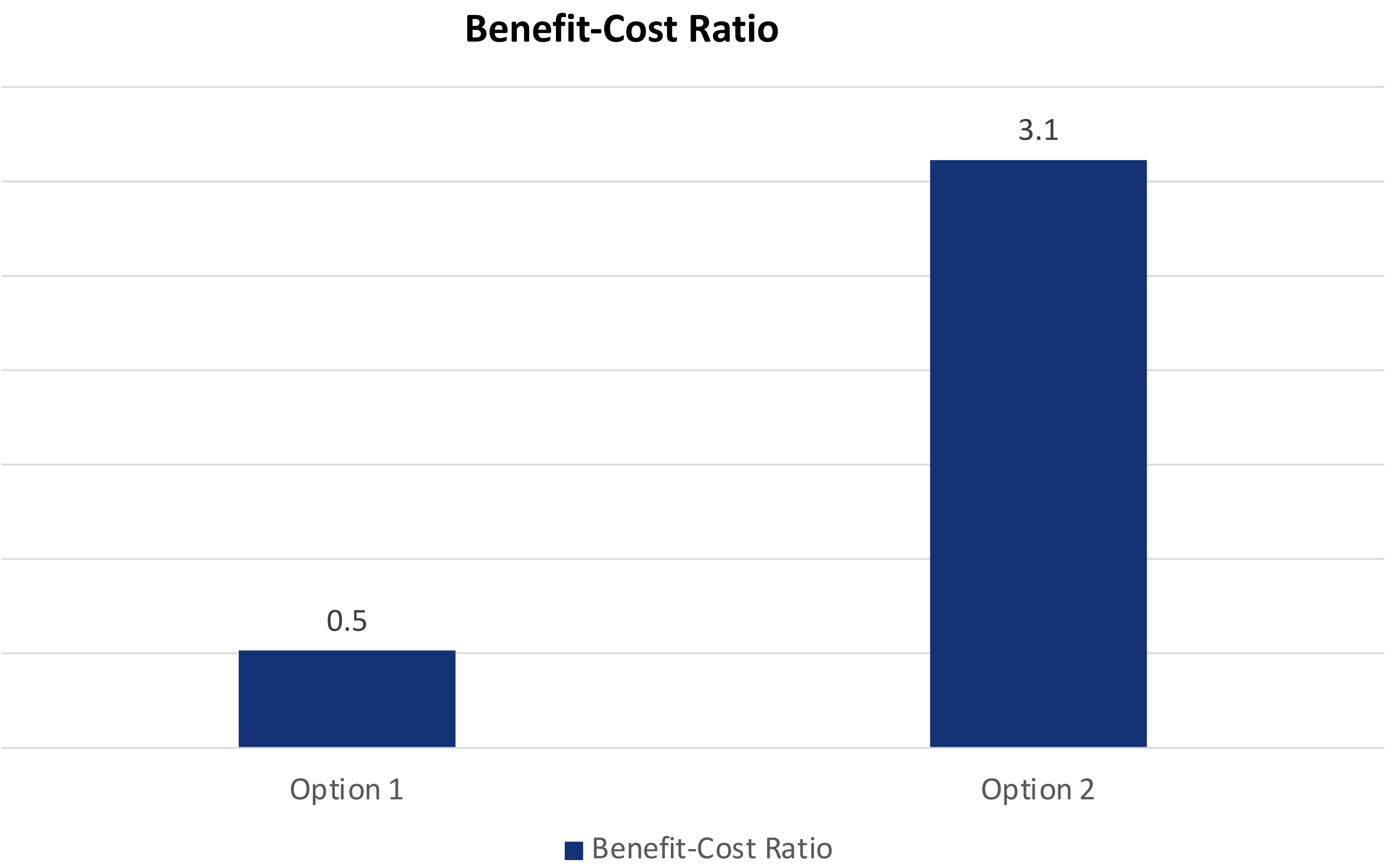
Policy Implications of Risk Analysis

Policy Implications: Relative Costs and Benefits



Examine costs and benefits across programs

Policy Implications: Relative Costs and Benefits



Analyze the cost-effectiveness of proposed programs.

Policy Implications: Risk Reduction

Examine relative levels of risk reduction across programs.

- Here, option 2 was more cost-effective (see last slide) but reduces less risk.

Policy Implications - Summary

- Quantitative estimates illuminate tradeoffs of safety and affordability
- Often, however, it is possible to find ways to reduce costs without proportional decreases to safety impacts
  - Example: A mix of options 1 and 2 could lead to lower costs while maintaining the majority of safety benefits
  - 80/20 rule – can you achieve 80% of the benefits for 20% of the costs?
  - This can be achieved if risk is relatively concentrated – e,g. diminishing returns as you move from highest risk to lowest risk locations or circuits

Implementation Issues in California

Utility risk modeling has improved due to interest from Commission/stakeholders and recent attention on wildfire issues.

However, there is need for constant improvements due to implementation issues:

- *Tranche granularity* – risk tranches often defined too broadly which limits the usefulness of results.
- *Lack of transparency* –
  - Risk-spend efficiencies (RSEs, the current term for benefit-cost ratios) are currently based on utility proposals. It can require significant effort to calculate RSEs of alternate proposals.
  - Often difficult to re-create calculations and source utility information.
- *Inability to compare risk scores across utilities* – utility methodologies and calculations differ enough that risks and scores cannot be compared across utilities.
- *Lack of data on mitigation effectiveness* – mitigation effectiveness has relied almost exclusively on utility subject matter expertise, rather than recorded data.

Implementation Issues in California

- *Siloed proceedings* - there is a disconnect between the stakeholders and individuals familiar with risk modeling and GRCs.
  - *Utility buy-in*:
    - Some utilities continue to fight moving risk modeling forward.
    - Utilities downplay or argue against the usefulness of cost-effectiveness data.
  - *Definition of appropriate risk threshold*
    - Hard for Commission and utility to admit that risk cannot be driven to zero. So what is the ”right” amount of risk to aim for?
  - *Societal problems cannot be solved by electric utilities.*
    - Myopic use of risk modeling for utilities can distort view of other solutions to societal problems (EVs, wildfire risk, etc.).
  - *Tends to be forward-looking* – hard to examine what has already been done.

Sources

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