# Resilience in Regulated Utilities

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DECEMBER 11, 2014

# Everybody Loves Resilience

- It guides or reaction to and qualification of catastrophic events!
- Resilient populations and cities:
  - New York
  - New Orleans
  - Boston
  - Joplin
  - Atlantic City

# Intro

- NARUC's Department of Grants and Research
- The U.S. Department of Energy office of OE
- Resilience as a term of art, in the context of a hearing room, needs a definition and an understanding of how to appropriately incentivize it

# What's Missing

- Policy-makers may want to verify a common resilience understanding for the regulatory context
- A definition*
- In *Resilience in Regulated Utilities*, we define resilience within the existing agreed-upon terminology of reliability

# States/NERC

- North American Electric Reliability Corporation oversees the enforcement of system reliability for BES
- States approve investments and set service benchmarks in the course of setting rate, terms and conditions

## NARUC's *Resilience*

Resilience; noun, regulatory term of art:

- *Robustness and recovery characteristics of utility infrastructure and operations, which avoid or minimize interruptions of service during an extraordinary and hazardous event*

# Reliability Metrics

- Utilities' investments in reliability already cover a lot of the investments under our definition of resilience
- But, frameworks we use to evaluate reliability may need tweaking to recognize a good investment in resilience
- **Duration** – how long the service is interrupted
- **Frequency** – how often

# How we measure reliability

$$SAIDI = \frac{Total\ Duration\ of\ Customer\ Interruptions}{Total\ Number\ of\ Customers\ Served} = \frac{\sum r_i N_i}{N_T}$$

$$CAIDI = \frac{Total\ Duration\ of\ Customer\ Interruptions}{Total\ Number\ of\ Customer\ Interruptions} = \frac{\sum r_i N_i}{\sum N_i} = \frac{SAIDI}{SAIFI}$$

$$SAIFI = \frac{Total\ Number\ of\ Customer\ Interruptions}{Total\ Number\ of\ Customers\ Served} = \frac{\sum N_i}{N_T}$$

$$\text{MAIFI} = \frac{\text{Total Number of Momentary Customer Interruptions}}{\text{Total Number of Customers Served}} = \frac{\sum ID_i N_i}{N_T}$$

# ICE Calculator / IEEE 2.5 Beta Method

- Interruption Cost Estimate calculator (ICE) developed by DOE, 2011
  - Uses SAIDI etc., residential/non and State
- IEEE 2.5 Beta Method
- Value is still missing – economic damage may be undervalued

# Where Reliability Metrics Break Down

- What’s not covered by applying duration and frequency metrics?
- They miss
  - The value of impact of large-scale events, instead focus on normal operating conditions
  - They price lost load at a flat rate, where in fact it compound the longer it’s lost

# Value to ratepayers

- Large scale events warp the math because the restoration costs are so high and because they are likely to inflict longer-term service interruptions
- In catastrophe situations the value to ratepayers for surviving the event without losing service is especially high
- The duration formulas value each lost kWh equally across time, but customers do not
- And finally, we're dealing with a new set of threats
- The best investments for large-scale events will not be evaluated if you ignore large-scale events

## What does this capture that was otherwise missing?

- Using this way of thinking, what kinds of resilience challenges are captured that were otherwise missing?
  - Non-traditional hazards
  - Large-scale catastrophic events that resist restoration
  - Events with the capacity to induce long-term outages
  - Cascading failures

# … and how?

- Thinking about resilience as an aspect of reliability allows us to explicitly consider large scale events and non-traditional hazards that were sometimes cut out of the math before
- It allows for variable pricing for duration and a better understanding of scale by adapting to risk-based frameworks that capture interdependencies and likelihood

# How should regulators review resilience?

- (what needs to be fixed?)
- We might be better offer to evaluate under non-blue sky conditions
- Scale measurement – we have to take into account how big the event is
- Variable or compounding outages – the value of lost service on day 1 / 30
- And also -

A good investment in one area may create trade-offs elsewhere

| Example 1: unique encrypted passwords for all utility "smart" distribution devices | | |
|---|---|---|
| | Resilience | |
| Availability | Robustness | Recovery |
| Poor: more likely errors will occur through everyday user mistakes | Good: More resistant to malicious software or hackers | Poor: more likely that password management and use will slow restoration efforts |
| **Example 2: wooden distribution poles for power lines** | | |
| | Resilience | |
| Availability | Robustness | Recovery |
| Good: repairs and maintenance are simplified, and do not require excavation crews | Situational, but usually poor: more susceptible to wind, vegetation, and fires; less susceptible to floods | Good: materials are inexpensive and easy to replace. |

# Trade-Offs

# Cost of Trade-Offs; 3 Factors

- If we can't afford to make everything resilient, how do we prioritize?
  - **Scale** – how many customers are affected?
  - **Duration** of the interruption
    - And this has to account for compounding value effects – reduce duration for long outages
  - **Value** of lost load
- Harmonizing these three factors may require new analytic framework

# Measuring Regulatory Impact of Resilience

# Resilience in the Regulatory Context

- More and more, significant investments and cost recovery efforts undertaken under the signifier "resilience"
- Some threats to the continued delivery of reliable, affordable utilities are existential – they require investments from much more dynamic models than the ones we use for static duration and frequency of outage
- Started asking: What is resilience? When we use it in a hearing room, do we understand it universally?

# The workshops

- Building on *Resilience in Regulated Utilities* (Cody & Keogh, Nov 2013) and *Resilience for Black Sky Days* (Stockton, Feb 2014), create a workshop to play out investments that address catastrophic threats

UAV Drone Infrastructure Program

- Unmanned Aerial helicopter drones carry cameras and other sensors and can be flown into areas with damaged transportation systems
- Data indicate that restoration times can be cut by 25% by assessing damage and prioritizing restoration with the 10 requested unmanned aerial vehicles
- $4 million
- Although this may be rarely used, it can also be helpful for monitoring remote systems such as transmission rights of way during normal operating circumstances

**The Icemen Cometh Not!**

Existing workforce strike + polar vortex, ice storms

- Timing: November
- Poles and distribution lines destroyed or severely damaged, some road damage
- Customers out: 150,000
- ETR: 19 days
- Cost: $20 million

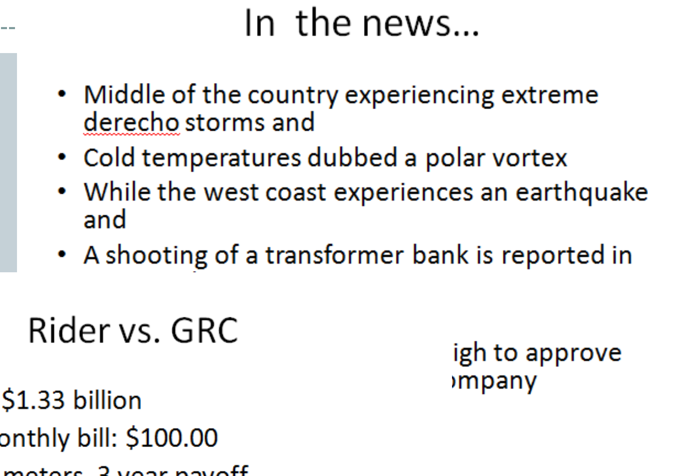
Calamity 4

# Spring/Summer 2014

- NECPUC
- MARC
- MACRUC

# The experience

- Political context
- Given existing rates and a variety of rate pressures/caps/cap expiration
- 1 of 6 outcomes, one of which is “Blue Skies”
- A final report out to the Governor


In the news…

- Middle of the country experiencing extreme derecho storms and
- Cold temperatures dubbed a polar vortex
- While the west coast experiences an earthquake and
- A shooting of a transformer bank is reported in

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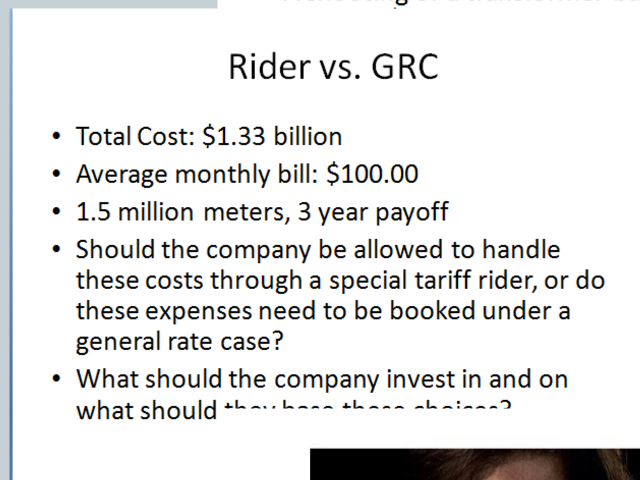
Rider vs. GRC

- Total Cost: $1.33 billion
- Average monthly bill: $100.00
- 1.5 million meters, 3 year payoff
- Should the company be allowed to handle these costs through a special tariff rider, or do these expenses need to be booked under a general rate case?
- What should the company invest in and on what should


The Governor

# The outcomes

- Mutual assistance
  - Saw regional approaches vary widely in embracing RMAGs
  - Saw non-traditional mutual assistance agreements and investments: cybersecurity consultants and drones
- Calamity-averse
  - Vegetation management remained the favorite and most easily defendable investment, even in the face of catastrophic threats
- Limited exposure to calamity – only one round
  - If we played out the calamities over longer period, would investments have different pay out?
- Future plans for the workshop

# Conclusion

- We all want resilience for our systems
- In many cases, we are already prudently investing
- Regulators want to be as smart as possible in evaluating utility proposals in resilience
- New tools, new partnerships and generation of new understandings

# Thank you!

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