Energy Equity in Power System Operations and Planning: Reliability and Resilience

ESIG
ENERGY SYSTEMS INTEGRATION GROUP

Overview of Issues and Challenges

Energy equity is connected to power system reliability and resilience in several ways. In this break-out session, we will explore how considering equity, cumulative impacts, and vulnerability would impact the planning, operations, and decision-making tools and processes we have traditionally used to ensure reliability. We will also consider the emerging grid objective of resilience and how equity objectives interplay with resilience.

- **How does the variation in customers' dependence on electricity across a utility footprint affect reliability?** Not every kilowatt-hour is the same. In the event of an outage, certain customers may experience significant setbacks—loss of income, loss of functioning medical equipment, and an absence of backup power or community support options. Customers may have a very high dependence on electric power for essential services in the home and business (including, but not limited to, medical equipment) or for income (communications, internet, sufficient cooling or heating in the house). This creates uneven vulnerability to power outages and compounding effects. Through cooperation with health authorities and voluntary sign-ups, utilities may offer special reliability-related accommodations for these customers, such as rates, outage notices, and priority power restoration.

- **How could consideration of vulnerability affect current approaches to power restoration?** Typical approaches to power restoration practices follow grid and economic structures: newer equipment and easier paths are given higher priority, as are areas with high economic productivity or a large number of customers. Heuristic and optimal restoration strategies treat each outage independently and will always choose the same restoration path for the same outage. But there may be a "new optimal" that takes vulnerability into account, as well as a re-balance for traditional restoration tools that currently prioritize economic activity.

- **How could consideration of vulnerability affect resilience quantification and planning?** Common resilience metrics, based on probabilistic-risk methods or structural methods, focus on infrastructure and generally do not consider customer vulnerability. Valuable tools, such as the Interruption Cost Estimate (ICE) calculator, which estimates economic costs of outages by duration and customer class, reinforce that the optimal power restoration strategy is one that does the least harm to economic productivity—however, this strategy potentially runs counter to one that avoids the most direct harm to vulnerable populations.

- **How can anecdotal information of outage and restoration disparities be used to make the case for analyzing outages and restoration practices at the utility level?** Customer-aware (or customer-level socio-demographic-resolved) outage analysis would need to be performed to understand what types of outages affect which kind of customer. Anecdotal information exists as evidence of the inequities in the grid. Whether it is the winter storm outage in Texas in 2021, where minority populations were more impacted by the power outage, or reports that have documented (albeit spottily) the outage disparities across customer groups, it is important to take these cases seriously to ask the hard questions of why grid operational decisions led to these inequities.

- **How does the age of existing equipment and underlying technology affect investment in equitable, reliable service?** The nominal and actual lifespans of grid infrastructure are measured in decades. Given the accelerating changes to grid technology and climate change, equipment in service today may have been selected and installed under outdated models and assumptions, with limited foresight about circumstances today. Problems that increase the frequency or duration of outages would generally only be addressed when they become observable at the macro-system level, leaving local problems at the individual and community level potentially unaddressed. Planning investment in the electric grid—for maintenance or to enable expansion of distributed energy resources and other services—should consider the cumulative effects of past investment to achieve equitable outcomes.

- **How can reliability metrics be supplemented to describe the granularity of population dynamics and the uneven distribution of the effects described above?** Typical reliability metrics for regulatory purposes are too spatially and temporally broad to capture relationships to populations. System-scale or averages by customer class do not connect to feeder or neighborhood-level performance, or include population dimensions that have greater vulnerability to power outages and disruptive events, such as the ages of a home's occupants. For example, SAIDI and SAIFI,[1] which neither consider vulnerability nor capture neighborhood or community specifics, can lead to the same customers always experiencing the longest outages and are not traditionally aggregated at the neighborhood or community level.

- **How can responses to extreme weather events account for compounding effects on frontline communities experiencing both the event itself and the loss of services?** Customers with marginal resources may directly experience damage from extreme weather in addition to the indirect loss of services such as power, water, or transportation on which they depend for critical communications and mobility. In addition, these communities may have fewer resources to respond to or ride out the damage. For example, in a heat wave, customers may have homes with no or limited air cooling and less efficient envelopes (e.g., mobile homes). Resilience in these communities may look different than in more affluent communities, and these customers may require much more support than the average customer in order to achieve the same performance outcome.

[1] SAIDI: System Average Interruption Duration Index; SAIFI: System Average Interruption Frequency Index

Motivating Questions

- What equity challenges are embedded in current processes and practices for reliability planning and power restoration? Some are listed above.
- How can feedback from impacted communities and vulnerable customers be given due weight, translated to technical outcomes, and captured equitably throughout a footprint? What data and data capture tools would be needed to do this?
- How could reliability metrics shift to reflect customer vulnerability across a system footprint?
- What evolution in reliability planning and investments would consider social/vulnerability factors? For example, how could envisioning climate impacts on populations influence reliability decision-making?
- How do the traditional engineering and economic models and tools used to analyze and plan the power system for reliability accommodate concepts of equity? What kinds of factors (e.g., spatial data) are "easy" to layer into these models? Which require work outside of the model but still allow for use of the model, such as scenarios with artificial constraints or post-processing, and how might that work in practice?

Community Perspectives and Case Studies

Approaches for equitable grid technology deployment:

- Energy Storage for Social Equity
- Together New Orleans resilience strategy

Programs that track customers with life-dependent medical equipment:

- City of Austin
- Portland General Electric
- Seattle City Light
- FirstEnergy
- National Grid (NY)

EPRI resources on climate resilience and vulnerability:

- *Equity and Resilience: Implications at the Intersection of Climate Change and Community* (3002025062, September 2022)
- *Climate Vulnerability Considerations for the Power Sector: Health and Safety, Environmental Justice, and Ecological Patterns* (3002026316, June 2023)
- *Climate-Informed Planning and Adaptation for Power Sector Resilience* (3002026317, May 2023)