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Challenges Surrounding Electric Power Resiliency [1]

Deck:
Costs v. Benefits

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The presumption among industry observers is that the resiliency of the U.S. electric power sector is deficient. If industry spends additional monies on improving its resiliency, the benefits should outweigh the costs.

We are seeing a hard push at the federal, state and local levels to bolster the resiliency of electric power, even if it costs a substantial amount of money. The thinking is that the benefits are too large to ignore.

This sentiment derives largely from four sources: More severe weather, a growing threat of cyber-attacks, higher reliance on electricity by society, and consumer expectations of higher quality electric power service. These all have increased the value of a resilient electric system.

One factor that could contribute to deficient resiliency is the public-good aspect of the benefits. Actions taken by a single power operator inevitably improve other operators' resiliency. The interconnection of grid systems is the main reason. Consequently, leaving it up to individual power operators to determine the level of resiliency would result in a deficiency from a societal perspective.

Electric service interruptions of long duration and wide-area impact certainly have received prominent media coverage, which aggravates the loud cries from different quarters for improved resiliency. Customers, the media and the public have judged utilities more critically in recent years on how they respond to disasters.

The concern over extended service interruptions on its own is rational. It is obvious to me, however, that because policymakers and system operators rightly fear extended service interruptions and blackouts, they may not think twice about burdening electricity consumers with the cost of avoiding them. They will therefore almost surely err on the side of excessive caution that translates into higher electricity prices.

Evidence in different contexts has shown that what is called probability neglect, namely, a sole focus on outcome and disregard for probability, helps to explain excessive reactions to low-probability, catastrophic events.

These events have a significant effect on people's beliefs and behavior, with exaggerated risk perceptions a likely outcome of the substantial publicity given to such events. We know that rational decision making should account for the probability of events, whether calculated objectively with historical data or subjectively. It is plausible that the policy debate over electric power resiliency may exemplify this mindset.

What is a sensible public policy toward low-probability, high impact catastrophes such as extended power outages? One strategy would expend resources today to prevent a small chance of future disaster; but this begs the question of how much we should spend and how we should spend it.

From a public-interest perspective, the cardinal question is whether a so-called resiliency problem exists. Too little resiliency may exist because of its public-good nature. On the other hand, we may have too much resiliency because of decision-makers' excessive caution and probability neglect. If there is a problem, what should be done, and how do we know if improved resiliency is a net benefit to society?

No Single Definition of Resiliency

One perception of resiliency is that it mitigates the probability of long-lasting and widespread power interruptions. Some sources of interruption, such as severe storms, are natural. Others, such as cyber and terrorist threats, are human.

Various definitions abound, differentiated by the scope of actions required to make a power system resilient. One concise definition of resiliency is that it measures the performance of a system under threat or stress; for example, power grid performance in severe weather conditions or under cyber-attack.

A RAND study relates resiliency to the different aspects of service performance, with the following questions to be asked: Has service been degraded? How much of the service has been degraded? How quickly has service been restored? Finally, how completely has service been restored?

A broad definition of resiliency has two components.

One is static, meaning the ability of a power system to remain functional when shocked. The other is dynamic, which involves hastening the speed of recovery from a disruption.

The first component relates to keeping the lights on. The second, when the lights go out, tries to restore service quickly and with minimum cost to electricity consumers and society.

Each can substitute for the other. By spending more money to prevent service interruptions, the operator can reduce the money spent on managing an outage and restoring service. The economics of each component differ, with the first closely related to the concept of reliability.

The National Academy of Sciences says that, "A resilient system is one that acknowledges that large outages can occur, prepares to deal with them, minimizes their impact when they do occur, is able to restore service quickly, and draws lessons from the experience to improve performance in the future."

A holistic perspective of resiliency would encompass how power operators, electricity consumers, and the economy as a whole respond to a disruption. How electricity consumers react to an extended service outage and what precautions they took prior to the outage affect the actual harm they suffer. They can, for example, prepare for an outage by buying extra batteries, flashlights, and blankets, and mitigate losses by purchasing surge protectors and back-up generators.

Complicating Factors

Analysts label power interruptions of long duration as a high impact, low probability (HILP) event. In some circles, a Black Swan. There is a high degree of uncertainty over the expected effect of such events. Because of deficient historical data, it is mere speculation to predict their frequency and the damage they are likely to cause.

One example of uncertainty that has proliferated recently is the more extreme weather that has no historical precedent, at least since the reporting of weather data began.

HILP events pose special challenges for decision-makers because of their far-reaching impact, poorly understood risk or uncertainty, or costly mitigation.

There is also an unclear role for industry and government - for example, the sharing of responsibilities.

In contrast, reliability concerns are more of a risk. Their probability of occurrence derives from statistical data for both system peak load and power-plant outage rates. Reliability is also more precisely measurable and has less ambiguity in its definition.

In the real world, risky and uncertain situations are insurable, but uncertainty precludes decision-makers from relying on historical data to calculate the objective probability of an adverse event.

Uncertainty is really a poorly understood risk. It is non-quantifiable and requires subjective judgment. With uncertainty, the preferred approach for analysts is often to describe various hazard scenarios or assign them a subjective probability of occurrence.

Uncertainty inevitably forces decision-makers to rely heavily on value judgments. It also makes strict cost-benefit tests less viable because of dubious results. Any analysis of resiliency, however defined, faces these limitations.

Uncertainty over the benefits of action does not mean that the status quo is okay and optimal. The weak form of the so-called precautionary principle says that the absence of certainty in the face of large risk does not justify inaction; it reflects the adage "better safe than sorry."

But even if doing something is possible, it cannot be open-ended in terms of taking action to prevent the possibility of future harm. For some, the best policy in the face of uncertainty is to avoid the worst outcome. For example, multi-day outages spreading over a large geographical area, no matter what the probabilities are for different scenarios.

While uncertainty can warrant deliberate action, decision-makers should exercise caution. We do this all the time as individuals when deciding to do something with uncertain benefits.

We rationally hesitate to pursue costly activities when we are unsure of the economic or other gains. What policymakers should do is continuously acquire better information, whether from credible modeling or more informal sources, to increase the chances of good decision-making in the face of uncertainty.

Utilities have myriad options to improve resiliency, with some deserving higher priority because of their larger benefits or lower costs (such as cost-effectiveness), or both. They include more redundancy, by stockpiling spare parts, hardening distribution lines, and designing systems to accommodate recovery. Also, smarter operation of the distribution component and better communications with customers.

EPRI separates resiliency practices and investments into five categories. They include overhead structures, vegetation management, undergrounding, grid modernization with AMI, and storm response practices that cover emergency planning, communications with customers, and incident management.

Of course, just listing the options begs the question of which ones are most practical and cost-effective. Some studies on resiliency list several pages of recommendations that would be extremely costly if all were executed. They provide no guidance as to which ones are most effective and economical, and whether any of them would actually pass a cost-benefit test.

Another challenge for decision-makers is designing a widely-used single metric for identifying a baseline level of resiliency, setting a standard, or quantifying the tradeoffs within a cost-benefit framework.

Inherently, developing metrics for resiliency is difficult, as they would have to involve assessing how well system operators prepare for and deal with rare events without any history. Here again, the issue is uncertainty.

In a study by the National Infrastructure Advisory Council, resiliency is defined as "the capability to anticipate, absorb, adapt to, and/or rapidly recover from disruptive events." Decision-makers would find assigning standards to each of these activities difficult, let alone measuring them.

Consumers and communities can control, to an extent, the harm from a service interruption. A business can reschedule production and purchase a backup generator. It may well be more cost-effective for electricity consumers to improve their resiliency than for the utility to improve it.

Any public policy should recognize that power operators, communities and consumers could mitigate the harm from a massive service interruption. The widely recognized Coase theorem says that liability should fall on those parties that are able to address a problem most cheaply.

While the outcome would tend to be an efficient allocation of risk, it evades the question of who should bear the risk, from a fairness perspective. Is it fair for consumers, for example, to take on resiliency costs when the operator is imprudent in managing a service interruption?

A further challenge is quantifying the benefits of improved resiliency. It involves more than measuring the value of lost load (VOLL) or customers' willingness to pay for the improvement.

We presently lack good information on the cost to electricity consumers and to society from extended service interruptions. We know little about what society is willing to pay for. Or the value derived from full or partial back-up service during widespread geographical outages of long duration. Informed decisions involving resiliency require this information.

Overall, we presently lack the knowledge to say how many additional monies we should spend on electric power resiliency and how we should spend it, from a societal perspective. The cost of improving resiliency is measurable with reasonable accuracy. But conducting a cost-benefit analysis of resiliency is particularly challenging because of high uncertainty on the benefit side.

Some of the benefits are non-quan-ti-fiable.

Tough Questions for Utility Regulators

Electric power operators at regulated utilities face the challenge of determining whether and how much to improve resiliency. They must demonstrate to their regulator how improving resiliency can benefit customers and thereby justify the costs for recovery.

Regulators must guard against gold-plating. Utilities could have the tendency to overinvest in resiliency, if only to increase their rate base and earnings. Regulators need to assure utility customers that they will benefit from improved resilience by at least the cost incurred by the utility to make this improvement. Indeed, this is a tough and almost imponderable task, given what we know today.

If the evidence points to deficient resiliency, regulators can encourage improvement by setting standards or targets for the number of outages and their duration. Targets, though, require that regulators have some idea of the optimal level of resiliency, which is probably beyond the capability of any regulator today.

A guaranteed service standard or warranty that would involve payments to customers for extended outages is another option for regulators. This would motivate utilities to more promptly reconnect customers. The United Kingdom has applied this approach to their distribution utilities, which many observers see as successful.

Utilities have obligations to prevent outages, develop an action plan such as an emergency strategy in the event of an outage, communicate with customers during an outage, and minimize the time for service restoration.

Accountability lies at the core of good regulation. Utilities suffer financially when they exhibit negligence in fulfilling these obligations. A symmetrical approach would involve utilities being rewarded when they perform exceptionally well.

Regulators could also consider the pricing mechanism to optimize the response to service interruptions by allowing utilities to charge a premium to customers who value continued service the most.

These customers, to the extent feasible, will have their service interrupted only after other customers have their service interrupted. This approach reflects service priority based on customers' willingness to pay.

Some industry observers have recommended that state regulators facilitate utility cost recovery for investments that improve resiliency as part of their ratemaking process. But prematurely approving those costs without reviewing the benefits to customers would represent bad regulation.

Finally, regulators should ask themselves whether they have created undue barriers, such as imposing excessive risks on utilities that desire to invest in resiliency. If they have, they should then identify those barriers and decide how to best mitigate or eliminate them.

These are difficult tasks, but ones that regulators should confront head-on to have any chance of achieving optimal resiliency, from a societal perspective.

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