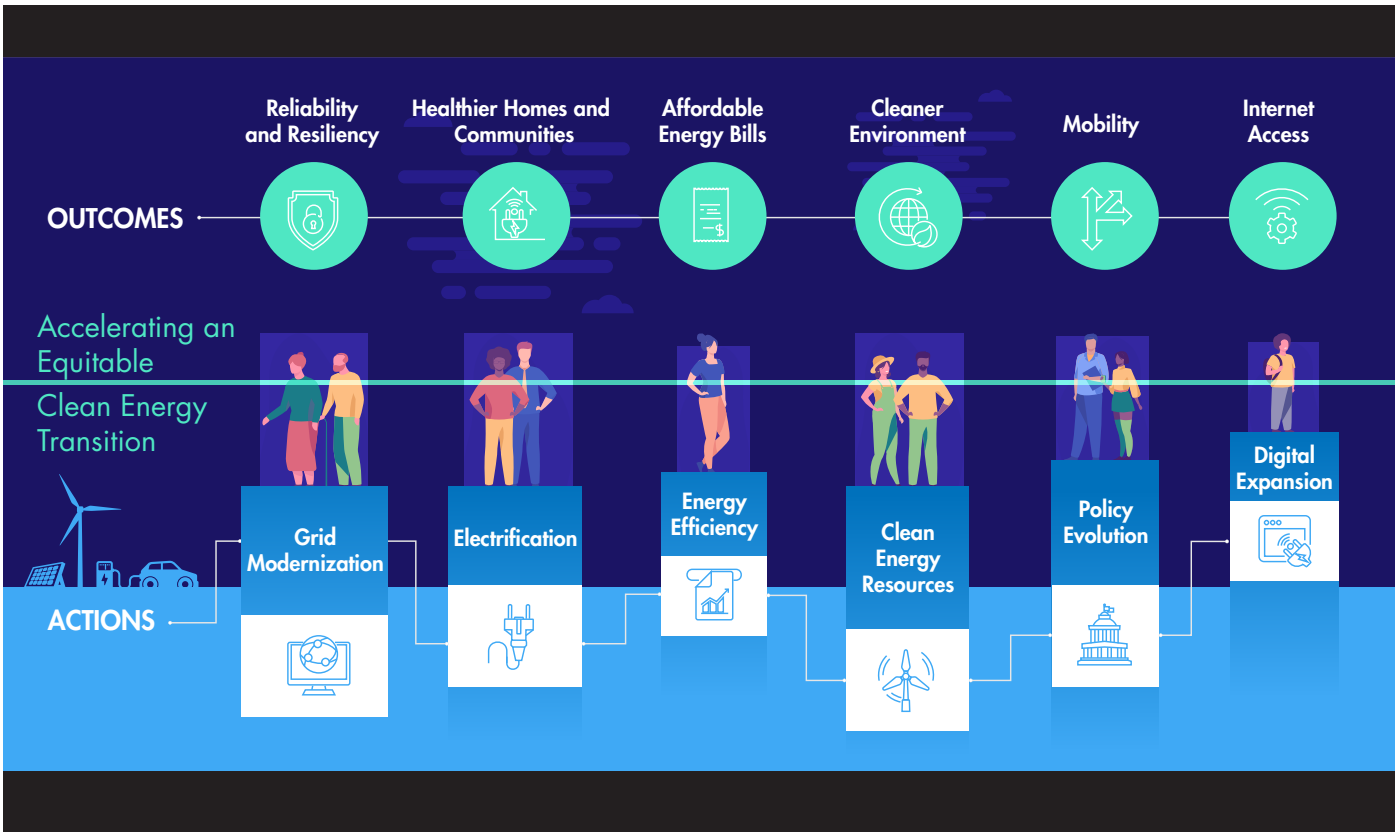
EQUITY AND RESILIENCE

Implications at the Intersection of Climate Change and Community



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Key Insights

- Addressing equity and resilience together may influence priorities, strategies, and approaches for both electric infrastructure and community planning and operations. Understanding how climate change impacts disadvantaged and vulnerable communities can inform grid modernization, transmission and distribution planning, investment decisions, asset management, and operations, as well as community development and resilience planning.
- Climate change and extreme weather are impacting community resilience. Climate change increasingly puts essential community services at risk. Extreme weather and temperatures, power outages, and related impacts disproportionally impact disadvantaged communities.
- Utilities and communities need to assess risks, consequences, likelihoods, and costs to prioritize and develop resilience measures. Understanding the disproportionate impacts of service interruptions across various communities can inform grid modernization and resilience planning.
- Resilience planning presents opportunities to support vulnerable communities. Including equity in decision-making to address community priorities can improve outcomes, build trust, and increase resilience. Both grid-hardening measures (e.g., automated switching, undergrounding, alternative feeds) and community projects (e.g., microgrids, energy efficiency, electric transportation) may be allocated to disadvantaged and vulnerable communities.
- Addressing opportunities to improve community resilience could positively impact society and advance equity as utilities and local governments invest in their communities. Prioritizing investments on metrics beyond loads and number of customers, and incorporating social factors such as income and access to essential services, can advance equity and resilience.

Introduction

Equity and resilience can have significant implications for communities and the utilities and governments that serve them. Incorporating equity into resilience planning may influence a utility's priorities, strategy, and approach. Understanding how climate change, along with the performance of energy and other systems and services, impact disadvantaged and disenfranchised vulnerable communities (i.e., low-income and communities of color) can inform transmission and distribution planning, investment decisions, asset management, and operations as well as community development and resilience planning.

A better understanding of the relationship between equity and electricity service can support investments that advance overall resilience for vulnerable communities. With this knowledge, governments and utilities can shape more equitable priorities, strategies, and approaches to electric infrastructure and asset management. This white paper explores the implications of utility investments at the intersection of equity and resilience, highlighting opportunities, challenges, and potential strategies.

Definitions and Drivers

Equity is the fair treatment and meaningful involvement of all people, regardless of ability, race, or socioeconomic status. *Equity* means fairness and justice, and relates to how benefits and burdens are distributed throughout society. *Energy equity* refers to affordable and equitable access to energy services and benefits, and includes having a presence in related decision-making. An equitable energy system is one where the economic, health, and social benefits of participation extend to all levels of society; achieving energy equity entails intentionally designing systems, technology, procedures, and policies that lead to the fair and just distribution of benefits in the energy system [1]. Accordingly, resilience pertains to both the community and its infrastructure, or in this case, the electric grid. *Community resilience* is the ability to prepare for anticipated hazards, adapt to changing conditions, and withstand and recover rapidly from disruptions [2]. *Infrastructure resilience* is the ability to reduce the magnitude and/or duration of disruptive events [3].

Climate change and extreme weather—and their infrastructure, economic, human, and societal impacts—are impacting resilience in numerous ways, including energy supply and power delivery as well as essential community services. Solution design involves under-

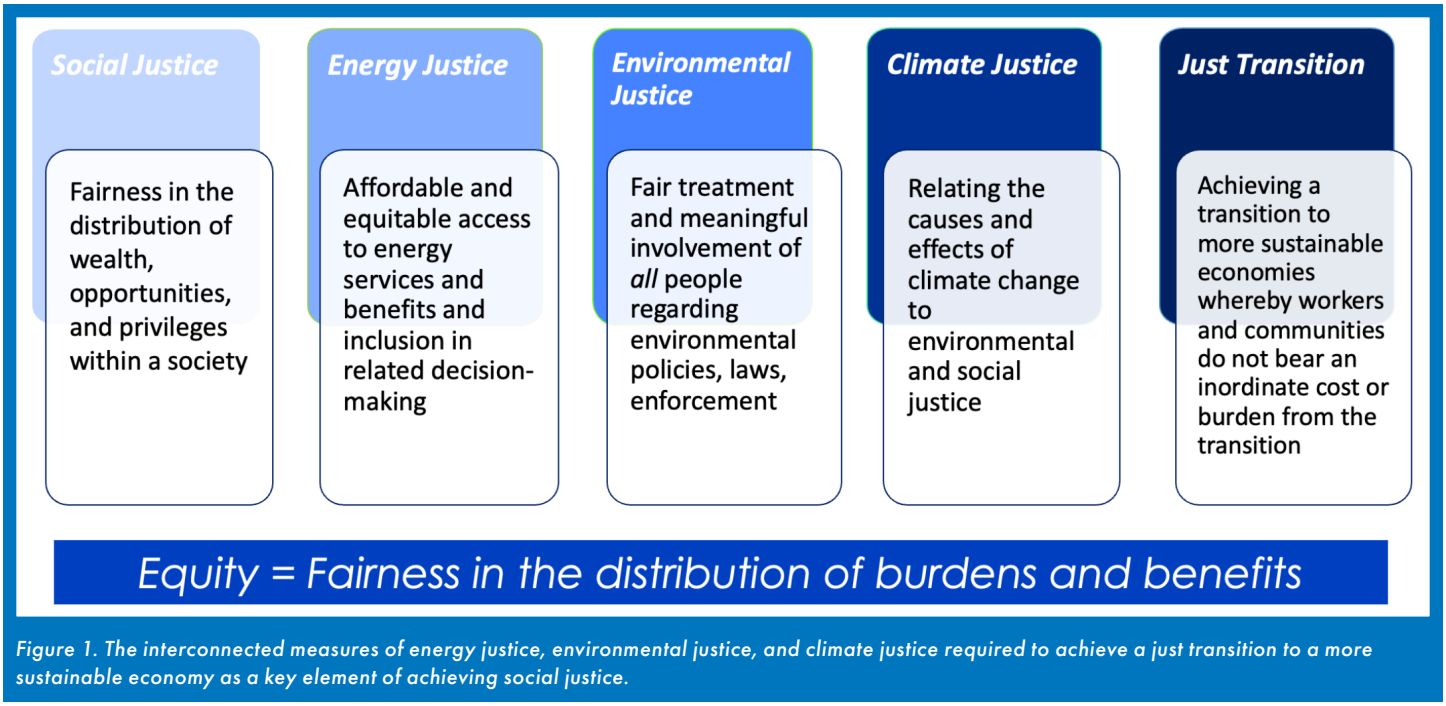

Figure 1. The interconnected measures of energy justice, environmental justice, and climate justice required to achieve a just transition to a more sustainable economy as a key element of achieving social justice.

standing the risks from these threats and the priorities for customers, businesses, and communities in reducing impact across these categories [4]. Extreme temperatures, power outages, and related impacts can disproportionally impact disadvantaged communities, as shown by recent experiences in Texas [5] and Oregon [6]. Vulnerable communities can face greater hardships from essential service interruptions as they may have fewer resources and limited ability to manage and recover. As climate change impacts the grid and those who depend on it, inequities can exacerbate the impacts highlighting the relationship between electric system resilience and community resilience.

There is growing attention to the problems of social inequity in the United States and globally [7]. Equitably distributing investments to enhance grid resilience and related benefits entails deliberate planning and program implementation along with an understanding of how to address institutional factors that contribute to disparate community experiences. Disadvantaged communities may be advanced, impacted, or left behind by these investments, as well as by investments in digital transformation, electrification, energy efficiency, and resilience initiatives. Recognizing and accounting for the differences in energy burden, social burden, living conditions, and access to services can inform and potentially alter how investments in resilience are prioritized.

Assessment and Planning

In *Climate Change and the Electricity Sector: Guide for Climate Change Resilience Planning*, the Department of Energy describes assessing exposures, consequences, likelihoods, and costs to understand vulnerabilities, prioritize risks, and develop a portfolio of resilience measures [8]. Similarly, the U.S. Climate Community Resilience Toolkit describes how communities should integrate resilience goals into comprehensive economic development, zoning, mitigation, and other local planning for buildings, public utilities, and infrastructure [9]. Both of these generally mirror utility risk management processes [10]. The commonalities in these planning efforts that span vulnerability assessments and resilience planning present opportunities for coordinated planning among the utility and local governments—bringing together grid resilience and community resilience.

Identifying vulnerabilities and assessing the adaptive capacity of a community involves identifying, mapping, and analyzing demographic, economic, and physical factors [11]. Sample indicators are shown in Figure 2, and mapping these factors across a city, county, or service area could then reveal areas of focus for resilience initiatives and highlight specific or unique needs to be addressed. Analyzing these factors over time can also illuminate the efficacy of plans and efforts and inform their evolution.

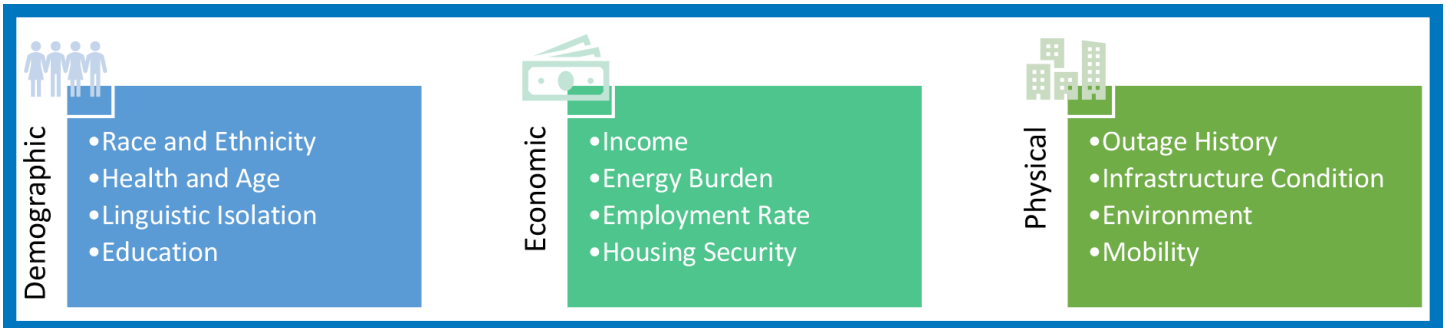

Figure 2. Mapping certain indicators across an area can reveal opportunities to introduce resilience initiatives, show how effective such measures are over time, and indicate aspects that should evolve.

Two federal government screening and mapping tools may be useful for this assessment:

- The Center for Disease Control's (CDC) Social Vulnerability Index (SVI) is a mapping tool that identifies communities that may need support in a disaster [12].
- The Environmental Protection Agency's (EPA) EJSCREEN is an environmental justice screening and mapping tool designed to support protecting public health and the environment [13].

Both use US Census data to map and display vulnerable or overburdened communities. SVI ranks each Census tract on 15 social factors (e.g., poverty, lack of vehicle access, and crowded housing) and groups them into four related themes: socioeconomic status, household composition, race/ethnicity/language, and housing/transportation. EJSCREEN presents three kinds of information: environmental indicators, demographic indicators, and Environmental Justice (EJ) indices spanning air, toxic substances, water, and waste.

Furthermore, understanding the impacts of service interruptions across various communities can illuminate factors to consider in resilience planning. Understanding the economic value of power system resilience is one consideration in decision-making [14]. Additional considerations involve social burden measures designed to assess the interactions between needs, abilities, and the effort of dealing with service interruptions [15]. Researchers are working to integrate customer interruption data and climate impacts into regional economic models to more accurately evaluate the costs of widespread and long-duration outages and the value of resilience as it changes over time [16].

Adding social impact into reliability valuations increases our understanding of equity and resilience. There are a range of needs and essential services that, when lost, become burdens to overcome. Losing power for any length of time can impact needs and services such as light, clean water, communications, safety systems, medicine storage, temperature control, food storage, medical devices, and transportation [17]. The ease with which certain communities and customers can replace these services or fulfill their needs is a function of their capacity and the resources and services available to them (e.g., proximity to stores and transportation, money for food, temporary housing, and places with power and internet from which to work or study). For disadvantaged and vulnerable communities, a lack of these resources can present extraordinarily difficult challenges. Taken together, these considerations may influence grid resilience planning and the resulting technology, programmatic upgrades, and other solutions.

Grid resilience impacts community resilience, and both benefit from integrated planning and collaboration across public, nonprofit, and private entities—entities that include the utility, the city, and the disadvantaged communities. The local government typically coordinates the range of interests related to community resilience, as it is responsible for implementing local codes, statutes, and community plans. The utility and its regulator also play important roles in decision-making and implementing resilience strategies. For example, if a community plans to set up a shelter in a community center, then the utility may plan on reinforcing service to the center or serving the area with a microgrid. Depending on the jurisdiction, such plans and investments in resilience may require regulatory approval.

Opportunities

Resilience planning presents opportunities to support and advance vulnerable communities that can face greater hardships from interruptions in essential services [18] and are particularly vulnerable to effects of climate change such as extreme temperatures [19]. The equitable distribution of the benefits from grid resilience investments depends on how utilities and their regulators shape and implement plans that consider the needs of disadvantaged and vulnerable communities.

In addition to the utility-focused opportunities such as grid modernization, electrification, mobility, energy-efficiency programming, and digital transformation, there are opportunities for non-utility solutions as well, including nature-based solutions (e.g., tree planting), multi-purpose community centers, and alternative provisions for essential services such as housing, groceries, and transportation. The federal government's Justice40 initiative is working to distribute a greater share of benefits to disadvantaged communities, and may provide guidance and lessons learned for utilities and localities [20].

Involving community members in identifying needs and developing solutions that address community priorities may lead to improved outcomes by building trust and increasing resilience. Equating energy system impacts to individual or societal values may include estimating individuals' direct costs and non-financial costs. However, decision-support frameworks vary in their ability to capture these kinds of human, infrastructure, economic, and societal aspects [21].

To address equity and resilience, typical grid-hardening measures (e.g., new hardware and poles, undergrounding, advanced sensors, automated and advanced switching, and alternative or loop feeds for redundancy) may be implemented in disadvantaged and vulnerable communities. Similarly, community-level microgrids, community solar, energy storage, and other distributed energy resources—in addition to electrification, energy efficiency, electric transportation, and digital technologies—may be allocated to disadvantaged and vulnerable communities.

Prioritizing these investments typically factors in the number and duration of outages, loads, and number of customers. Budget and resource availability, as well as any legal or regulatory requirements, also factor into this prioritization. Augmenting this prioritization with equity might include estimates of social burden and related factors such as income strata, mobility, and access to essential services. In practice, including the scope of threats considered, benefits targeted, and decision-makers involved is key to determining which costs and valuation approaches may be most appropriate to support decision making [22]. The resulting decision-making could include weighting these factors together to rank potential projects, or simply evaluating vulnerable communities to assess the distribution of projects that support them.

There may be opportunities for distributed energy resources (DER) and microgrid solutions to address resilience challenges. Potential solutions consider probability, severity, equity of risk, and access to mitigations. EPRI and other organizations have identified several key considerations, including:

- Distributed energy resources technology and asset considerations
- Deployment and interconnection of local energy resources
- Local or on-site control of energy resources
- Incorporation of distributed energy resources into power system planning
- Coordinated control of energy resources and power system to maximize benefit

Examples include battery storage installations at schools and other buildings such as police stations, hospitals, and water treatment and supply facilities [23]; and microgrid installations [24] in facilities used as shelters in the event of an emergency [25]. Additionally, nature-based solutions (such as maintaining and increasing tree cover) can mitigate urban heat-island effects, particularly in vulnerable communities [26].

Conclusion

The issues and opportunities at the intersection of equity and resilience are many and broadly applicable. Vulnerable communities can face greater hardships from interruptions of essential services [27]. Moreover, disadvantaged communities are particularly vulnerable to the greatest impacts of climate change, such as extreme temperatures [28]. Addressing these challenges could positively impact society and advance equity as utilities and local governments invest in and engage with communities. Moreover, governments, utilities and their customers, stakeholders, enterprises in other sectors, and the public can drive more effective and equitable change through collaboration. Lastly, as the economy electrifies and decarbonizes, energy grid reliability and resilience will be paramount; adaptation and reslilience efforts such as EPRI's ClimateREADi are providing a framework for assessing and addressing grid resilience objectives within the broader context of industry priorities, including equity.

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Technology Innovation

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