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THE CASE FOR DISTRIBUTION GRID INVESTMENT

The United States has set a bold goal to create a greenhouse gas emissions-free power sector by 2035 and a net-zero emissions economy by 2050. Massive electrification of transportation and building energy use and a proliferation of renewable energy and distributed energy resources (DERs) are central to the strategy to achieve emissions reductions.

However, the strategies to reduce greenhouse gas emissions aren't being pursued in a vacuum. They have a disruptive effect on the United States electric grid, particularly local distribution grids that are already being tested by more extreme weather.

There's a clear case that distribution grids around the country need increased investment for greater resilience and reliability with the added stresses of electrification, intermittent renewables, and DERs.

S&C Electric Company, a leader in grid resilience, details the scale of underinvestment in the U.S. distribution grid and how it will limit electric reliability and America's pursuit of a resilient, clean energy future. It also outlines a series of practical steps grid stakeholders, such as utilities and state regulators, can take to improve the distribution grid investment gap.

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What the Distribution Grid Needs: Improved Performance, More Investment, Better Preparedness

Distribution grids in the United States tend to share three things in common that have an outsized impact on total electric system reliability and efforts to transition to a clean energy future:

1. They are the location of the vast majority of power outages.
2. Due to myriad reasons, such as their massive, sprawling nature and regulatory and ratepayer pressures, there has been an overwhelming lack of investment in them, dating back decades.
3. Electrification, renewables, and DERs are making them arguably the most critical piece of infrastructure in the electric system, and they are not ready for the job.

The Case for Improved Performance

In its 2023 report "Electricity Grids and Secure Energy Transitions," the International Energy Agency (IEA) noted that the United States is one of four countries in the world where more than 90% of power system interruptions originate in the distribution grid. In the most recent national report of its kind, the Lawrence Berkeley National Laboratory evaluated 2014 system average interruption duration index (SAIDI) data from U.S. utilities and determined that 94% of system interruptions, including major events, originated on the distribution grid.

Table 2 Proportion of SAIDI due to interruptions originating from the bulk power system in year 2014

	SAIDI with major events, %	SAIDI without major events, %	SAIDI major events alone, %
mean	8	7	14
median	4	6	3
customer weighted mean	6	6	8
number of utilities (*n*)	90	90	80

Key takeaway: SAIDI customer weighted mean transmission outages = 6%, meaning distribution outages = 94%.
Source: Lawrence Berkeley National Laboratory

On average, Americans spent eight hours without power in both 2020 and 2021 — roughly double the rates seen in any year from 2013 to 2016. Major blackout events increased by more than 60% from 2015 to 2020.

Looking at 2022 SAIDI data on California's investor-owned utilities released by the California Public Utilities Commission, 88% of interruptions originated from the distribution grid.

	PG&E	SDG&E	SoCal Ed	Pacificorp
Total 2022 INCL MED	283.9	70.39	131.13	1037.1
D SAIDI	240.6	69.48	129.98	608.7
D SAIDI %	84.7%	98.7%	99.1%	58.7%
T SAIDI	43.2	0.9	1.15	428.4
T SAIDI %	15.2%	1.3%	0.9%	41.3%
Total 2022 EXCL MED	213.5	70.39	101.03	126.41
D SAIDI	184.5	69.48	100.29	96.7
D SAIDI %	86.4%	98.7%	99.3%	76.5%
T SAIDI	28.9	0.9	0.74	29.7
T SAIDI %	13.5%	1.3%	0.7%	23.5%

Source: California Public Utilities Commission

The plight of the distribution grid in California is particularly relevant to the United States as the state is well on its way to achieving ambitious renewable, DER, and electrification goals — igniting a fierce debate on the need to invest more in distribution grid modernization to maintain reliability and build resilience in the face of rapid system disruption.

The Case for More Investment

According to the IEA's "Electricity Grids and Secure Energy Transitions" report, only 23% of distribution grid infrastructure in advanced economies like the United States is less than 10 years old, while more than 50% is more than 20 years — in many cases, more than 50 years old. That reality led the agency to state: "There is a growing need to modernize this aging infrastructure to enhance efficiency and reliability and accommodate new energy resources."

Despite steady efforts by utilities to improve distribution grid planning and performance, investments in that portion of the grid appear to be falling short of what is needed nationwide.

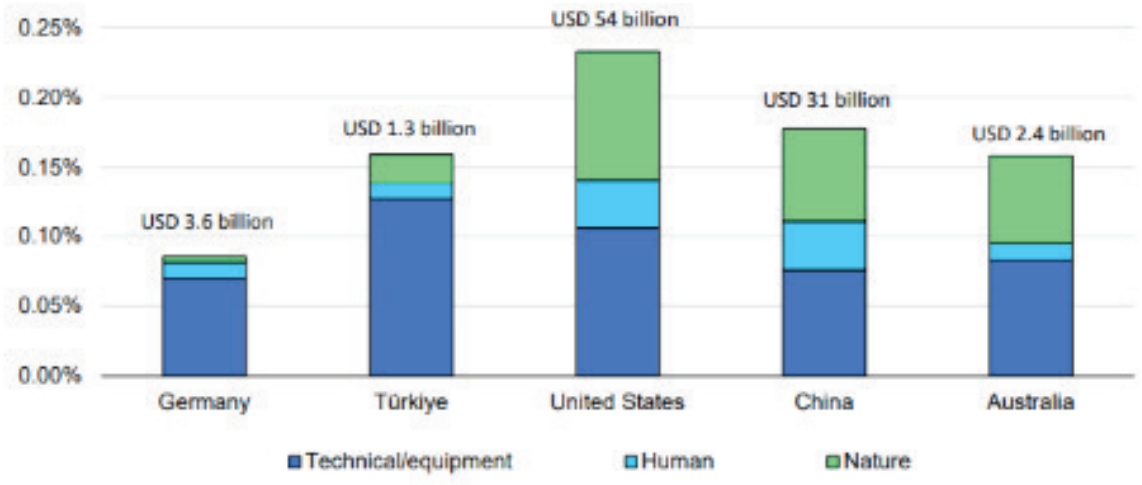
In a recent report, the American Action Forum estimated that preparing the U.S. grid for the coming wave of distributed solar PV adoption and EVs will cost nearly $1 trillion by 2035. That means utilities may need to spend upward of $61 billion per year through 2035 to prepare their distribution grids for solar PV and EVs. In reality, utilities have been spending closer to $30 billion per year in recent years, according to the report.

Many assume that massive electric power system investments approved in the Bipartisan Infrastructure Law (BIL) and Inflation Reduction Act (IRA) will put an end to the underinvestment in the distribution grid. While those funds do more to move the needle, they still fall short. In the BIL-funded $3.5 billion first round of Grid Resilience and Innovation Partnerships (GRIP) Program grants announced by the U.S. Department of Energy in October 2023, only 50% was allocated to distribution improvement projects, with 50% allocated to transmission projects.

Yet, in an era in which more than 90% of U.S. power interruptions originate in the distribution grid, does a 50-50 funding split reflect the system's actual needs?

Distribution grid underinvestment has a significant cost to society. The IEA reports that electric grid-related outages in the United States in 2021 had a $54 billion economic impact, and the vast majority of those outages occurred on the distribution grid.

Estimated economic impact of grid-related outages by cause as a share of GDP in selected countries, 2021



Note: The reasons for outages can be grouped into three main categories: technical failures due to equipment, outages caused by human interference, and outages due to uncontrollable nature-related factors such as weather, animals, trees and natural catastrophes.

The Case for Better Preparedness

Extreme weather is causing an increasing number of power outages in the United States, and climate change is only expected to increase extreme weather events. Electrification is rising in the form of mass adoption of electric vehicles (EVs) and electrified building appliances, such as air source heat pumps and hot water heaters. Tax incentives in the IRA are boosting a rapid increase in both large-scale wind and solar and DERs such as rooftop solar and battery energy storage systems. All those factors — extreme weather, electrification, intermittent renewables, and DERs — put pressure on the distribution grid. They also necessitate a shift from an electric grid designed to serve power in one direction from large, centralized power stations to one designed for distributed, multidirectional power with more complex supply and demand shifts.

Given the shifting reality, a status-quo approach to investment will leave the distribution grid unprepared for the future — prone to decreasing reliability and lacking resilience.

The IEA reports that distribution grids are the element of the power system that is most vulnerable to climate impacts and the leading cause of climate-driven outages in many countries. At a local level, EVs are experiencing rapid growth, yet countless local segments of the distribution grid are at risk of failure if too many EVs start plugging in before upgrades are made.

The IEA also says the electric grid has become a bottleneck for the transition to net-zero emissions, with 3,000 GW of renewable power projects stuck in grid connection queues globally. The IEA points to an unprepared distribution grid as a major cause. "To meet national climate targets, grid investment needs to nearly double by 2030 to over $600 billion per year after over a decade of stagnation at the global level, with emphasis on digitalizing and modernizing distribution grids," the IEA wrote.

Changing the Narrative

Experts agree that both globally and in the United States, investment in the distribution grid needs to double on an annual basis. For utilities facing myriad demands and pressure from customers and regulators to limit rate increases, the idea of proposing such a steep increase in spending can seem daunting.

But doubling spending is not the only answer. Utilities, state regulators, and other distribution grid stakeholders can work together to pursue a multipronged strategy to optimize grid performance, investment, and preparedness to achieve a reliable, dynamic distribution grid of the clean energy future. There are several tactics all utilities should consider developing to execute a successful, multipronged distribution grid planning strategy.

- **Focus on grid hardware:** As there has been increased focus on distribution grid investment, it has flowed toward digitalization efforts,

such as data management systems and digital controls systems. While these investments are undoubtedly an important piece of the puzzle, they should not overshadow the need for investments in distribution grid hardware.

When a storm hits, software cannot keep the system online or return it to service without help. More modern devices installed on the distribution grid allow the system to survive the storm and limit economic impacts on communities. When a highway truck stop wants to install the EV charging infrastructure to enable electrified long-haul trucking, which could spike peak power demand at the site from 250 kW to more than 30 MW, only hardware can prepare the grid to serve that load. The vision for a reliable, clean energy future depends on hardware.

- **Communicate benefits:** Utility customers want to be able to plug in EVs, replace gas heaters with electric heat pumps, and benefit from DERs. As they do so, electricity will become more important to their lives. Utilities should implement a communications plan that clarifies the link between distribution grid investments and achieving customers' desired future. To better communicate with regulators, utilities can update their metrics to reflect the full reality of distribution grid performance. SAIDI, excluding major events, has been a key metric used by utilities and regulators for years. It tells a story about grid performance on blue sky days, but major events such as extreme storms are the new normal. Metrics that reflect the reality of decreasing reliability in the face of extreme weather can help regulators and policymakers understand the value of distribution grid spending, especially when coupled with data showing the negative economic impacts of outages on communities.

- **Continue to innovate:** Meeting the challenges of the future requires innovative technology that will help modernize distribution grids. Utilities can make small bets on innovations through pilot programs, scaling up on innovations that prove to be the most cost-effective. In addition, utilities can pursue alternative means of funding, such as federal grant programs, to limit the cost to customers, plus advocate with policymakers for new funding programs that would best move the needle.

- **Advocate for a national standard on distribution grid resilience:** Industry stakeholders can join together to use their collective voice to push for a federal standard for resilience. The standard could be as simple as measuring SAIDI and SAIFI, including storm days. This baseline requirement would set a minimum level of resilience that must be achieved in any part of the grid and allow flexibility to address different challenges in different parts of the country. A national resilience standard would create a focus on enhancing the grid as a whole, which would spur technology investment down to the grid's edge.

The Distribution Grid Can Be the Best Supporting Actor in the Clean Energy Future

Increasing extreme weather, electrification, intermittent renewable energy and DERs are all putting pressure on distribution grid performance, while simultaneously making the distribution grid more important to the economy and the average citizen's life. At this moment, when the distribution grid is being asked to enable the clean energy future, it needs help to thrive amid those disruptive changes. The case for improved performance, more investment, and better preparedness is clear.

Yet, much of the discourse from the kitchen table to Capitol Hill remains focused on investments in transmission and renewable energy infrastructure. Utilities and grid stakeholders know the focus should be on the distribution grid. It's time to change the narrative and take a more aggressive approach to distribution grid investments so it can play its role as the best supporting actor in the clean energy future.

With over 100 years of grid expertise, S&C Electric Company is focused on empowering the transformation of the grid for the next 100 years. We offer unparalleled expertise, industry-leading quality, and customer-centered innovation. Our technology solutions work with a utility's existing distribution grid infrastructure to automate and upgrade the grid, extending the useful life of equipment and improving resilience and reliability.

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