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RESEARCH BRIEF

Resilient Decarbonization for the United States: Lessons for Electric Systems from a Decade of Extreme Weather

Sohum Pawar

The past decade has seen an unprecedented surge of climate change-driven extreme weather events that have wrought over $800 billion in damage and taken more than 5,200 lives across the United States — a trend that appears poised to intensify. At the same time, the need for a large-scale effort to decarbonize the U.S. electric power system has become clear, along with the growing climate risks and impacts that any such effort will face.

In a new Working Paper, Sohum Pawar argues that the principles of resilience can play a valuable role by enabling the decarbonization of the U.S. electric system, in the face of the escalating risks and impacts of climate-driven extreme weather. His research results also offer lessons for addressing weather-induced electricity grid failures such as those recently witnessed in Texas in February 2021.

The Working Paper seeks to inform present and future resilient decarbonization efforts by examining the lessons of the past decade of extreme weather, and its impact on electric systems in the United States. To do so, it considers three cases:

- Hurricane Maria, which struck Puerto Rico in 2017, causing the world's second-largest blackout;
- The 2017-2019 Northern California wildfire seasons, which sent the nation's largest investor-owned-utility into bankruptcy and remain the most devastating on record
- Superstorm Sandy, which served as a wakeup call for the New York/New Jersey region, when it made a sudden left turn towards the region in 2012.

Pawar finds that resilient decarbonization, while a challenging process to set into motion, does in fact meet its dual mission of protecting electric systems against growing climate risks, while enabling their decarbonization. In his research, Pawar also examines the ways in which electric system institutions take climate risks into account, the strengths and weaknesses of resilience-based measures for electric systems, and overarching questions about the role of electricity and electric utilities in American society today.

Foundation: Decarbonization, Climate Risk, & Resilience

Before diving into the cases, Pawar first establishes three key pillars that form the foundation of the concept of resilient decarbonization: the need for decarbonization, the growing climate risks to the U.S. electric system, and the notion of resilience.

He first considers the need for decarbonizing the electric system. After examining the progress to date, the Working Paper highlights the estimated massive scale of infrastructure expansion that decarbonizing the U.S. electric system will require — on the order of 2 TW of generation and a more than doubling of transmission capacity.

Pawar then draws on climate data to examine the growing climate risks the U.S. faces, and the impacts those could have on a decarbonized, expanded power system. By comparing metrics of historical vulnerability to environmental risk with the geographies that will likely be major sites of electric system expansion and investment, he finds that the most vital regions are also the ones that have historically faced the greatest risk — an intuitive result of having a massive, nationwide electric system.

That means that any effort to decarbonize the U.S. electric system will require building gigawatts of new infrastructure in harm's way — regions that are known to face current and future climate change impacts. Pawar's analysis examines which impacts matter most, recognizing that extreme weather events cause the overwhelming majority of weather and climate-related damages in the U.S., and that they have accelerated in intensity at an alarming rate over the past decade, and indeed, over just the past three years.

And finally, the Working Paper identifies the principle of resilient decarbonization as a potential solution to this conundrum. To this end, Pawar highlights the potential value of resilience — a focus on the proactive, risk-informed design of systems that can gracefully fail in the face of overwhelming impacts, in order to minimize damage and facilitate an effective recovery. Pawar argues that resilience can not only help ensure that the electric system is better equipped to handle the risks of climate-driven extreme weather, but also enhance and enable its decarbonization.

Lessons from a Decade of Extreme Weather

Building on the foregoing foundation, Pawar proceeds to look back over the past decade, to see what lessons can be gleaned from three of the most devastating extreme weather events on record.

First, he considers Hurricane Maria, which blazed a path across Puerto Rico in September 2017. In its wake, Maria left 3,000 dead, completely destroying the Puerto Rican electric system and causing the second largest power outage the world has ever seen. Pawar examines how a legacy of legal loopholes, financial missteps, and the systematic second-class status accorded to U.S. territories weakened the commonwealth's institutions. He also examines the series of events that led up to the blackout, and follow the island's slow, halting recovery.

In the wake of Hurricane Maria, Pawar examines how Puerto Rico's financially crippled utility and government lacked the capacity to recover effectively from the unprecedented level of devastation wrought upon its electric system — and notes that it was the most socioeconomically vulnerable parts of the population that bore the brunt of the loss of life that resulted. However, his research also affirms the remarkable effort at realignment that PREPA and the commonwealth have made in the years since, centering their entire electric planning philosophy on the concept of resilient decarbonization, by pushing for grid isolation capabilities that can also enable the deployment of more solar generation and battery storage. But in the wake of a series of earthquakes that have struck the island this year, he notes that Puerto Rico's plans still have a long way to go.

Next, Pawar examines the 2017 and 2018 Northern California wildfire seasons, and the Camp Fire — the deadliest wildfire in California history. He begins by following the stories of the two most destructive wildfire seasons the state has ever seen, before diving into the story of the Camp Fire, and the events that precipitated it. Pawar's Working Paper considers how an increase in climate-driven wildfire risk (among other factors) has threatened – and continues to threaten – Northern California, before turning to the other key figures in these fires: the Pacific Gas and Electric Company, whose electrical equipment caused eighteen of the most destructive fires over the past three years, and the regulators charged with overseeing them.

In Northern California, Pawar's research leads him to assess the role of PG&E: a utility so busy trying to juggle its past missteps and its future decarbonization efforts, that it allowed the presently growing risk of extreme, climate-driven wildfires to catch it unawares — as it did the regulator, CPUC.

Pawar examines the decades-long chain of priority whiplash that led both organizations to neglect safety and maintenance, leading to the most devastating wildfire seasons California has ever seen. In the aftermath of the Camp Fire, he examines how mounting legal liabilities under California's unique doctrine of inverse condemnation sent PG&E into bankruptcy — placing billions of dollars of renewable power purchase agreements at risk.

But from there on out, Pawar's analysis reveals a profound change in orientation. As it sought to emerge from bankruptcy, PG&E appears to have thrown itself headfirst into its Wildfire Mitigation Plan and system resilience efforts. And the state government created the Wildfire Fund, a novel financial mechanism designed to shield utilities from the runaway liabilities that brought PG&E to its knees, while still trying to maintain some modicum of accountability. In the aftermath of the relatively mild 2019 fire season, aided by PG&E's Public Safety Power Shutoffs, Pawar finds that while the utility met the test of resilience on a technical level, plunging millions of Californians into the dark, in order to avoid burning down large parts of the state, can hardly be considered true resilience.

Third, Pawar's research takes him back to 2012, when Superstorm Sandy made an unexpected left turn towards New York and New Jersey, to understand how that surprise storm has served as a remarkable catalyst for resilient decarbonization After examining the events of the storm, its impact on the two states' electrical systems, and the subsequent recovery efforts, Pawar considers the climate-driven strengthening of Atlantic hurricanes that Sandy foreshadows.

He observes how basic storm hardening measures proposed in ordinary rate cases morphed into full-fledged resilience programs, and notes the first-of-a-kind order issued by the New York PSC, which turned the old-fashioned ratemaking process into a regulatory force for resilient decarbonization. In his Working Paper, Pawar therefore previews how those investments in resilience have become the foundation of a whole new generation of multi-decadal plans for resilient decarbonization.

Lessons for Resilient Decarbonization

Looking across all three of these cases, Pawar's research identifies three major categories of lessons for resilient decarbonization: those about the risks we face, those about the role of resilience, and those that encourage us to reimagine our electric systems.

He notes that climate risks and impacts can no longer be ignored, as they exacerbate a multitude of existing vulnerabilities by amplifying extreme weather events. He also examines the legal and financial risks of climate change, both as tipping points to be wary of, and as opportunities to exploit an information asymmetry in support of resilient decarbonization.

Turning to the role of resilience in electric systems, Pawar's findings lead him to conclude that it not only offers tangible protection against the growing risks of climate-driven extreme weather, but also serves to enable and catalyze decarbonization efforts. He finds that crises like devastating hurricanes and wildfires can serve as powerful vehicles for transformative change if there is sufficient institutional capacity present, but can prove overwhelming in its absence. While resilience may be a buzzword, Pawar finds that its components decidedly are not, and that neglect of essential functions like maintenance and safety has led to many of the crises examined in the Working

Paper.

Admitting that resilience is far from a silver bullet for the inequities that Pawar's research has highlighted, he nevertheless contends that resilience can help cushion the blows of extreme weather events for those communities and populations that are already the most vulnerable to them. And while stopgap measures may have been accepted as a necessary tool, he cautions against letting such interim measures become locked-in.

Pawar then takes a step back, and noteds that in many cases, proposing radical, likely unrealistic proposals that challenges the status quo of an electric system can help jolt a stagnant bureaucracy or a stalled conversation, helping enable tangible progress towards resilient decarbonization.

And finally, Pawar questions the incentives that drive the generation, transmission, distribution, and sale of electricity — a commodity upon which our lives so firmly depend in this day and age — and posits that short-term financial drives are, in many cases, crowding out long-term public goals.

Lessons for resilient decarbonization

1. Climate risks and impacts are not black swans
2. Climate impacts make the bad, worse: loss amplification & compound risks
3. Legal & financial climate impacts: tipping points & potential opportunity
4. Resilience offers tangible protection against extreme weather
5. Climate resilience can enable and catalyze decarbonization efforts
6. Is a crisis a terrible thing to waste? It depends
7. Harness existing regulatory processes, but do it early
8. Resilience is a buzzword, but its most important elements are not
9. Resilience is not a silver bullet for inequality
10. Stopgap measures will likely play a role, but beware lock-in
11. Ambitiously questioning the status quo can catalyze tangible progress
12. Electric mismatch: short-term financial incentives vs. long-term public goals

Resilient Decarbonization Challenges for a New Decade: Texas

While the Working Paper focuses on the past decade of extreme weather impacts on power systems, this new decade has already provided a fresh example of how a lack of resilience to extreme weather can cripple an electric system — and a reminder of the challenges of building that resilience in the face of an uncertain future.

It seems fair to say that the historic cold wave which swept across the U.S. in mid-February of 2021 hit the Texan electric system harder than any other. By the end of it, over 4.5 million Texans served by the state's electrical grid — famously designed to minimize interconnection with the rest of the nation (and thus, federal regulation) — had been left without power for days.

While the cause of the outages are being scrutinized by state and federal regulators, as well as the Texas Legislature and U.S. Congress, a few key drivers already appear clear. Cold weather that exceeded the Texas grid operator's most extreme winter planning scenario led to an historic spike in electric-heating-driven power demand, just as record amounts of generation (primarily thermal natural gas plants, as well as coal, wind, and even nuclear units) were going out of service as instrumentation, equipment, and even the wellheads and pipes supplying them with natural gas froze up. The resulting supply/demand imbalance reportedly put the grid just "minutes" away from a total system failure that could have led to much longer outages, forcing grid operators to preemptively impose outages.

Even from just the facts that are known now, a few lessons for resilient decarbonization are clear. First, as in California, NY/NJ, and Puerto Rico, this was no black swan event. While it clearly exceeded the planning of the Texas grid, a 2011 FERC report warning of the need for winterization in the wake of another disruptive cold snap shows that this was a recognized risk.

If so, why was it not acted upon? Again, the (for now, still metaphorical) jury remains out. But a few key elements still seem evident. As the failure to weatherize appears to show, private incentives alone were not sufficient to achieve public policy aims of reliability. And policymakers' failure to mandate such efforts highlights — just as we saw in California and NY/NJ — that while regulatory processes can serve as key forcing functions for resilience, they can just as easily lag behind on urgent needs.

More broadly, the events in Texas reinforce the need for greater systemic resilience in electric systems — both as a ward against extreme weather to come, but also as a prerequisite to effective decarbonization. Electric systems like Texas's (and California's, NY/NJ's, and Puerto Rico's) have been designed, built, and operated largely based on historical assumptions. But for a whole host of reasons (climatic and otherwise) those assumptions are beginning to break down — and we must take steps to plan and respond accordingly.

The Working Paper highlights the question of "a crisis wasted" — the idea that the aftermath of a disaster can serve as powerful motivation for transformative change, or send us into a defensive crouch, depending on the institutional capacity at hand. What lessons we draw from the Texas crisis remains to be seen — and remains up to us.

References

Pawar, Sohum (2021), "Resilient Decarbonization for the United States: Lessons for Electric Systems from a Decade of Extreme Weather." MIT CEEPR Working Paper 2021-004, February 2021.

About the Author

Sohum Pawar is a proud MIT, CEEPR, and Roosevelt Project alum. He currently serves as a lead policy advisor on climate/energy, cybersecurity, and homeland security for U.S. Representative Elissa Slotkin of Michigan. He is focused on building resilience against climate and cyber threats to U.S. critical infrastructure — a challenge he has explored at the White House, Department of State, EPA, a cyber threat intelligence firm, and an advanced nuclear reactor startup. Sohum received an M.S. in Technology and Policy from MIT in 2020, and an A.B. in engineering sciences, environmental science and public policy from Harvard University in 2018.