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Redefining the power industry

Quick takes on the pressures posed by climate change—and potential responses.

The demands of a changing climate are starting to affect how many businesses operate, from attempting to tamp down their carbon emissions and ramp up energy efficiency, to adjusting to new risks caused by violent weather. Electric utility companies in the United States are no exception.

Here, we offer four quick takes on the changes in store for the power industry. In the first two, we size up the rising peril to utility assets and show how one US state is aspiring to meet new, tough clean-power mandates. Then we look at the potential of residential batteries and how they might buttress the industry's stressed-out grids.

Finally, we tap the ideas of one expert who warns that climate change may be shifting the economics of long-term infrastructure investment. Power suppliers and many other businesses will need to be much more resilient in this changing environment.

1 Investing in grid resilience

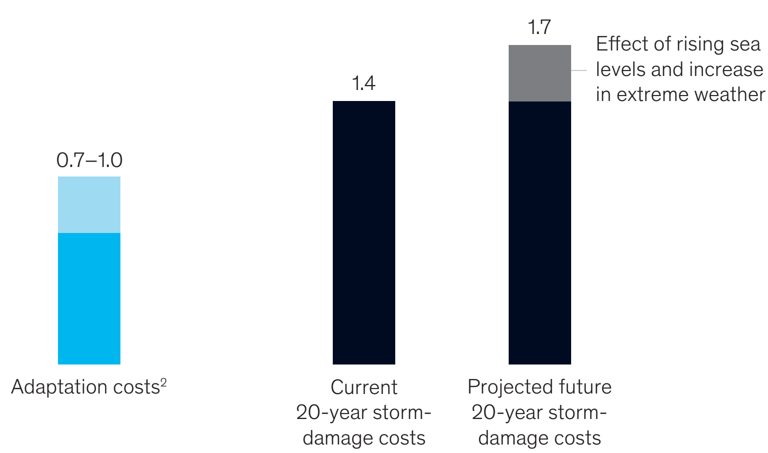
Strengthening utility infrastructure could help offset the effects of violent weather.

Extreme weather has begun exacting a high cost to life and property, and the price is likely to get steeper. The utility industry in the United States has already felt the effects on its operations. The industry's business model calls for investments in long-lived assets, often in relatively risky locations. Consider that many of the more than 8,600 power plants in the United States were deliberately sited near shorelines in order to have access to water; thus, when hurricanes rage, power plants can face significant damage from flooding. The costs and risks have only increased as more homes have been built in areas prone to flooding or wildfires and power-industry assets have followed them.

We examined the financial records of ten large power companies in seven US states where hurricanes are common, as well as in New Jersey, where the coastal population is dense. A typical utility in these zones has experienced storm-damage costs totaling $1.4 billion over the past 20 years. We estimate that those costs will grow considerably in the next 30 years, based on forecasts of more severe weather and rising sea levels. We also found that investments to make assets more resistant to climate effects would significantly insulate companies from future damage and risk—and would more than pay for themselves.

Taking action on resiliency can be cost-effective, especially when climate-change risks are taken into account.

Adaptation costs compared with 20-year storm-damage costs[1] for a typical utility in southeastern United States, estimated, $ billion



[1] Storm-damage costs include lost revenue (currently $0.1 billion), in addition to damage repair.
[2] Adaptation involves "hardening the infrastructure," ie, reinforcing the transmission and distribution infrastructure.

Source: Energy Information Administration; National Climate Assessment; utilities' financial statements

To prevent or reduce damage from violent weather, the power industry will need to invest in hardening its grids, thereby making transmission and distribution infrastructure stronger and more resilient. One intriguing option is to build “microgrids,” with locally controlled power loads, and distributed plants that create power resources that can function apart from today’s more centralized grids. Another move, which we’ll discuss more in depth later, is greater use of battery storage to provide local pools of power during unexpected outages.

“Climate change creates new risks and exacerbates existing vulnerabilities in communities across the United States, presenting growing challenges to human health and safety, quality of life, and the rate of economic growth.”

For more, see “Why, and how, utilities should start to manage climate-change risk,” on McKinsey.com.

From the Fourth National Climate Assessment *report, on globalchange.gov.*

About the authors

Sarah Brody is a consultant in McKinsey’s Washington, DC, office; **Matt Rogers** is a senior partner in the San Francisco office, where **Giulia Siccardo** is an associate partner.

The authors wish to thank Romina Mendoza and Jinchen Zou for their contributions to this article.

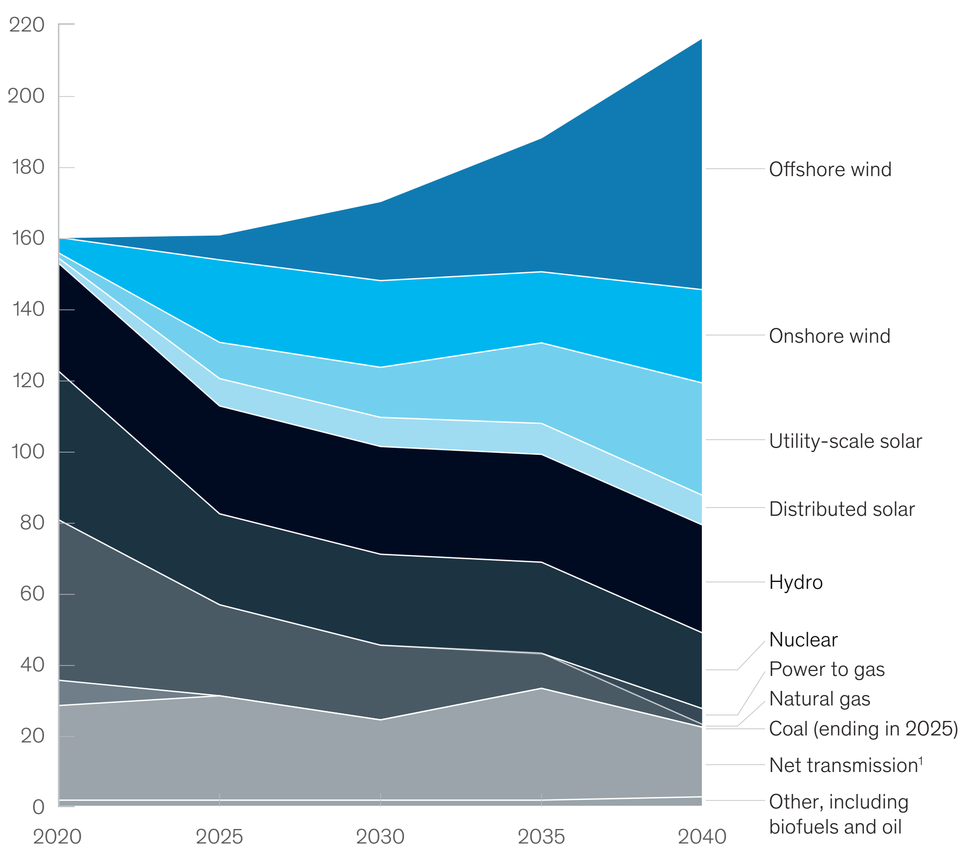
2 Managing clean-power mandates

New York plans to reduce greenhouse-gas emissions sharply, and utilities could be the foundation for greater electrification of the state's economy.

A number of US state governments have unveiled 100 percent clean-power targets, requiring dramatic shifts in the composition of power grids. The scope and aggressive timetables of New York's plan make it a good case study of the management challenges facing the industry. The state's Climate and Community Protection Act calls for 70 percent renewable-energy production by 2030 (up from 26 percent now, of which more than 80 percent is hydroelectric) and 100 percent zero-emissions electricity (including hydropower and nuclear) by 2040. It also targets a cross-sector reduction in greenhouse-gas (GHG) emissions of 40 percent by 2030 and 85 percent by 2050 (compared with 1990 levels).

By 2040, more than 60 percent of New York State's electricity may come from wind and solar power.

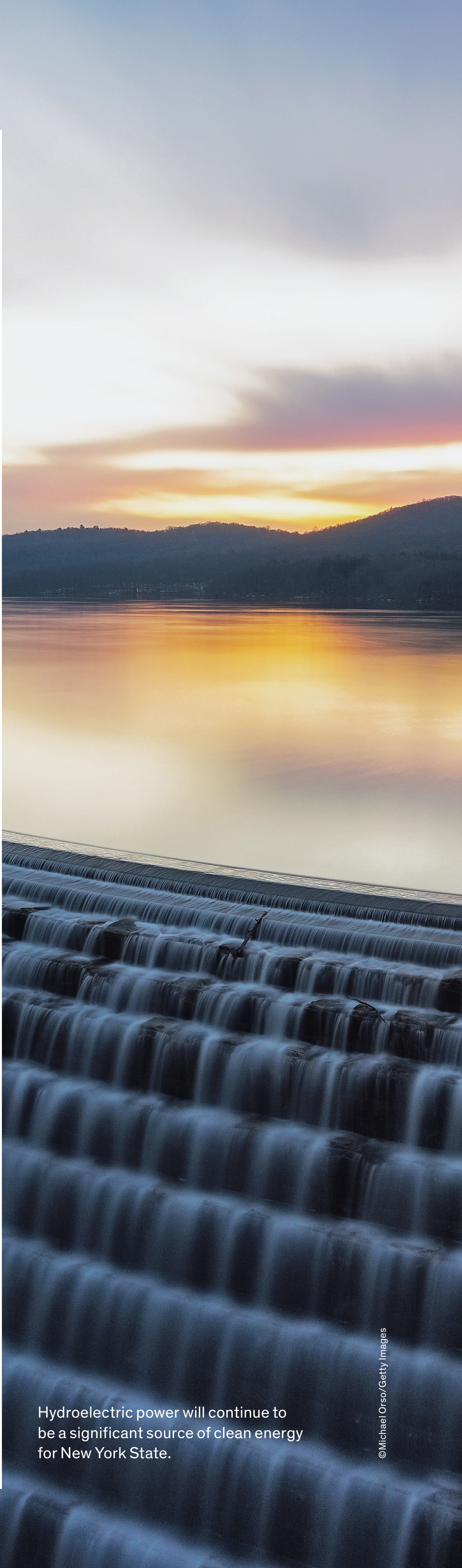
Projected electricity generation 2020–40, terawatt-hour (TWh)



[1]Sum of power supplied from outside the state (from other states and Canada) via the grid minus New York State's sales of power to other states.

To gain insights into the investments and system changes that are needed to meet the timetable, we created a model of New York's plan. We forecast that wind and solar power would largely replace conventional fuels and provide much of New York's electricity by 2040 and explored the implications. Significantly, reducing power generation to zero GHG emissions wouldn't meet the state's broader goals, since power accounts for only 17 percent of total GHG emissions. It would require greater electrification of the entire economy of New York—and likely require a shift to electric vehicles and electric heating for many residential and commercial properties. For utility leaders, that would mean developing new approaches to serving customers. Another twist: our model projects that electrification would increase power demand by one-third by 2040, a big change that would follow a period of flat or declining demand.

According to our model, the industry's operations will require adjustment as well. The grid will need to become more robust and adaptable as the use of wind and solar power grows. One reason is that renewables cannot supply power 24/7, so a variety of options will be needed, including hydro and natural-gas facilities, and storage, to ensure grid reliability. This raises the question, however, of how gas fits into a low- or zero-emissions context. It may be possible to deliver net-zero-emissions gas at scale through power-to-gas technology.[1] It has been proved to work, but costs would need to drop considerably for it to be deployed on a large scale.



Hydroelectric power will continue to be a significant source of clean energy for New York State.

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[1] In power-to-gas technology, excess power—often from renewable sources—produces hydrogen from water via electrolysis, which can be combined with CO_2 emissions from industrial sources to create methane, the major component of natural gas. This "zero emissions" gas is used to generate electricity.

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Bioreactors filled with green algae that capture CO_2 are one method power companies use to help reduce emissions from flue gases.

Decreasing the energy intensity of economic activity is a starting point to fighting climate change.

For more, see "The decoupling of GDP and energy growth: A CEO guide," on McKinsey.com.

Batteries that can store renewably generated energy could help manage the new stresses on grids and balance supply and demand. Although storage is evolving and getting cheaper, it will not save the day by itself. To provide flexibility during the transition to renewables, other avenues need to be explored, including increased energy efficiency, new approaches to demand response and management, and evolving technologies such as those linking vehicle batteries to the grid. New York's climate, which swings between hot summers and harsh winters and causes demand to spike sharply, adds to the challenge.

New York's goal is ambitious, and reaching the last 10 to 20 percent of power-sector decarbonization, in particular, will be difficult. It will require extensive efforts across sectors (including power, transportation, industry, and building heating), successful bets on technology, and complex policy changes that use market incentives, build customer acceptance, and assure electrical interconnections with adjacent regions. We estimate that new generation and storage—along with associated transmission interconnections—could cost $30 billion more through 2040 than a system with no decarbonization targets.

For more on the authors' model of New York State's plans, see "The global relevance of New York State's clean-power targets," on McKinsey.com.

About the authors

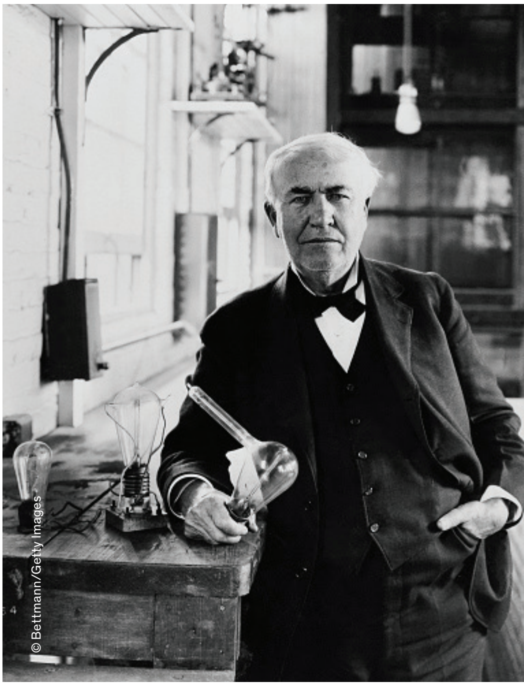
Rory Clune is a partner in McKinsey's Boston office, **Jesse Noffsinger** is a solutions manager of McKinsey's Power Solutions and is based in the Seattle office, and **Humayun Tai** is a senior partner in the New York office.

3 Embracing residential battery storage

Networks of residential batteries could provide backup power and help utilities manage challenges to the grid. Home storage is becoming more attractive to consumers as well.

Battery packs the size of a couple of suitcases and mounted on a garage wall could be one answer to the growing strains on utility grids. The infrastructure of the US industry is aging, and governments are placing new demands on electricity networks with mandates for wind and solar power. Meanwhile, households are installing "behind the meter" energy-storage systems, which help homes control energy costs and keep the lights on during grid outages. Aggregating millions of these systems could eventually help the power industry manage the richer mix of renewables and provide many more customers with distributed backup electricity when systems go down (increasingly likely as global warming makes for more damaging, unpredictable weather). And household systems could become assets for modernizing and fortifying the grid sooner than many expected.

Residential batteries are gaining ground with consumers. Annual installations in the United States jumped from 2.25 megawatt-hours (MWh) in 2014 to 185 MWh in 2018, and we estimate they could exceed 2,900 MWh in 2023. Battery prices have fallen by more than 15 percent annually in recent years, and customers can recoup some of the cost by using stored energy when the price of grid power is high, thereby saving money on electricity. The power industry is also ramping up incentives: in Massachusetts, Rhode Island, and Vermont, companies pay customers to feed home power back into the grid with "bring your own battery" programs. California offers incentives of up to $2,500 for residential storage systems. Not surprisingly, the rising incidence of severe weather—which undercuts grid reliability and increases the



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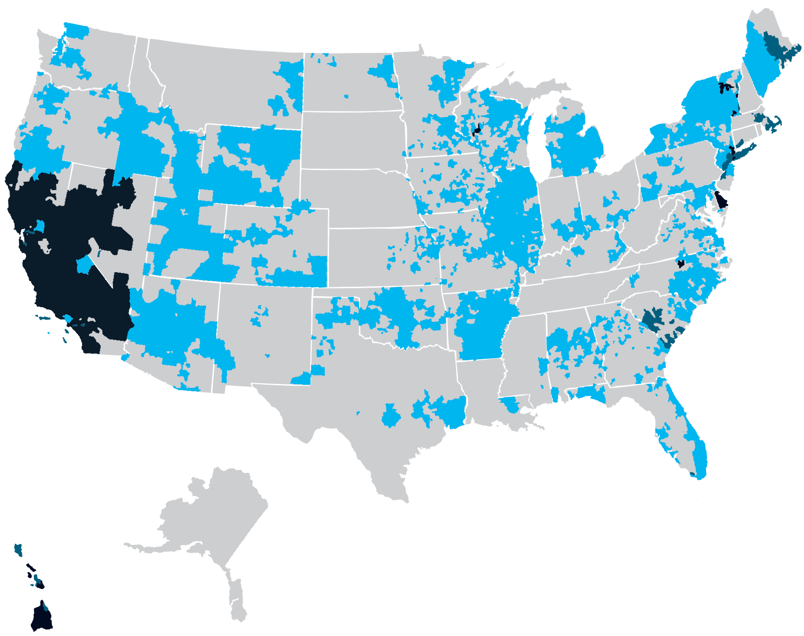
Early on, Thomas Edison envisioned electric power as a decentralized asset, distributing electricity via what today are known as "microgrids."

For more, see the T&D World *article "A short history: The microgrid," on tdworld.com.*

Grid capacity and reliability requirements make residential energy storage attractive for more than 20 percent of US customers today.

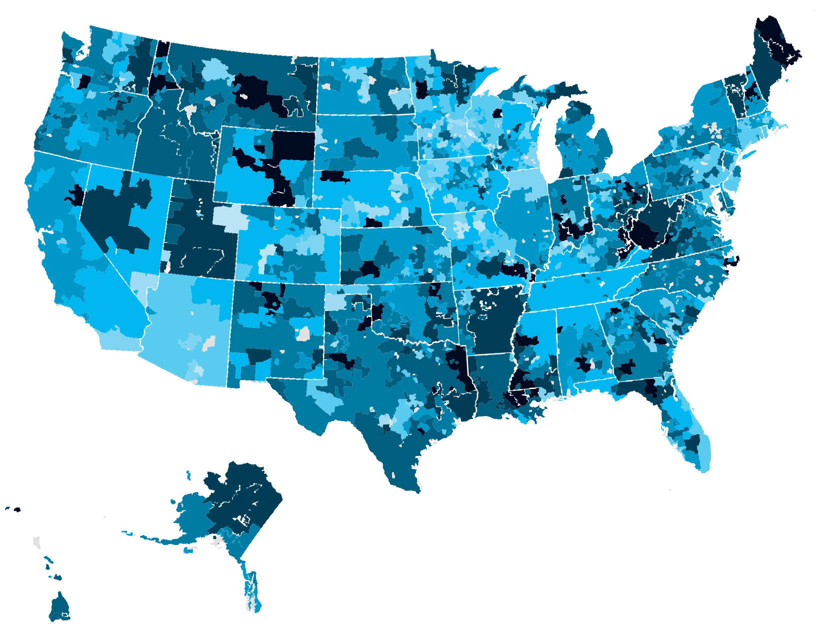
Potential value for residential customers based on grid capacity

Profitable today | Nearly profitable | Not yet profitable despite existing time-of-use rates | Not yet profitable—few or no time-of-use rates



Battery attractiveness for residential customers based on grid reliability

Batteries **less attractive;** grids more reliable — Batteries **more attractive;** grids less reliable



Source: OpenEI Utility Rate Database

odds of power outages—is giving a further push to demand. Every time a major power outage hits, battery-installation rates increase sharply, and that's particularly true in storm-affected states such as California, Florida, and Texas. All these factors have made residential systems attractive to a substantial number of US households today.

For utilities, it's possible to link together residential batteries to help balance supply and demand, easing local bottlenecks and providing backup power during outages. With an array of local batteries in place, the marginal cost of dispatching home power could be quite low.

A few issues will have to be addressed first. Consumers need to be fully convinced that they can still rely on their own batteries when sharing them with utility networks. The power industry, meanwhile, must design incentives in ways that encourage households to install batteries—particularly households in areas where the stored power would best help manage supply and demand. Utilities also need to be assured that technologies for aggregating residential energy-storage systems meet exacting regulatory demands for reliability and can do so over many years. These hurdles will likely be overcome, allowing residential storage to become a permanent resource to keep grids humming.

For the full article, see "How residential energy storage could help support the power grid," on McKinsey.com.

About the authors

Jason Finkelstein is an associate partner in McKinsey's San Francisco office, where **Matt Rogers** is a senior partner; **Sean Kane** is a partner in the Southern California office.

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4 Needed: Newer, better infrastructure

Spencer Glendon, a senior fellow at Woods Hole Research Center, discusses the importance of incorporating the effects of climate change into long-term business decisions.

Over the past five years, Houston has seen a couple of 1-in-500-year events and a couple 1-in-100-year events. Actually, the city hasn't experienced a period of time that *didn't* have an unusual event. So what was unusual then has become more common, and what is unusual now is much more extreme than what came before.

One of the trickiest parts about incorporating climate change into your thinking in business, or in government, is that it's not a one-time change that we're adapting to. It's moving out of stability into permanent instability. And so the duration of any decision becomes more complicated. The people who need to be caring about this most practically are those making long-term decisions. The best example of this is the building of infrastructure. We actually know that there are different grades of road quality and different grades of rail quality and different grades of electricity-equipment quality. And everywhere in the world, the providers of those things optimize for some mix of expected reliability and cost. And everywhere in the world, some of those expectations are being revealed as inaccurate. In some cases, this inaccuracy is currently inconsequential, while in others, people are already living with infrastructure that is simply wrong.

If you were to go back and replan, you would have optimized differently. So the question is, how do you optimize now when you put new infrastructure in place? And the answer is you need much more engineering than you needed before, because any long-lived asset will now go through phases when it exists in essentially different climates. That's a big change.

About the authors

Spencer Glendon is a senior fellow at Woods Hole Research Center. This is an edited excerpt of an interview with Glendon conducted by **Simon London,** a member of McKinsey Publishing who is based in McKinsey's Silicon Valley office.