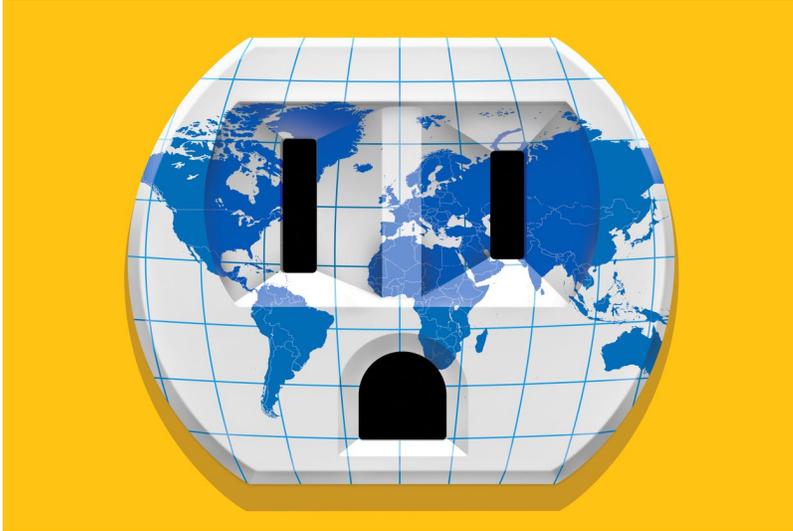


JOURNAL REPORTS: ENERGY

The Electrification of Everything: What You Need to Know

More of the energy we use will come from the electric socket. And we aren't ready.



The electrification of a lot more stuff is happening, whether we've made a conscious decision to do it or not.

ILLUSTRATION: DOUG CHAYKA

By [Amy Myers Jaffe](#)

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If you've lost power anytime recently, you've come face to face with one of the fundamental truths about energy today: There are a lot of things we once could do without electricity that now require it.

You've also come face to face with one of the hottest, and most poorly understood, buzz phrases in energy—the “electrification of everything.”

The concept, most simply put, is that more of the energy we use will come from the electric socket. Instead of having fuels like natural gas or oil or gasoline flow directly into

our homes, offices, manufacturing facilities and cars, those fuels—and other sources of energy—will increasingly be converted to electricity first.

The idea is being pushed by several groups with a vested interest in seeing it happen—most notably, environmentalists and the tech industry. But in some sense, consumers have already made the choice to move toward at least the “electrification of a lot more things,” if not everything. That’s because our smartphones and computers and all the other devices that attach to them require electric power. So electrification is happening, whether we’ve made a conscious decision to electrify or not.

And that trend will only accelerate. The Biden administration’s infrastructure bill, for instance, has set aside \$174 billion for electric vehicles and related public charging stations. An additional \$100 billion is allocated to bringing broadband to those who currently lack it. In California, electric heat pumps are gaining traction as more than 26 of the state’s counties and cities have enacted bans on natural-gas hookups in new construction. Other places have done the same, and there’s no doubt many others across the country will follow.

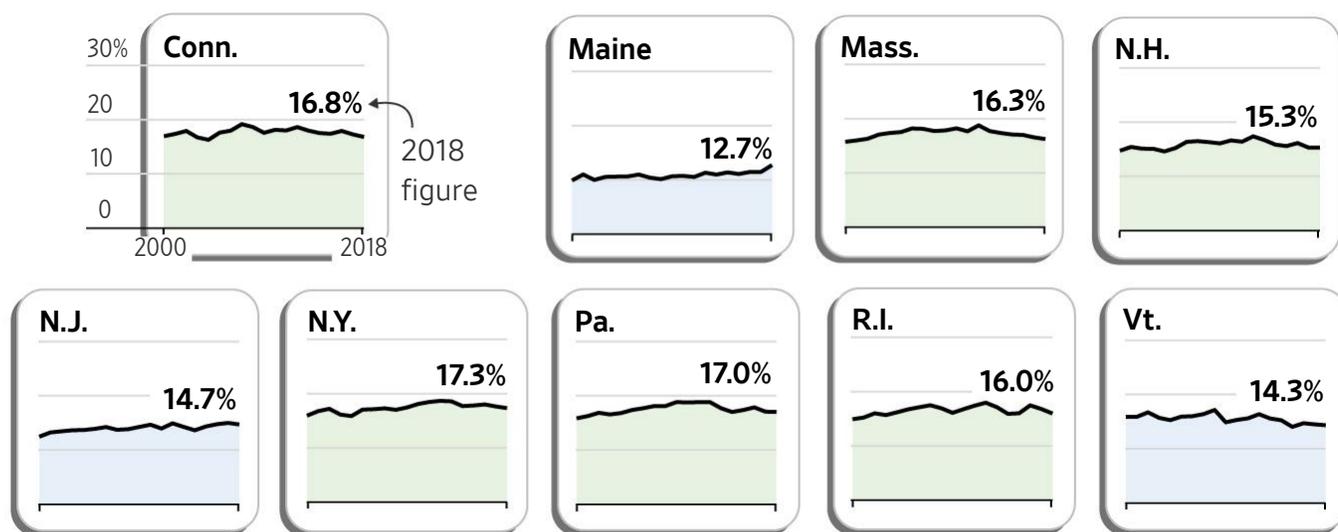
In total, according to a study from Princeton University, electrifying nearly all transport and buildings could contribute to doubling or more the amount of electricity used in the U.S. by 2050. That would lift electricity’s share of total energy used to close to 50% from about 20% today.

But while the idea of such a radical transformation of our energy system is a simple one, it raises a host of complex questions. Among them: What are the implications of getting from here to there? What are the possible benefits? What are the possible risks? And if this change is inevitable, what should we be doing to prepare for it?

Because here’s another fundamental truth about energy today: The electrification of (almost) everything is coming, and we’re just not ready for it.

Plugging In: The Northeast

Homes, businesses and other sectors are drawing more of their energy from electric sources, rather than from fuels used in furnaces and combustion engines. Here's a look at electricity's share of total energy use in the Northeastern states.



Source: Energy Information Administration

We better upgrade the grid, quickly

If we're going to rely much more on electricity, we need to know the grid isn't going to break down. Right now, we don't know that, even for today's level of demand. Sections of today's grid were built in the 1950s and 1960s and are approaching end-of-life conditions. The 2019 wildfire crisis in California, for instance, highlighted how much of PG&E's PCG thousands of steel electricity towers needed to be repaired or replaced.

Over the past decade, the number of U.S. electricity outages has doubled. There is a long list of culprits—from high winds toppling tree limbs to wildfires to ice storms to aggressive squirrels.

The Biden administration recently said it plans \$8 billion in new high-voltage transmission lines, along with other grid improvements. That's a start. But to truly reduce the risk of electrifying everything, we also need to think differently about making power disruptions less likely.

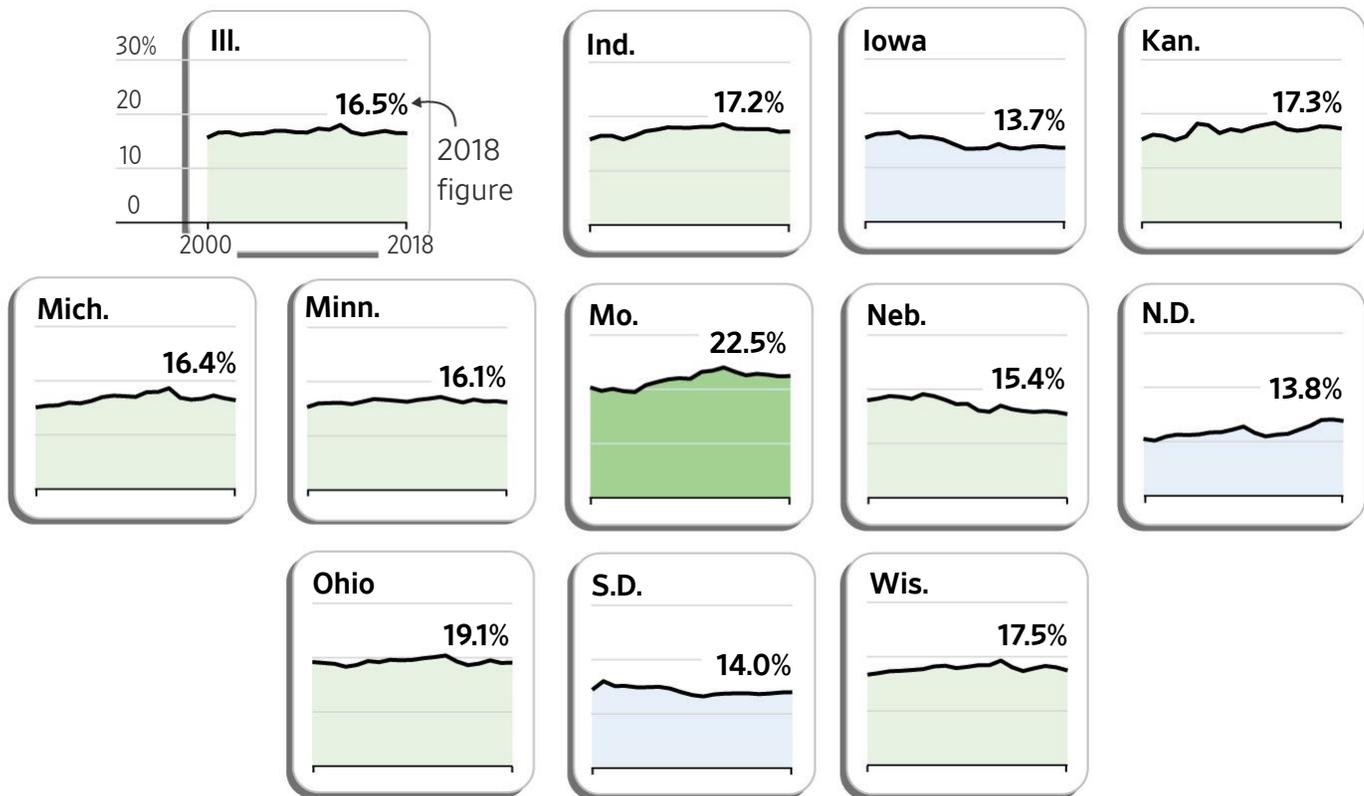
One approach is to strengthen grid backup systems. Much the way the U.S. and its allies created strategic oil stocks after the 1970s oil crises, it's time to reassess how electricity backup reserves can be bolstered to eliminate brownouts and blackouts. Then when demand surges suddenly in a heat wave, or when the wind stops blowing unexpectedly,

there can still be enough electricity available from backup power to meet total demand without cutting service to customers.

That's particularly important in places where current reserve systems are known to be insufficient, such as Texas, where the recent deadly electricity crisis offered a preview of what could happen if we don't plan for this new electrified future.

The Midwest

Electricity's share of total energy use in Midwestern states.



Source: Energy Information Administration

With electricity, strategic reserves can be built in two ways: holding surplus power-generation capacity on standby, or expanding some form of electricity storage such as batteries, pumped water or air, or hydrogen. For standby power, the local system operator would pay a utility or another kind of supplier a continuing fee to maintain backup generation that can be called upon to replace or supplement everyday operations when needed.

As for storage, in past decades, it has been almost impossible to create economically viable storage solutions for electricity; instead, utilities opted for controlled interruptions in service, either via shifting electricity away from interruptible contracts, where customers agreed to be turned off in exchange for cheaper rates, or by engineering

rolling blackouts where service is cut in a staggered fashion across a geographical area. However, recent breakthroughs in the costs of industrial-size batteries and other technologies are positioning storage as an effective solution and a key enabler of the electrification of everything.

Your home as an island of power

As the electrification of everything takes form, more consumers—aware of the increasing downside of losing power—will want a higher degree of control over their own electricity supply. New technologies are creating the ability to go it alone.

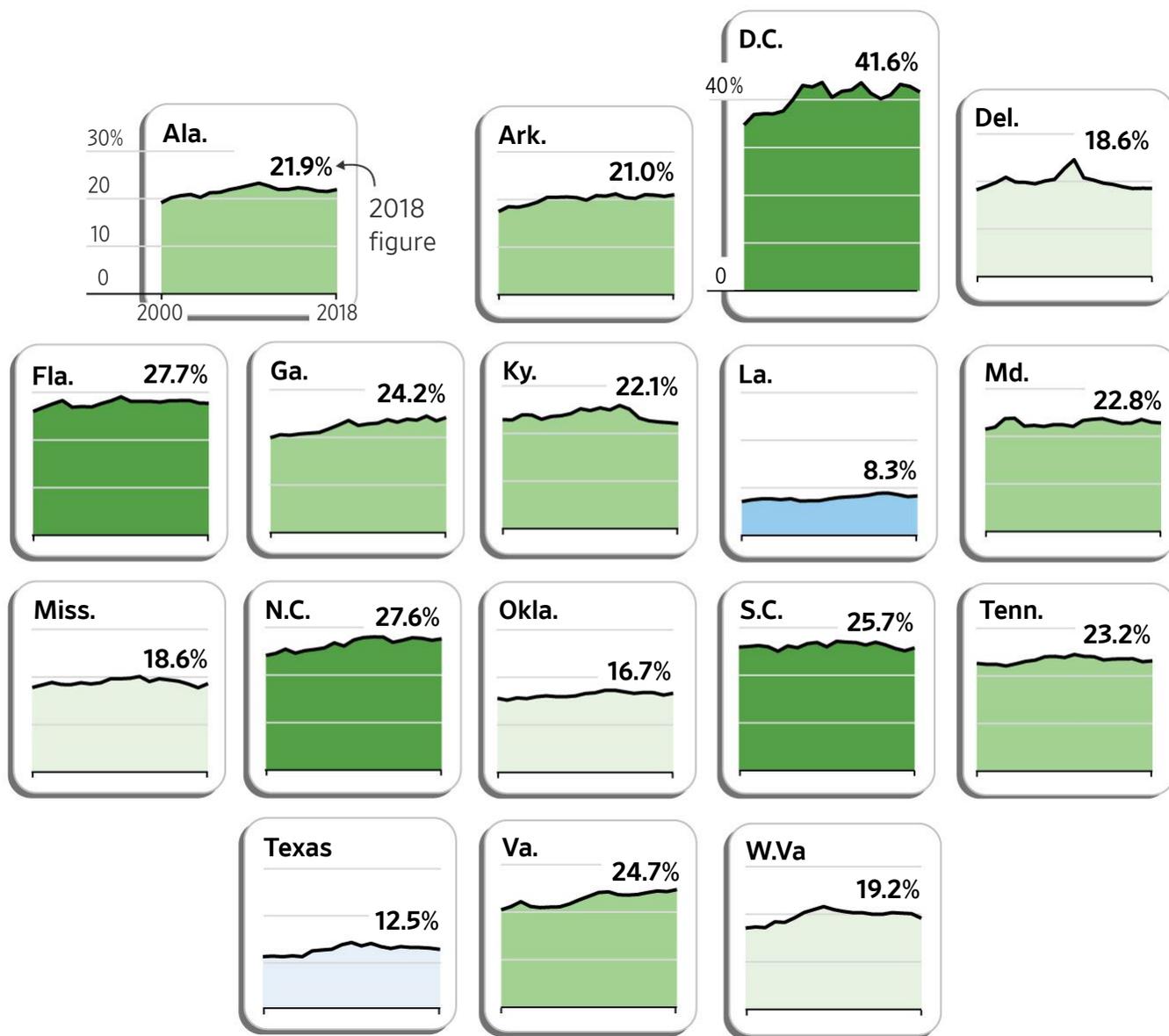
The idea is that companies, data centers or individual homeowners can install their own generation system, potentially with a clean energy source like solar power or geothermal energy, and operate independently of the grid. Many of these systems will remain connected to the grid and can sell any excess power into the grid to save money. But they also will have smart equipment that automatically isolates them from the central grid if there is a power surge or shutdown that could fry their equipment.

Some see these island systems, referred to as distributed energy resources, as a potential solution to fostering reliability for the electrification of everything by decentralizing power generation. It's a way to reduce pressure on the grid as demand for electricity takes off.

In particular, these systems are giving a boost to interest in rooftop solar combined with battery storage, especially in parts of the country with abundant sunshine. Elsewhere, whole-house generators powered by propane or natural gas are likely to become much more common.

The South

Electricity's share of total energy use in Southern states.



Source: Energy Information Administration

New regulations will be needed

Backup systems, as well as the individual island solutions, are crucial if we want to make the electrification of everything reliable. But they aren't likely to happen at the necessary scale under today's regulatory policies.

U.S. electricity pricing and regulation remains outdated, based on a time when monopolistic, centralized power stations directed electricity to flow from their generators to the end user. Utilities are typically rewarded for promoting higher electricity use—not energy conservation or cleaner fuels.

As a result, new fee structures are needed that give utilities an incentive to adopt more resilient, innovative technologies, such as these smaller distributed networks or the integration of large industrial-scale batteries. Policy makers also must study market mechanisms that will encourage consumers to conserve and diversify backup sources, as well as enable them to sell some of the clean power from their backup systems back to the grid.

Another way policy makers can ensure that the electrification of everything doesn't turn into a road to power-failure disaster is to encourage more diverse grid connections.

Northern Europe has already shown the path, with its successful Nord Pool system. Nord Pool is an efficient "imbalance" market—an auction-based power exchange that interconnects the grids of nine countries and allows trading of power to lower costs and prevent brownouts.

For example, when Denmark's wind output exceeds its electricity demand, it sells excess power to neighboring countries like Norway. Conversely, when the wind is ebbing, Denmark purchases electricity from Nord Pool.

Similar large regional or intercountry transmission wires will be the new pipelines of national and international energy trade. Because weather patterns can be localized and electricity sources diverse based on differing locations and time zones, more grid connections can spell increased energy security where additional unaffected utilities can potentially supply more power into a disrupted market.



A wind turbine under construction at Duran Mesa, one of four wind farms in central New Mexico that will make up the Western Spirit Wind Project.

PHOTO: MIKE RADIGAN FOR THE WALL STREET JOURNAL

Not in my backyard

No one wants high-voltage wires and substations near their home. Unfortunately, we can't have the electrification of everything without a lot more of those wires and stations. Princeton University estimates the country will need between double and triple today's electricity transmission capacity to accommodate the Biden administration's goal of achieving net zero greenhouse-gas emissions by 2050.

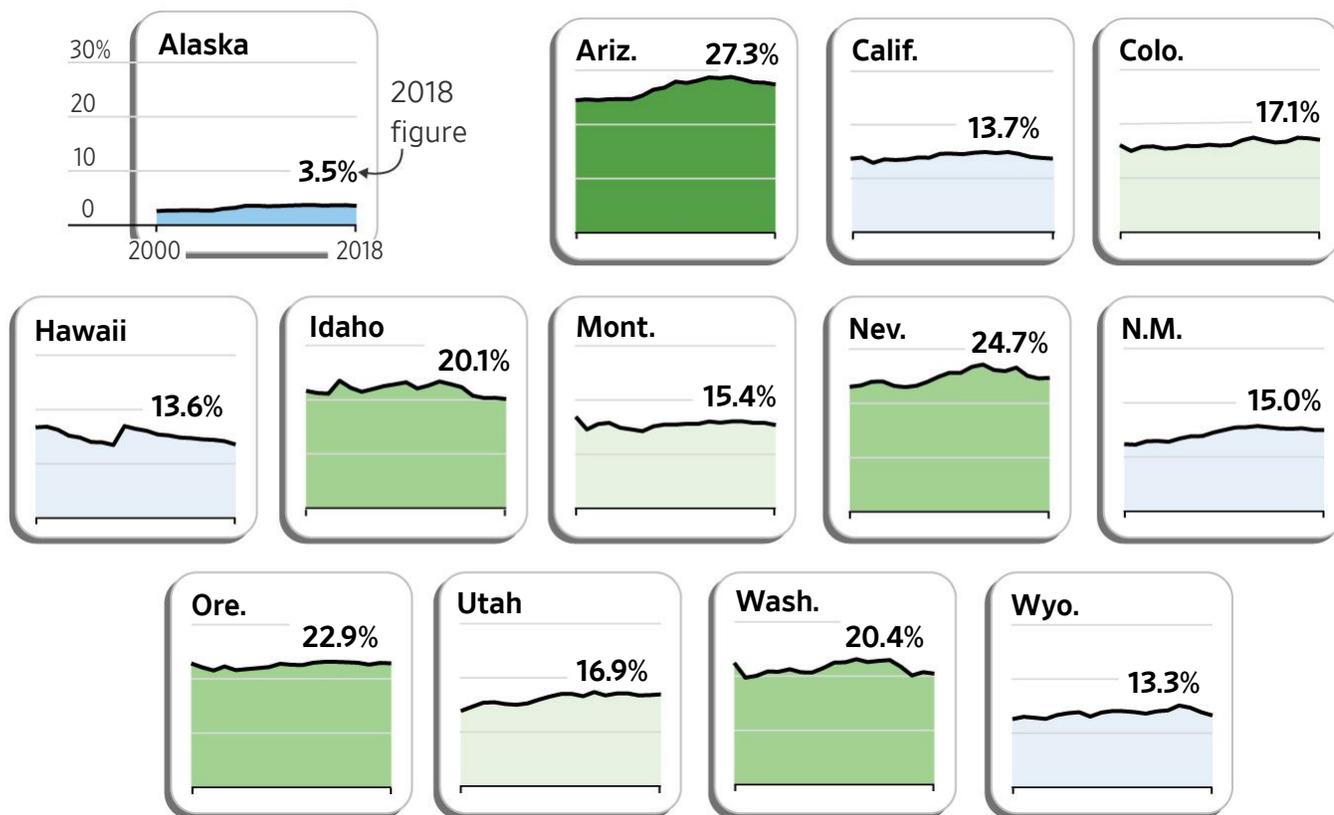
That's going to pit cities versus cities and states versus states. For instance, New Hampshire refused to serve as a conduit for Canadian hydropower to reach Massachusetts, and a public referendum is pending in Maine that might block routing through that state.

How to solve that standoff so it doesn't paralyze the building of new transmission lines? In the U.S., that will mean more federal authority to site transmission lines to enhance resiliency. Back in 2005, Congress tried to strengthen the ability of the Federal Energy Regulatory Commission to more easily pre-empt state vetoes of private-sector transmission development, but when federal authorities tried to use the new authorization, they still ran into problems in the courts. A House committee has proposed a new legislative pathway to strengthen federal authority. Other options include burying transmission lines underground in hopes of reducing local opposition, or laying new wires along existing rights of way on federal highways and railways. The Biden

administration has said it is considering the latter approach. The U.S. Department of Transportation has already issued guidance for use of highway rights of way for public needs related to climate change and energy reliability.

The West

Electricity's share of total energy use in Western states.



Source: Energy Information Administration

Good news for bad guys

More interconnections lowers the risks of greater electrification. But it also increases the risks of a cyberattack by providing more gateways and larger linked attack surfaces for hackers to enter undetected into a vital system to interrupt U.S. economic activity or safety. The more things that are digitized and connected to a plug, the more activities that have to increase cyberprotection tools and practices.

Cyber risks are likely to increase the preference for distributed networks based on renewable energy, which tend to be more dispersed and easier to restore quickly. If a cyberattack damages a large power plant, it could take months to repair. If it takes down a solar mini-grid, it might take a few days.

For countries that might consider importing electricity from a less-than-friendly neighboring country (unlikely to be a problem in North America), there is a new concern related to electricity of everything: What if that unfriendly country tries to use electricity supply as a tool of coercion by threatening denial of service at a critical time? In this case, interdependence could be weaponized to extract political concessions.

One solution to electricity coercion would be to have more countries locked together, each carrying supplemental reserve capacity that can be deployed all at once or to cover a threatened nation in the network.

The benefits for renewables

The electrification of everything is often associated with an increase in renewables.

Theoretically, of course, the electrification of everything is fuel-neutral—that is, the electricity itself could be generated using the same fossil fuels currently piped directly to us.

SHARE YOUR THOUGHTS

How do you see your own life become more electrified in the coming years? Join the conversation below.

But in practice, renewables are likely to have an advantage in the electrification effort. For one thing, environmentalists are focused on electrification as the fastest way to decarbonize the U.S. energy system, in particular with electric cars and converting home heating to electricity. Backup mini-grids are particularly well-suited, as noted, to solar.

In addition, the technology and data industry are big proponents of both the electrification of everything and renewable energy. These companies aim to connect virtually everything we do to their smart, digital devices. In a world of the Internet of Things, it will be hard to find equipment that can operate without a plug or wireless input.

So promoting the electrification of everything—and its accompanying grid enhancements—is in their economic interest. They want electricity to be accessible and reliable. At the same time, their customer base is concerned about renewable energy. Put them together and you can see why electrification of everything—even if theoretically fuel-neutral—is likely to result in a greater emphasis on renewables.

Some things can't be electrified

When we speak about electrification of everything, we don't actually mean *everything*. For some energy-intensive activities, it could be economically and technically preferable to switch to another kind of low-carbon-fuel carrier such as hydrogen. That's because it's still difficult to build a battery large enough and light enough to use in a long-distance jet or giant ship, and hydrogen would also be better suited for some heavy industrial processes.

But those are the exceptions. For most other things, electricity works just fine. Now it's up to all of us to make sure it's there when we need it.

Ms. Jaffe is the author of "Energy's Digital Future: Harnessing Innovation for American Resilience and National Security," and a research professor at Tufts University's Fletcher School. She can be reached at reports@wsj.com.

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Appeared in the May 17, 2021, print edition as 'Why We Aren't Ready For the Electrification of Everything Get Ready for the Electrification Of (Nearly) Everything.'

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26

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