

100% RENEWABLE



AN ACTION PLAN FOR US ENERGY INDEPENDENCE



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FiRe
Future in Review

TECHNOLOGY DRIVING
A BRIGHTER FUTURE

DIRECTOR'S NOTE

What would it would take to transition the US grid to 100% renewables?

That's the question Future in Review set out to answer last year as we convened a series of roundtable conversations with experts from across the renewable-energy space.

The US is the world's second-largest emitter, spewing 15% of greenhouse gases every year. (China, the world's first-largest emitter, is responsible for 30%.) A lion's share of US emissions is generated by four sectors: transportation (27%), industry (24%), electricity (25%), and commercial and residential (13%).

Transitioning the US grid to 100% renewables would allow for the complete electrification of all four, representing an 89% potential decrease in US greenhouse gas emissions – a 13.35% drop globally. This transition is key to unleashing the full potential of ongoing global efforts to "electrify everything," which will require a significant increase in global power supply.

Naturally, this raises questions. What kinds of infrastructure need to be built to facilitate this shift? Where is policy change needed? What technological hurdles still need to be overcome?

The answers to these questions are laid out in the plan that follows: **100% Renewable: An Action Plan for US Energy Independence.**

With a lowest-cost, maximum-impact orientation, this plan focuses on actions available to consumers, communities, private industry, states, and federal agencies, mostly without involvement by Congress. These steps are available now and could robustly benefit both consumers and utilities.

Our hope is that this plan serves as a shared roadmap for individuals, businesses, utilities, policymakers, and investors around the country working to reimagine and reconstruct our shared future.



Berit Anderson

COO, Future in Review; and
Managing Director, *FiRe Action Tank*

INTRODUCTION

The US stands at a historic and encouraging pivot point.

The Russian invasion of Ukraine and the tightening alliance between China, Russia, Iran, North Korea – CRINK – and Saudi Arabia have made it clearer than ever that America's future success is deeply intertwined with its energy independence.

Renewable energy is now typically cheaper than fossil-fuel alternatives, even before factoring in benefits to climate and health – and private investment in alternative-energy technologies, policies, and infrastructure stands at an all-time high.

Congress, too, has made significant headway, passing two historic bills in the past year – the American Infrastructure Act and the Inflation Reduction Act – that allocate significant funding to the transition to renewable energy.

But even in the face of all this progress, the American energy transition faces an uncomfortable truth: our current approach is still vastly insufficient.

Grid enhancements currently planned, or even seriously envisioned, are significantly undersized for meeting future electrical demand, and they require timelines too long to head off the worst effects of the climate emergency.

Critically, they fail to sufficiently improve the resiliency of America's power supply at a time when we expect increasing disruptions from climate-fueled weather extremes, solar flares, and infrastructure-related hacking attempts.

Nothing currently on the policy horizon seems likely to remedy these weaknesses.

That's where Future in Review comes in: a forward-looking working group of technologists, researchers, investors, and business leaders.

About Future in Review

Future in Review is one of a pair of independent family media companies. For 20+ years, we've been hosting the Future in Review conference, which coalesces the world's brightest minds around solutions to intractable global challenges. *The Economist* has named it "the best technology conference in the world."

Through our sister company, Strategic News Service, we publish the world's most accurate source of analysis about the future of technology and the global economy. Founded in 1995, our annual predictions have a publicly graded accuracy rate of 95.6%.

Collectively, our efforts have changed local, national, and international policy; launched new economic frameworks; and built the world's most advanced machine-learning company from scratch.

As the COVID-19 pandemic ramped up, Future in Review launched its first virtual Action Tank, focused on the ethical deployment of technology to solve global challenges. Its first mission: to identify the simplest, strongest, and fastest path to fully decarbonize the US grid.

Over the year that followed, we convened a series of roundtable discussions to solicit the input of experts across the renewable-energy space. We talked to technologists, thought leaders, policy-makers, entrepreneurs, renewable-energy developers, and utilities.

Our questions for them were simple:

- What would it take to transition the US grid to 100% renewable energy by 2050?
- What challenges need to be overcome in order to make that transition?
- What innovations or ideas might help us overcome those challenges?

The vision that emerged is more complex.

The Path to US Energy Independence

Transitioning the US to 100% renewable energy by 2050 will require actors across the energy ecosystem to fully embrace the creation of a two-way grid, adopting infrastructure and policy that maximizes the development of distributed renewable-energy with the same focus already being applied to centralized wind and solar farms.

The capture and storage of that energy will require innovations in grid-level and local on-site batteries and energy storage. Its transmission across the country (during increasing climate disruptions and weather variability) will depend on increasing connections between North America's three separate grids, prioritizing higher-capacity long-distance transmission technologies along existing rights-of-way.

Making this transition will allow homes, businesses, and manufacturing facilities to make money on the production and storage of their own on-site renewable energy. Electric vehicles and EV fleets will serve an important role in this equation as backup power sources and load balancers, recharging their large battery capacity during off-peak demand hours.

This stepwise increase in energy assets will require a corresponding increase in the sophistication of their management through software and artificial intelligence.

- Front-of-meter, on the utility side, software and AI will play a key role in balancing the distribution grid in real time, automatically storing extra power when available and deploying it as needed.
- Behind-the-meter, on the customer side, a galaxy of smart appliances, inverters, and efficiency components will increasingly use their infrastructure to smooth peaks and valleys in individual demand.
- To keep the grid balanced, consumer energy storage will need to be dispatchable by utilities, allowing them to manage the supply, demand, and power quality of the distribution grid.

Importantly, utilities will need to evolve away from relying on oil, gas, and coal for "baseload" power, which currently serve as an always-on crutch to maintain grid voltage balance.

In their place, an array of flexible, climate-friendly energy solutions, newly enabled by emerging technology, will power a distributed network of baseline storage capacity. Recent simulations by the National Renewable Energy Laboratory, Rocky Mountain Institute, and others help illuminate how this can work.

A Paradigm Shift

The priorities of this plan are complementary to, but fundamentally different from, the energy investment priorities laid out in the 2021 Infrastructure Bill and the 2022 Inflation Reduction Act.

Both pieces of landmark legislation are critically important to accelerating the deployment of centralized renewables. However, there's no chance the US can fully decarbonize by 2050, as the laws of science - and survival - require, without a corresponding plan to unlock the full potential of decentralized renewable energy.

The timing logistics of siting and developing centralized wind and solar farms, securing right-of-way for new transmission lines, and constructing upgrades simply will not get us there in time. Our children and grandchildren will suffer.

What's more, a boom in centralized renewables alone will not provide the step-function increase in resilience necessary to keep American homes, businesses, and communities supplied with energy through the coming years of climate-related disasters, as microgrids necessarily do.

A fully two-way grid would place the consumer at the center of America's future electrical infrastructure, empowering all Americans to generate their own energy and receive fair compensation for its value.

This would vastly speed the renewable transition, unlocking the economics needed to incentivize third-party financing of distributed energy installation around the country.

Unlocking incentives for third-party financing would increase the equity of the transition, bringing benefits of energy-cost savings to those who cannot currently afford their own renewable systems or do not own homes.

In short, it moves the power to make this transition from the hands of a few to the hands of many. And many hands make light work.

What Do We Mean by "Fully Two-Way Grid"?

Many in the energy industry believe that the US already has a fully two-way grid.

It does not.

Current US distribution grids allow for *some* bidirectional flow of energy through the use of smart inverters. But inverters are limited in their capacity to provide the reactive power necessary for large-scale deployment of renewable energy back into the grid.

When too much power is generated by consumers, the current system will curtail, or limit, the amount of energy the grid accepts. In other words, that extra energy will be wasted.

In the US, where only about 3% of homes include solar, we have yet to hit the limits of curtailment. But elsewhere in the world, countries further along in the transition offer useful lessons for what to expect from our renewable energy future.

In Australia, where roughly one-third of the population has installed rooftop solar, up to 80% of the power generated by a household may be curtailed.

Similar limits also apply to centralized renewables, which often have insufficient on-site storage to capture all the energy generated. In China, nearly 50 terawatt-hours of wind energy were curtailed in 2016. That's enough to power New York City for a year.

Curtailment makes investing in distributed renewable-energy projects financially infeasible, creating inconsistent revenue streams that cannot be forecasted.

It doesn't have to be this way. The widespread adoption of technologies outlined further on in this plan would largely solve this problem, without the need to replace distribution grid infrastructure.

Those who install renewable systems in their homes and businesses would find payback times much shorter. Investors would be incentivized to finance distributed renewable projects that currently lack financial backing. Installations across the US would skyrocket.

Is It Possible?

The United States stands ready today to produce 80%-90% of its electricity through climate-friendly technology, mostly solar and wind.

"Analysis and experience to date point to no fundamental technical reasons why a 100% RE electric power system cannot be achieved," experts at the National Renewable Energy Laboratory and the Department of Energy wrote in a May 2021 study, "but the economic challenges indicate the need for advancements in several technologies as well as careful consideration of the suite of options that could be used to achieve equivalent carbon-reduction goals."

The Action Plan set forth in these pages lays out a path to bridge that 10%-20% gap and to roughly triple the renewable-power supply, creating a platform for the electrification of transportation – the largest current greenhouse-gas producer in the US – as well as for industrial, commercial, and residential buildings.

But make no mistake. This transition will require significant near-term investment and coordination.

It will require an unprecedented campaign to convert the nation's power systems and the regulatory systems that control them. It will mean solving serious logistical challenges in how we provide power.

Moving from here to there will require unprecedented levels of coordination and teamwork among energy actors that haven't traditionally pulled in the same direction.

It is our goal that *100% Renewable: An Action Plan for American Energy Independence* can serve as a shared roadmap for actors in the US energy space as they navigate this transition.

We have done our best to outline clear priorities for each of the major actors involved: utilities, energy companies, individuals, businesses, state utility regulators, state lawmakers, investors, startups, renewable-energy developers, and the Federal Energy Regulation Commission (FERC).

This is fundamental change. But achievable change.

In short, we can fight climate change, better harden our communities against climate-fueled weather extremes, add jobs, and – in the long view, with property and human health benefits tallied – save money.

We hope this work will be helpful in informing and guiding your efforts, wherever you fit into the ecosystem of American energy independence.

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We know there's an ample portfolio of suitable technologies at reasonable cost to do the job. And that's all we need to know. An embarrassing diversity of workable options is not a showstopper. It's just a happy preparation for learning by doing.

So we should suspend disbelief, stop arguing, speed building, and go wandering into the wilderness together and find out.

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– Amory Lovins, Founder, Rocky Mountain Institute; Strategic Advisor, Future in Review 100% Renewable Action Tank



STATE OF THE CURRENT US GRID

To create a viable path to a 100% renewable grid, we need to start with a shared understanding of the constraints we face, including the physics of energy distribution, the current structure of the US grid, the actors involved in its function and governance, and the timeline we have to deal with.

Basics of the Grid

The overall structure of the US grid is relatively straightforward: Energy companies generate power, which is distributed through transmission lines to transformers. Those transformers adjust the local distribution grids, which are overseen by utilities. Those distribution grids provide power to energy consumers.

In any given home in America, when you turn on a light, the power keeping that bulb lit comes from a unique bouquet of regional energy sources that might include solar, wind, nuclear, hydropower, coal-fired power plants, geothermal, and/or oil- and gas-powered power plants.

The specific makeup of a region's power depends on a wide range of factors, including environmental (How many days of the year is it sunny? How windy is it? Is there snowpack nearby?), political (Do any regional laws exist that mandate a certain percentage of renewable energy use by utilities?), and consumer demand (Are there major energy consumers in the area with specific requests for their energy sources?).

But that simplistic description belies the complicated web of actors, incentives, and physical and technical challenges that make its operation, governance, and the transition fully two-way grid powered 100% by renewables so complex.

The Grid is Increasingly Fragile & At Risk of Attack

Both fragmented and overly centralized, the underlying architecture of the US grid has remained mostly unchanged since its creation.

Energy demand, hacking attempts, and the impacts of climate-related weather events, unfortunately, have not. The confluence of these factors means the fragility of the grid has increased year-over-year.

In 2020, power outages hit their highest level yet, according to the US Energy Information Administration. And those outages have real impact:

- Fifteen US industry sectors suffered annual combined losses estimated at \$647 billion – a number forecasted to quadruple over the next decade, absent significant investment.
- In 2019, the average household's power bill increased by an estimated \$23, to \$169 per year.
- One 2003 outage that stretched from Cape Cod in Massachusetts to Ohio to Canada's Hudson Bay – caused by a software bug – was linked to nearly 100 deaths. The 2017 Thomas Fire outage in southern California, which resulted from strong winds pushing together high-voltage transmission wires, killed 24 people.
- Even the relatively tiny July 2019 outage in Manhattan, caused by an equipment failure and fire at a substation, snarled streets, trapped thousands of people in elevators and subways, and made the lights go out on Broadway. All this in a city where most power lines are underground and therefore less vulnerable to weather.

And while hurricanes and fires grow more common as culprits of outages, so has the very age of the grid – the power plants, the transmission wires, the substations, and the in-city distribution lines.

The year 2021 also saw what experts called an "unprecedented" number of hackers targeting the grid. When asked in June 2021 by CNN if a sophisticated actor had the ability to crash the grid, US Energy Secretary Jennifer Granholm was blunt in her response: "Yeah, they do."

At the time, many energy experts dismissed the threat, saying that hackers were primarily financially motivated and that nation-state actors, unlikely to commit an act of war, were the only real threat.

"OT systems are very complex and the attacker will need a certain level of knowledge and sophistication," Kevin Perry, former director of critical infrastructure protection at Southwest Power Pool, told Utility Dive at the time.

"That [would] most likely be a nation-state backed hacking group. An activity of a nation-state actor that intentionally causes a blackout will likely be viewed as an act of war and will likely result in a kinetic or electronic response, or both, once the actor has been positively identified."

Two years later, Vladimir Putin is threatening to drop nuclear weapons on Ukraine, and Xi Jinping has just appointed his most insular loyalist Politburo yet, while pushing economic, cyber, and information warfare initiatives in the West.

The motivation for nation-state-actors such as China or Russia to commit acts of cyberwar against the US appears to have reached an all-time high. A resilient US grid has never been more essential.

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The federal government has a fear of the risk of intrusion into that system [distributed grid-connected energy storage] and what it can mean. We've all heard about people hacking into cars and taking control of cars. Imagine if that happened with a battery system.

– Joern Tinnemeyer, Senior Vice President and CTO, EnerSys;
Strategic Advisor, Future in Review 100% Renewable Action Tank

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Constraint #1: We Have Less Than 30 Years to Transition

The biggest and most important constraint facing our transition to 100% renewable energy is time. The US has less than 30 years to make this transition.

And not only do we need to transition our current energy supply – we also need to increase our capability to generate energy overall by 2x-3x in order to meet the demand expected from electrifying transportation, building heating and cooking, manufacturing, construction, and shipping.

If we simply follow the existing process – gaining the necessary rights-of-way, building transmission lines, securing permits for centralized renewables, and constructing wind and solar farms – we will not meet the goal of a 50% renewable-energy supply by 2030.

Typical rollout time for electric-line projects necessary to transmit power from as-yet-unbuilt solar and wind farms is approximately 10 years. We have only eight years to reach the interim 50% goal.

Adding to urgency is the fact that, in the last 10 years, only four out of five centralized renewable projects planned for the Western US were actually completed. The rest fell victim to permitting, routing, and other regulatory hurdles.

Even if we somehow manage to triple our current centralized renewable-energy capabilities by 2050, that gets us only halfway. We would also then need to develop 3x the transmission infrastructure, substations, and distribution infrastructure to deliver that energy – another extremely expensive and time-intensive process.

By definition, a huge percentage of the improvement in the next few years must emanate from something other than the current centralized approach.

In order to maximize the use of renewable energy and increase the resilience of America's power supply, we will need to transition to a fully two-way grid.

Constraint #2: Energy Must Be Used or Stored Immediately

The physics of energy demands that electricity produced must be either used or stored as soon as it's produced. Any extra energy produced that cannot be either immediately used or stored is wasted. This very basic fact underlies a significant portion of the other constraints we face in transitioning to a 100% renewable US grid.

Constraint #3: The Timing and Volume of Much Renewable Energy Production Is Intermittent by Nature

Unlike coal and gas-fired power plants, which can produce power on demand, solar and wind are by definition variable. Combined with Constraint #2 (energy must be used immediately), this makes it much more challenging for utilities to rely exclusively on renewable energy.

Even hydropower, which provides constant baseload power in many places, isn't a forever guarantee. Every year, overall the United States loses more snowpack – the source that feeds those dams and powers American homes and businesses – and drought reduces water levels in rivers around the country.

Most consistent are geothermal (geographically limited), tidal (complicated and expensive), and nuclear (potentially dangerous) power.

Constraint #4: Most Grid Scale Energy Storage Is Short-Duration

When we hear the words "energy storage," most Americans think primarily of batteries, imagining perhaps the package of AAs at home in their cupboard. But whereas AAs might power your devices for weeks or months, depending on the device's power use, grid-scale lithium-ion batteries generally only last 4-5 hours.

Combined with Constraint #3 (renewable production is unpredictable by nature), this means that current widely deployed energy-storage systems can provide backup support to the grid to get it through a few hours of cloudy or still weather patterns – but not a few days.

Luckily, batteries aren't our only energy-storage option. And the DOE, DARPA, and national labs such as the National Renewable Energy Laboratory (NREL) and Argonne are dedicating significant resources and energy to identifying, spinning out, and funding new solutions to this problem.

There are five main types of energy storage:

- **Batteries:** The battery category includes a range of electrochemical storage solutions, including advanced chemistry batteries and flow batteries.
- **Thermal:** Thermal-energy systems capture heat and cold to create energy on demand or offset energy needs.
- **Mechanical:** Innovative technologies that harness kinetic or gravitational energy to store electricity have begun to be deployed at grid scale.
- **Hydrogen:** Excess-electricity generation can be converted into hydrogen via electrolysis and stored.
- **Pumped Hydropower:** Water can be pumped uphill during times of excess power production, then run through dams to produce power.

Currently, much of the attention of energy planners is focused on large, utility-scale energy storage, which can act as a source of backup power and forestall the need for expensive upgrades of the transmission and distribution systems. They also can be useful for arbitrage, frequency regulation, load following, load management, and system-peak shaving.

Constraint #5: The Transmission Grid Is Divided

The US transmission grid is split into three separate and essentially isolated parts, or "interconnections," that don't allow the transmission of energy from one region to the next: the Eastern Interconnection, which covers North America east of the Rockies, including the Canadian provinces of Saskatchewan, Manitoba, and Ontario; the Western Interconnection, which serves western Canada and the United States; and the Texas Interconnection, which serves most of Texas.

Of the 950 gigawatts the Eastern and Western grids can produce, they can share just over 1 gigawatt – in other words, just over 1/10th of 1%.

Texas – the state producing the most wind energy of any in the nation – is effectively cut off from the Eastern and Western grids altogether, an artifact of its attempt to escape federal regulation after the 1935 passage of the Federal Power Act.

Knit together, the connection of these disparate parts could significantly boost our ability to rely on renewable energy. The 2018 Interconnections Seam Study ("Seams"), conducted by NREL, modeled the benefits of constructing a 7,500-mile transcontinental supergrid, using high-voltage direct current technology.

As investigative journalism outlet InvestigateWest* reported at the time: "Even in the study's less ambitious scenario, the supergrid was saving consumers \$3.6 billion a year by 2038."

Deemed a threat to the coal industry, Seams itself was effectively muzzled by the Trump-era Department of Energy and was significantly altered before NREL was allowed to publish it.

Constraint #6: The Grid Is Managed, Regulated, and Operated by a Complex Set of Stakeholders

A successful plan to transition the US grid to 100% renewable energy must take into account the wide range of actors overseeing its operation and the role each plays in this complicated framework – many with competing victory conditions – limiting legal guidelines for operation and creating unwieldy regulatory frameworks to navigate.

The Executive Branch. The president and his team hold a unique ability to direct and coordinate federal policy and funding in the clean-energy transition – most notably, through oversight of the Department of Energy, the Department of Labor, and the Environmental Protection Agency.

They can also influence the energy transition through the appointment of key energy-related positions that don't answer directly to the White House, through the issuance of Executive Orders (which can only be overturned by a sitting president), and through executive influence over infrastructure- and grid-related funding.

*Disclosure: InvestigateWest was co-founded by this plan's co-author, Robert McClure. Co-author Berit Anderson is a member of its board of directors.

President Biden's key executive orders on the renewable transition have already established an Interagency Working Group on the Social Cost of Greenhouse Gases to direct decision-making in federal agencies. They have also expanded opportunities to develop offshore wind energy and related workforce development in the Gulf of Mexico and on the Atlantic and Gulf coasts, in coordination with 11 state governors.

Congress. Congress can allocate federal budget to specific grid-related bills, as it has with the Inflation Reduction Act and the Infrastructure Investment and Jobs Act. However, even these two pieces of landmark legislation, which encourage the development of infrastructure to serve electric vehicles among many other admirable goals, allocate only \$68 billion for grid infrastructure and transmission upgrades.

The American Society of Civil Engineers has said \$208 billion is required by 2030 just to maintain a reliable electricity system. What's more, the 22 projects identified as "shovel-ready" in 2021 by Americans for a Clean Energy Grid, in support of the Biden Administration's efforts to pass infrastructure legislation, represent "only about 10% of the transmission investment that is needed to decarbonize the power system."

The Department of Energy. In addition to funding and overseeing national labs that research technical aspects of grid modernization, the Department of Energy offers a number of loans and loan guarantees for the deployment of large-scale energy infrastructure programs through its Loan Programs Office. It also oversees a number of other programs geared toward research and deployment of smaller-scale energy infrastructure projects.

The Federal Energy Regulatory Commission. FERC, led by a board of presidential appointees, oversees the interstate transmission of power by utilities, independent system operators, regional transmission organizations, and power marketers. FERC answers to Congress, which has considered, but not granted, the right to the agency to site most interstate transmission lines.

FERC Order 2222, issued in 2020, created the legal and market framework to transition the US to a fully two-way grid. It ordered operators of regional grid systems to allow distributed-energy resources to compete on national energy markets, which had previously been restricted to wholesalers.

Eventually, this will open up the markets to aggregated outputs from energy storage, intermittent generation such as small-scale solar and wind, demand response (e.g. "smart homes" that allow scheduling of energy uses when they're most advantageous for balancing energy demand with supply), energy efficiency, and even car batteries. However, independent system operators (ISOs) and regional transmission organizations (RTOs) are currently dragging their feet to even create plans for the institution of this new plan.

Utilities. The importance of the role utilities play in our ability to transition the US to a fully two-way grid cannot be overstated. Responsible for the purchase, distribution, and sale of energy through the distribution grid, utilities maintain, upgrade, and repair distribution grid infrastructure. They also set metering policies for ratepayers in their jurisdictions. The policies and technologies they put in place in the next five to 10 years will make or break our ability to transition to 100% renewable energy by 2050.

One of the utilities' most important roles is balancing the electrical load on the distribution grid. In general, each utility is responsible for understanding the "load" of its system and communicating that to ISOs and RTOs, which are responsible for making sure that enough energy is being supplied to the distribution grid. Getting this wrong can be catastrophic and was the source of failure in the 2021 Texas freeze that left so many without power.

Complicating this is the fact that there are three kinds of utilities – public, cooperative, and investor-owned – each with different cultures, incentives, and accountability structures, making any kind of centralized coordination of best practices across a wide range of utilities nearly impossible.

Energy Producers. As with utilities, there are many kinds of energy companies. In some regions, energy markets are vertically integrated – meaning, utilities also own energy production assets. Other energy markets, known as disaggregated markets, don't allow utilities to own both the production and the sale of energy, instead relying on private or municipally owned energy companies.

Even in private energy production, there are variations. Some companies own energy-generation infrastructure outright; some merely aggregate it and resell it on the wholesale market.

Whatever their approach, the purchasing habits of energy companies are essential to accelerating the transition to renewable energy and are most influenced by the demands of their customers – nearby utilities and large corporate purchasers of energy such as Amazon, Microsoft, and Google.

Independent System Operators and Regional Transmission Operators. ISOs and RTOs are independent nongovernmental organizations that oversee the transmission grid in a specific geographical area. There are nine total in the US, each of which is responsible for balancing grid load and demand, ensuring that sufficient backup power is available, conducting long-term regional planning, operating the electricity wholesale market, and managing the interconnection of new sources of power generation.

At the moment, backlogs at these organizations are a significant limiting factor in our ability to ramp up the production of centralized renewable energy. The PJM Regional Transmission Organization – which distributes power across a 13-state swath, from the Mid-Atlantic to the upper Mississippi Valley – is proposing a two-year delay in starting to consider about 1,250 renewable-energy projects already in the queue.

New projects? Those would have to wait until the end of 2025 just to start being considered. They would have an answer by late 2027.

And the PJM example is not unusual. Average wait times for such decisions are running to 3-1/2 years - up 84% over a decade, according to a study by Lawrence Berkeley National Laboratory.

State Legislatures. State lawmakers are key players in the acceleration of the renewable transition at a local level through funding allocation and policy creation.

At least 30 states have already passed mandatory renewable portfolio standards or similar measures known as "clean energy standards." About three-fifths of renewables growth from 2000 to 2015 was driven by these standards. And health and environmental benefits from expanding these requirements significantly outweigh projected costs, even under conservative assumptions.

State Utility Commissions. Utilities operate according to a specific set of guidelines set by state regulators. Often this takes the role of a public utility commission, which has primary responsibility for the siting of new transmission lines and power plants and may issue rules on energy efficiency and renewable portfolio standards, requiring a certain percentage of renewable energy use.

In 35 states and the District of Columbia, commissioners are appointed, usually by the governor, while 15 states elect their commissioners.

Under the traditional "cost of service" model, state regulators calculate the total amount that each utility needs to recover from energy consumers in order to cover its costs and make a "reasonable" return. This serves as the baseline cost for ratepayers. This calculation includes a guaranteed return on infrastructure improvements, typically around 10% of the total capital a utility spends.

This system incentivizes utilities to turn to centralized, capital-intensive grid upgrades. Why wouldn't they? The more they invest, the greater their profit.

A Closer Look at Utilities

The importance of utilities in making this transition cannot be overstated. They will face significant challenges, unique to their geographic location and the current makeup of their energy supply. They will need additional support in the form of funding, legislative, and regulatory incentives. They will need help to overcome supply-chain issues and workforce development challenges.

They will need to uproot beliefs that have grown calcified in the industry:

- That budget and planning cycles must run on three- to five-year timelines
- That it's impossible to rely on renewables for baseload power supply
- That consumer-demand response technology must be centrally controlled rather than act as a distributed Internet of Things (IoT) network

Over time, as the unit cost of energy falls closer and closer to zero, the entire prevailing business model will need to be rewritten.

The Utility Business Model

Australia, which is years ahead of the US energy transition, provides a useful case study in challenges that utilities and ratepayers can expect as distributed renewables proliferate in the years to come.

As the percentage of Australian homeowners with rooftop solar and batteries has grown, utilities there have come up against a key challenge to their core business model.

Their fixed costs have increased as they installed more grid-scale energy storage and made expensive upgrades distribution lines to facilitate added transmission from wind and solar farms. However, their revenues have been impacted as increasing numbers of energy consumers produced more energy than they used or went off-grid altogether.

To help cover their revenue decline, the cost of energy per unit has increased, spread across the remaining customers who hadn't yet made the switch to distributed renewables.

Herein lies the problem. Practically speaking, those Australians who can least afford to install their own microgrids and renewable solutions are increasingly saddled with the cost of the transition.

And, because most Australian utilities haven't yet adopted the technology we'll touch on below – eliminating the need for curtailment – there is not sufficient return on investment to incentivize outside investment in the development of renewables, especially in low- to middle-income communities.

If the US energy industry continues as currently planned, this is where we, too, are headed.

Those utilities that cannot, or do not, innovate will eventually be outmaneuvered by multinational corporate actors, which are already reimagining how energy can be produced, stored, and transmitted.

Just look at Kodak, which, before the rise of digital photography, made its money on each unit of film. As the cost of film fell to zero, failing to innovate, Kodak was left with no choice but to file for bankruptcy.

The United States cannot afford to bankrupt its utility infrastructure. Our ability to continue powering US homes and businesses and maintain American energy independence is only as strong as our shared electrical infrastructure.



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I just don't think the utility revenge narrative has gotten us anywhere. [Even] if you bought them out, you're just capitalizing the banks to do what we have to do anyway. It's just a different way of writing a government subsidy.

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– Saul Griffith, Founder & Chief Scientist,
OtherLab & Rewiring America

THE ACTION PLAN FOR AMERICAN ENERGY INDEPENDENCE

By definition, a huge percentage of the improvement in the next few years must emanate from something other than the current centralized approach.

We need to get creative about building an energy system that contributes to the long-term safety, health, and wellbeing of our children and grandchildren.

The steps outlined below draw on the experience of leaders in renewable energy from around the world and their advice for getting the US to a 100% renewable grid on time.

Step 1: Unleash the Full Development of Distributed Renewable Energy

To hit our goals, we'll need to give every ratepayer in America the incentive to become their own renewable-energy developer. Outdated and limiting regulations will need to be brought up to date. New policies and incentives that prioritize long-term resilience will need to be set.

Executed correctly, this will create an explosion in microgrid installations across American communities.

Each individual microgrid should be equipped with enough production and energy storage to operate independently under emergency conditions. Their connection to the distribution grid should be mediated automatically, through AI-powered demand response to help utilities with load balance, minimize energy costs for consumers, and maximize the use of renewable energy.

This will require utilities to employ policies that incentivize that process for ratepayers and technologies that unlock the financial returns needed to motivate third-party financing of those distributed energy assets.

ACTION ITEMS FOR STATE LEGISLATURES

Pass Legislation Mandating Utilities Transition to 100% Renewables on a Specific Timeline

One of the most effective mechanisms for transitioning the US grid to 100% renewable energy lies with state legislatures, which can pass laws to mandate that utilities eliminate emissions on specific timetables.

Oregon's HB 2021, for example, is the nation's most ambitious state law on emissions, mandating that power suppliers transition to zero emissions by 2040. Part of its effectiveness is its open-endedness about how utilities get there, combined with a set of tiered accountability check-ins. Along the way, regulated entities must submit plans to reduce emissions by 80% by 2030 and 90% by 2035.

Eliminate Right-of-Way Prohibitions That Block Power Sharing Among & Between Microgrids

Across the US, current right-of-way prohibitions dating to the late 19th and early 20th centuries block non-utility entities from sharing power among themselves.

In California, as the Center for Sustainable Energy reports, "Code Section 218(b), known as the over-the-fence rule, prevents any entity other than a utility from distributing electricity generated at one property to more than two neighboring properties or to any nonadjacent property."

These rules were put into place at a time when electric utilities were competing with one another, before they enjoyed monopoly status. Today, though, they can prevent a hospital with its own microgrid from selling power to a fire station across the street. They can make it illegal for neighbors to share their power supply with one another during an emergency.

According to Think Microgrid's 2022 Microgrid Climate Vision Report, "We are witnessing a classic example of technology outpacing policy. Too often those seeking to install microgrids face delays and extra costs because of rules and regulations designed for an electric grid of the last century. These outdated rules make it difficult, and at times impossible, to fully capture the opportunities offered by software-based energy systems such as microgrids.

Appropriate Funds for Workforce Development in Renewable Interconnection

One challenge for utilities lies in hiring and training the talent needed to interconnect microgrids. Ratepayers can sometimes wait for months between the time their solar and wind systems are installed and when they're finally connected to the grid, allowing them to take advantage of their benefits.

States can help ease this bottleneck by allocating budget for workforce development with a focus on creating jobs and training opportunities in communities most impacted by climate emergencies, as well as those whose residents were previously employed in the fossil-fuel industry.

Create Tax and Other Incentives to Spur Community Solar and Microgrid Development, Especially in Low- to Middle-Income Communities

Community solar projects allow any ratepayer to subscribe to an aggregate of solar panels in a community-sponsored solar array, opening up the benefits of renewable energy to renters and condo owners. Typically, subscribers receive credit against their electric bills.

Community solar is still a nascent aspect of the renewable industry, but on average, its capacity has doubled every year since 2010. One 2020 study projected that community solar projects could provide up to 2.6% of US electrical needs by 2030. By that time, an estimated 75 million to 113 million homes and businesses will lack access to rooftop solar.

Third-party financing of microgrids in low- to middle-income homes and businesses would increase the equity of the transition, unlocking the cost savings of switching to renewables for communities that have, in other countries, borne the brunt of renewable transition costs as more and more wealthy ratepayers install self-sufficient systems.

ACTION ITEMS FOR STATE REGULATORS

Add Emissions Reductions to Utility Management Criteria

State regulators have traditionally overseen utility performance based on three main criteria: reliability of power, cost, and consumer service. These metrics, established in the early 20th century, should be urgently reformed to include climate-protection goals – which are equally important to the future of energy consumers.

Implement Performance-Based Ratemaking for Utilities

Performance-based ratemaking relies on measurable "performance incentive mechanisms" to determine a utility's profit. Has the utility optimized affordability? Reliability? And – crucial in this context – use of renewable energy?

At least 19 states and the District of Columbia have considered, or experimented with, some form of performance-based regulation, which comes with metrics such as how difficult it is for someone to hook up a rooftop solar unit. If the targets are hit, the utility is rewarded. If they fail, they're penalized.

Ideal performance-based regulation should incentivize the adoption of technologies that increase resiliency of the grid overall and begin to decouple a utility's revenues from the total amount of power sold.

These should include:

- Maximizing the total production volume of distributed renewables
- Maximizing total households with demand-response technologies installed
- Minimizing the time to interconnection
- Decreases in electric rates – and at least partially decoupling a utility's revenues from the amount of power sold

Eventually, the utility business model should operate more like an internet service provider – issuing monthly bills to ratepayers that depend more on overall costs than on unit costs, giving utilities the motivation to reduce power use rather than try to sell more to make more profit.

ACTION ITEMS FOR UTILITIES

Modernize Grid Technology to Eliminate Future Curtailment

EleXsys, our partner on this Action Tank initiative, produces a power electronics device that solves exactly this problem. Its AI platform, deployed either front-of-meter or behind-the-meter on a neighborhood level, almost entirely eliminates curtailment, making the grid 100% two-way and allowing for the full utilization of existing network infrastructure.

Installed front-of-meter, eleXsys provides utilities with network management capabilities and power quality improvements, which solves challenges that utilities have with gaining access and visibility to behind-the-meter distributed energy technologies such as Google Nest and other smart home devices.

The eleXsys platform is already being deployed throughout Australia, where IKEA has used it to turn its Adelaide store into an energy production facility and Energy Queensland is working with the federal government to test eleXsys's capacity in managing the distribution grid.

Shorten Budget Cycles to Accelerate Innovation

One of the most commonly cited challenges to accelerating change from within utilities, according to utility employees we surveyed, is the length of the average utility's budget cycle.

Commonly, funding within a utility is already allocated for the next four to six years, creating a critical inability to fund experiments and innovation internally and stifling the ability of those motivated to drive the transition from within.

Shortening that cycle to one year, as publicly traded companies do, would put utilities more in line with the technologies they're trying to integrate into their ecosystems, allowing them to experiment more frequently and accelerate their transition to 100% renewable power.

Transition to a Feed-in-Tariff Metering Model

Feed-in tariff metering compensates ratepayers per unit of energy they produce.

Widely adopted, this system would greatly enhance adoption of renewables, creating the economic incentive to maximize renewable installations in businesses and homes.

It also opens up the financial incentives needed to attract third-party financing for the installation of renewable systems in low- to middle-income homes and communities, bringing the benefits of renewable generation to all ratepayers.

Importantly, it maximizes the potential for utilities to one day depend on distributed renewables as an asset to balance distribution grid load, reducing their dependence on fossil fuels. The greater the penetration of distributed renewables in a community, the more utilities can depend on distributed-energy storage as a tool for baseload power generation and grid balancing.

Remove Artificial Limits on Renewable Energy Installations

Today, some US utilities limit the amount of solar they'll allow homeowners to install, based on their historic energy use. This is problematic on more than one level:

- In the years to come, as more and more households transition to EVs, replace gas ranges with electric, and install heat pumps in place of natural-gas heating systems, Americans' energy use at home is expected to increase significantly.
- Artificially limiting solar and wind installation crucially handicaps the financial incentive to maximize renewable-energy production in homes and businesses and eliminates entirely the financial incentive for third-party financing of distributed renewables. This is exacerbated in the case of commercial and industrial buildings, the large rooftops of which could export significant amounts of power if space were optimized.

Dedicate Staffing to Securing Additional Transition Funding

Due to the aforementioned budgeting cycles, most utilities don't have the funds they need to innovate in making the transition to a two-way grid. In the short term, utilities will need to pursue additional funding from federal and state agencies to pay for needed innovations and experimentation. Those that haven't yet done so should plan to dedicate at least one FTE to pursuing additional financing outside their current budgets. The USDA, for example, provides grants and loans to utilities in rural communities to help hasten the transition to renewable energy.

Create a Culture of Continual Interconnection Improvement

One of the biggest complaints we've heard from solar developers and homeowners is how long it can take for homeowners to get their home microgrids officially approved and connected to the distribution grid. In some cases, fully installed microgrids may sit idle for months. Utilities corroborated this, citing lack of talent available for hire and fieldworkers who are afraid they may be shocked by distributed-energy resources (DER).

Utilities will need to get serious about excellence in interconnection, establishing transparent standards for approval of new microgrids, processes for interconnection, accelerating hiring, and creating standardized training for new hires to facilitate the coming rush of distributed renewable systems.

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If we're going to unleash this economic, environmental, and resilience trifecta, we have to figure out how to restructure the electricity industry to make sure that utilities are motivated to make it happen. Because right now they're particularly unmotivated to make it happen.

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– Craig Lewis; Founder and Executive Director, The Clean Coalition;
Strategic Advisor, Future in Review 100% Renewable Action Tank

PARTNER CASE STUDY

The only technology we are aware of that solves the US grid's coming distributed renewable-energy hosting capacity and curtailment challenges is that of eleXsys Energy. This is why we chose to partner with eleXsys on this Future in Review Action Tank initiative.

We first met the eleXsys team in 2019, when we selected it as one of just a handful of what we call "FiReStarter companies" – companies using innovations in technology to change the world for the better – at our annual Future in Review conference.

Using advanced power electronics and AI software, its device increases grid hosting capacity for distributed renewable energy up to 200% of the distribution transformer rating, allowing for a significant increase in the amount of distributed energy that can be installed without requiring expensive network upgrades.

It's an invaluable asset even for utilities that aren't yet facing curtailment challenges – eleXsys can be installed either behind-the-meter or front-of-meter, making it an effective solution for multiple kinds of users and energy-market structures. It also does double duty as a grid balancer, automatically maintaining voltages within statutory limits.

And while eleXsys is a relatively young company, its technology is already being deployed in a variety of use cases around Australia that demonstrate its value to large energy ratepayers, utilities, and solar developers, reducing emissions, balancing the grid, and increasing distributed-energy hosting capacity.

- IKEA is using eleXsys technology as part of an initiative to power its stores with 100% renewable energy and to halve its global carbon footprint by 2030. The premiere eleXsys project at its Adelaide, South Australia, location will provide up to 100% of the store's needed electricity, include three EV charging stations, and help local utility SA Power Networks maintain grid balance.
- The Australian government is deploying the eleXsys platform as a solution to challenges with the distribution grid across Queensland. In partnership with utility company Energy Queensland, eleXsys devices are being installed in five test locations across the region.

- At Pasadena Shopping Center in South Australia, eleXsys is being deployed as part of a virtual power plant that will charge shoppers' EVs and will include a community battery to feed back into the grid during periods of high demand.

"[The] eleXsys energy management system will support the balancing of the electricity grid not just on stores in Australia, but across the IKEA network around the world," IKEA Australia CEO and chief sustainability officer Jan Gardberg said of the project.

"Large numbers of DER (such as rooftop solar and home batteries) are contributing to voltage management issues on Australian distribution networks," the Australian government's ARENA initiative explained in its project case study. "The eleXsys has the potential to increase DER hosting capacity and delay the need for more costly physical augmentation of the network."

“

We have to fix the technology. It's a one-way grid designed 120 years ago. We need it to go two ways, right? And we need to do that in a cost-effective manner.

**– Richard Romanowski, Co-Founder and Executive Director,
eleXsys; Strategic Advisor, Future in Review
100% Renewable Action Tank**

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Step 2: Accelerate Research, Development, and Deployment of AI-Based Grid Management

Artificial intelligence will be key in managing the transition to a decentralized grid. The teams of highly trained professionals that staff the control rooms of utilities, ISOs, RTOs, and other entities will still be needed.

But the work of maintaining optimal flow of electricity throughout the transmission and distribution grids could be much simplified by adopting AI-based technologies to help model energy use, production, and weather events. And this transition to an AI-centered grid is already underway.

"Utilities will have to decide if they are working with software companies, or if they want to become software companies in their own rights," wrote Emmanuel Lagarrigue of the French firm Schneider Electric, for the World Economic Forum Global Technology Governance Summit.

"These advancements require a shift in thinking from legacy models of capital investment in a few large energy generation assets to demand management of an exponentially growing number of privately owned assets – all while protecting customer data and privacy and ensuring cybersecurity of grid management."

In fact, in a detailed examination of the grid operated by the Electricity Reliability Council of Texas, RMI demonstrated that so-called "demand flexibility" paths to decarbonization are less expensive and can handle varying degrees of the job.

The study simulated hourly power use in a future, highly renewable Texas power system, showing that shifting the time and other variables when energy is used can boost revenues by up to 36%.

In addition, the measures reduced annual operating costs by \$1.9 billion, CO₂ emissions by one-fifth, and curtailment by two-fifths.

Demand-response technologies are still in their infancy, but their front-of-meter popularity in homes and businesses means they will play an increasing role in solving current-day grid balancing challenges faced by utilities.

ACTION ITEMS FOR FERC

Accelerate FERC 2222 Implementation Through Multiple Phases & Clear Deadlines for Execution

FERC 2222 was revolutionary in that it mandated that distributed-energy resources be allowed to participate in wholesale markets, forcing ISOs and RTOs to create marketplaces for their participation. But their timeline for implementation is too slow to help the US transition in time.

Implementing a multiphased demand-response market would allow for utilities, ISOs, and RTOs to test demand-response implementation with more stable energy storage assets before opening up the entire market.

An ideal inclusion of demand-response in FERC Order 2222 would:

- Begin with assets that can have the most impact today, such as standalone energy storage
- Mandate accelerated implementation of FERC Order 2222 to allow 1MW+ energy storage to participate
- Create specific timelines by which financial returns must be guaranteed through demand response efforts.

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We're seeing real momentum, and this is a really important shift in the industry's history. This journey that we're all on, this energy transition, is really complex – and in most cases, it's not yet fully charted.

**– Julia Hamm, Former President and CEO,
Smart Electric Power Alliance; Strategic Advisor,
Future in Review 100% Renewable Action Tank**

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ACTION ITEMS FOR UTILITIES

Incentivize the Voluntary Installation of Desired Demand-Response Technologies

This transition is an opportunity for utilities to influence the standards and fundamental mechanics of the distributed-energy ecosystem. Using ratepayer incentives and working closely with leading demand-response platforms, utilities can accelerate the voluntary adoption of demand-response technologies that can be leveraged to help balance distribution grid supply and voltage.

Tied with a requirement that new renewable installations include utility access to home energy storage, utilities could incentivize ratepayers to install systems that make the utilities' jobs easier rather than harder, without expensive upgrades to grid infrastructure.

Just look to the example set by the energy cooperative OPALCO, which serves a small island community in Washington state. Using an FDA grant for rural communities, OPALCO is offering zero-interest financing for energy-efficient devices, solar- and wind-generation capabilities, and energy storage systems for its consumers.

OPALCO's pilot program hasn't included any restrictions on types of devices or their specifications, but it's an excellent model for how other utilities might influence homeowners to adopt specific technologies to help ease the transition to 100% renewable energy.

Step 3: Continue the Accelerated Deployment of Energy-Efficiency Innovations in Homes & Businesses

Some strides have already been made in updating construction standards to prioritize efficient, green building and convincing US ratepayers to adopt energy-efficiency measures in existing homes and businesses. But there is still a significant amount of progress to be made on this front.

A 2019 report by the American Council for an Energy Efficient Economy found that "energy efficiency can cut US energy use and GHG [greenhouse gas] emissions in half by 2050, getting the United States halfway to its climate goals."

"The United States can achieve almost all these savings," the plan states, "worth \$700 billion in 2050, under an ambitious set of government standards, investments, and other policies."

The largest savings in this category will come from the continued adoption of efficient and electric vehicles, industrial efficiency and decarbonization, transportation-system efficiency, upgrades to existing buildings and homes, zero-energy new buildings and homes, and appliance and equipment efficiency.

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We must allow solar to be effective by making it not reliant on the grid, but [rather] installing microgrids in homes and businesses, putting control and generation in the hands of those who are affected by climate change.

– Stephen Honikman, Senior Vice President,
Electriq Power; Strategic Advisor, Future in Review
100% Renewable Action Tank

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Step 4: Rewire Existing Transmission Lines to Increase Energy Transmission Capabilities

Rather than building and siting new transmission lines, focusing efforts on rewiring existing transmission lines to carry much more power could revolutionize the drive to decarbonize the US grid – and on a much faster timeline.

California-based TS Conductor has introduced a transmission line with a carbon-composite conductor at its core, which can replace the aluminum core steel reinforced cable that has been common for more than a century.

Seattle-based Powerlight Technologies uses light to transmit power through the air or over fiberoptic cable, successfully transmitting hundreds of kilowatts over distances as great as 300 meters. Scaling-up this capability could be revolutionary.

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We've got most of the technologies that we need today. And there will always be new technologies coming around the corner – but it shouldn't stop us from getting on with what we have today, and using it, and then adapting the newer ones later as we move on.

**– Peter Newland, Chief Information and Strategy Officer,
eleXsys Energy; Strategic Advisor,
Future in Review 100% Renewable Action Tank**

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Step 5: Increase Research, Development, and Production of Mid- to Long-Term Energy Storage

In the world of grid planning, huge strides are already being made in long-term grid-level energy storage, with continued emphasis and funding coming from the Infrastructure Act, the DOE, and DARPA. Less emphasis and attention has yet been paid to smaller energy-storage solutions that can serve communities, medical and other institutions, and even individual homes. These are a critical part of the future envisioned by participants in Future in Review's 100% Renewable Action Tank.

Consider electric vehicles, for example, many of which run on lithium-ion batteries. Already the biggest battery in many homes, they can be configured to run a household for a short time in an emergency situation. But the most important potential use of EV batteries lies in the week-in, week-out balancing of consumer demand. They can be configured to recharge at the most opportune times of day, maximizing renewable use while shaving consumer costs.

Smart buildings can also become important assets in the energy storage ecosystem, allowing utilities to pull energy from office buildings to source residential power needs. At night, for example, when offices are usually empty and residential power use is at a peak, smart buildings could sell energy back into the grid to help utilities keep the distribution grid balanced.

So, why have smaller-scale batteries been given short shrift by utilities, grid operators, and planners? Some of the answer has to do with the limits of utilities to access front-of-meter batteries and the current near-total reliance on utility-scale solutions to the decarbonization challenge.

But it's also partially about cybersecurity.

Adding more internet-connected devices to the grid creates more opportunity for incursion into the system by hackers. At the moment, many lithium-ion batteries are manufactured in China, creating worry for US agencies that are already battling information and cyberwarfare from the international alliance of China, Russia, Iran, and North Korea (CRINK).

New standards for home and EV battery systems will be needed to ensure that microgrids minimize the potential for built-in back doors or deliberate vulnerabilities.



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Storage is going to be the thing that unlocks [the energy transition puzzle]. I'm a huge fan of storage. To build out 100% of the grid under renewables absolutely requires storage.

– Aaron Fyke, Founder and Managing Partner,
Thin Line Capital; Strategic Advisor,
Future in Review 100% Renewable Action Tank

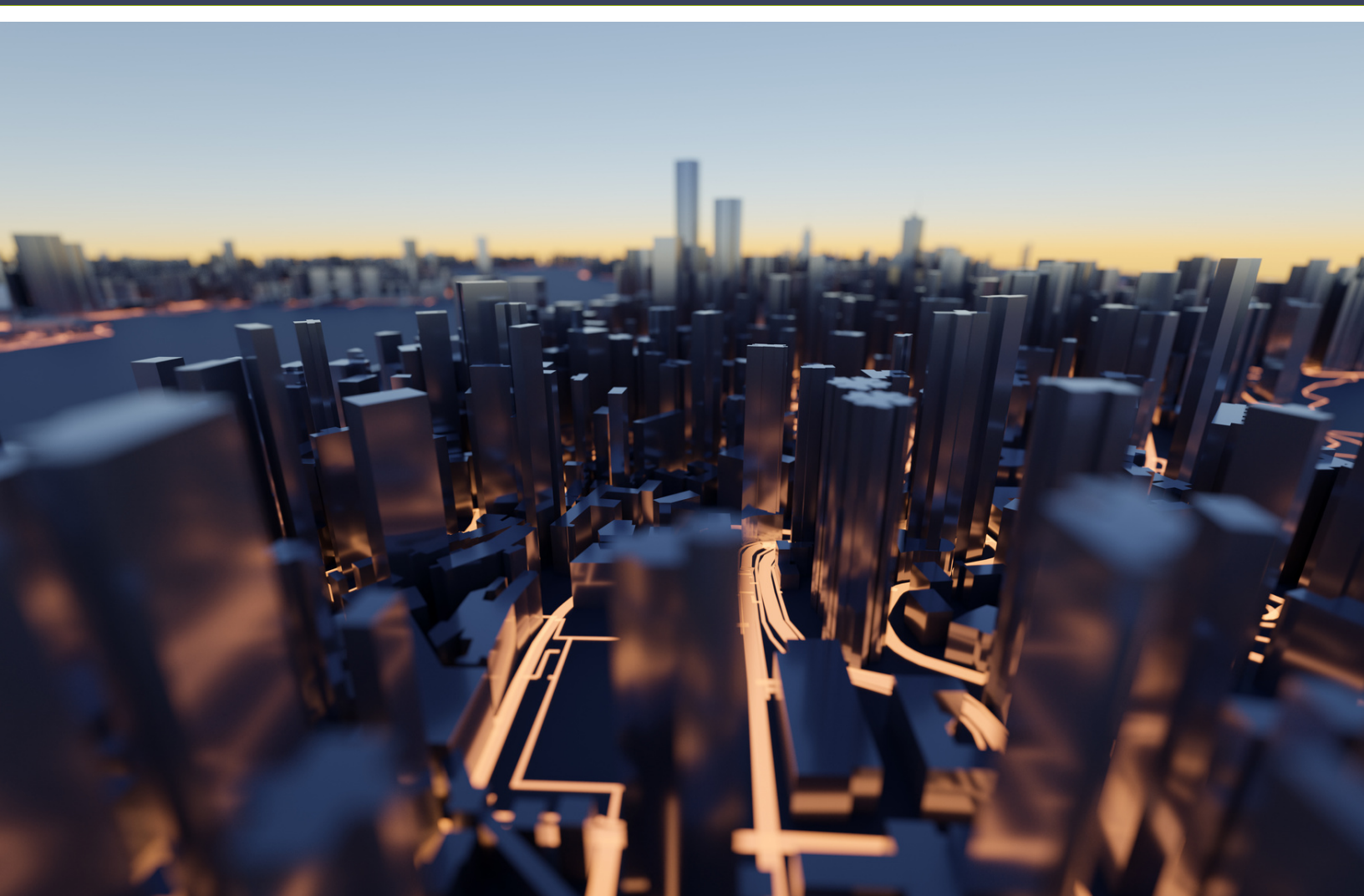
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It turns out that as you bring in modern AI techniques, you can really start to look at real-time data out of the grid about pricing, source of origin [. . .] weather patterns and weather predictions, etc., and you can start to manipulate those things in real time. [With the introduction of AI] every building becomes a smart battery in and of itself. Even smarter if there's actual batteries in it.

– Bert Van Hoof, President and COO, Willow;
former Partner, Azure IoT, Microsoft; Strategic Advisor,
Future in Review 100% Renewable Action Tank

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Step 6: Unite the Grids

Uniting the three North American grids would pay for itself, according to a National Renewable Energy Laboratory study, which estimated that it could save US consumers \$3.6 billion and reduce carbon emissions.

It would allow grid operators to purchase power across a wider swath of the nation. And it would create true competition among energy sources at a time when renewable solar and wind are the cheapest competing energy sources. When the Southwest is baking in midafternoon, its intense solar power could give Northeasterners juice to cook their dinners. As sunlight fades in the West, wind power from Texas or wind energy from the Eastern Seaboard could be shipped in.

Doing so, however, would take an act of Congress, as Ari Peskoe, director of the Electricity Law Initiative at Harvard Law School, told *The Atlantic*.

"[I]f your goal is a continent-scale grid – the kind that engineers working on decarbonization dream about – the policy will require Congress," he said. "Congress has to do it."

The Streamlining Interstate Transmission of Electricity Act, filed in August 2021, would have given FERC new power to approve interstate transmission lines. But that bill was referred to subcommittee soon after it was introduced. It has not yet resurfaced.

A bill that directs a uniting of the grid without giving FERC veto power over transmission-line siting would be both less controversial and less likely to get stuck in committee.

At the very least, FERC could compel the operators of the Eastern and Western interconnections to replace the aging interties between them, reaching the end of their intended lives at a half-century or so, with more advanced technology. They will have to be replaced soon, no matter what other ideas are in the wings.

LESSONS FROM HAWAII

So far, the state with the best shot at fundamentally changing the utility business model is Hawaii, one of three – along with Minnesota and Rhode Island – leading the charge.

With more than three-quarters of its electric power coming from imported petroleum or oil, Hawaii is in the early years of a regulatory reform that promises to truly transform the utility business model.

Hawaii is a special case because, by definition, it can't hook up to the grid. (In fact, each island has its own grid.) And Hawaii consumers pay the highest electric rates in the country – for now. Meanwhile, the state legislature has mandated that by 2045 the state use only renewable fuels. And legislators have forbidden the use of coal, prompting the shutdown of the island chain's only remaining coal plant in September 2022 – a plant that had been producing 16% of Oahu's power.

All these factors have propelled Hawaii to the vanguard of the performance-based regulation movement. Hawaii's system rewards utilities for:

- Exceeding requirements for the use of renewable power
- Offering faster connections of small-scale solar and battery systems
- Providing low- and middle-income consumers with ways to save money on their electric bills by better managing their energy consumption
- Harnessing the benefits of advanced metering infrastructure (AMI) – the integrated system of data management systems, smart meters, and digital networks that make communication possible between utilities and the customers' equipment in real time or near real time

The first order under this new regulatory scheme was directed at the Hawaiian Electric Co., which can earn, for example, \$3 million for hitting its target for bringing rooftop solar units onto the grid – but can also lose \$900,000 by not making the goal. Bringing enough renewable energy online by 2023 could net the utility a \$15 million profit.

An "earnings sharing mechanism" is designed to ensure that excessive earnings or losses outside a certain predicted band will be shared by the utility and consumers.

The Hawaii Public Utilities Commission projected that it would save consumers nearly \$70 million in the first five years, with average savings ranging from \$17 to \$33 per month, depending on location.

To help with the transition, Hawaii is extending its three-year multiyear rate plans to five years, a move that the Rocky Mountain Institute, which advised state officials on the process, says will provide "longer-term revenue certainty and more immediate cost recovery" for utilities supporting "nontraditional investment."

"This decision puts Hawaii in the lead nationally by reforming regulation to achieve a 'win-win-win' for customers, the utility, and the environment and climate," said Ron Binz, a former Colorado Public Utilities Commission chair who helped move along the Hawaii process as a consultant to Hawaii clean-energy nonprofit Blue Planet.

And other states are in the wings, waiting to see what might happen. Marissa Gillet, chair of Connecticut's Public Utilities Regulatory Authority, said in an interview that her commission is closely following Hawaii's experience with performance-based regulation because it's "the only state that has really tried to take it from soup to nuts."

Unfortunately, with just over six years to reach the United States' 50% emissions-reduction goal, we don't have time to wait and see how this will work out state-by-state.

We will need to move forward, coordinating public and private sector efforts, in a new model of public-private collaboration.

“

When you start talking about the algorithms that support security and all this, it's going to go right over the regulators' heads. It is imperative that we spend the time to educate them.

**– Amanda Martinez, CEO, Artemis Technology Group;
and Strategic Advisor, Future in Review
100% Renewable Action Tank**

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A COHORT-BASED MODEL

The key to moving quickly in transitioning to a truly two-way grid will lie in collaboration across states by like bodies and in close collaboration within states by the actors specific to that state.

State legislatures, FERC, the Department of Energy, public-utilities regulators, clean-energy entrepreneurs, and utilities themselves will all need to dive in headfirst, sharing their experiences, lessons learned, victories, and losses in collaborative spaces.

This approach represents a significant shift from the way things have been done, with many states and utilities currently still taking a "wait-and-see" approach.

Organizations such as the Smart Electric Power Alliance (SEPA) are already bringing utilities and technologists together to help accelerate the transition and learn from one another's wins and losses. And the Department of Energy has created spaces and opportunities to collaborate between the public and private sectors on many of the challenges outlined in this plan.

This kind of collaborative approach will need to be scaled-up across regulatory bodies in order to bring the US to a full reliance on renewables.

In the transition to a fully two-way grid, mistakes and losses will come. It is uncharted territory. When they do, it's this kind of cohort-based model that will help utilities, regulators, ISOs/RTOs, and the like dust themselves off, figure out what went wrong, and begin again in a new direction.

We hope this plan can help guide their collaboration.

ACTION ITEMS FOR YOU

Share This Plan with Utility Regulators & Legislators in Your State

Policies set by state legislatures and state utility regulatory bodies have been one of the most effective tools to accelerate the US transition to 100% renewable energy. Share this plan with your state legislators and utility commissioners to make sure they understand the importance of a two-way grid in advancing US energy independence.

Share This Plan with Your Local Utility

Utilities will be key in making the transition to a two-way grid. Share this plan with leadership at your local utility to help them understand the importance of transitioning to a fully two-way grid, feed-in-tariff metering, and how to make sure their business model will be resilient in the transition to a 100% renewable grid.

Install a Microgrid at Your Home or Business

If you have the capital and you own property, consider installing a microgrid at your home or business. Talk to your local utility – not just a developer of renewable energy – about any requirements or restrictions they might have, as well as their metering model for distributed renewables. To increase your personal resilience, make sure that your system includes sufficient on-site energy storage and that you can disconnect your microgrid from the distribution grid in case of emergency or power outage.

Join or Create a Community Microgrid Where You Live

If you don't own a home or simply don't have the capital to invest in a microgrid, you may still be able to join a community microgrid project, reducing your energy footprint – as well as your energy bills. If none exists in your community, consider reaching out to local community groups, environmental advocacy groups, and local government as potential partners in community microgrid development.

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- **Julia Hamm**, Former President and CEO, Smart Electric Power Alliance
- **Bert Van Hoof**, Past Partner, Microsoft; Group Product Manager, Azure IoT
- **Craig Lewis**, Founder and Executive Director, Clean Coalition
- **Amanda Martinez**, President and CEO, Artemis Technology Group
- **Ramez Naam**, Chief Futurist and Partner, Prime Movers Lab; Author; Co-Chair for Energy and Environment, Singularity University
- **Aaron Fyke**, Founder and Managing Partner, Thin Line Capital
- **Danny Kennedy**, CEO, New Energy Nexus
- **Jason Huang**, Co-Founder and CEO, TS Conductor
- **Stephen Honikman**, Senior Vice President, Electriq Power
- **Bob Galyen**, CEO, Galyen Energy; Former CTO, CATL
- **Mike Landau**, CEO, ParkMyFleet
- **Tom Nugent**, Co-Founder and CTO, PowerLight Technologies

Partners

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About Future in Review

Future in Review (FiRe) is a networking and events company that convenes leaders around the role of technology in solving the world's most pressing issues. The annual FiRe conference, which *The Economist* has called "the best technology conference in the world," explores the intersection of technology, economics, and geopolitics. From panel discussions among global leaders to pitches from cutting-edge startups, workshops on skills, and built-in networking opportunities, we have been bringing the FiRe tribe together for 20 years to problem-solve, innovate, and act as a cohesive group.

Contact Us

Have feedback on the plan? Want to get involved with *100% Renewable*? Looking for advice about how your team or organization fits into all this? We want to hear from you!

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