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The Sustainable Resilient Affordable Debates

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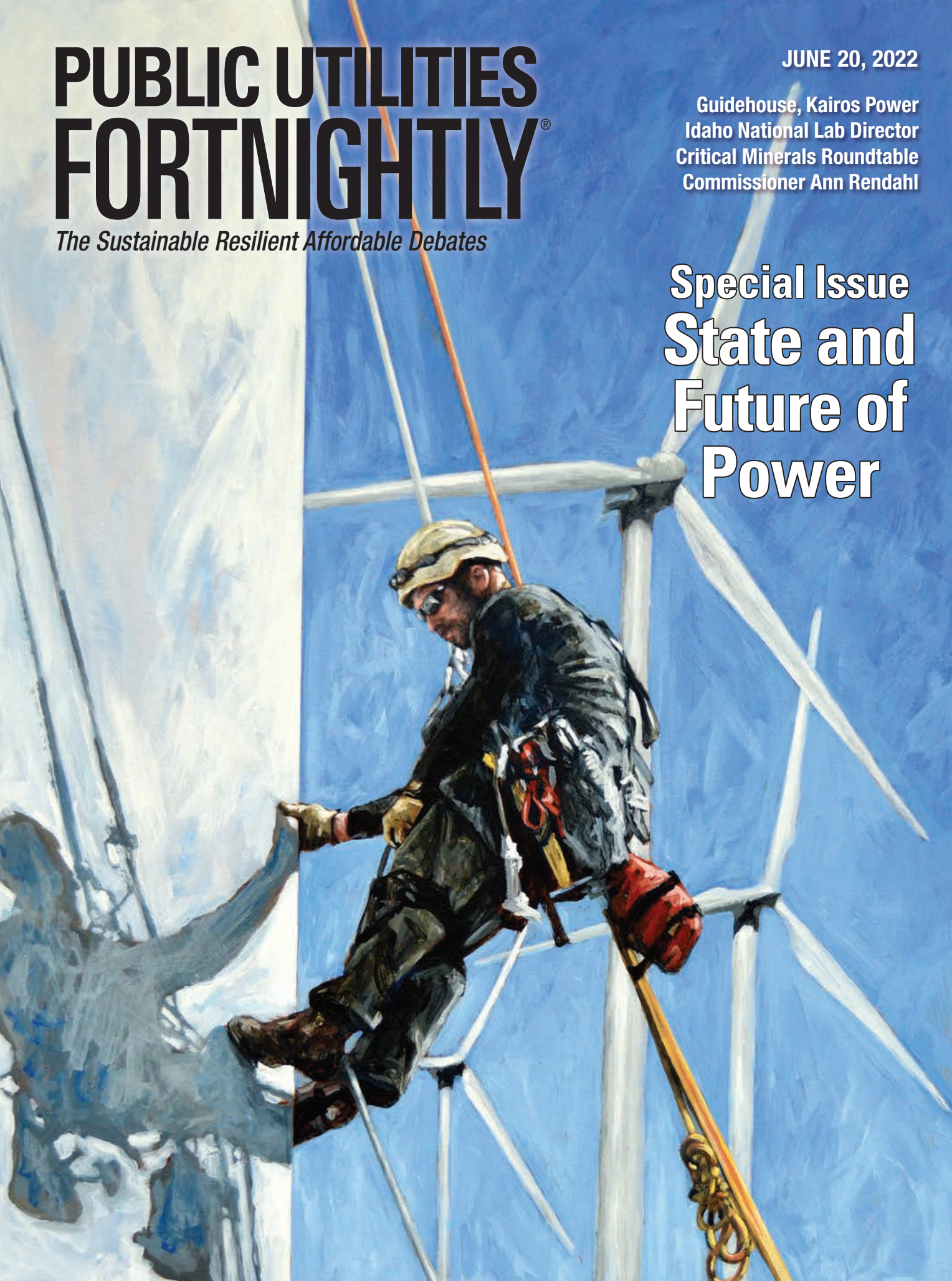
Special Issue
State and Future of Power



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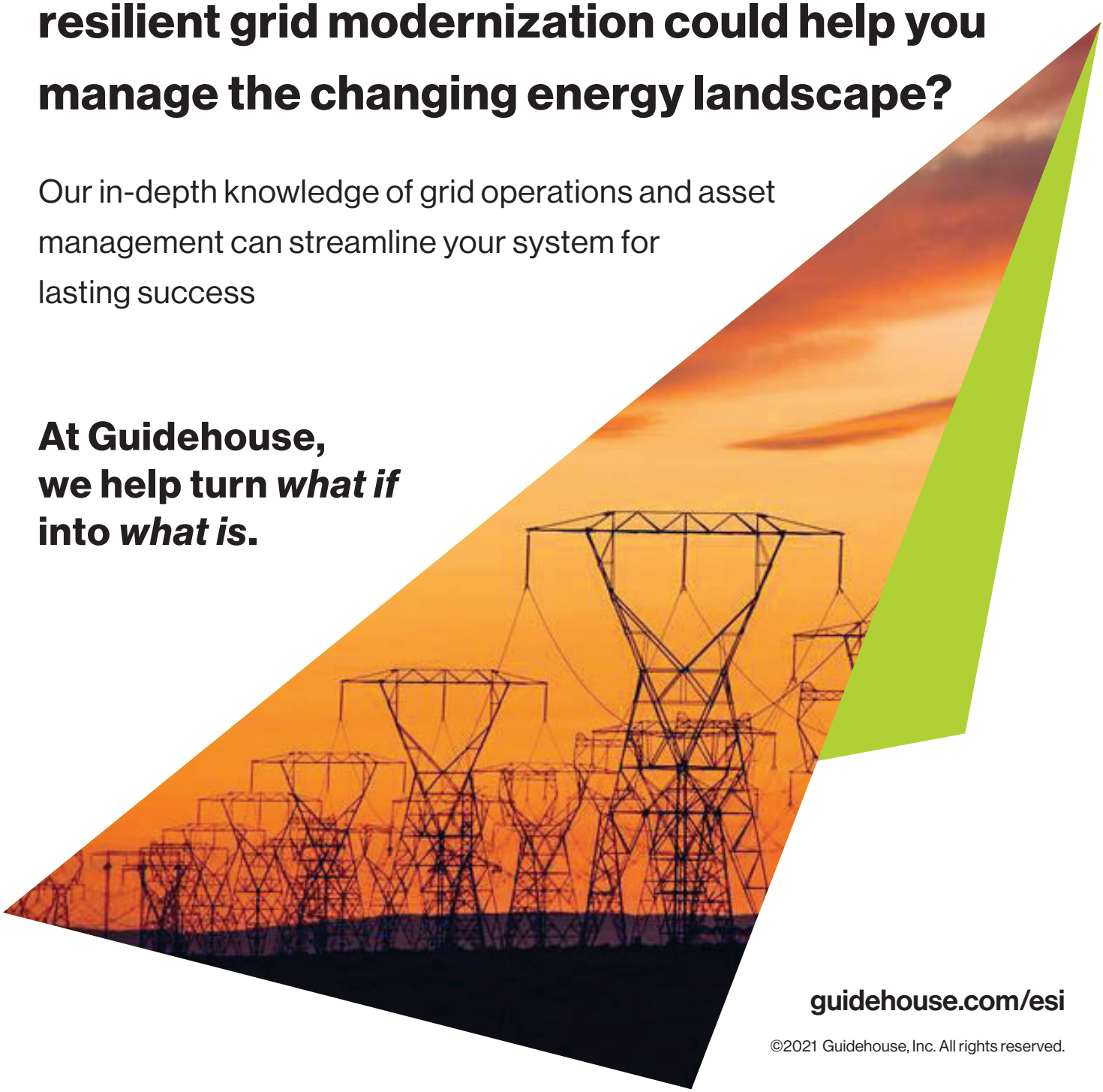

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Front cover, a painting by PUF's Paul Kjellander, "Borrowing the Wind for Power."

The Future is Fast

State of Power Accelerating, Future of Power Approaching

BY STEVE MITNICK, EXECUTIVE EDITOR

If you have been in the utilities industry since the late seventies as I have, or nearly that long, then you too will have survived the score or more years when the industry was accurately said to be slow, sleepy, sluggish, static, stagnant. You too saw the contrast with some other industries as remarkably refreshingly open to change, as I did, oftentimes embracing change with enthusiasm. And you and I knew throughout that period that this wasn't at all characteristic of our industry. Not even close.

A favorite saying, indicative of the age, supposedly came right out of the mouth of an industry exec. It went something like this:

"I don't want this company to be the first to do anything. I'd rather that we're the tenth company to adopt something new."

Fast forward to today. We sure are flying now. Utilities in the present aim to be fleet of foot. For them, nimble is a common buzzword. Fail fast is another.

The pace can be dizzying for us industry vets. So, I really must ask. Is this even the same industry? And one more thing. What exactly happened that made change and not continuity the norm?

Ok, let's go through the list. First, in no particular order, utility customers have come to expect more in a time when our phones and retailers confer instant gratification. Second, customers in the main are also demanding decarbonization, like fast. Third, a couple more d-words characterize the industry today as much as they didn't yesterday: digitization and diversity.

Another word about diversity if you please. Imagine a world in which virtually every utility officer and senior manager is an older white male. Well, I can picture that fairly easily. Since that is precisely how the industry was, until the last few years.

It does cause me to wonder about what is the cause and what is the effect. The accelerating transformation of the industry has resulted in, among other things, a huge increase in diversity. But what about the opposite causal direction? Has the huge increase in diversity helped to accelerate the transformation itself? I do believe so.

Fast forward to today. We sure are flying now. Utilities in the present aim to be fleet of foot. For them, nimble is a common buzzword. Fail fast is another.

And there's the role of innovation, sprung from Silicon Valley most prominently but elsewhere too, that's making our heads spin with so many new possibilities. Solar was expensive. Then it was not. Wind turbine sizes tripled, and capacity factors doubled. Don't forget offshore wind that only a couple years ago seemed to be a pipe dream.

Batteries burst onto the stage. And they are already being built at scale. Hydrogen hubs, mass electrification of transportation, ultrasafe modular nuclear; am I leaving something out? Surely, I must be.

It's an industry that's driving fast and furiously towards the future. And that future is unfolding before our eyes as if we're time travelling.

It seems like yesterday that our system operators managed baseload,

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Power's state and future seems less certain than earlier in my career. It makes our industry more dynamic, more open to possibilities, more susceptible to game-changing innovations.

intermediate plants and peakers to smoothly ride the load duration curve. Heck, we don't even have a deterministic load duration curve anymore. What with customer-side generation and storage, electric vehicle charging, and demand side virtual power plants.

It seems like yesterday when resilience – which we placed beneath the reliability umbrella back in the day – was a matter of restoring the poles and lines after a hurricane. But then that was before wildfires and cyberattacks joined the threat list.

Power's state and future seems less certain than earlier in my career. That's not so hot in some ways. Certainty is good for many aspects of what we do including financing our future. But it's white hot in other ways. It makes our industry more dynamic, more open to possibilities, more susceptible to game-changing innovations. It allows us to attract some of the best and brightest to work with us, to help craft that future.

The utilities industry is actually cool. Imagine that. No way you could say that in 1980, or in 1990, or even in the year 2000.

The nation and indeed the world is counting on us to deliver that future, as it is wanted and as it is needed. So, let's think it up. And then let us do it. PUF

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Making Less Vulnerable the Minerals Critical to Power's Future

Conversation with General Motors' Michael Maten,
Dominion Energy's Alex Moyes,
Center for Strategic & International Studies' Jane Nakano,
U.S. Energy Department's Grant Bromhal

The Energy Act of 2020 defines a critical mineral as a non-fuel mineral or mineral material essential to the economic or national security of the U.S. and which has a supply chain vulnerable to disruption. But there is a lot more to the discussion when it comes to where the energy and utilities industry is headed on the road to decarbonization.

The terms, critical minerals and rare earth minerals, are bandied about especially when it comes to electric vehicle batteries. It is important to realize, as renewables generally are more favored for reaching clean-energy goals, that solar photovoltaic plants, wind farms, and electric vehicles require more minerals to build than their fossil fuel-based counterparts. A lot more.

The shift to clean energy is driving a huge increase in requirements for such minerals, so the energy and utilities sector is among those vying for these markets. To figure this all out, PUF brought together four experts to discuss this important issue.

PUF's Steve Mitnick: According to General Motors, why should the industry find this subject of critical minerals important?

Michael Maten: The transition to electric vehicles is inevitable. It is the best solution to decarbonize the transportation sector. That means there's a massive role for batteries and electricity.

The best technology we have right now for batteries is lithium-ion and that's going to persist into the future. Perhaps we find different chemistries, elements that are more abundant, so that we can make more energy-dense batteries. That's what we hope will happen.

In the meantime, we're trying to go through this shift quickly and you see an article every day about this critical mineral. The bottleneck could very well be, not demand for electric vehicles but supply of the materials to make the batteries.

It gets more attention because of the semiconductor crisis today, but it will be a real issue in the late twenties unless we start thinking about the problem now. It involves a couple of things.

It's availability of critical minerals, but also about security of supply chains as we look to domesticate these supply chains. A lot of this capability is in North America and by building it here, you can guarantee sustainability and security.

We have to keep an eye on cost competitiveness and how we make that cost competitive. Batteries are more expensive than the alternative but there's so much money being thrown at this, there's so many smart minds and research that I know we're going to get there.

It's going to play a massive role in the way energy is distributed. You're going to have cars with enormous energy needs, but also enormous storage capability.

We are going to deploy essentially the world's largest energy storage network. We're going to have to think about how to use that asset efficiently.

Is everybody's car going to become a storage place for the grid? No, that's not what we're talking about, but they will be a part of this overall energy storage network that can be optimized for the best efficiency, given that some of the energy creation, solar, wind, is intermittent. Batteries become a big part of that energy equation.

The secret that not everyone knows, is for many of these critical minerals, the U.S. has them here domestically. They can be found in different sources across the country. But can they be recovered in a way that's environmentally friendly and can compete on cost?

– Grant Bromhal

Batteries are also a solution to some of the fast-charging needs as you build out the EV charging infrastructure. If you have four or eight or ten, three hundred fifty kilowatt chargers in a location, it's doubtful you're going to have a service that can support concurrent use of all those chargers. You're going to need some stationary storage that points to batteries, which gets us back to this critical minerals issue.

PUF: Turning to Dominion Energy, why is this subject important to one of the biggest utilities in the country?

Alex Moyes: Utilities are working with auto manufacturers like GM, Ford, Tesla because to charge their batteries they need reliable electrical services. We're intertwined, so the growth of EVs is also the growth of load for our system.

That means we're able to deploy more capital and that's how a utility earns income. We need to be in lockstep as these electric vehicles are hitting the market, so we're building a grid that can sustain it, but it also needs to be a grid that is green.

It needs to be as carbon-free as possible or else the benefit of an electric vehicle isn't as beneficial if you're still running the grid say, from a coal-fired generation plant. That's on the EV side of the mix.

The storage potential of vehicles is something we're looking at,

but one of the complications is often when we need to balance the grid, as that's not when they want us to drain their batteries and put that energy into the grid. Matching supply and demand can be challenging, which brings up the stationary storage concept that utilities are exploring in a big way.

There are some stationary storage options that are less critical mineral intensive. You might be using some of these ion flow type batteries that are less energy dense, take up more space, but require less critical materials. There are more materials available for these types of batteries but they're not necessarily commercially ready to go.

A lot of the grid in the U.S. isn't to a point where there are enough renewables on the grid that we're able to capture a lot of excess energy from. We do need to think about the storage side of things, once we have renewables built out enough that we're over-generating and can use that excess capacity to power when we have high peaks. There is going to be a critical mineral component whether it's a lithium backup battery or otherwise.

When we talk about low-carbon energy generation at Dominion Energy, we are all-in on offshore wind. Offshore wind has many benefits, such as a higher utilization rate compared to onshore wind, to solar. All three are important, but offshore wind is also the most material intensive of renewable energy generation.

We're in the process of building out one of the largest offshore wind projects in the United States, offshore Virginia, and there's going to be two thousand six hundred megawatts from one hundred seventy-six wind turbines. These are massive pieces of machinery that have a high critical minerals demand.

We're looking at about a million and a half pounds of rare earth elements that'll be going into those turbines to help generate electricity. When you scale that, since the world average grade for rare earth elements is about one percent, that's a lot of earth that needs to be excavated.

You're now talking about mined materials of over a hundred million pounds just for the rare earth elements in the turbines and a utility needs to think about that.

Our customers are not thinking about who supplied these rare earth elements to Dominion. They're looking at Dominion and saying, you have deployed this energy source, we hope you are using critical minerals that have been mined in a sustainable way, they haven't used any forced labor, haven't been coming from a mine that's done massive environmental damage.

These are questions that utilities need to be asking since currently the majority of critical minerals are processed in China. Many of them are also mined in China where mining standards are much lower than in Western nations.

We need to have our hands on what are the processes that they're using and how can we ensure that these mines are using low-carbon energy sources? Utilities should be partnering with mines and thinking about how we can help them power their operations with natural gas, solar or wind, and battery backup here in the United States.

Because of how interconnected autos, utilities, and mining are, we need to be partners and help each other make this as sustainable a transition as possible for the folks in North America.

PUF: Where are all these critical minerals? You have to know where they're coming from?

Jane Nakano: These critical minerals and rare earth are available in many places and it's not that they're rare, even when it comes to rare earth. One tricky thing about rare earth is that when people hear rare, they think it almost does not exist.

But it is rather rare to be able to extract, produce, and supply them at commercial scale. Rare earth and other critical minerals, there is certainly geographical concentration of these minerals.

We're in the process of building one of the largest offshore wind projects in the U.S., offshore Virginia, and there's going to be 2,600 MW from 176 wind turbines. These have a high critical minerals demand. About 1.5 million pounds of rare earth elements.

– Alex Moyes

For example, for lithium, there are four or five countries including China, also Australia, Chile, a couple others in Latin America that have large reserves.

When it comes to refining, that's where I stress that much of the refining capacity lies in hands of Chinese companies. That's where some of the geopolitical concern arises from multiple countries wanting to get more value out of minerals and turn them into consumer products, including electric vehicles, as well as renewable energy, power-generation equipment.

PUF: The Department of Energy is all over this subject, so talk about what the government is focused on and what the path is to make things better.

Grant Bromhal: The Department of Energy sees the rare elements of critical minerals as critical to the clean-energy future. Every energy aspect we're looking for in the next thirty years is going to require more use of these.

Projections from the International Energy Agency say critical minerals in general will rise by a factor of four times more than what's used today. Lithium will rise by a factor of over forty, graphite by a factor of twenty-five. Rare earth elements by a factor of seven, over what they are today.

We're already reliant on other countries and especially

China for most of these. The secret that not everyone knows, is for many of these critical minerals, the U.S. has them here domestically. They can be found in different sources across the country. But can they be recovered in a way that's environmentally friendly and can compete with others on cost?

The Department of Energy is trying to develop the technologies that enable us to do this sustainably, so we can meet these needs coming forward, including generating new extraction technologies and processing technologies.

In the group I'm working in, we're focused on waste material, for example, coal waste and acid-mine drainage. It turns out we can recover rare earth elements from these sources.

What we've seen so far, tells us we can recover rare earth elements and other critical minerals, like lithium, cobalt, and nickel from these waste materials. We're in the process of standing up the technologies that will show we can do that at a large scale, the next step toward commercialization.

PUF: What is GM trying to do to secure its ability to manufacture and sell a lot of electric vehicles cars?

Michael Maten: We're working across the entire EV ecosystem and plan on offering a full portfolio of electric vehicles. Starting of course, with the Bolt EV, Cadillac LYRIQ, and Hummer EV, which are out there today. Also, the Silverado EV that's coming out next year. The Equinox EV at a thirty-thousand-dollar price point.

We plan on offering a full portfolio of EVs for all uses, at all price points. We also have efforts in the infrastructure space with companies like Dominion to make sure the infrastructure is there.

We can't just focus on one aspect. We have to look at residential infrastructure. How can people charge at home or from their apartments?

Workplace charging is important. That's the other place vehicles spend a lot of their down time is at the workplace, even in a post-COVID world. Finally, public fast charging, which is going to be important for road trips to get people comfortable that they can get a charge.

Look into alliances with trusted allies like Canada, Australia, that we know are resource rich. To potentially form agreements to secure supply for all this capacity that's coming online in America and then longer term in the six- to ten-year timeframe.

– Michael Maten

The government with its 7.5 billion allocated for the charging infrastructure rollout, leaving the spending to the States. That's a critical step.

But frankly, the 7.5 billion is only a fraction of what is needed in that space. It's probably ten percent, maybe less.

On the supply chain side, working to build our capacity and assemble electric vehicles. We know how to assemble a vehicle. We're going to switch our plants over to electric. But also getting into the cell manufacturing space, making those cells right here in the U.S.

Critical minerals and rare earth are available in many places and it's not that they're rare. It is rather rare to be able to extract, produce, and supply them at commercial scale. There is geographical concentration of these minerals.

– Jane Nakano

We're trying to cover all aspects of the supply and demand equation and bring everybody along with us. This isn't something that can just be for the rich and trickles down. This effort can be used to create American jobs too.

PUF: What is Dominion doing to secure its supply chain?

Alex Moyes: This is such a new concept for most utilities. I don't know that the utility industry as a whole has got its arms around it. While we're – renewable energy companies – all working together, there's some level of competition for the natural resources required for the transition.

You're seeing the auto manufacturers leading the way. You've seen a lot of direct investments in mines to ensure they have the available supply.

You haven't seen utilities necessarily start moving in that direction, which would be an important step for utilities. Take rare earth elements and lithium for example.

GM and Tesla, among others, have gone into supply agreements and the direct funding of mining operations.

If you look at rare earth elements, we need a lot of those for offshore wind, but they need those same rare elements for their electric vehicle motors and communications technology. Those permanent magnets are so important in everything from the motor that rolls up your window, to the speakers inside a telephone.

People don't understand how many of these permanent magnets are in modern electronic devices. They all need rare earth elements.

Utilities are a bit behind on making sure we've got the supply. It would take about sixteen years on average to go from exploration to have mine production of critical minerals. This must be taken into consideration during planning for renewable energy deployment to ensure the demand is matched with sustainable supply, and in many cases, they are out of sync.

Utilities should be finding ways to look at the waste we have here in the U.S. The industry has generated a massive amount of coal ash and other byproducts. Dominion is looking into new, innovative ways on how we might be able to extract, in particular, rare earth elements from our coal ash.

Hopefully, that's something over the next few months, we'll have potentially more to say about. You've seen other utilities such as Berkshire Hathaway, which has geothermal assets in the Salton Sea. They've got a unique opportunity to coproduce lithium with their geothermal brine.

Depending on the assets utilities have, they might be able to directly contribute to the critical mineral supply. Those options are more limited than we would all like, but utilities do need to come together and explore those brine and coal-ash opportunities.

Utilities are starting to partner with large mining companies that are starting to install solar. There is an opportunity to at least partner, to make sure we're supplying as much clean energy as possible to these mining operations.

For our supply chain, we are trying hard to make sure those suppliers we buy from have secured contracts for these critical minerals. We do our best to ensure our suppliers are getting their critical minerals from nonconfrontational countries or countries using the highest environmental standards. But it's hard because traceability is almost nonexistent since the majority of the upstream and midstream supply chain is in China.

PUF: Jane, talk about what companies and governments are doing to address these problems of the vulnerability of supply. Not just in the U.S.

Jane Nakano: Let me speak more to what the governments are trying to do, as opposed to individual companies. Europeans have been looking at this intersection of decarbonization and industrial competitiveness for quite a while.

Securing the rare earth and critical minerals requirement for them is about being able to deliver on the decarbonization goal, and to expand their economic opportunities. I'd argue they've been ahead of the United States.

The U.S. has been focused on critical mineral supply chains, but more from a national security requirement perspective. It's rather recent that we've put two and two together that there's great economic opportunities to be seized.

There are other OECD developed economies interested in getting more value out of this ongoing energy transition. The Japanese and Koreans are heavily dependent on imports for some of the upstream supplies, but they have some midstream capabilities.

They're looking at ways to collaborate with mineral-rich countries, such as the United States. But also, with countries like Australia and Canada.

The permitting process takes a lot longer in the United States, than some other western economies with comparable respect for governance, sustainable mining, and labor standards. Such countries are more attractive as partners to some of these mineral-importer countries.

I want to note the Chinese are hoping to stay competitive. It took them a while to fully develop their supply chains. They were more of a simple supplier of rare earth and other minerals in the past.

But since the turn of the century, the Chinese have been able to capture more values out of their minerals and metals, also being able to manufacture clean-energy technology components and supply to the global market. They also face a supply and demand concern over minerals themselves.

Securing critical minerals supply is a concern universally shared among all the economies that have climate-mitigation interests and industrial competitiveness objectives. In the United States, it has lot to do with our desire to ensure that supply chain is secure so our energy transition will be geopolitically sustainable.

PUF: Grant, give an overview of what the U.S. is doing to address some of these problems and that the Department of Energy is looking into and working on.

Grant Bromhal: Diversifying supply, finding different sources, is one of the main things we're working on. DOE is also working on developing substitutes.

We're looking at ways we can use more available minerals that might have the same functionality as some of these rare earths now. For example, can we use sodium-ion batteries instead of lithium or find substitute materials for the rare earths in magnets that will still give them the same functionality?

We're looking at the recycling landscape. Now, recycling is not going to be a huge part because we're still in the growth stage, we're still ramping up. We expect if you take everything we produce now and look at end of life, we're not going to recycle our way to where we need to go.

We plan on offering a full portfolio of EVs for all uses, at all price points. We have efforts with companies like Dominion to make sure infrastructure is there. We can't just focus on one aspect. How can people charge at home?

– Michael Maten

In the next decade or so, we want to be ready with our technology, so we can get a significant portion of the materials we need for all these clean-tech energy technologies from recycling.

This is something we're looking at across the Department of Energy and government.

As we look toward the energy transition, there's going to be a significant change in the next ten to thirty years from energy resources in this country. There are going to be communities that are hard hit.

We're looking at working with those communities to make sure as we bring back this manufacturing base into the country, we're building their needs into this, we're keeping their air, land, and water clean, and also from a workforce development standpoint.

In addition, DOE is working across the government to do a better job at identifying what these future needs are going to be. Identifying which minerals and materials we need to focus on.

We're working with organizations like ISO to develop standards that are going to be used for mining, extraction, processing, refining of rare earth elements, lithium, and other critical minerals, so we can better play on a level playing field with other countries in this space.

PUF: In the next, three to five years, what can the industry do to help you move forward?

Michael Maten: It's important, what are the near-term needs? The infrastructure, those chargers have to get put in the ground, be deployed, and they have to work.

On the supply chain side, we have a massive amount of cell-manufacturing capability that's going to come online in the next three to five years in the U.S. Probably a couple one hundred gigawatt hours in the next five years, probably five or six giga-factories of cell-manufacturing capability.

At the same time, you're going to see the raw-materials processing. The cathodes, anodes, separators, electrolytes that go into those battery cells, most of that comes from Asia, largely from China today, but those factories will start to ramp up here.

What we're not going to see in the next three to five years is a lot of extraction because those projects are longer term, but that doesn't mean we don't need action. We need people at DOE, as well as other parts of government to take a look at where these minerals are. Find the best, most sustainable way to extract them.

Look into alliances with trusted allies like Canada, in Australia, which we know are resource rich. To potentially form agreements to secure supply for all this capacity that's coming online in America and then longer term in the six- to ten-year timeframe.

PUF: Alex, look three to five years out. What can the utilities industry, state governors, regulators, policymakers, legislatures do to help you succeed in strengthening our supply?

Alex Moyes: In the short-term, we have seen so many announcements for gigafactories over the last year, and that is great news.

There's a lot of capacity to build more batteries even here in the United States. But the announcements for new mines are lagging behind. We need to change the rhetoric. Right now, mining has a dirty past.

We need to focus on what is mining doing now and where is mining going in the future? Think less about the unfortunate past of mining, but lessons have been learned and we need to start creating an environment in the United States where we become pro-mining again.

That brings me to what I think is potentially a short-term and long-term challenge. One of the biggest risks we face in the United States is our students are not going into mining-engineering. They're not going into metals- and materials-engineering.

That's a big problem. We need to figure out how we get our youth excited about being part of the energy transition. We have not done a good job going into the high schools and colleges and explaining the connection between mining and our modern, technological society.

A lot of college students would tell you, We love renewables. They don't understand the connection to mining. That's something I'm working on with other academics on how we can better get that message out.

Here's an interesting fact. Take a one thousand pound electric vehicle battery, and for the nickel, cobalt, and lithium, you're looking at about five hundred thousand pounds of raw material for that battery.

If you look at the targets for electric vehicle deployments over the next twenty years, we will be mining more materials for those electric vehicle batteries than we have throughout all human history. That takes serious innovation.

In the near term, we're focused on waste streams. That is a fantastic place to start. We have a long legacy of mining in the United States. From the early days of mining, we have big waste piles, and big tailing piles, which hold a lot of these critical minerals that we can go back and reprocess. That's similar to the coal-ash story.

Tell the public this low-carbon energy system will be mineral intensive. That does not mean stay away from low-carbon energy technologies. Nor do I advocate complete shutdown of oil and gas wells because there is important value to what fossil fuels can do.

– Jane Nakano

Developing new technologies to be more efficient at reprocessing waste could be something that's going to make a big difference. The innovation part of it is going to be important.

We talk about replacements. There are fifty critical minerals that the U.S. has deemed critical. For about half of them, we are one-hundred-percent import reliant upon.

We are having these conversations about, what if we switch this critical mineral for this mineral that's less critical, but what could happen is called anti-innovation. We need to be careful because some of these critical minerals have important properties that are hard to replicate and using less efficient metals and materials would take us in the wrong direction.

We need to find a balance of not moving backward just for the sake of the supply chain. We are better off trying to figure out our supply chain and trying to do as much domestic production as possible, so we can continue to innovate, and not forgo these critical minerals because of our predicament.

PUF: Jane, what's your crystal ball? Where is this issue going in the next three to five years?

Jane Nakano: There is a continued need to tell the public

that this so-called, low-carbon energy system, will be mineral intensive. That does not mean we should stay away from low-carbon energy technologies. Nor do I advocate for complete shutdown of oil and gas wells because there is still important value to what fossil fuels can do.

There is an emerging recognition that we require a lot of mining, a lot of minerals to be able to expand clean-energy supplies. Communities need to become more aware that we can't say we want more wind turbines, but we don't want any mining for minerals and metals for wind-power equipment, while feeling economically secure.

There is always a trade-off. The high import dependence comes with a lot of the political concerns.

Go to high schools, go to elementary schools, just to let the kids start thinking about different opportunities. But the mineral supply chain will be more important, as there is this healthy rivalry not just between China and the west, but also among a lot of western economies, to be able to have more secure supply chains and create more jobs at home.

At the same time, though, there is a sense of the urgency when it comes to the climate crisis. The idea is to collaborate with countries that do have similar values, mining standards, and governance standards, to figure out where we could benefit from synergy, from interdependence that has brought about important benefits to different parts of economies in the past.

Going forward, I expect more discussion, especially in the short-term, on what to do with mining regulations. There's the federal level, with close to half a dozen key ones, and then state and local level permitting requirements.

Especially looking at what Europe is going through vis-a-vis the Russian aggression, just because it might require more mining, doesn't mean we should turn away from this EV transition or greater renewable power deployment.

The idea is to recognize that each has different energy security attributes, as well as climate attributes. Just because we transition to a certain type of energy system doesn't mitigate geopolitical concerns. They just come with a different set of stakeholders we need to deal with and try to find the best way to safeguard the critical mineral supply chains.

There's competition for natural resources required for the transition. GM and Tesla have supply agreements and direct funding of mining operations. Rare earth elements, we need a lot for offshore wind, but they need those for EV motors. Utilities are a bit behind.

– Alex Moyes

PUF: Grant, what's in your crystal ball the next three to five years?

Grant Bromhal: I'll start by using the word infrastructure. From a DOE perspective, I'll mention the bipartisan infrastructure law. There are significant resources in there, that we're in

(Cont. on page 42)

NARUC Executive Committee Member Looks Forward

Conversation with Commissioner Ann Rendahl
of the Washington Utilities and Transportation Commission,
and NARUC Executive Committee Member, and
NARUC Electricity Committee Past Chair

So much is going on in the energy and utilities industry out west that it seems impossible to keep up with it all. In an attempt to do that, the PUF team homed in on a Commissioner who is tough to track down, because she is everywhere, learning and doing in the public interest.

If you want to find out what is going on out west, you need to talk to Washington Utilities and Transportation Commissioner Ann Rendahl. That is because the region is considerably large, and it takes a ton of knowledge to understand all about it.

Washington State UTC, NARUC, the Body of State Regulators for the California ISO's Energy Imbalance Market, EPRI's Advisory Council, New Mexico State U's Center for Public Utilities are just some of the organizations that have benefited from her expertise. PUF's Paul Kjellander sat down with Commissioner Ann Rendahl and discussed the plethora of energy initiatives in the west she is engaged with. Enjoy.

PUF's Paul Kjellander: When I think of Commissioners who are active on power issues in the west, your name always comes to the top of the list. Is there any major effort there you aren't involved with?

Ann Rendahl: Given the number of efforts underway in the west, in multiple ways, I feel like I'm dipping my toe in the water. There are a number of amazing leaders of Commissions in the west who are making the effort. I'm not the only one.

I'm engaged, but others are also engaged in the Energy Imbalance Market, the Western Resource Adequacy Program, the Extended Day-Ahead Market conversations, the Markets Plus Initiative, and the NorthernGrid transmission planning organization.

There's a lot of engagement with western Commissioners and energy office staff. It's a great time to be doing this because there're a lot of people interested and involved in it.

PUF: You're at the cutting edge as you start to look at those things and how they're evolving in the west.

Ann Rendahl: It's exciting. It's hard to believe it's only been seven years since I started really engaging in this, so there's been a lot of movement. While there has been a lot of turnover in Commissioners, there's a lot of engagement. It feels good to be spending time talking about these issues.

PUF: Before we jump into what you see as the future and ask you to pull out a crystal ball of sorts, how would you describe the current state of electricity and power concerns as it relates to the west?

Ann Rendahl: There is a lot going on. As many issues as there are states and utilities in the west, there're a lot of issues in different regions.

The most critical issue right now is resource adequacy and making sure that in every state and for every utility, whether they're a public utility or investor-owned utility, that there is sufficient power, sufficient energy, because it could be both through demand response or actual physical capacity energy from generation, to get us through some of the difficult times.

That's whether it's the heat and the drought that's going on this summer and in past summers, or the cold, to get us through the cold and the dark with this important transition of energy that we're going through and how we can do so reliably. That's one of the critical issues.

It's resource adequacy, supply chain headwinds, and also market development. Those are the key issues in the west, regardless of whether you're a state with clean-energy policies or not.

The other most recently now, because of COVID and the geopolitical issues going on with Ukraine is supply chain. Supply chain is a big problem and how we're going to be able to build the new energy facilities, whether it's wind, solar, electric vehicle charging stations, and even nuclear. It's just basic steel in the ground too.

How are we going to get access to all of this, with the supply chain affecting both materials and the time it takes to get these built? And let's not forget labor and the difficulties finding people for the building trades. There are a lot of headwinds right now.

We've got the importance of the transformation and then we have the headwinds that are making it more difficult. But it's resource adequacy, supply chain headwinds, and also market development. Those are the key issues going on in the west, regardless of whether you're a state with clean-energy policies or not.

PUF: About fourteen states are part of the Western Interconnection and they're diverse geographically, politically, and in resources used to provide power. The Western Interconnection is the largest in North America. How difficult does that make it in trying to plan for the future?

Ann Rendahl: Diversity can be a challenge and an opportunity. Frankly, because it's a big place with lots of types of resources, the benefit of the market is that, for trading across the west, you can benefit from different time zones and diversity of resources, when wind comes on, or solar comes on, or where you have gas plants operating or nuclear, and let's not forget hydro.

That's huge. The benefit of having a diversity of resources that

might be generating at different times, is both an opportunity and benefit for the west.

The challenge is having significant resources coming offline, or the drought in the southwest and in California affecting hydro availability, affecting when you have gas line disruptions in the winter.

The diversity of resources is a great thing, but within different regions, it might pose problems if we don't have greater diversity. Connecting all the regions is critical to making the grid work.

PUF: As you look ahead, with so much you're engaged in, where do you hope the west might be in five years?

Ann Rendahl: I'm hoping that we have an effective day-ahead market that our utilities, whether they're public or private, can engage in to share the diversity of these resources.

Whether that expands to a full RTO, is another question. But it's been an incremental learning how to work with one another through the EIM and other efforts. I do see it coming together.

Now with the Western Resource Adequacy Program and where that ultimately goes, we need to get it off the ground and successfully implemented to address the resource adequacy issues.

But having a day-ahead market of some form, it's going to happen. There's enough interest and enough momentum behind it. Where it will be, how extensive it will be, whether there will be multiple markets, that crystal ball is cloudy.

We'll have to stay engaged. Many of the utilities are engaging and working on this, but also understanding that it's going to take some time to pull something together.

With the Western Resource Adequacy Program, we need to get it off the ground and successfully implemented to address the resource adequacy issues. But having a day-ahead market of some form, it's going to happen.

PUF: What needs to happen to see the future of transmission in the west evolve in the right direction?

Ann Rendahl: I was just attending the Western Interstate Energy Board's meeting jointly with WIRAB and CREPC from folks all around the west. One of the things that came out in our conversations about transmission is historically we have planned transmission based on where the resources were, looking at where the congestion was, and planning out going forward that way.

But now we need to take a longer look. We can't just look at the short-term contingencies. We need to be planning for where the changes in generation are going to be, not specific generation, because it becomes a chicken or egg problem.

If you're still using that model, you're not going to build transmission until there're resources. You're not going to get resources until there is firm transmission capacity. There has to be a different way of doing this.

DOE is implementing the Infrastructure Bill and its funding, looking at corridors in different ways. There are many initiatives

ENERGY VIEWS TV by PUF

Florida PSC Chair Andrew Fay on His EV Journey

Florida Public Service Commission Chair Andrew Fay literally takes us into his Tesla for a drive around his state in this four-minute video. Follow Chair Fay and see some of Florida's beauty and hear its PSC Chair reflect on the state and future of electric vehicles.

Watch at www.fortnightly.com

right now looking at transmission. We have to stop doing things the way we have been and look at how to get something built.

Transmission has just been built in the southwest, which is exciting, but it takes a long time. One aspect highlighted in the CREPC meetings was the west is different than other areas of the country. Many of our states have significant amounts of public lands and siting transmission across public lands is a difficult and timely effort.

In order to build more transmission, to get the diversity across the west of the resources, current and future, we're going to have to work better together. We're going to have to work together with our federal partners, state partners, and with the utilities.

It can't all just be the utilities planning it, it can't just be an independent power producer or independent transmission operator, it's going to take all of us working together to get this to happen.

PUF: Beyond being a leader in the west on power-related issues, you're also active at the national level with NARUC. You're coming off of a three-year stint as Chair of the Electricity Committee, one of the major committees at the national association.

What are you seeing on the national level that needs to be addressed?

Ann Rendahl: On the national front and from my perspective, having been Chair of the Electricity Committee at NARUC, which was a great opportunity, I learned a great deal about what was going on in other states. And because outside of California and Alberta, the west doesn't have an RTO or an ISO, there are other market issues going on nationally. One of these issues is how to ensure markets can effectively track clean-energy attributes.

How can we make markets work better to track compliance with the clean-energy policies that states, companies, and customers want? We want to be able to track, not just the energy and know what the price was, but we want to know if we're achieving the goals we have set forward for clean energy, and to have tracking or data systems in place to do that.

We want to to track, not just energy and what the price was, but if we're achieving the goals we have set forward for clean energy, and to have tracking or data systems in place to do that. That is a difficult nut to crack.

That is a difficult nut to crack. I know all the different markets are looking at it in different ways, while at the same time you want to make sure you incent sufficient capacity to serve customer load.

Then there is reliability. At the same time as we need to track clean-energy trading, we also need to ensure there is a reliable grid.

There are so many different pressures for reliability, whether it's extreme weather, cybersecurity or just sufficient capacity. Those are some of the key issues on the national front on electricity that I've been following. PUF

Lightning Round on Power's Future

Fourteen Guidehouse experts hit their buzzers and answer our questions: Hector Artze, Dan Bradley, Michelle Fay, Lisa Frantzis, Nicole Reed Fry, Ben Grunfeld, Derek Jones, Robyn Link, Chris Luras, Macky McCleary, David O'Brien, Molly Podolefsky, Danielle Vitoff, Ted Walker

You have a short elevator ride alone with the chief executive of a major utility. What would you want to tell him or her?

Macky McCleary: Clean, affordable, reliable electricity is within our reach, but without significant upgrades to the electric distribution system, the affordable and reliable goals will get further and further from our grasp. Integrating intermittent clean-energy sources into our existing generation fleet will require a more complex and flexible control system than is our current infrastructure.

Our current electric distribution system was built for the previous century. It is aging, expensive, and built for one-way power flow. Grid animation to flatten out demand curves will drive significant savings for ratepayers, but it's hard to fix the plane as we are flying it.

Regulators (Public Utility Commissions, ratepayer advocates, etc.), utilities, product manufacturers, and telecommunications companies are uncomfortable bedfellows, and a fractured regulatory environment makes this a challenging space for systemic change.

Nonetheless, systemic change is certain to occur. We are in the midst of the largest investment in infrastructure in two generations. The time is now for utilities to seize the day and invest in new services, and new relationships with customers and communities.

The breadth of the Bipartisan Infrastructure Law – from broadband to electric vehicles – presents an enormous opportunity for public good, which is why utilities were created in the first place. ❍

The utility's customer relationship continues to evolve. What innovative approaches and programs are you seeing emerge across the utility landscape?

How are utilities moving beyond the customer (and including the broader community) to facilitate a fair energy transition?

Robyn Link: Utilities are positioned to be the orchestrator for change, bringing their customers together to achieve improved and more equitable outcomes, but they cannot do this alone. For their part, utilities are building next-generation solutions to facilitate a fair energy transition through several key efforts:

Personalized digital customer experiences to both guide and engage customers on their energy use, taking advantage of increased data availability and advanced analytics solutions;

Comprehensive program aggregation strategies are increasingly leveraged to merge energy efficiency (EE) and distributed energy resource (DER) programs that maximize operational and systems benefits while giving customers cleaner energy choices;

Market-based pay for performance approaches designed to promote innovative projects are being used to offset the saturation of traditional programs and lagging cost-effectiveness;

Fuel switching pilots for hydrogen – driven by DER maturity and regulatory emphasis on decarbonization – are increasingly coupled with customer-centric strategies and high-touch customer engagement to balance the energy transition; and

Utilities should also rely on their relationships with partners – vendors, customers and their communities, and state and local governments – to create programs that accelerate decarbonization and energy equity goals.

For example, through stakeholder engagement, utilities are making programming more accessible through communities and equitable for customers. Utilities are also applying workforce development strategies to drive community and energy savings growth through career assistance and up/re-skilling for emerging green jobs. Climate change impacts are here, but so is the growth of flexible, resilient, and low-carbon grids capable of delivering more affordable, equitable, and reliable power. ❍

Absent regulatory requirements, what immediate steps can utilities take to become Environmental, Social, and Governance (ESG) leaders in the power industry? How can the industry more effectively meet evolving societal, shareholder, and board expectations?

Molly Podolefsky: Regulatory requirements by the U.S. Securities and Exchange Commission, still undergoing public comment, signal that ESG has moved from the periphery to mainstream corporate practice. Absent regulatory requirements, the underlying imperatives are immediate and serious enough to warrant priority attention and action by utilities.

As the incidence of climate-related disasters and market disruptions accelerates, society looks to utilities for leadership, increasingly holding them accountable for either compounding or mitigating these threats. Utilities can lead the charge in combating climate change, stabilizing markets, and protecting society, thereby meeting evolving stakeholder expectations, while at the same time maximizing shareholder value and capturing upside from the energy transition.

But first, utilities must evolve beyond a compliance and risk avoidance-based approach to ESG, instead embracing ESG as a tool for value creation. This means engaging the full spectrum of internal and external stakeholders in a thorough materiality assessment, identifying risks, and highlighting opportunities for change, constructing, and implementing a comprehensive ESG strategy, and reporting on goals and achievements through annual ESG reporting.

By leveraging ESG reporting as an opportunity to control their sustainability narrative, public utilities can positively affect internal and external stakeholder perceptions and understanding of their role as good stewards and responsible partners driving social and environmental good.

Second, utilities must move urgently to understand, control, and report on their Scope 3 (upstream and downstream)

emissions. Public utilities must put processes and systems in place to track these emissions effectively, and to monitor and report on improvements. Utilities must start engaging with their supply chain in a meaningful way in order to create the leverage they will need to reduce upstream emissions in the future.

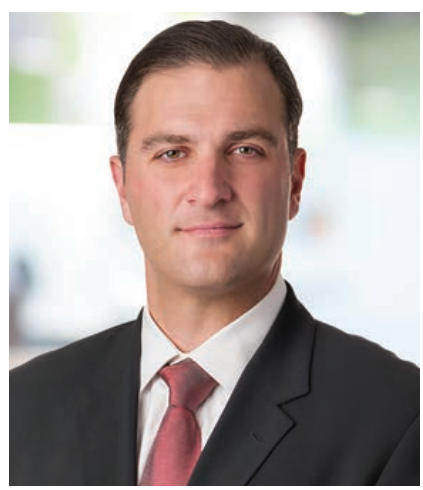
Finally, utilities should educate their boards and executive leadership about ESG topics and set up good governance. Boards should receive regular updates on material ESG issues throughout the year and be charged with approving the utility's annual ESG report. Utilities should also form an ESG committee responsible for fostering ESG awareness throughout the firm and supporting operating units and management teams in achieving their ESG goals. ❍

Cybersecurity threats to the grid have increased substantially in recent months. What should utilities do to protect information technology (IT)/ operational technology (OT) systems and digitally enabled physical infrastructure?

Chris Luras: Given the recent rise in threats and cyberattacks to the U.S. electric grid, utility leaders should take the following actions:

Play defense: Validate and fortify the security of your perimeter defenses. Boundary protection for OT systems, specifically substations, typically composed of firewalls, anti-virus and intrusion detection/protection systems (IDS/IPS).

However, utilizing Software Defined Networks (SDN) focusing on the OpenFlow 1.3 standard, allow for specific ingress/egress communications on network layers 1 through 4. When used with traditional firewalls, SDN replaces the switch inside critical networks and can provide



specific ports/protocols to specific physical ports, allowing for only the network traffic designed into the substation.

This removes the need for virtual local area networks (LANs) by segregating layer 2 traffic, limits network traffic to only authorized communications, and provides added benefits such as allowing all unknown traffic to be directed to a separate physical port for inspection by and IDS/IPS.

Since substations are static, with few changes, SDNs provide the known traffic communications needed and expected within a substation, thus increasing the security within and between devices on critical OT networks.

Take inventory: Assess, validate, and ensure accurate inventories of key assets (staff, applications, data, vendors, etc.) and critical points of failure, and review maximum allowable downtime estimates to manage risk exposure. Importantly, ensure segregation of operational technology from your mission-critical IT systems and data resources from the rest of the organization.

Plan ahead: Run scenario-based simulation tests to prepare and identify any gaps in your security and resiliency plans.

Engage stakeholders: Meet with key suppliers to understand their level of vulnerability to supply chain, communication, and energy disruptions.

Have a crisis communication plan: Review and enhance your Incident Response and Crisis Management capabilities, recovery and communications plans, and contact lists. Open clear escalation channels to high-risk areas of the business to establish a rapid-response capability.

Review third-party agreements: Review and confirm agreements for your third-party incident response support by asking questions such as: Is your organization guaranteed priority support in the event of widespread problems? Is this documented in your service-level agreements? Do you have a backup, or alternate, provider?

Implement security framework best practices: Finally, implement security best practices and guidance provided by security frameworks such as ISO-27001 and NIST 800-53/800-171. ❍

How can gas utilities preserve their business value as society transitions from fossil fuels? What role can hydrogen play in diversifying the natural gas business case?

Danielle Vitoff: As the energy system decarbonizes, we will see a sustained move away from fossil fuels, which raises the question: What will happen to businesses like gas utilities that are built to deliver fossil fuels?

The answer for gas utilities and the gas system as a whole requires understanding that the gas system infrastructure is different from the molecules that flow through it. Gas utilities currently own an incredibly effective and resilient energy delivery system, one that provides redundancy to the current electric system and is critically important when it comes to ensuring continued energy service through extreme weather events.

In fact, as we highlighted in our work with the American Gas Foundation, during the January 2019 Polar Vortex in the Midwest, the gas system in the Chicago area delivered three and a half times the amount of energy as was comparatively delivered by the electrical system in the same geographic area.

As we see increasing electrification and resulting load increases on our electric system, it is also unlikely that in just a few decades we will also be able to build enough new electricity infrastructure to replace energy delivery through the gas system during resilience events.

Currently, gas utilities are not explicitly remunerated for the insurance value that

their systems provide, but perhaps they should be?

Following logical decarbonization pathways of the energy system through the mid-twenty-first century shows that gas systems will have significantly fewer therms moving through them, even as natural gas is replaced with low- and zero-carbon fuels, such as renewable natural gas and hydrogen.

Meanwhile, it will become increasingly important to have that gas available when it is needed, such as, in response to resilience events. Understanding the value for gas utilities and the gas system as a whole increasingly requires a vision for the implications of decarbonization and delivery across the entire energy system, taking a holistic view of what each portion of the energy system is best suited to deliver. ❍

The federal government's Producer Price Index data for the month reported, April, showed sharp increases in energy prices. Coal was up 43.5% year-over-year, natural gas 107.4%, residual fuel 52.8%, gasoline 55.0%, diesel 86.5%, and jet fuel 127.5%.

For residential consumers, electricity was up 10.6%, natural gas 24.6%, and home heating oil 118.4%. For commercial consumers, electricity was up 9.4% and gas 28.4%. For industrial consumers, electricity was up 11.0% and gas 29.1%. For electricity generators, natural gas was up 47.6%.

Climate change poses an unrelenting threat to physical assets and business continuity for utilities. What can utilities do to improve resilience in the next three years and increase business continuity readiness?

Hector Artze: A growing number of institutional investors, state utility regulators, and the SEC are bringing focus to climate-related risk reporting. Utilities across the globe are coming to the realization that many recent extreme weather events exceeded all historical records, and that in certain regions the frequency of severe weather events is growing. Therefore, it is important to understand the threat climate change poses to their physical assets and financial performance.

Utilities should quantify their risks from extreme climate hazards by using downscaled stochastic climate models to understand acute physical risks such as extreme wind and flooding, and chronic risks such as extreme heat and cold, which have unique impacts on an asset's failure modes, and by using their asset data to understand the probability of failure and impact across the utility footprint and time.

By quantifying this risk, utilities can:

Substantiate and prioritize investments to improve system resilience and improve business continuity;

Develop and implement resilience programs that mitigate both acute and chronic risk;

Integrate the results in their infrastructure planning processes, and in the development of future-proof standards; and

Be prepared to comply with climate-risk disclosure requirements.

We expect that utilities will incorporate climate change impact to inform their strategy, and to transform their planning and business processes. ❍

How can utilities partner with their customers to accelerate decarbonization initiatives? How have we seen utilities shifting more decarbonization choices to their clients?

Dan Bradley: Decarbonization is an economic imperative for multinational corporations. Of the Fortune Global 500 companies that have combined revenues of thirty-two trillion and employ seven million people around the world, nearly four in ten have delivered a significant climate milestone or are publicly committed to do so by 2030 and that is increasing each year.

Small and midsize businesses, communities, and cities are also committing to significant climate milestones. As the world moves toward a net-zero future, these utility customer segments are no longer asking if, when, or why to decarbonize. They want to know how to decarbonize now.

Today, leading utilities are ramping up energy efficiency and demand-side investments that are provided to customers through a growing number of programs. Utilities can improve the decarbonization choices to their customers by increasing the speed to market of customer-centric programs that are tailored to customers along with a modern customer experience.

Sustainability as a Service (SaaS) is an example of one such commercial customer program. SaaS entails bundling products and services within the customer experience to provide bespoke decarbonization choices and the tools to measure the investment yield of the carbon savings.

Connected Communities is an example of a community or municipal program. Utility and community partnerships are the new channel to the mass market for decarbonization investments.

Community engagement can also be tailored to address disadvantaged communities, vulnerable populations, and social justice. The program connects customers' needs with products and services that address issues such as access, workforce development, resiliency, and air quality.

Looking ahead, we see utilities adapting their business model, organizations, and programs to better partner with customers to accelerate the speed and scale of investment in decarbonization measures. ❍

Nineteen percent of U.S. carbon dioxide emissions in 2021 came from coal-fired electricity generation.

Regulatory constraints impede dynamic innovation, say utility executives. How can regulators support aggressive innovation and optimize outcomes for all?

David O'Brien: When you think about it, innovation has always been a natural byproduct of competitive business. Innovate around your customer, bring them new technologies, new features, reinvent the vertical, all to create value for customers and shareholders. As the linchpin to success, innovation has been table stakes in competitive business.

In the regulated utility industry, the emphasis has been on providing service. As a natural monopoly, the business model was built to ensure reliable service and fair

treatment to all customers. It was built as a do-no-harm system; not one to foster creativity and innovation.

In 2022, the conditions have changed dramatically – customer expectations in the digital age are entirely different. The distributed energy system is upon us.

Regulators need to reimagine the regulatory system to provide the degrees of freedom in the process for utilities to innovate and offer a financial reward for bringing them to customers. ❍

What can utilities do to position themselves to succeed and access funding under the bipartisan infrastructure law and related initiatives under the Biden administration?

Nicole Reed Fry: The Bipartisan Infrastructure Law (BIL) funding presents a historic opportunity for utilities to upgrade infrastructure, advance climate initiatives, improve resiliency, and expand transportation electrification, while at the same time strengthening community partnerships and supporting underserved communities.

Utilities can start by recognizing this transformational opportunity, devoting leadership and resources at the beginning, and examining the funding opportunities they may be well-positioned to pursue (both directly and through partnerships).

BIL funding program opportunities will likely range from those with clear alignment with existing or planned projects (where federal funding may help drive down costs to customers) to programs where federal funding can tip the scales to bring emergent projects to life, to funding that could accelerate entirely new, innovative programs that put utilities at the forefront of a cleaner and more resilient energy future.

Thinking strategically and proactively about BIL funding now – while conducting targeted outreach to potential partners such as state and local governments – can allow utilities to identify the high-value opportunities with shared interests and alignment that can enable utilities to take advantage of the historic opportunity in front of them. ❍

What are the critical challenges utilities face in deploying long-duration storage and transmission and what critical actions should they take today to increase capacity for renewable integration?

Lisa Frantzis: Lithium-ion batteries are typically the storage technology being used for four to eight hours of storage, and the average pumped hydro system is roughly ten hours. Both are insufficient to solve multi-day reliability challenges alone.

Emerging technology options like iron-air (Form Energy one hundred hours-plus), hydrogen in salt caverns, or thermal storage using molten salt (Malta for ten to two hundred hours) hold promise to transform intermittent renewable energy to perform more like firm dispatchable assets to the grid. »

Utilities must scale these newer technologies to drive down costs and provide proof points for more wide-scale deployment.

With transmission, utility companies are challenged by a lack of situational awareness on their lines, as well as the need for increased capacity for new renewable generation. Today, U.S. Energy Information Agency estimates that less than one percent of transmission lines globally are monitored and Lawrence Berkeley National Laboratory notes there are nearly a thousand Gigawatts of interconnection projects stuck in the queue.

Companies like LineVision help address these challenges as their non-contact sensor-based platform is able to equip grid operators with data on the performance of their transmission lines and unlock additional capacity through dynamic line ratings, enabling operators to reduce interconnection queues while also providing real-time system visibility.

Utility companies should deploy dynamic line-rating technology, as it is able to create additional capacity and enhance system resilience at a fraction of the cost of traditional projects without requiring time-consuming permitting processes. ❍

What immediate actions can utilities take to unlock benefits and social equity for stakeholders from trends in electrification in transportation and buildings? What are utilities behind on or what bottlenecks will need to be overcome?

Derek Jones: Promoting energy independence, sustainability, and resilience through building and transportation electrification without impeding customer and societal objectives is paramount for utilities. There are abundant opportunities to unlock benefits and social equity for stakeholders through full-site conversion. Full-site strategies will address fleet, facility, and fuel conversion needs through a controlled, low-risk implementation platform.

If the platform addresses the four conversion priorities – acquisition, infrastructure, interoperability, and change management – utilities can avoid becoming a bottleneck in this transition. Proactive platform implementation can also provide an on-ramp to financial, operational, environmental, and equity benefits for utility stakeholders.

The biggest mindset shift for utilities is recognizing that the pace for this global transition is fueled by relentless innovators, aggressive non-utility-centric policy goals, and swelling capital market infusions – and they better keep up! ❍

Hector Artze is a Partner in Guidehouse's Energy, Sustainability, and Infrastructure. His professional career spans more than 30 years in the electrical utility and energy fields. Hector is the ES&I's global growth lead for energy transformation and infrastructure resiliency. He assists energy, utility, and public sector clients plan for the transition to Net-Zero carbon emissions; build infrastructure resiliency to mitigate the impact of natural disasters and climate change; modernize their utility systems; reduce the cost of operations and maintenance through process automation, optimization, and technology; and manage asset investments.

Dan Bradley has worked with clients to develop strategies, grow earnings, deliver outcomes, work with stakeholders and testify before regulatory commissions. Dan's most notable recent work centers on his role as director-in-charge of REV Connect, where he is helping the State of New York advance its Reforming the Energy Vision (REV) goals through a first-of-its-kind program that facilitates partnerships between innovative companies and utilities. REV Connect was named Utility Dive Project of the Year, and Dan was named a runner up for Public Utilities Fortnightly's Innovator of the Year awards for his role.

Michelle Fay is a partner in the Energy, Sustainability, and Infrastructure segment supporting clients as they implement transformational programs. She brings more than 20 years of experience planning and delivering complex and innovative programs for utilities. Michelle's expertise includes program and project management, organizational change management, account management, process and performance improvement, grid modernization, energy efficiency, analytics. She is an experienced leader specializing in emerging technologies and is respected for her integrity, leadership, team building, strategic planning, and laser-focused execution.

Lisa Frantzis is a partner in Guidehouse's Energy, Sustainability, and Infrastructure segment, responsible for decarbonization go-to-market initiatives such as clean hydrogen, e-mobility, and renewable energy solutions. Throughout her 40 years of consulting experience, she has determined clean energy integration options for utility companies; identified energy program options for international government agencies; developed business strategies for clean energy manufacturers; and conducted due diligence for financial firms considering clean energy investments. Most recently, she is leading Guidehouse's Hydrogen Consortium, Building the Clean Hydrogen Economy, with over 20 companies working together to create and launch innovative pilot projects/hubs that use clean hydrogen to decarbonize heavy transport,

What role should utilities play in facilitating innovation from industry stakeholders, including oil & gas, automotive, tech, telecom, and others? What investments and programs should integrated planning prioritize to support?

Ted Walker: Utilities are at the core of the clean-energy value chain and are well-positioned to own and optimize key parts of the emerging Energy Cloud. Utilities should embrace this role and drive collaboration with other players (as opposed to putting up walls to protect their franchise).

New sustainability-focused customer solutions will require once-disparate industries to collaborate. For example, a regional transportation electrification initiative will have a much bigger impact if automotive manufacturers, traditional oil & gas players, governmental entities, major customers, and utilities all work together. A utility going it alone will likely have a much smaller impact.

Multi-decade planning horizons are nothing new to utilities, and a similar approach is needed to drive innovation. We see innovation investments in two categories:

Clean energy grid optimization – investments that make the T&D grid more resilient and robust, including DER integration, EV smart charging, climate resiliency, etc.; and

Clean energy ecosystem engagement – investments that facilitate innovation across the value chain, including market engagement programs, open innovation platforms, joint sustainability-as-a-service offerings, etc.

By taking a lift-all-boats approach, utilities can optimize the clean energy outcomes for all stakeholders, while optimizing their own bottom lines. ❍

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increase renewables integration, and decrease emissions in the U.S. energy sector.

Nicole Reed Fry is a Director in the Energy, Sustainability, and Infrastructure segment, focusing on strategy, planning, and evaluation for energy efficiency demand-side management and distributed energy resources. Nicole works with government, utility, and private sector clients, leading projects related to market transformation, impact and process evaluation, customer engagement, energy efficiency financing, and market strategy. Prior to joining Guidehouse, Nicole spent four years with the Office of Energy Efficiency and Renewable Energy at the U.S. Department of Energy, where she managed policy and programs focused on innovative energy efficiency initiatives.

Benjamin Grunfeld is a partner in the global Energy, Sustainability, and Infrastructure segment and the European and Middle Eastern utility and energy company sector leader. He is a trusted advisor to senior leaders across the entire energy sector value chain. Benjamin has considerable consulting project experience in the areas of strategy and operations, mergers and acquisitions, project development and finance, energy efficiency and demand-side management programming, regulatory economics, electricity market design and operations, and energy policy. He is a recognized expert on the energy sector globally and has served as an expert witness in regulatory and civil matters.

Derek Jones is a Director in Guidehouse's Energy, Sustainability, and Infrastructure segment where he leads the Mobility Solutions group. Derek has over 15 years of experience in the transportation and energy sectors. Derek manages teams bringing leading syndicated research, direct industry experience, and proven consulting expertise, to develop outcome-based solutions that enable a sustainable future. He supports market actors across the ecosystem – including utilities and energy providers, automakers, equipment manufacturers, service providers, and governments – in developing and delivering innovative programs, products, and services.

Robyn Link is a director within the Energy, Sustainability, and Infrastructure segment where she leads the commercial and industrial solutions consulting group. She brings more than 17 years of experience successfully driving, accelerating, and delivering organic growth for both established and early-stage businesses within the energy sector. Robyn has partnered with 80+ utility companies (IOUs, Co-ops, and Municipals) in North America to create and deliver new, transformational load management and customer engagement solutions that drive results and resolve significant business challenges for utilities.

Chris Luras has over 17 years of energy industry experience. At Guidehouse, Chris serves as the solution leader for Guidehouse's Risk, Compliance and Security services, working with utilities on all aspects of NERC Reliability and Security compliance, Cyber and Physical Security, Risk Management, and Resiliency. Specifically, Chris leads the development, management, and execution of tools and services aimed at cybersecurity, security compliance, risk management, internal controls, and process and program improvement within the energy sector.

Macky McCleary is a proven utility, insurance, and environmental regulator, a clean energy entrepreneur and a transformation and organization leader. Trained as an architect at Yale University and a consultant at McKinsey & Co., Macky brings creativity, vision, and

COVID and geopolitical events have heightened the risk calculus for global energy markets. How have these events changed risk management for utilities? What can utilities learn from other industries?

Ben Grunfeld: First and foremost, you are not alone in recognizing you don't have all the answers or all the solutions in place. Less than forty percent of CEOs globally say they believe they are well-prepared to meet challenges posed by a major crisis related to inflation, cybersecurity, supply chain disruptions, or climate change.

This is a shockingly low number, considering that in the past two years alone, extreme weather events, cyberterrorism, and COVID have forced companies to adapt in real time to what only recently had been largely hypothetical risks.

We recommend that companies across the energy, financial services, health, security, and defense sectors implement the following risk-management best practices:

Improve visibility and awareness: Identify essential business services and functions, measure impact, and identify acceptable disruption tolerances.

Strengthen business practices: Diversify risk and reduce single points of failure through digital transformation, process re-engineering, or capacity improvement.

Harden physical assets: Increase the resilience of physical assets through improvements in design standards, enhanced risk-mitigation measures, and threat detection and security controls.

Effective risk-management practices are essential to business resilience. In today's turbulent economic and geopolitically charged environment, strengthening business resiliency should be a priority for all leaders. ❍

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attention to detail to bear for his clients in every engagement. Macky drives innovation for clients in the converging industry sectors of energy, finance, telecom, government, infrastructure and transportation. He has combined expertise in strategy, operations, branding, consumer and behavioral insights and business development. At the intersection of business and government, he has spent the past 15 years delivering high value projects for clients and citizens alike.

David O'Brien is a Director in the Strategy & Operations group within Guidehouse's global Energy, Sustainability, and Infrastructure segment. He advises clients regarding the transformative change taking place in the energy industry. David helps clients examine the macro drivers changing the physical and financial domains of the distribution grid and to consider sustaining business models and complimentary regulatory frameworks. With more than 28 years of experience in accounting, commercial lending, economic development and energy policy, David specializes in applying a macro view of a changing industry landscape to integrated strategies for technology and regulatory approach.

Molly Podolefsky is a director in Guidehouse's Energy, Sustainability, and Infrastructure segment. She brings considerable experience as an applied econometrician to energy efficiency and demand-side management engagements. Prior to joining Guidehouse, Dr. Podolefsky earned her doctorate in Economics from the University of Colorado, Boulder, with an emphasis in energy and environmental economics, focusing her research on the effectiveness of solar incentives in California. During her tenure at Guidehouse, Dr. Podolefsky has served as project manager for engagements both with large investor-owned utilities and smaller municipal and cooperatively owned utilities.

Danielle Vitoff is a Director within Guidehouse's Energy, Sustainability, and Infrastructure practice. She focuses on strategic engagement around decarbonization, resilience, and sustainability for governments, corporations, and utilities. Danielle is a skilled project manager who has successfully led clients in exploration and public engagement to develop defensible sustainability strategies that support multi-faceted business goals. Notable engagements include the San Antonio Climate Action and Adaptation Plan, leading the development of the American Gas Foundation resilience study, decarbonization roadmaps for multiple natural gas utilities, managing the California Sustainability Alliance, and the development of a science-based target for The Coca-Cola Company.

As a key leader in Guidehouse's strategy, policy, and regulations team, **Ted Walker** is a strategic advisor to energy companies, focused on growth opportunities and the changing role of the utility in the evolving energy ecosystem. He has worked with many large and medium electric and gas utilities to develop and plan for strategies that diverge from their "business as usual" mindset. His content focus areas include distributed energy resources, alternative transportation fuels (including electric vehicles), non-commodity products and services, digital customer transformation, innovation strategy, emerging technologies (including particular depth in blockchain), and M&A. Ted has worked across the utility value chain, with particular focus in energy retail, T&D, customer front/back-office, and shared services.

What will the utility of the future look like in 2030? How will it be different from today's utilities?

Michelle Fay: Ambitious net-zero goals at the state and federal levels, increased intensity and frequency of extreme weather events, and increased stakeholder pressures are requiring utilities to make more changes in the next eight years than they have in the past hundred.

The transition to a cleaner, more resilient grid is no longer a nice to have, but a must have, and utilities will need to accelerate the pace at which they adapt to these evolving conditions.

Accelerated penetration of DERs and beneficial electrification are causing changes to the traditional peak demand profiles and introducing large volumes of intermittent load. The complexity of managing this dynamic system requires

an increasing dependency on technology to provide transparent and real-time analytical capabilities to forecast, manage, and optimize the resources and the system.

Utilities will no longer simply deliver a service. They will orchestrate a dynamic system that must respond to changes and demonstrate a nimbleness previously only expected from the technology sector.

To compete in this new world, utilities will need to put innovation at the core of their business. They will need to extend beyond the traditional energy efficiency, demand response, and smart grid programs, and quickly and effectively bring new technology and programs to scale. They will need to bring customers along on this transition – ensuring the programs are created and implemented in an inclusive and equitable manner to meet the needs of their diverse customer base. PUF

Idaho National Lab Director Inventing the Future

Conversation with INL Director
John Wagner,
with PUF's Paul Kjellander

Most who work in the energy and utilities industry know of Idaho National Laboratory as the nation's lab for nuclear energy research and development. But much more gets done there in strategic areas of energy, national security, science, and environment.

The research comes in many forms, but perhaps the best way to explain INL is as an applied energy laboratory, where smart people conduct practical research that can be put to use to solve big problems. A major one facing the industry today is achieving decarbonization.

PUF's Paul Kjellander, who hails from Idaho, sat down with Lab Director John Wagner, who came there to build advanced nuclear reactors, part of the clean-energy solution. Listen in on the future at INL.

PUF's Paul Kjellander: You're the Director of the Idaho National Laboratory. As you look at the state of powering not just our region but the nation with electricity, how would you describe the current state today?

John Wagner: Energy worldwide, nationwide, and regionally is at a crossroads. We're all looking to how we're going to reduce carbon emissions and ultimately get to what we're trying to do at the laboratory, which is net-zero carbon emissions of our site operations by 2031.

A lot of that leads to electrification, which then leads to more generation. We're looking at it more holistically than we did in the past, and that is not just decarbonizing electricity, but also transportation and industrial processes.

In our region we're talking a lot about, including when I recently had the opportunity to talk with Wyoming Governor Gordon, the coal-to-clean-energy transition and carbon capture and utilization.

At the laboratory, we think a lot about the coal-to-nuclear transition. We're excited about the TerraPower project in Kemmerer, Wyoming that would transition a coal site to a nuclear site, utilizing existing infrastructure and workforce.

But we also think about, over what period of time that transition takes place, and how we might further reduce and capture the carbon emissions of existing fossil resources because this is going to take a little time.

PUF: How much time could the transition take and what role will the lab play in helping to shave off some time as you look at the horizon?

John Wagner: When we look at deep decarbonization, it's going to take at least a couple of decades. We have to be careful that the decisions we're making for short-term gains aren't making it more difficult for us in the future.

There's a lot the laboratory can do to help shave some time off, and there's a lot we are doing, such as working to accelerate advanced nuclear technologies from the computer to deployment. We have a strong focus.

That's what brought me to this laboratory, to build advanced reactors. To play a role in making the transition from talking about so-called paper reactors to actually building reactors. We have to demonstrate that we can deploy reactors again, accelerate deployment, and drive down costs.

When we look at deep decarbonization, it's going to take at least a couple decades. We have to be careful that the decisions we're making for short-term gains aren't making it more difficult for us in the future.

We are an applied energy laboratory, so we conduct practical-minded research. An example is the integrated energy systems work that we do.

We know the future state is going to be regionally dependent based on available resources, whether there's wind availability or solar, for example. But we also know that wherever you're at, you're going to need to use multiple sources and use those effectively.

The other key is that the future integrated energy systems must be secure. As we build out the energy systems of the future, whether that's a lot of distributed microgrids or something else, they have to be secure, so physical and cybersecurity are baked into everything we do.

I worry that if you move too fast without incorporating cyber-physical protections, you could end up taking a step backward in terms of cost, reliability, or resiliency of your system.

PUF: Idaho National Lab plays a significant role in the advancement of cybersecurity nationwide. How do you handle that? It's constantly changing.

John Wagner: Unfortunately, that's true. It's hard to see when the work is done in terms of cybersecurity.

I don't know the origin of it, but I've heard that the half-life on cybersecurity knowledge is eighteen months. That means that every eighteen months, you're out-of-date in terms of the threats and approaches to address them. That's concerning.

But we have to deal with it. That part, we can't change. In terms of when are you ever done, it may feel like you're always chasing threats. What I like about the team here is they've developed a methodology.

They call it consequence-driven cyber-informed engineering,

We have, just over this decade, developed a strategy that involves multiple advanced reactor demonstrations beginning next calendar year and then having successive new reactors demonstrated approximately one per year for the rest of this decade.

and that is trying to get people early in the process of whatever system they're developing to think about cybersecurity as opposed to what we're doing largely now with existing infrastructure, which is using Band-Aids to secure them.

We're thinking about cybersecurity at the outset, having it involved in everything in designing a new system. The other key piece is thinking about it from an adversarial perspective.

If you are going to attack this system, how would you do it? What do you need to protect, and what do you need to protect in terms of the most consequences of somebody getting into a system?

PUF: You mentioned trying to move away from paper reactors to real reactors. What's happening on that front?

John Wagner: That's what I'm the most excited about. We've developed a strategy at the laboratory, working with the Department of Energy and other stakeholders, in terms of how to move the needle on building reactors.

If you're not close to this field, you likely think about nuclear reactors as gigawatt-scale, as ten years to build, and ten billion dollars. That's the current generation.

When we think about advanced reactors, novel systems, we had another piece that came into our strategy, and that is a strong market interest in small systems. We've developed a strategy that starts small and simple, enabling us to learn how to do this again. We haven't demonstrated a new reactor at the laboratory since the early '70s.

We're learning how to do it again with systems that are small and simple, and building up from there. We have, just over this decade, developed a strategy that involves multiple advanced reactor demonstrations beginning next calendar year and then having successive new reactors demonstrated approximately one per year for the rest of this decade.

PUF: Talk about net-zero initiatives, why you're so aggressive, and trying to accomplish that in a relatively short window of time.

John Wagner: It was a little more than a year ago when I became Lab Director. At that time, I expanded my understanding of this laboratory to what a significant enterprise this is, eight hundred ninety square miles. We have over six hundred vehicles, and over three hundred buildings. We have our own landfill.

I started understanding that the challenges we face to go to net zero are the same or similar challenges to what a city, state, or other major organization faces. I gained a broader understanding of our clean energy and critical infrastructure security mission space, which is developing technological solutions to these challenges, with the expectation that others will adopt these technologies.

It dawned on me that the combination of our R&D mission and site operations provide a unique opportunity for us to lead by example. Since about a year ago, it's already had tremendous

impacts because it's a focal point now that brings our research and operations together around real solutions, that once demonstrated, we can transfer to others who have similar goals.

In terms of the schedule, it is aggressive. National laboratories, all of us, were originally established to do big things. That's why we exist in the first place.

First, we thought a lot about what our role is as a national laboratory in solving major problems for the nation. Second, what's the appropriate time scale relative to the problem and the urgency of the problem we're addressing?

It's aggressive and ambitious. People use the word audacious. We are on track to do it by 2031.

PUF: The research you do at the lab, it's a delicate balancing act. You have to put your finger on the problems that need to be addressed but can't push the outcomes in any specific direction. That's not a simple task.

John Wagner: That's absolutely right, and that's where partnering and being attached with what I call the real world, is so critical. One of the risks that an organization like a national laboratory has, is that our research becomes detached from the real problems that cities, countries, or private companies are facing, or what the market needs.

It's more of why I love this laboratory. As an applied energy laboratory, we take extra effort to be connected to the real world, and make sure we understand what the right problems are to be solving, not just the problems that we happen to be interested in solving.

PUF: As you look at the dynamic changes happening in the electricity sector, how important do you think the lab's role will be in resolving some of those issues and helping get them from the lab bench to the real world?

John Wagner: You're talking to a Lab Director, so it's going to be very important. You see that as evidence through our growth. Our growth is not just in federal programs, but also our growth is in terms of supporting private companies in what they do.

You might ask, why is that? First and foremost, it's our people and the expertise they have, but it's our people and expertise matched with facilities that either the private sector can't afford, or maybe for other reasons, aren't able to do.

When you think about our unique nuclear facilities, that's probably the most obvious example of where we can help companies develop and demonstrate technologies in a way that they otherwise could not afford to do because of the taxpayer investments in our infrastructure.

But the same can be said for our other clean-energy areas, like our battery testing laboratories, biofuel users' facility, and our many national security test ranges, including our critical infrastructure test range and our wireless security test range.

PUF: There are programs and projects that people in the real world can come, utilize, and take advantage of.

We're working toward a microgrid powered behind the meter to demonstrate how that would work to power up facilities. Then that could be a grid and set of capabilities that others come in, and not just understand, but actually use.

John Wagner: Yes. It's part of our net-zero effort. We already have a couple of microgrids, but we're working toward a microgrid powered behind the meter to demonstrate how that would work to power up facilities. Then that could be a grid and a set of capabilities that others come in, and not just understand, but actually use.

PUF: It sounds like the future is bright.

John Wagner: It absolutely is. It's exciting, but the challenges before us are at times daunting. We want to move toward eliminating carbon emissions. At the same time, we're going to electrify a lot more things.

What I haven't talked about that I worry about, are critical minerals, where they come from, how do we sustainably mine them, and how do we optimize their usage so that we're using them most effectively?

I see a bright future for nuclear. I see an exciting future around microgrids in terms of resiliency and security, and just a lot of opportunity. PUF

Of the 124 million homes in the United States, a hundred percent of them have electric utility service. But sixty percent of them have natural gas utility service. This according to the just-released 2020 Residential Energy Consumption Survey of the U.S. Energy Department. Forty-seven percent of the nation's homes use natural gas for space heating. The same percentage use gas for water heating. Thirty-eight percent use gas for cooking. The usage of natural gas is highly regional. Sixty-six percent of homes in the midwest use gas for space heating. In contrast to this, thirty percent of homes in the south use gas for heating. Indeed, just forty-two percent of homes in the south have natural gas service. This percentage is seventy-four percent in the west, seventy-three percent in the midwest, and sixty-six percent in the northeast. Four percent of the nation's homes still use oil for space heating. This usage is very highly regional. Ten percent of homes in the northeast and eight percent in the midwest use oil for heating. In contrast to this, less than half a percent of homes in the west use oil for heating.

Like SpaceX, Incredible Innovation in New Nuclear

Conversation with Kairos Power VPs
Lou Martinez and Peter Hastings,
with PUF's Steve Mitnick

Kairos Power employees like to build, and their ultimate aim is a commercial nuclear reactor in service in 2030. Specifically, they plan to build the Kairos Power fluoride salt-cooled high temperature reactor, or KP-FHR for short.

They say they are disruptors, and their novel advanced reactor technology aims to be cost competitive with natural gas in the U.S. energy market. That achievement will come from the method used by SpaceX, an iterative development process to build increasingly complex rockets, applied here to nuclear technology.

Kairos Power is on a fascinating journey. To find out more about this, PUF discussed what the company is up to, and it's a lot. Listen in as Lou Martinez and Peter Hastings envision the future.

PUF's Steve Mitnick: You are developing an innovative advanced nuclear technology. What is your technology and what drove you to put this company together to bring this technology to fruition?

Lou Martinez: Kairos Power is a mission-driven company. We are singularly focused on our efforts to commercialize an advanced reactor technology. What singular means is that we are only developing one technology, which is a fluoride salt-cooled high-temperature reactor. We need to do it in time to play a significant role in the fight against climate change.

Kairos in Greek means the right or opportune moment. By the 2030s, there will be a lot of natural gas combined-cycle retirements in the U.S. and large nuclear reactors will need to be replaced.

Energy needs will continue to increase as our society grows. Therefore, we need to deliver a clean-energy solution with robust safety at an affordable cost.

PUF: Peter, how did you all get together and why did you do this?

Peter Hastings: Kairos Power grew out of an integrated research project, collaborating with DOE, UC Berkeley, MIT, University of Wisconsin-Madison, and National Laboratories.

Our three cofounders, all of whom worked on that project, concluded that the next logical step was to establish a private company to commercialize the fluoride salt-cooled high-temperature reactor to accelerate the development of an innovative nuclear technology to transform the energy market.

Our hybrid design uses TRISO fuel, which is virtually indestructible and has been demonstrated not to fail at temperatures that exceed our operating conditions – including postulated emergency conditions – by hundreds of degrees. It is coupled with a molten salt coolant, which has a tremendous heat capacity, chemical stability, and affinity for radionuclides.

In the unlikely event of fuel failure, where radionuclides leak out of the fuel, they're latched onto by the molten salt. You couple that with a primary system pressure that's, for all intents and purposes, atmospheric pressure, and it eliminates the volatilization component of a pressurized system.

You end up with a design that has orders-of-magnitude increases in safety over what is already the safest electricity technology ever developed. It's a no brainer.

We are singularly focused on efforts to commercialize an advanced reactor technology. Singular means we are only developing one technology, which is a fluoride salt-cooled high-temperature reactor.

– Lou Martinez

PUF: There are always questions about nuclear safety cost. These are not thousand-megawatt plants that you're going to build.

Lou Martinez: A commercial unit of our advanced fluoride salt-cooled high-temperature reactor is expected to be a hundred forty megawatts electric. Different numbers of units can be combined together at any given site depending on the needs of the grid.

It's important to understand how our cost and safety case are related to the affordability of our reactor. What Peter just described is giving us incredible inherent safety. The combination of fluoride molten salt with TRISO fuel allows us to have an optimized nuclear safety footprint.

With our inherently safe design, we dramatically reduce the physical footprint of safety-related systems. That supports our objective to deliver clean energy at an affordable cost. We have four primary workstreams in which we are working hard to solve difficult problems and reduce risk in order to achieve cost certainty before building the first reactor.

First, we know to be cost competitive we must mitigate technical, licensing, manufacturing, and construction risk. To do so, Kairos Power is applying a rapid iterative development approach, which means building successive hardware iterations so we can learn by building.

We will have four major hardware iterations – nuclear and non-nuclear – prior to our first commercial reactor. That is one of our first strategies to prove cost certainty.

The second workstream is construction. We capture learnings and reduce construction risk as we build the different iterations.

The third workstream is the supply chain and manufacturing. We have a strong and vigorous vertical integration strategy for

In less than 2 years, we went from the decision to deploy that test reactor to acquisition and characterization of the site, development of the construction permit application, and submittal and acceptance of that application. To its credit, the NRC has kept up.

– Peter Hastings

safety-related and critical components to ensure we achieve cost certainty.

The last workstream is licensing. We need to know the risks and have a high level of certainty that we can license our technology. If we have a high level of certainty on the technology, construction, supply chain, manufacturing, and licensing, we can translate that into a high level of certainty on the cost of the first nuclear reactor.

PUF: The NRC moves at a certain pace. How does that look? Are you optimistic?

Peter Hastings: I was heavily involved in the last large, light-water reactor renaissance as a member of the NuStart consortium where we worked to license AP1000 plants at seven sites under six different utilities.

Only two of them have gone to construction so far, and while I'm two-hundred-percent supportive of my friends and colleagues at the Vogtle plant, the outcomes at the other sites were not what anyone hoped for.

I've been doing exclusively nuclear work my entire career, nearly forty years, and the majority of that time has been in licensing nuclear facilities. I've never been as optimistic as I am now about the prospects of deploying new nuclear plants.

There's a new recognition of the value that nuclear energy brings to enabling the world's transition to clean energy. That's the nexus with our mission, not only among policymakers, but at the grassroots level as well.

We have worked with the NRC to ensure the agency is ready to receive and review applications for new technologies. Developments include establishment of a risk-informed regulatory framework for advanced reactors, right-sizing of emergency planning, security reforms, and more generic treatment of environmental reviews.

The NRC has adopted, and we've helped pilot, innovations that include streamlined review processes, increased use of in-office reviews and audits, and the core-team concept to provide for continuity during review from one year to the next.

In the past five years in the licensing space, we've set the pace for industry and pre-application engagement with the NRC. It's hard to say this without sounding like we're bragging, but we've submitted almost a dozen substantive, methodological topical reports, eight of which have been approved.

We've established all this while introducing an additional iteration in our iterative strategy – the deployment of a test reactor.

In less than two years, we went from the decision to deploy that test reactor to acquisition of the site, characterization of the site, development of the construction permit application, and submittal and acceptance of that application.

In forty years, I've never seen a case like that. To its credit, the NRC has kept up. I'm optimistic.

PUF: Lou, what are you building?

Lou Martinez: I have something cool to show you. This is a non-nuclear version of a fuel pebble that has been manufactured in our lab. We need a lot of them to make our reactor work. A single fuel pebble can produce the same amount of energy as burning four tons of coal, but without any carbon-dioxide emissions.

We are mirroring what SpaceX did with their rapid spiral development – we call our approach rapid iterative development – which allows us to accelerate test cycles for innovation and optimization.

The first big hardware demonstration we are building is the Engineering Test Unit, or ETU, which is going to be hot-commissioned in a few weeks in Albuquerque. It will perform integrated testing of a select set of systems, structures, and components in a non-nuclear and unenriched Flibe environment.

The scale of ETU is approximately the same as the Hermes demonstration reactor, for which we have submitted a construction permit application to the NRC. ETU is going to be the largest Flibe facility ever built in the U.S. by an industrial company.

The primary objective of ETU is to demonstrate design integration. We are already assembling a vessel, pump, pipes, and cooler stuff like pebble handling equipment, the reactivity control and shutdown system, and all our instrumentation.

ETU has helped us to initiate and exercise the supply chain for Hermes' specialized equipment and materials and figure out what we need to vertically integrate, versus what we are going to source from outside suppliers.

After ETU, we have the Hermes demonstration reactor in Oak Ridge, Tennessee. Its output will be thirty-five MWth, and it will not be connected to the grid. Very similar to ETU, we are building Hermes to prove we can deliver nuclear heat at an affordable cost and derisk the licensing path of KP-FHR technology.

After Hermes, we're moving again to a non-nuclear iteration called U-facility, or user facility. There, we will have a full-scale, non-nuclear version of our first commercial reactor. It will have the pump, the vessel, and all the other systems, and will be used as a training facility.

ETU is going to be the largest Flibe facility ever built in the U.S. by an industrial company. After ETU, we have the Hermes demonstration reactor to prove we can deliver nuclear heat at an affordable cost. After Hermes, we're moving to a full-scale, non-nuclear version of our first commercial reactor.

– Lou Martinez

Photos courtesy Kairos Power

The Engineering Test Unit Demonstration Experiment (ETUDE) test stand validates integral hydrodynamics performance and pebble fuel recirculation methods, in Kairos Power's R-Lab in Alameda, California.

From U-facility, we will gain the ability to derisk operations and maintenance costs. We have built alliances with major utilities in the U.S., including TVA, Constellation, Southern Company, and also Bruce Power from Canada.

Our last iteration will be the first commercial reactor. It's a single-unit, one hundred forty megawatt electric KP-FHR. It's still an iteration because it will be the first-of-a-kind build, and we need to keep learning by building.

Within Kairos Power we have two streams of development: one is the product, and at the same time we are investing in the infrastructure needed to manufacture it and reduce costs. That's why we have our facilities here in Alameda, California with two labs.

There is the RAPID prototyping lab where we are constantly performing tests. Then, after we learn from an experiment, we dismantle it and build something new to keep learning. We also have the Salt lab where we design and build test cycles involving molten Flibe salt.

Albuquerque, New Mexico, is the home of ETU. It's also home to our manufacturing infrastructure. From welding to robotic CNC machines, we have all the basics to create those main components.

PUF: Peter, what is the timeframe and what obstacles are in front of you?

Peter Hastings: We'll have our Hermes test reactor operating by 2026 and it has a fairly short lifespan. Our first commercial plant is planned for 2030. One of the challenges we expect to have – a good problem – is keeping up with the order book after that.

We do need regulatory certainty. We need continued support for out-of-the-box thinking with regard to issues that affect broad deployment of new technologies.

– Peter Hastings

In terms of obstacles, I wouldn't describe our needs as hurdles, because we believe most of what we need to do is doable. We do need regulatory certainty. We need continued support for out-of-the-box thinking with regard to issues that affect broad deployment of new technologies.

We need forward thinking in policies on issues such as supply chain. For example, how do we modernize quality assurance requirements to stand up the supply chain for nuclear components and recognize that some of the rules in place for the existing operating fleet are out-of-touch with modern practices?

We'd like to see contracting reform on programs such as the Advanced Reactor Demonstration Program, for which we were one of several awardees.

Photos courtesy Kairos Power

Engineers in the Rapid Analysis, Prototyping and Iterative Design Laboratory (RAPID Lab). R-lab is collocated with Kairos Power's Alameda, California headquarters.

We have congressional support on improvements in licensing. We'd love these innovations to be administration-proof, and not subject to appropriation cycles. We need congressional support for infrastructure for development of high-assay, low-enriched uranium.

Utilities can buy lots of reactors and maintain steadfast support regarding their commitment to a low-carbon portfolio, including a recognition that green does not necessarily mean clean. More important than pursuing artificial targets on renewables is pursuing meaningful targets focused on clean energy, including nuclear.

We'd love to see progress at the state level. Not only continued support we've seen emerge fairly recently for maintaining the existing operating fleet, but also making sure those mandated portfolios around carbon reduction provide a seat at the table for nuclear technology.

PUF: Why should the industry keep an eye on Kairos Power?

Lou Martinez: We are disrupting the industry with our rapid iterative development and vertical integration strategies to deliver an energy solution that has robust safety with an affordable cost. As an industry, we have forgotten how to build things, and you need to build things to learn.

That is what makes the Kairos Power approach unique.

Peter Hastings: Throughout my career, I've tried to find the altruistic outlook, asking myself, what is the company I'm working for doing to make the world a better place? This company knocks the socks off of all previous companies I've worked for in that regard. We have a team of people who believe they're coming to work to help save the world.

We are disrupting the industry with our rapid iterative development and vertical integration strategies to deliver an energy solution that has robust safety with an affordable cost. As an industry, we have forgotten how to build things, and you need to build things to learn.

– Lou Martinez

We have set forth an audacious mission. I encourage anybody who's interested in Kairos Power to look for opportunities to engage with us. We will make the impression that this is a company they want to be in business with.

Lou Martinez: We have a hybrid workforce. We have nuclear engineers and non-nuclear engineers. We look broadly to build our team because, to embrace innovation, we need to explore things in a different way as we are trying to solve problems that have never been solved before. PUF

PUF Annual Pulse of Power Survey

How You Answered Eight Questions

By Guidehouse's Mackinnon Lawrence and Richelle Elberg
with Roberto Rodriguez Labastida, Scott Shepard, and Maria Chavez
contributing, an analysis of the survey results

For seven years running, Guidehouse and Public Utilities Fortnightly have taken the pulse of the power industry via a survey of executives with North American utilities, regulatory bodies, and product and service vendors. In 2022, responses underscore many of the same concerns and opinions expressed in prior years – for example, nearly two-thirds of respondents still indicate that rapidly growing distributed energy resources, such as solar and electric vehicles, are the most disruptive forces the industry faces today.

But there are also new focus areas for an industry facing unprecedented challenges and change. For example, resilience is increasingly top of mind – despite the growing frequency and severity of extreme weather events and fires – but it is cybersecurity, rather than physical security and grid hardening, where utility industry participants see the greatest risk currently. Meanwhile, emerging opportunities, such as in electrification of buildings and transportation, as well as in the Infrastructure Investment and Jobs Act (the Act), are giving the industry hope.

Cybersecurity Weighs on Resilience Goals, More than Physical Security

Nearly three-quarters of 258 survey participants indicated that cybersecurity of IT/OT systems represents the most acute risk to utility operations resilience. About 28% of respondents said physical security and asset-hardening are the greatest risk, while just a handful cited the ongoing pandemic.

High-profile cyberattacks on the energy industry have certainly made cybersecurity a focus, but it is notable that far greater investment is taking place in grid-hardening technologies. Guidehouse Insights estimates that some $820 billion will be invested in global grid enhancements over the next decade – of that just $31.5 billion can be attributed to cybersecurity.

Of course, connected systems such as smart-metering infrastructure or grid management systems such as ADMS and distributed energy resource management systems (DERMS), are a significant part of that multibillion-dollar overall investment – and here is where increased cyber-risk emerges. As a growing number of assets throughout the grid become connected and integrated into sophisticated software systems, the surface area for a cyberattack grows exponentially.

And, as opposed to physical threats that involve more concentrated damage – e.g., a tornado knocking out a single substation or a backdoor to the IT systems running a utility's entire power grid – it means that the damage inflicted can cover a more devastating portion of the system. In preparation for increased cyberthreats, survey respondents said that investments in advanced asset, information, and network control technologies, followed by accelerated internal training efforts, should be prioritized (46% and 41% respectively).

In addition to cybersecurity, business resilience is another key focus for a utility industry facing growing disruption and competition. As reflected in the survey, utilities face an ever-expanding array of stakeholders in the Energy Transition, which encompasses both potential partners and competitors.

As in prior years, tech and telecom concerns were seen as the greatest competitive threat (59%) – but notably, auto, and oil and gas companies are of growing concern as they expand investments in renewable alternatives to conventional energy fuels. This year, more than 20% of respondents indicated these competitors pose the greatest threat, compared to just 13% in 2019.

Resilience is increasingly top of mind – despite the growing frequency and severity of extreme weather events and fires – but it is cybersecurity, rather than physical security and grid hardening, where utility industry participants see the greatest risk currently.

Converting Generation Sources Seen Boosting Resilience

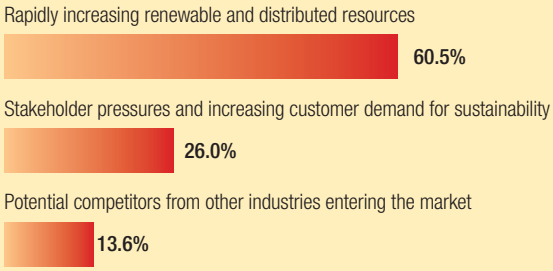
To bolster business resilience, survey participants indicate that converting to sustainable generation sources and increasing investment in digital technologies are top priorities, at 40% and 35%, respectively. This will be emphasized by a shift toward DERs, which are key to increasing resilience, but must be enabled through digital tools. In its Global DER forecast database, Guidehouse Insights expects that cumulative DER will account for more than 28% of total installed capacity in 2030, up from less than 22% in 2022.

In order to manage the increasingly diverse and distributed sources of generation, the integration of digital technologies will be critical. Thirty-five percent of respondents agreed that accelerating digital investments should be prioritized by utilities to improve business resilience in the face of climate change.

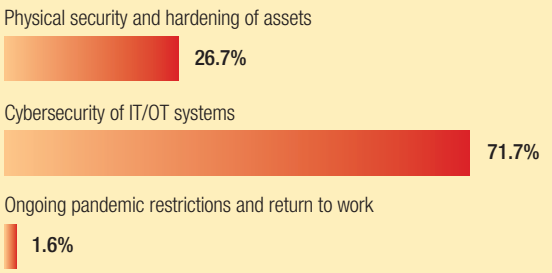
Grid modernization investments are well underway. Guidehouse Insights expects global investment in DERMS to increase by an order of magnitude between 2021 and 2031, growing from $240 million to nearly $2.4 billion worldwide, for a better than 23% compound annual growth rate.

Disruptions

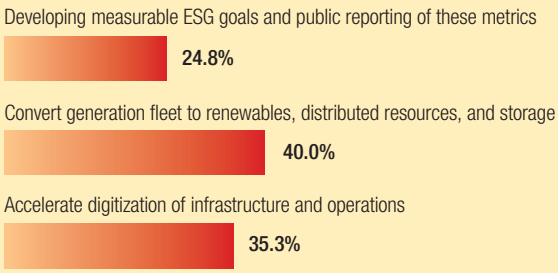
Q1. Which is most disruptive to the utility business model?



Q2. What represents the most acute risk to utility operational resilience?



Q6. What immediate action should utilities prioritize to improve business resiliency in the face of climate change?



Machine learning and analytics – aka AI – are also projected to be adopted at an impressive pace. Utility analytics investments are forecast to grow at an estimated 14% compound annual growth rate through 2030.

AI will help manage a diverse portfolio of power generation sources. On any given day, a utility can choose hydroelectric power, local DER, or power from a fossil fuel generation plant, among others, to meet load requirements. With AI, utilities will be able to blend these available resources to meet changing demand in real time, while also maintaining a high level of service quality.

Indeed, years after the term smart grid was first bandied about, the world's largest machine is transforming quickly into a more intelligent, responsive, and self-healing system, a necessity for true resilience in the face of climate change.

Electrification Seen as Utilities' Best Near-term Opportunity – Not Transactive Energy

Industry disruption also means new opportunities for incumbent utilities, and consistent with previous years, survey participants in 2022 believe the most attractive near-term opportunities will be found in the electrification of buildings and transportation. Not only will growth in these areas offset falling load due to energy efficiency and wider end-user ownership of renewables, but they also present opportunities for better real-time grid-edge management and balancing.

EV flexibility, for example is increasingly tapped to support grid utilization and renewables integration, reducing consumer electricity costs and decreasing grid emissions. Government programs that educate consumers and promote building and transportation electrification are also emerging, with incentives for utilities to target lower income neighborhoods – thereby supporting Environmental, Social, and Governance (ESG) goals, another growing priority in the industry.

Notably, interest around orchestrating transactive energy platforms has waned. In 2020, nearly 50% of respondents said building and operating a transactive energy platform was the most attractive business model in distributed resources.

This year, less than 20% felt it provides the most attractive near-term opportunity. This is likely due to inconsistent and often restrictive regulatory regimes seen across the states, as well as market immaturity and conservative industry culture – all barriers to new business models cited in the survey.

The Infrastructure Bill Supports Industry Priorities

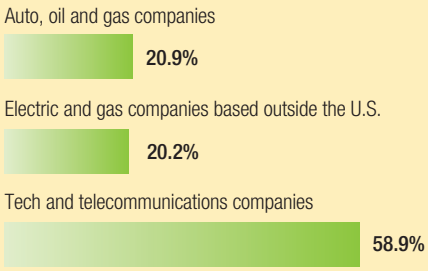
In keeping with the themes seen throughout the survey, when questioned about the most attractive opportunities made available to the industry by the Act, respondents focused on transmission and distribution (T&D) upgrades and resilience, transportation electrification, and cybersecurity (75%, 67%, and 36%, respectively).

Considering that cybersecurity was deemed, by far, the greatest risk to utility operational resilience, however, it's interesting that twice as many respondents chose T&D upgrades versus cybersecurity. This could simply reflect the higher cost of physical infrastructure upgrades compared with cyber upgrades, although arguably the long-term impact of cybersecurity investments to resilience could be greater.

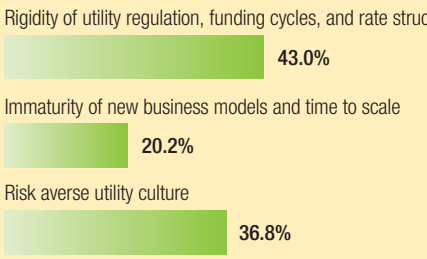
Renewable energy, advanced nuclear, and energy efficiency/weatherization were also selected by 24%-34% of respondents as attractive opportunities, while carbon capture and hydrogen technologies garnered less interest. Guidehouse Insights expects that renewables will account for almost 40% of the total installed capacity in 2030, up from 31% in 2022. This could further accelerate once the full impact of the Russian war in Ukraine is understood.

Challenges

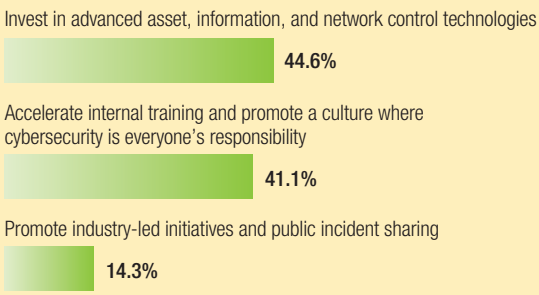
Q3. Which potential competitors pose the biggest threat to utilities?



Q4. What is the primary impediment to utilities investing in new business models?

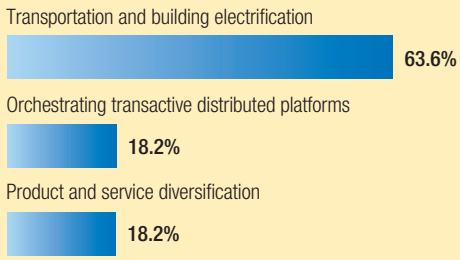


Q5. What should utilities prioritize to best prepare for potential cybersecurity threats?

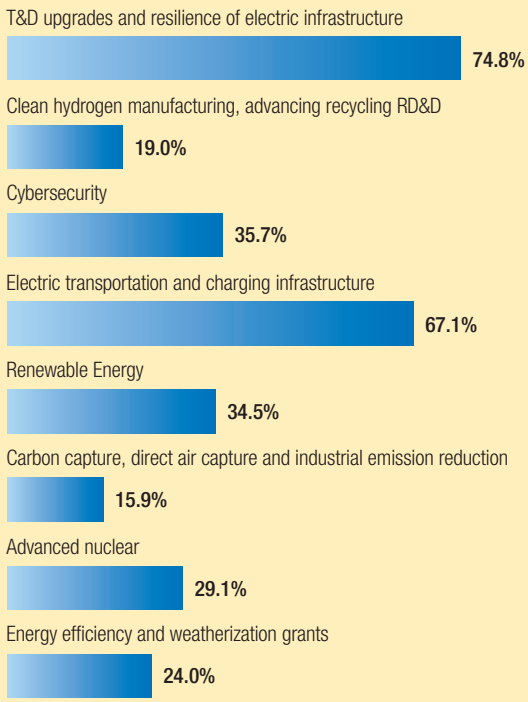


Business Strategies

Q7. What is the most attractive opportunity for utilities in the near-term?



Q8. (pick 3) What is the most attractive funding opportunity for utilities in the infrastructure bill?



The Act makes $65 billion available for long-overdue upgrades to the power grid, and another $12.5 billion in support of EV adoption, charging infrastructure, and adoption of low-carbon and zero-emission school buses nationwide. Market momentum for EVs is growing considerably across all vehicle segments – passenger cars, pick-up trucks, buses, and commercial trucks.

Guidehouse Insights projects one of three new vehicle sales in North America will be an EV by 2030, up from the one of 22 in 2021. EVs represent significant new and novel loads for utilities. Investment in smart charging technologies will be a component of utility management strategies. However, in many cases, such as electrification of heavy commercial vehicles, T&D upgrades, and resilience investments and strategies will also be required.

At the same time, utilities still feel the rigidity of regulation, funding cycles, and rate structures are the primary impediments to new business model investments (43%), but by embracing emerging opportunities around electrification and the shifting generation mix, they can continue to compete effectively while supporting sustainability and ESG priorities.

Interesting Times

"May you live in interesting times" is generally considered a curse rather than a blessing. The utility industry today is undoubtedly living through interesting times, but it's encouraging to see increased focus on tangible, near-term investments that can have a direct impact on long-term grid and business resilience and renewables integration – an important tool in the fight against climate change. PUF

Critical Minerals

(Cont. from p. 13)

the process of working out how to fund new research and development projects.

There's six billion dollars in grants programs aligned for battery-materials processing and battery manufacturing. There's information on where people can apply on DOE's website, and the goal is to stand up facilities, create several demonstration and commercial-scale facilities in the next few years to help build out that midstream and downstream supply chain that's so important for these critical minerals.

We have an RFI for building out a demonstration facility, and we're in planning to take those waste materials that I mentioned before, either acid-mine drainage, mine waste, or similar materials, and generate a facility that will refine those all the way to metals here in the U.S., at a significant scale. We expect in the next three to five years to have that facility in place and demonstrating this can be done.

The Department of Defense has been using the Defense Production Act for rare earth elements already, looking to generate processing facilities in the U.S., whether from domestic or trusted foreign sources. DOE and DOD are going to work together to figure out how we can best use that for battery materials in different forms.

One of the programs we run in my division is our CORE-CM initiative. These are a series of regional groups across the country that are looking at, what are the resources available within these regions that can be used to help build domestic supply chains?

We're looking at mineral resources from this broad variety of sources, but we're also looking at what are the infrastructure resources? What are the workforce resources we can help retrain, or have the skills we can bring together? A lot of those are run by universities.

The Critical Materials Institute has been in place for almost a decade now, producing new technologies across the spectrum from recycling to developing substitutes. They have new technologies that I hope and expect will be moving toward commercialization in the next few years.

We're looking at ways we can use more available minerals that might have the same functionality as some of rare earths. Can we use sodium-ion batteries instead of lithium or can we find substitute materials for the rare earths in magnets that will still give the same functionality?

– Grant Bromhal

This year, it's the 150th anniversary of the 1872 Mining Law that's used for all hard-rock mining, and there's a concerted effort across the government to review that with the USGS. The Department of the Interior is a leader.

Many other agencies are involved to see what we can do to update that, so that we can help facilitate moving forward in a safe, environmentally friendly, just, and expeditious way that will help us meet future clean-energy goals. PUF

Of the carbon dioxide emissions by the United States in 2021, 37% came from transportation and 32% came from electricity production. And of the emissions from electricity, 59% came from coal-fired generation and 40% from gas-fired generation.

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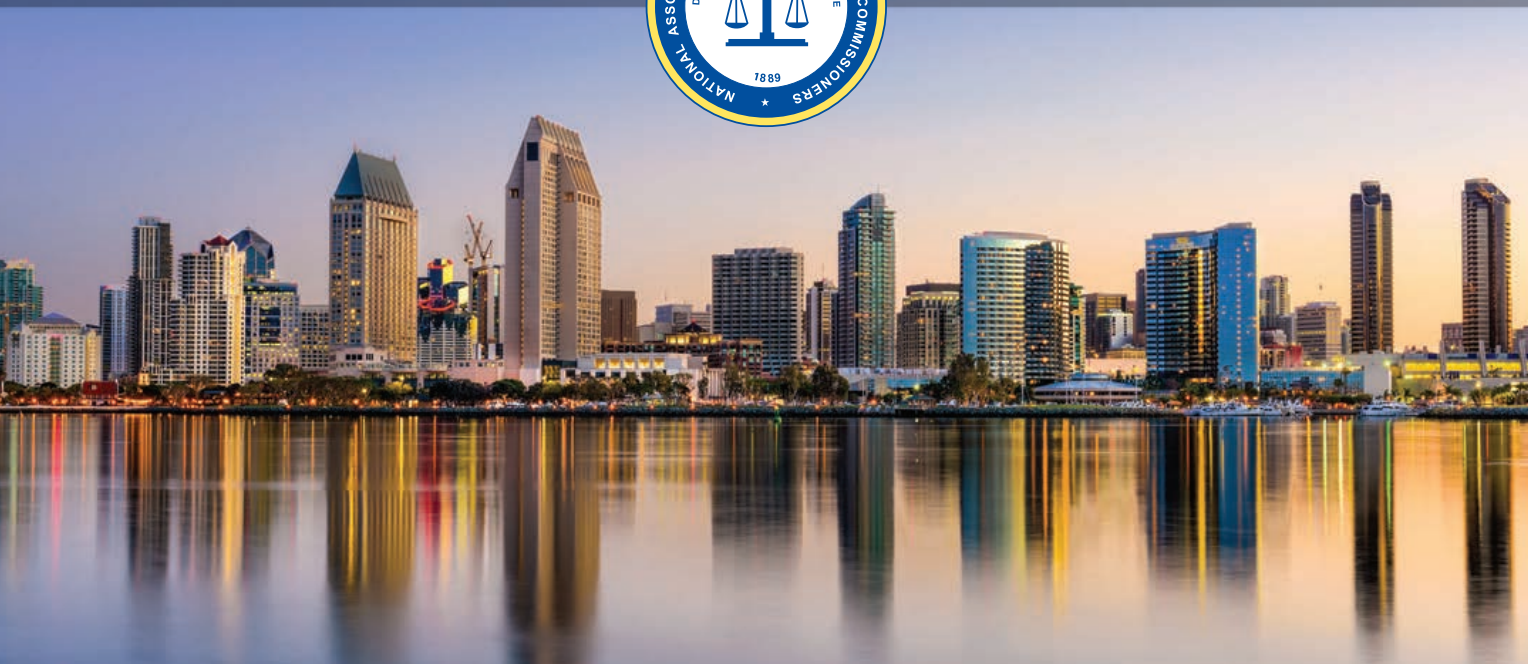

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