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Innovation Matters



AI is Already  
Impacting the  
Energy Industry

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## AI is Already Impacting the Energy Industry

*EPRI's Jeremy Renshaw on the benefits and limitations of artificial intelligence in the power sector*

**Interview By Chris Warren**

It may seem as though artificial intelligence (AI) was born with the [launch of ChatGPT](#) in late 2022. However, the reality is that the development of AI and the study of its many potential applications has been underway for several decades, dating back to shortly after the invention of the computer. Indeed, EPRI has researched the impacts of AI on the energy industry for over a decade. EPRI has completed or is currently involved with [over 70 projects](#) using AI to improve everything from wildfire detection and response to grid management to cybersecurity.

Policymakers, regulators, utilities, and the public have many questions about the appropriate and responsible use of AI. EPRI Senior Technical Executive Jeremy Renshaw [testified](#) before a U.S. House Energy and Commerce Subcommittee last year about the challenges and opportunities of leveraging AI to build a more reliable, resilient, clean, and efficient power system. Renshaw recently sat down with *EPRI Journal* to discuss the many

current uses of AI in the energy industry, how AI can deliver more value and the critical importance of quality data in delivering on the promise of AI.

**EJ: Talk of AI is everywhere these days. At a high level, how does EPRI view AI, and how is EPRI helping with its effective application in the electric power industry?**

**Renshaw:** AI is one of the biggest buzzwords today. From startups to tech companies, whenever you turn around, it seems like somebody is trying to sell some new product with AI. At EPRI, we're trying to help people understand the value of AI without overhyping it. It's a difficult balancing act to ensure that we're appropriately telling people what AI can do and what it might be able to do in the future. It's exciting, but we want to ensure that what we're saying is backed up by facts without overselling or overhyping it.



**EJ: Is most of the AI activity in the electric power industry just research right now?**

**Renshaw:** There is much talk and many R&D projects, but there is also increasing adoption. We have seen energy companies using AI for wildfire detection, improvements in online monitoring and predictive maintenance, and more, but adoption has lagged in some other industries. Part of the reason the industry has moved a little slower than others is because of its focus on safety and reliability. For example, if you're doing marketing or sales and advertising and have trained an AI model that reaches 99% accuracy on the people you want to reach, that's a huge win. If you're in the electric power industry and hit 99% electricity availability, that's a huge miss since it means 14 minutes per day without power. People expect more. There are different expectations of safety and reliability for electric power versus just about any other industry.

**EJ: You recently had the opportunity to testify before Congress about AI in the electric power industry. One of your points was that humans still need to be relied on to do the tasks humans are best at, while AI can help expand the value that computers and technology can deliver. What were you trying to get across?**

**Renshaw:** For example, my kids were on a swim team for several years. And you do four different strokes in these relay races. If you allow each person to do the stroke that they want to do, you may not end up with as good of a result as when each kid is doing their best stroke. It's similar to humans doing what humans do best and computers doing what they do best. If you love doing math and are great at performing calculations, you'll still never be able to perform calculations as fast or accurate as computers. However, there are things that humans can do far better than computers in terms of creative thinking, developing new ideas and concepts, or responding to new scenarios they've either seen once or never been exposed to—what we call single-shot or zero-shot learning in the AI community. By helping humans and computers work together, doing what they do best, the result is greater than the sum of its parts.



**EJ: What is an AI use case that benefits the industry today?**

**Renshaw:** Several areas are delivering value now, like predictive maintenance. Our Generation Sector uses AI to look at wind turbine gearbox analysis. They have machine learning models that monitor the different operational parameters. Using that data, they can predict gearbox failures months ahead of the failure. When you do that, a utility can schedule maintenance and repair components at an earlier stage of degradation where they're only replacing a \$50,000 component versus a \$350,000 system. The analysis that they've done shows that an average wind turbine farm, in aggregate, can save about \$1 million per year by planning its maintenance around what they see with the data they already have.

**EJ: What are some promising new applications of AI?**

**Renshaw:** One that will continue to improve for many years is grid management. The U.S. power grid is often described as the most complex machine humans have ever built. There are several opportunities for AI to help today in improving forecasting for both loads and weather, evaluating control center alarm data, and analyzing the large numbers of images utilities capture of their T&D (transmission and distribution) infrastructure to perform evaluations. Despite these and other current benefits, some things will take quite a while, like solving optimal power flow. That's one of the most complex, if not the most complicated, mathematical challenges in the world because the

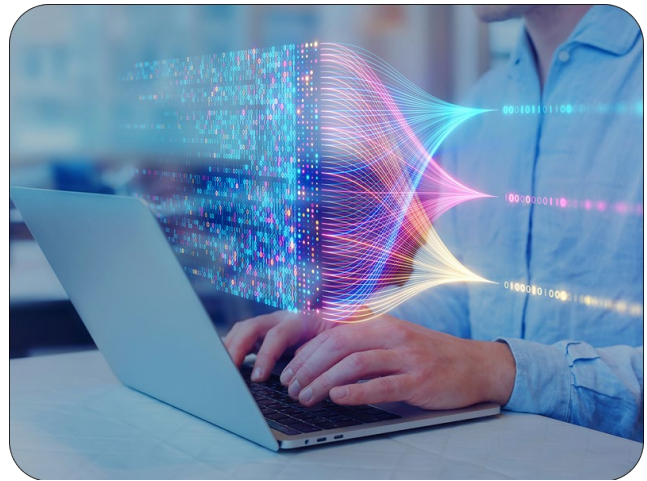
complexity scales exponentially with each grid-connected component and is far beyond what even today's supercomputers could do in any reasonable amount of time. And so, while the power grid is operated safely, reliably, and reasonably efficiently, it's essentially impossible with today's technology to fully optimize power flow in a power network because it's exceptionally complex.

**EJ: Can AI help with the complexity of distributed energy resources and variable renewable generation?**

**Renshaw:** That's a big challenge for sure. With solar, the sun goes behind a cloud, and your power output goes down by 30%, 50%, or 70% almost instantaneously, and the grid must adjust. Fortunately, there is much inertia on the grid currently that helps. However, with increasing renewable penetration, these swings can become more severe and unpredictable, so inertia alone won't be enough. For example, I was recently in Texas, and in certain areas, they're starting to see power peaking at 7 pm or 8 pm when the sun goes down instead of the traditional peak of 3 or 4 in the afternoon. AI can help you understand how and when to turn on your other power plants or turn off smart resources so that you have both more flexibility and more lead time to ramp up generation in response to changes in generation or consumption.

**EJ: What is another impactful use case?**

**Renshaw:** One of the applications I'm most excited about is AI for wildfire detection. We worked with a company using cameras on mountaintops, looking for evidence of smoke and fire throughout the day. This potentially allows utilities to respond significantly faster to wildfires and extinguish them at earlier stages when they're easier to handle. It also can save money because you don't need an army of people looking for fires. AI can analyze images all day, every day. It never gets bored, distracted, or takes a break while looking for fires. Regardless of the source of a fire, this solution may offer a low-cost, reliable, and safe way to help with a real threat to people, property, and the environment that can have drastic consequences.



**EJ: How much of the value of AI depends on the quality and volume of data?**

**Renshaw:** Data is at the heart of AI. Data quality and quantity are central to anything you will do with AI. Everyone likes to think their data is clean and wonderful, just waiting to provide insights. However, a large percentage of a data scientist's job is cleaning up messy data. Let's say you're monitoring a power plant. If you periodically shut the power plant down for an outage, now you have sensors gathering data that's not very useful because the plant isn't operating. Temperatures, pressures, and flows are all very different but generally do not provide any operational insight. You may need to manually remove that data from the analysis, or you'll have a bunch of zeros or weird numbers that are not indicative of anything useful. It's just unusable data.

Similarly, many things can happen during operations, such as interference, instrument noise, noise from a loose wire or poor physical connection, poor communication, or simply a dropped data point that may cause you to need to go and evaluate the data before you can just upload it into an AI model. If you plug unconditioned data into a model and assume it will work, you will often come out with something that wastes time and is useless. This often results in people thinking that AI can't do things it can. It's just more complicated than people realize to do the pre-work before training and using an AI model.

**EJ: What are data quality implications for utilities and others in the industry pursuing AI?**

**Renshaw:** You'll generally get more bang for your buck by increasing your data quality and quantity than you will from using the latest and greatest AI model. People are always coming up with new algorithms and models. What inexperienced users often forget to focus on is feeding them very high-quality data as well. The biggest value will almost always focus on the data first, then the model second. Of course, we want to use the best models available, but cleaning and preparing the data should come first.

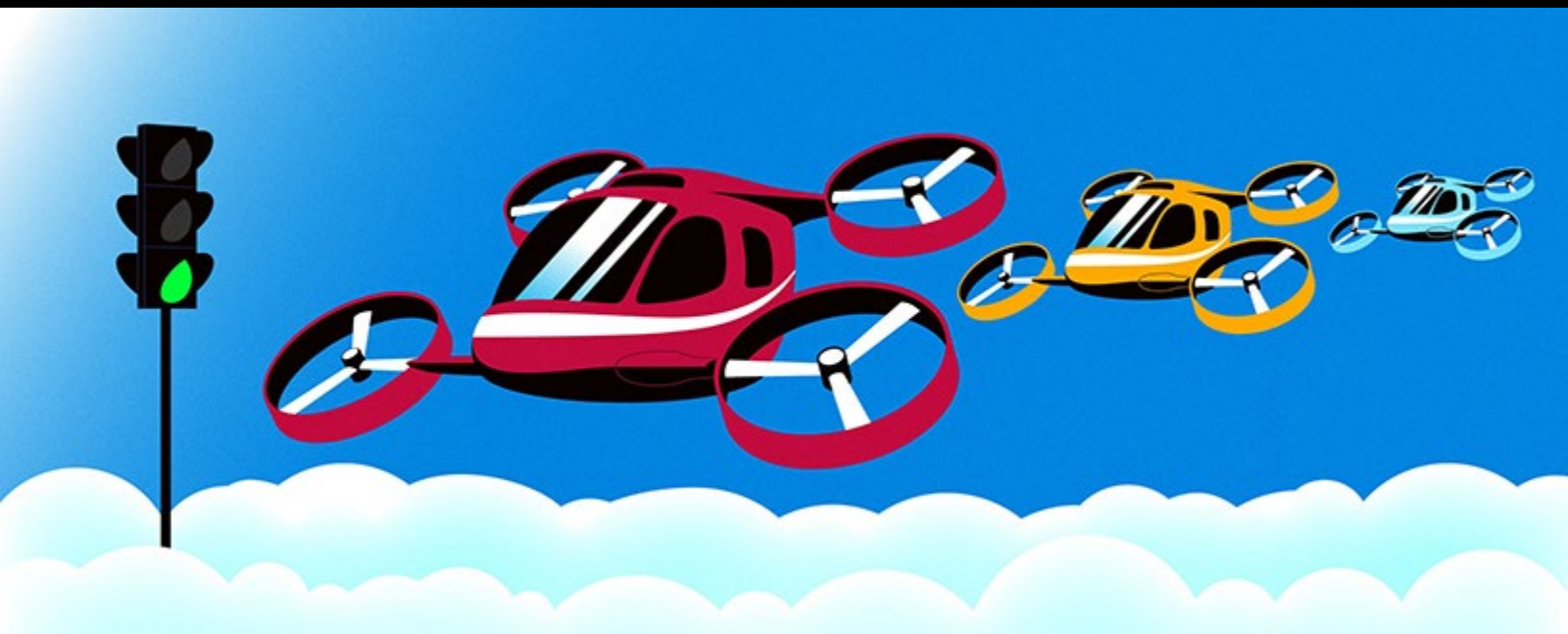
**EJ: EPRI is currently working with Google, Nvidia, and other stakeholders to develop AI capabilities to improve grid management. What are some other AI projects EPRI is pursuing?**

**Renshaw:** As mentioned earlier, EPRI has about 70 AI projects that are active or recently completed. We have a few that are rising to the top that we need to execute, including generative AI, which is the buzzword of buzzwords right now, though I should point out we were doing generative AI before it was cool. We have worked with generative adversarial networks or GANs to generate images of insulators and other transmission and distribution infrastructure and create nondestructive evaluation (NDE) data to train inspectors on a wide range of

virtual flaws. We have built on that work to look at how we can use large language models to augment what we're doing with our EPRI.com search. Similar to what Bing, ChatGPT, or some of the other tools will do, we want to augment our EPRI.com search to ask questions and get accurate answers quickly and easily. In parallel, we're also working on program-specific expert systems so that each EPRI.com search will give you the best possible answer to your question based on your access. In that way, we're hoping to be able to provide essentially expert-level answers to questions that people ask, as well as the underlying reference materials. This allows people to double-check answers because, at the end of the day, the large language models are essentially a very fancy autocomplete and have a tendency to hallucinate. We want to ground models to minimize the chance that the model is making up an answer and have the model provide the reference the answer is based on so it can be verified. It'll take a while before we get there. As I mentioned, this is much harder than most people think. But if we could bring all that knowledge together, it would be an extremely valuable tool. All of this takes a long time to accomplish and is difficult, but we believe it's worth the effort.

## EPRI Technical Expert

Jeremy Renshaw



## Ready for Liftoff

*Can Electric Vertical Takeoff and Landing (eVTOL) aircraft transform transportation?*

*By Chris Warren*

These days, electric transportation is basically synonymous with light-duty electric cars and trucks. That is understandable. Sales of new electric vehicles (EVs) in the U.S. in 2023 [surpassed](#) one million for the first time and were up by over 50 percent compared to 2022. The momentum is expected to continue in 2024, with market research firm Cox Automotive [forecasting](#) that the combined purchases of EVs, plug-in hybrids, and hybrid vehicles account for nearly 25 percent of all sales.

While EVs are quickly becoming mainstream on global roadways, another form of electric transportation is also poised to rise—literally. Electric Vertical Takeoff and Landing, or eVTOL, aircraft are attracting significant investment and development as companies seek to commercialize their use. Recently, EPRI published a *Quick Insight* report, [Look Up for eVTOL: Overview on the Flying Vehicles that Could Revolutionize Air Transportation](#), which outlines the drivers for eVTOL development, technological challenges that must be overcome, as well as grid infrastructure and equity considerations.

Though not widely known by the public or utilities, eVTOL development has been brisk in recent years. "This industry has gone from just talking about what an eVTOL should look like and what to do if we have eVTOLs to getting certifications and talking to the FAA (Federal Aviation Administration) about certifications and getting ready to commercialize their products as early as this year," said Purandhya Vij, an EPRI Strategic Insights Associate and co-author of the *Quick Insight* report. Indeed, there are currently over 600 eVTOL concepts at some stage of development, and the entire market could reach nearly \$18 billion by 2040, according to an [analysis](#) by the consulting company Deloitte.

### Cheaper, Quieter, and Cleaner

To understand why there is such a proliferation of eVTOL concepts and activity, it's important to grasp what eVTOLs are and the use cases they can uniquely address. As their name suggests, eVTOLs feature electric propulsion systems that allow them to take off and land without the need for runways. Put simply, eVTOLs operate more like helicopters



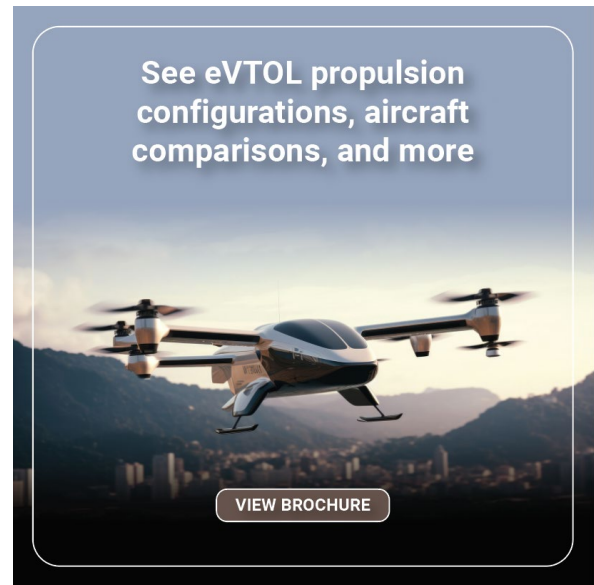
than airplanes, albeit minus the internal combustion engine. Besides their capacity to elevate and land vertically, eVTOLs are five times as fast as automobiles.

Though the concepts and features of eVTOLs are still in their infancy, current vehicles come in two basic categories. One is a wingless aircraft with multiple rotors and two or more thrust units that enable it to maneuver. For example, multicopters combine propulsion units that allow the aircraft to elevate and descend vertically with rotors that enable forward movement. The other common eVTOL category is powered lift, a winged aircraft that combines various thrust units that determine their maneuverability.

While eVTOLs have different features and capabilities, their appeal is driven by several common attributes. "The kind of utility that eVTOLs offer comes from the fact that they're going to be cleaner, cheaper, and produce less air pollution or no emissions while in flight," Vij said. Indeed, because eVTOLs have electric motors instead of gas-powered engines, they are easier and cheaper to maintain than helicopters. By one [estimate](#), eVTOLs cost \$1.50 per passenger mile to operate compared to \$6 to \$8 for helicopters. Electric propulsion also has other benefits, including the comparatively quiet operation that makes it more suitable for urban environments concerned about noise pollution.

The reduced or eliminated noise and air pollution eVTOLs offer, combined with the fact that they won't get caught in traffic jams, helps explain the use cases operators are pursuing. The primary eVTOL use cases include:

**Urban air mobility.** Anybody who has ever been late for school, work, or a doctor's appointment because of bottlenecked traffic will understand the appeal of jumping in an eVTOL that rises above a sea of stationary vehicles to quickly deliver a passenger to their destination. The prospect of providing what is essentially an air taxi to frustrated drivers has attracted investment and development by many eVTOL companies. Beyond the obvious benefit of improved transportation efficiency for passengers, eVTOLs also significantly reduce carbon emissions compared to helicopters. For example, a World Economic Forum [study](#) found that eVTOLs reduce



greenhouse gas emissions by 90 percent compared to helicopters. The same study also found that eVTOLs could be a significant source of employment, potentially creating 2.5 million new jobs over the next two decades.

**Emergency medical services.** Helicopters have long played an essential role in quickly transporting patients who urgently need medical care to hospitals. This legacy makes it easy to envision cheaper, quieter, and less polluting eVTOLs replacing helicopters. "There could be very few changes required in terms of regulation because there are already routes established for emergency medical flights," said Nicolas Sockeel, a co-author of the Quick Insight and Research Engineer at EPRI who specializes in energy storage and advanced vehicles. "It could be a substitution." Companies such as Beta, Volocopter, and EHang are pursuing partnerships in which eVTOLs transport patients to hospitals, deliver doctors to the scenes of emergencies, and transport organs.

**Cargo delivery.** Nearly [60 million](#) parcels are delivered each day in the U.S., a number that is expected to grow quickly in coming years. While a combination of airplanes, trucks, and vans currently deliver parcels and other cargo from point A to point B, eVTOLs have the potential to accelerate delivery times, particularly in urban areas where dense traffic slows drivers. eVTOLs also offer the possibility of reducing cargo delivery expenses because they don't require extensive ground and airport logistics



systems. Delivery giant UPS partnered with eVTOL operators to explore the benefits of the aircraft in small and mid-sized markets.

**Military applications.** The U.S. Air Force is spearheading the development of eVTOLs for military uses through its Agility Prime [program](#). At the end of 2021, the Air Force remotely piloted its first eVTOL, the Kittyhawk Heaviside aircraft. The military views eVTOLs as a beneficial tool for reconnaissance, transporting troops and equipment, logistics, and search-and-rescue missions.

## Challenges to eVTOL Deployment

Even though CEOs and executives at eVTOL companies are optimistic about their ability to launch their aircraft soon, numerous challenges are standing in the way of the vehicles becoming mainstream. As is the case with EVs, battery technology and charging infrastructure must both reach a level of performance and reliability to allow eVTOLs to scale.

"Energy storage density is one of the main issues for anything related to transportation," Nicolas Sockeel said. Indeed, energy density—which is the amount of energy a battery can store per unit of mass—is a significant factor in eVTOL prospects because the aircraft needs to be able to store a lot of energy in a relatively small and lightweight battery. Cycle life, the number of times a battery can be charged and discharged before losing capacity, is also important. So, too, is power density, which is the amount of power that can be delivered quickly and is critical to

generate the thrust eVTOLs need to takeoff. To be viable for a mass market, eVTOLs also need batteries to improve their energy density and reduce their cost of ownership.

Adequate charging infrastructure is also necessary for eVTOLs to scale. To serve hospitals and other emergency medical services, for example, eVTOLs will need to be able to recharge quickly. "The charging time for emergency medical services would have to be 10 or 15 minutes so that the eVTOL can turn around and make another trip," Nicolas Sockeel said. "That would likely require updates and upgrades to the infrastructure at medical facilities to be able to provide that kind of fast charge."

Currently, the infrastructure needed for emergency medical services, urban mobility, and other promising eVTOL use cases simply does not exist, which means that eVTOLs face the same chicken-and-egg dilemma that has challenged EVs. "The space is just developing, so there's nothing really available in terms of charging infrastructure," Vij said. "eVTOLs are only going to be economically viable if they're commercialized. And they will only be commercialized if they have charging infrastructure. So, everything must move in tandem to work."

For utilities, successful commercialization of eVTOLs could also result in significant load growth, requiring accurate transmission and distribution system planning. Especially important for utilities would be to prepare for increased load during peak demand.



For example, a [study](#) by NASA found that a vertiport—the eVTOL equivalent of an airport—could consume 50 MWh per day. One potential solution to reduce the grid infrastructure investments needed to charge multiple eVTOLs could be to swap out depleted batteries for already-charged batteries, a process that takes only about five minutes.

Several other challenges must also be overcome, including integrating eVTOLs into existing air traffic management systems and garnering public acceptance of the novel technology. Because pilots are a significant expense, one strategy for decreasing the cost of eVTOLs is to make them autonomous. Developing and deploying the technology to make this possible will require significant investment. And that investment will only be worthwhile if the public is confident that flying in a pilotless aircraft is safe.

## Integrating Equity Early in eVTOL Projects

Although eVTOLs have not yet been commercialized, company executives, utilities, policymakers, and regulators should consider equity in all their investments and decisions. There are a wide range of equity issues related to eVTOLs, including accessibility for everyone who could benefit from the efficient transportation they potentially provide. "We will see eVTOLs for urban transportation in Manhattan, but what about Queens?" Vij said. "If you're only giving access to the haves of society, then it's not accessible, and it's not solving the problem it was designed to address."

Equity should also be incorporated into decisions about siting vertiports and charging infrastructure, as well as how a proliferation of eVTOLs would impact communities. "It's making sure that not only air pollution is addressed, but we are also talking about visibility pollution and noise," said Annette Mosley, an EPRI senior technical advisor.

Equity isn't just about avoiding negative impacts. As with other aspects of the energy transition, eVTOLs offer the potential to deliver economic opportunity to disadvantaged communities. "There's an opportunity to create jobs, but that requires workforce development," Mosley said. "There could be opportunities to train or retrain workers in low-income communities but also to reach out to HBCUs (historically black colleges and universities) to establish career or entrepreneurial pathways in eVTOLs."

What's important, though, is that equity be integrated early in all eVTOL projects rather than as an afterthought. "It's about making sure equity considerations are thought of even when they can't be addressed immediately," Mosley said. "It's the golden thread that should go through everything."

## EPRI Technical Experts

Purandhya Vij, Nicolas Sockeel, Annette Mosley



Photo courtesy Bonneville Power Administration

## Blooming Success

*Celebrating the hard work of creating pollinator-friendly habitat in Oregon and Texas*

**By Chris Warren**

Residents of Portland, Oregon, don't have to travel far to immerse themselves in the unique natural beauty of the Pacific Northwest. In the northwest corner of the city lies the nearly 5,200-acre Forest Park, the largest urban park in the United States. Originally [conceived](#) by John Charles Olmsted—son of Frederick Law Olmsted, the landscape architect behind New York's Central Park and Jackson Park in Chicago—Forest Park attracts about one million visits each year from cyclists, walkers, birders, and runners drawn to the park's 80 miles of trails and dense canopy of Douglas fir, Western red cedar, and other trees.

Already treasured by Portlanders, Forest Park is unique for a new reason. A 67-acre portion of the park now provides an important habitat for pollinators, resulting from a novel collaboration between Bonneville Power Administration (BPA), Portland Parks and Recreation, and Metro, a regional governance agency. In 2023, the project was awarded the EPRI & North American Pollinator Protection Campaign's (NAPPC) Electric Power Award, which annually recognizes successful and

sustainable initiatives in the electric power industry that benefit pollinators.

"The North American Pollinator Protection Campaign, managed by Pollinator Partnership, has been recognizing pollinator champions in various categories for 24 years. In collaboration with EPRI in 2020, we created an award for the electric power sector," said Kelly Bills, executive director of the Pollinator Partnership. This non-profit works with farmers, gardeners, land managers, scientists, and industry to develop tools to promote pollinator health.

Winners of the award are chosen by a panel of scientists who evaluate applicants based on a project's tangible benefits to pollinators, which includes commitments to bolster pollinators over the long term. Past winners have included American Electric Power (AEP), Toronto and Region Conservation Authority (TRCA), and [Disney](#), which earned recognition for co-locating pollinator habitat and solar power plants at Disney World in Florida.



## Good for Pollinators, Good for Vegetation Management

BPA's involvement in the Forest Park pollinator project, better known as the P3 Project, had its roots in the federal government's recognition of the critical importance of pollinators to the economy and acknowledgment that populations of many bees, pollinator insects, birds, and bats were in dangerous decline. For example, in 2014, the Obama administration issued a presidential [memorandum](#) to create a federal strategy to bolster the health of pollinators, which resulted in the development of pollinator-friendly best management [practices](#) on federal lands and a host of other actions.

"Because BPA is a federal agency within the Department of Energy (DOE), recognition of the peril facing pollinators and their importance to the economy was shared throughout DOE," said Nancy Wittpenn, environmental protection specialist at BPA.

Within BPA, Wittpenn and other concerned staff launched a pollinator workgroup when the agency became a founding member of EPRI's Power-in-Pollinators [Initiative](#), which began in 2018 and is the largest collaboration of U.S. power companies and agencies working collectively to support pollinators.

For Chris Morse, who oversaw vegetation management in the region at the time, the decision to participate in the project was easy because it promised to reduce the risks posed to BPA's transmission system infrastructure located in Forest Park. "We eradicate any vegetation that is tall enough to grow and cause issues with our lines," said Morse, a BPA supervisory natural resource specialist. "We maintain our rights-of-way to eliminate incompatible species that have outage potential and identify and eradicate invasive and noxious weeds. Replacing them with low-growing pollinator-friendly species and native flora makes strategic and economic sense because less need for management usually equates to lower costs. There's really no reason not to do it."

### A Commitment to Collaboration

But transitioning from an agreement that made 67 acres of Forest Park BPA owns into both a haven for pollinators and less susceptible to vegetation-caused

outages required years of advanced planning and collaboration. Indeed, once BPA agreed to participate in the effort, representatives from the city of Portland and Metro held outreach meetings to drive planning and cooperation. "Within a year, we had phases of the project identified and determined who was responsible for what, from maintenance to funding to planning," said Morse.

The initial phase of the project was devoted to site preparation. Specifically, that meant the removal of Scotch broom in 2016 and the eradication of Himalayan blackberry, work that continued through 2017 and 2018. The City of Portland contractors also targeted invasive grasses and herbaceous species. Planting new, native, and pollinator-friendly vegetation started in the fall of 2018. Elaine Stewart, a botanist with Metro, led the work. Stewart collaborated closely with BPA and the city in devising her vegetation plan.

For example, while supporting pollinators was paramount, the new plants and flowers also needed to be resilient to BPA's vegetation management activities. "The planting had to work within the constraints of the infrastructure of the access roads and the structures that keep the transmission system off the ground with necessary clearances," said Morse. "For example, we have to mow around each structure up to a distance of 30 to 50 feet and maintain the roads, and we didn't want to plant something that can't sustain the impact of mowers and trucks and boots on the ground."

To help guide plant selection, BPA's geospatial professionals developed topographic style maps called isoclearance maps that showed how tall vegetation could be across the site without violating BPA's vegetation clearance criteria. The planting plan also considered the unique needs of pollinators in the Pacific Northwest.

"Pollinators have evolved to access types of plants and vegetation, and that is done via color, flower shape, bloom time, and nectar availability," said Wittpenn. "We have three growing seasons, spring, summer, and fall, so it was important to have plant variety and nectar that would attract pollinators whenever they were active."

In 2018, nearly 250 pounds of native wildflower and grass seed mixes were added to the area's existing native vegetation. In early 2019, about 6,000 native shrubs were also planted. For example, wildflowers like the Prairie shooting star, Showy milkweed, and Blue-eyed Mary were planted along with shrubs like the Red-flowering currant and Willow and grasses such as Dewey's sedge.

## A Model for the Future

The third phase of the project began in May of 2019. It focused on preventing the return of non-native vegetation and the implementation of a long-term vegetation management plan, which is done in collaboration with Portland Parks and Recreation. This includes eradicating any vegetation that could threaten transmission system infrastructure in the park every three years. Mowing schedules and techniques have also been adjusted to control vegetation while promoting pollinator health, and workers tasked with removing weeds are trained to identify native plants.

The benefits to pollinators because of the project are well-documented. Indeed, the non-profit Xerces Society for Invertebrate Conservation was hired by Metro to monitor and document pollinator abundance between 2016 and 2021—a timeframe that included the three years before project planting took place and three years after. In addition, the Xerces Society also compared the BPA rights-of-way in Forest Park that benefitted from pollinator habitat restoration and similar rights of way that were left untouched. The results confirmed greater overall pollinator abundance in BPA's rights of way.

Both Morse and Wittpenn are gratified by the improvement in pollinator health in Forest Park. But perhaps the most significant benefit of the project is that it has created a blueprint BPA can follow to benefit pollinators in other rights-of-way. "This project is a model for us and our partners and has laid the foundation for future work," said Wittpenn. "We now use this area to show other groups that may want to initiate a pollinator project on rights-of-way we own how it can be done."



*Photos courtesy Bonneville Power Administration*

In another collaboration with Metro, BPA is following the same approach it used on the P3 project to create a pollinator-friendly habitat in a transmission line right-of-way along the Willamette River. BPA is also working with a local soil and water conservation district and a regional park and recreation district to apply this model to other rights-of-way in the Portland area.

The success of these initial projects continues to build momentum for future pollinator initiatives. "There are plenty of BPA-owned rights-of-way in the Portland area," said Morse. "It's a straightforward thing for us to do now. If it fits into the work the crews are doing anyway, it's very easy for them to work with other partners to make a project work and help pollinators."

### A Hill Country Revival

New Braunfels, Texas, is home to a remarkable comeback story—for pollinators, the plants that support them, and a unique Hill Country ecosystem. The Headwaters at the Comal are a short distance from downtown New Braunfels, which is located between Austin and San Antonio. The 16-acre site is where the Comal River—the shortest navigable river in Texas—begins. The river is fed by the Comal Springs, the largest naturally occurring springs in the state.

Today, Headwaters at the Comal is a haven for those keen to experience the natural environment in a way that inhabitants of the Hill Country from thousands of years ago would recognize.

"The springs have supported people for 10,000 years or more," said Nancy Pappas, managing director of the non-profit organization that operates the site and provides a wide range of educational and volunteer opportunities for residents and visitors. "It became the original drinking source for this growing community when German settlers started settling here."

A few short years ago, however, the 16 acres were far from the natural, cultural, and historic idyll they are today. As the town grew, the municipal utility New Braunfels Utilities (NBU) was tasked with managing the precious water resource. Initially, that meant pumping water from the Comal Springs. Later, wells were drilled to directly access water

from the Edwards Aquifer. NBU used the site for its operations and fleet facilities, covering much of it with asphalt and warehouses and expanding the working water plant.

### A Higher and Better Purpose

Eventually, NBU decided to move its operations, a decision that began the transformation of the site from a retired operations and warehouse facility into an area recognized as runner-up for the 2023 NAPPC Electric Power Award. Pappas credits the original vision of NBU's board of directors with kickstarting the metamorphosis. "It's a municipal utility run by a board of directors who are community members appointed by the city council," said Pappas. "The utility brought this property to the board and said, what are we going to do with this? Some board members said they would only support restoring the damage to that site and using it for a higher and better purpose."

Once the decision was made in 2012 to transform the site, a master plan was developed with the help of partners like the architecture firm Lake-Flato, which specializes in connecting buildings to the natural environment, Ten Eyck Landscape Architects, and the Lady Bird Johnson Wildflower Center. The fundamental goal of the plan was to recreate the native prairie landscape that existed for thousands of years and protect the Comal Springs riparian area.

"It was essentially starting from zero to do our best to recreate what the habitat would have been," said Jack Downey, program coordinator at Headwaters at the Comal. "What the restoration is attempting to do is add back the ecosystem services that the site would have provided, one of those specifically being the pollinator piece."

Establishing a pollinator-friendly habitat required research about plants that were native not only to Texas, but specifically to the Hill Country. It also took some detective work because some of the species identified were not commercially available, such as the Gray Golden Aster, Rough Stoneseed, Texas Prairie Parsley, and Ozark Grass, which are all present on the site today. In the initial planting, Downey prioritized a mix of host plants where butterflies and other pollinators could live and raise their young and forage plants to feed on.



Another priority in selecting grasses, flowers, and other vegetation was ensuring a reliable food supply throughout the year. “We wanted to have a seasonal progression of flowering plants,” Downey said. “In the fall, when we have our Monarch butterflies migrating back through the area, we made intentional choices to have flowering species like Frostweed and Goldenrods that bloom when other species are fading out through the summer heat.”

One lesson that has emerged is that establishing a pollinator-friendly habitat is not a set-it-and-forget-it task. The ongoing maintenance involves enlisting volunteers to remove invasive species by hand. It also requires flexibility in vegetation management and planting. “The landscape is dynamic and will change from year to year, so some of the species we see this year might not show up again for another couple of years,” said Downey. “It’s definitely more of a process than a destination.”

The mission of Headwaters at the Comal is not just to restore the area’s habitat but also to engage the community and connect people to nature.

Maintenance of pollinator habitat, educational tours, and documenting species provide ample opportunities for residents to experience and support the ecosystem. For instance, butterfly monitoring teams come to the site monthly to record the number of butterfly and moth species (to date, teams have observed 74 butterfly species and over 100 moth species). The non-profit partnered with New Braunfels Kids Club last year to install a pollinator garden at their site and has participated in the city’s annual Monarch Festival.

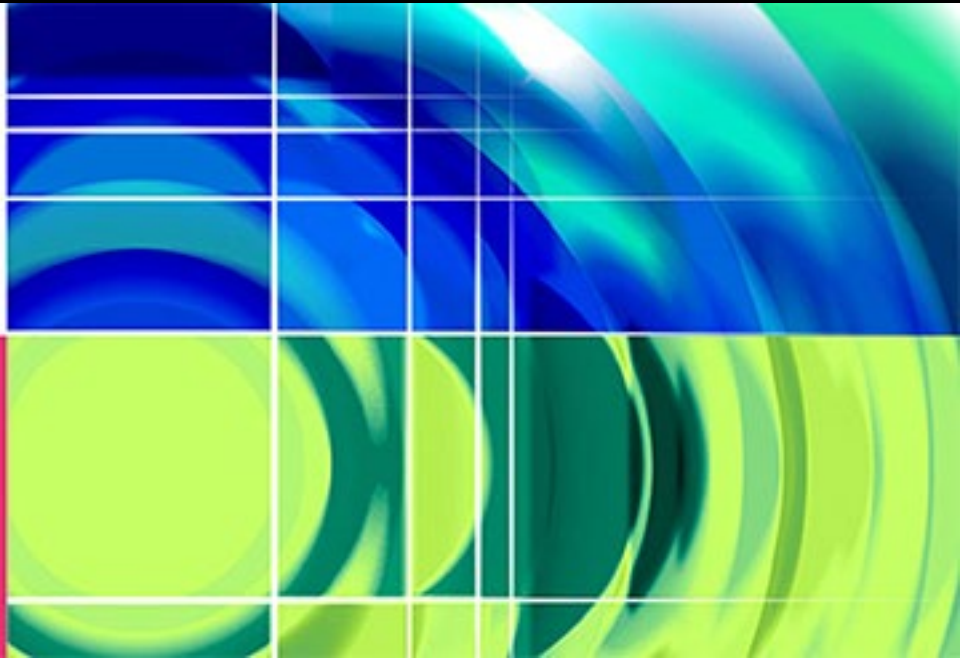
While supporting pollinator habitat is critical, it’s just one of many pieces that combine to create a thriving ecosystem. “Many of these different initiatives overlap and build on one another. As important as pollinators are to the ecosystem’s health, it’s just one part,” said Downey. “But that is what an ecosystem is. It’s all these different pieces that together have coherence, logic, beauty, and purpose. It’s exciting to see that all come together here.”

### EPRI Technical Expert

Jessica Fox



*Photos courtesy Headwaters at the Comal*



## Innovation Personified

*Five early to mid-career professionals share why innovation is critical to delivering on nuclear power's full potential.*

**By Chris Warren**

Innovation can mean different things to different people. For some, it's all about the breakthrough inventions or new technologies fundamentally changing people's lives. Others see innovation in the novel processes people follow to come up with and execute new ideas. Still, others understand that innovation can mean taking an idea others have already demonstrated and applying it to their unique situation.

It really doesn't matter how innovation is defined. A common definition of innovation is less important than recognizing its myriad versions are essential to drive progress. What's more important is to understand that innovation in its myriad forms drives progress. The role and importance of innovation in the nuclear power industry will take center stage at this year's Global Forum for Nuclear [Innovation](#) (GFNI), a three-day event set to take place in June in Miami, Florida,

USA. The aim of the event is both ambitious and simple: to equip participants with the tools, techniques, and mindset necessary to bolster innovation in their organizations and, importantly, to use innovation to turn ambition into action.

The GFNI does this by [redefining](#) what an industry event is; after all, an event devoted to innovation must defy expectations and provide practical tools for attendees to take home and apply in their organizations. These tools will "bottle up" the experience at the event and, when "uncorked," support the actual innovation taking place in the day-to-day work of nuclear professionals around the globe. And there is good news on that front. A new wave of professionals entering the industry brings both a passion for delivering the full potential of nuclear power and an understanding that innovation is a key ingredient to achieving it.

## New Wave of Nuclear Professionals

View interactive profiles at <https://eprijournal.com/innovation-personified/>







## Grace Stanke

Core Design Engineer  
Constellation Energy

After she was crowned Miss America in 2023, Grace Stanke spent the next year almost entirely on the road. There were visits to big-name events, like the Kentucky Derby, as well as trips to conferences, schools, state legislatures, and even overseas journeys to meet presidents.

In her countless meetings, interviews, speeches, and appearances, Stanke focused on one topic. "About 90 to 95 percent of my appearances were related to nuclear science in some capacity," said Stanke, who recently graduated from the University of Wisconsin-Madison with a degree in

nuclear engineering.

Stanke's emphasis on educating people about nuclear power was neither a mistake nor anything new for her. The daughter of a civil engineer, Stanke grew up visiting sites where her father oversaw the construction of bridges. In school, Stanke gravitated to math and science, not only because she had an aptitude for the subjects but also because the subjective nature of classes like English drove her mad. "In seventh grade English I could not get an A on this one paper and the feedback was you're almost right, you're almost there," recalled Stanke. "When I looked at my math classes, I was either right or wrong. There was no in-between."

It wasn't until Stanke was touring colleges—Texas A&M, to be precise—that she had any serious exposure to nuclear science. Stanke's decision to pursue nuclear engineering was solidified when her father told her there was no future in nuclear. "To a 16-year-old girl, that is pure motivation. I got into the field out of spite to prove my father wrong," Stanke said. "What kept me in the field is when I learned what it provides for the world. A big moment for me was when I sat down in class and learned that nuclear medicine is the reason my dad is a two-time cancer survivor."

Stanke has been advocating for nuclear power since she began studying nuclear engineering at the University of Wisconsin, visiting schools and Girl Scout troops keen to learn more about nuclear's potential to power a clean energy future. Now that she has graduated and completed her Miss America duties, Stanke is working for Constellation Energy as a core design engineer and clean energy advocate.

Stanke has spent years communicating the immense value of nuclear power to those who know little about it. But she also has a message for those in the nuclear industry about the importance of innovation. To foster the innovation it needs, Stanke believes the industry needs to become less insular. "Innovation is essential. You can't make progress without it," Stanke said. "When it comes to the insularity of nuclear, I think it is a problem because we don't really branch out all that much."

Stanke is encouraged to see companies that have not traditionally been in the industry pursuing innovative reactor designs and other advances. She thinks the industry should welcome it and seek to benefit from new technologies, ideas, and mindsets. As she begins her own career in nuclear, Stanke's approach to innovation is influenced by something her mother told her and her siblings when they were young. "She raised us with the mentality to try something new that scares you every day," said Stanke. "That leads to some scary things, but it leads to some really incredible things, too."



## **Tatsuya Hisatsugu**

General Staff  
Kyushu Electric Power Company

For the past year-plus, Tatsuya Hisatsugu has been working as a resident researcher at EPRI's Charlotte, North Carolina headquarters. Hisatsugu is spending two years away from his Japanese employer, Kyushu Electric Power Company, to research nuclear risk and safety management.

EPRI's Resident Researcher program is designed to promote scientific exchange and facilitate the sharing of technology information among EPRI's membership for the benefit of the global public. The program enhances the value, depth, and quality of EPRI's research while honoring distinguished researchers in the technical field.

Hisatsugu's time at EPRI has also been devoted to learning about innovations in the global nuclear power industry that could potentially benefit his employer and Japan's domestic nuclear industry. It has been time well spent. "EPRI is doing a lot of research about electric power not just in the U.S. but internationally," Hisatsugu said. "There is research about nuclear power in France and Asia and the Middle East, and there are lots of good insights for me."

To Hisatsugu, the experience has reinforced his understanding that innovation can mean more than just one thing. At one level, Hisatsugu says he has always thought of innovation as the creation of completely new technologies. But now he also sees that innovation can mean applying new ideas that have worked well elsewhere to the nuclear industry in Japan.

"We are now in the process of considering a risk-informed maintenance approach and how that is a benefit, and we have good insights from EPRI and how U.S. utilities do maintenance work and make it effective and reduce costs," Hisatsugu said. "I think we can take many insights and knowledge from utilities to make nuclear power operation safer."

Hisatsugu sees innovation as essential to the future role of nuclear power in Japan. For example, Hisatsugu says that the nuclear supply chain has become more challenging after the Fukushima nuclear accident. "In the future, if we can automate and use AI in manufacturing things like a reactor vessel, we can maintain the supply chain," Hisatsugu said.

Before his stint at EPRI, Hisatsugu's own career trajectory has required the kind of continuous learning and exposure to new ideas that breeds innovation. His first job was in the operations division at Genkai nuclear power plant. He later transitioned to a position in plant maintenance before moving to a corporate position doing regulatory assurance.

Hisatsugu's time at EPRI has only expanded his exposure to new ideas and he hopes to apply what he has learned when he returns full-time to Japan. "The situation in our industry is more difficult than I expected when I was a student," Hisatsugu said. "But after coming to EPRI, I have learned so many insights from different countries and learned about so many technologies and innovations that I wouldn't know if I stayed in Japan. So, I think collaboration and sharing is important for innovation."



## Alice Cunha da Silva

Innovation Project Lead  
Westinghouse Electric Company

Alice Cunha da Silva's parents didn't have much formal education, but they had a lot of wisdom. As a kid growing up in Brazil, Cunha da Silva learned exactly what she needed to do to build a bright future. "A big push from my parents was for their kids to have an education because they knew that was the way to a better life," said Cunha da Silva, whose mother worked as a nurse assistant and whose father was a handyman at a Brazilian air force base.

Cunha da Silva took her parents' advice seriously and translated her natural talents in STEM into an accomplished career in the nuclear power industry. Before taking up her current position as Innovation Project Lead at Westinghouse Electric Company in Madrid, Spain, Cunha da Silva earned a nuclear engineering degree at the Federal University of Rio de Janeiro, an MBA at the University of Bordeaux in France, and a long list of awards and committee memberships, including first place in the 2015 Nuclear Olympiad, an international competition organized by the World Nuclear University.

Cunha da Silva's own life has been a series of firsts; not only was she one of the first in her family to graduate college, but she was also the first to travel overseas and learn foreign languages. So, it's no surprise that she is comfortable with innovation. Today, her job at Westinghouse is devoted to driving innovation both within the company and across the nuclear industry. Cunha da Silva believes one way to drive innovation is to define it broadly.

"We often think of innovation as technology development or as a product," Cunha da Silva said. "For me, innovation is more cultural because you can be innovative in business models, and you can be innovative in the way you are doing things. Innovation is a mindset and there are several aspects to that mindset."

Cunha da Silva has been in the nuclear industry long enough to understand the challenges with promoting innovation. A safety-first mindset, she says, encourages strict adherence to established processes. While prioritization of safety will always be paramount, there still needs to be room to try new things. "We need to be an industry that nurtures environments where people can be creative," Cunha da Silva said. "And that's how we actually got here in the beginning. We had scientists and engineers trying different things that got us to the technology that we have today."

Until recently, Cunha da Silva was working to foster innovation at Westinghouse by facilitating collaboration internally and with external partners. The innovation is aimed at goals such as reducing costs and shortening the time-to-market for products. She also uses design thinking to focus innovation on specific problems that need to be solved in the industry. "We want to innovate with purpose," Cunha da Silva said.

Developing a culture that embraces novel solutions and welcomes new ideas is an important aspect of Cunha da Silva's job. Creating that culture involves removing any fear about speaking out. "If you have an organization where people don't feel comfortable sharing ideas, you are going to be less innovative," she said. "As an industry, we all need to create environments where people are comfortable raising their voices."





## Nelly Ngoy Kubelwa

Nuclear Power Engineer  
International Atomic Energy Agency

Nelly Ngoy Kubelwa didn't have to look far for career inspiration. Ngoy Kubelwa's father worked as an engineer in the copper mining industry in the Democratic Republic of Congo, and she always jumped at any chance to visit his office. "I was fascinated by the transformation from rocks to wires and other products," Ngoy Kubelwa said. "My father inspired me a lot."

Ngoy Kubelwa acted on that inspiration, helped by the fact that mathematics and physics came easily to her. After initially thinking she wanted to be a medical doctor, Ngoy Kubelwa eventually gravitated to engineering and earned a master's degree in electromechanical engineering from the Free University of Brussels in Belgium. It was only after earning her master's degree that she gravitated to the nuclear power industry, which appealed to her interest in theoretical knowledge and rigorous safety culture.

"I fell in love with the nuclear industry after my master's," Ngoy Kubelwa said. "Continuous, low-carbon and affordable energy supply is vital for human well-being. I really liked the precision and the rigor in the nuclear industry because we have so many standards and codes that we must comply with. I enjoyed the compliance analysis and the review of the different I&C (instrumentation and control) architectures and the defense-in-depth concept. My love for nuclear came from the useful practical applications from the theoretical part of the work."

Today, Ngoy Kubelwa works for the International Atomic Energy Agency (IAEA) in Vienna, Austria. The opportunity to innovate with professionals in the nuclear industry from around the world was a big reason Ngoy Kubelwa wanted to join the IAEA.

In fact, Ngoy Kubelwa has enjoyed working with IAEA staff and members from around the world who naturally cultivate an innovative culture in their work. "I do not believe that innovation is doing something extraordinarily different or something completely new. I think that innovation comes from the combination of different ideas that leads to something new," Ngoy Kubelwa said. "Each Member State has its own preferences and is working in a different way, and I really like to be exposed to those differences because it helps me reconsider my ideas and improve."

For example, Ngoy Kubelwa is leading an IAEA working group to examine the deployment of artificial intelligence (AI) applications in the nuclear industry. This group has been created in the frame of the IAEA International Network on Innovation to Support Operating Nuclear Power Plants ([ISOP](#)). "This work is really interesting because the different Member States are not at the same level and do not focus on the same aspects," Ngoy Kubelwa said. "The terminology is not yet standardized."

Rather than considering divergent attitudes and experiences as a roadblock, Ngoy Kubelwa sees the collision or clash of ideas as an opportunity to innovate. And to Ngoy Kubelwa, a focus on innovation is an expectation of the younger generation now entering the industry. "The younger generation thinks differently," she said. "The industry has to adapt a new mentality. When you consider the educational system, they are constantly innovating. For example, looking at another innovative industry, the medical sector, they are introducing new equipment and new components constantly. For nuclear, we also have to always consider which innovations can be used safely and securely."



## Jennifer Upton

Commissioning Engineer  
Hinkley Point C

Jennifer Upton doesn't have to think very long to pinpoint the importance of innovation in her day-to-day work. Upton is a commissioning engineer at [Hinkley Point C](#), a twin-unit 3,260 megawatt nuclear power plant that is expected to power six million British homes with carbon-free electricity once it is operational. Hinkley Point C is the first nuclear power plant to be constructed in the United Kingdom since the Sizewell B plant was connected to the grid in 1995 and the first in the nation to use the EPR pressurized water reactor design.

"Everything we are doing on the commissioning team is complete innovation because we haven't commissioned anything in the UK for decades," said Upton, who notes that 3D models and other tools she relies on in her work weren't even available the last time a nuclear power plant was commissioned. "That has challenged me to think of innovation as not just the big technological stuff but it's also when we are doing anything for the first time."

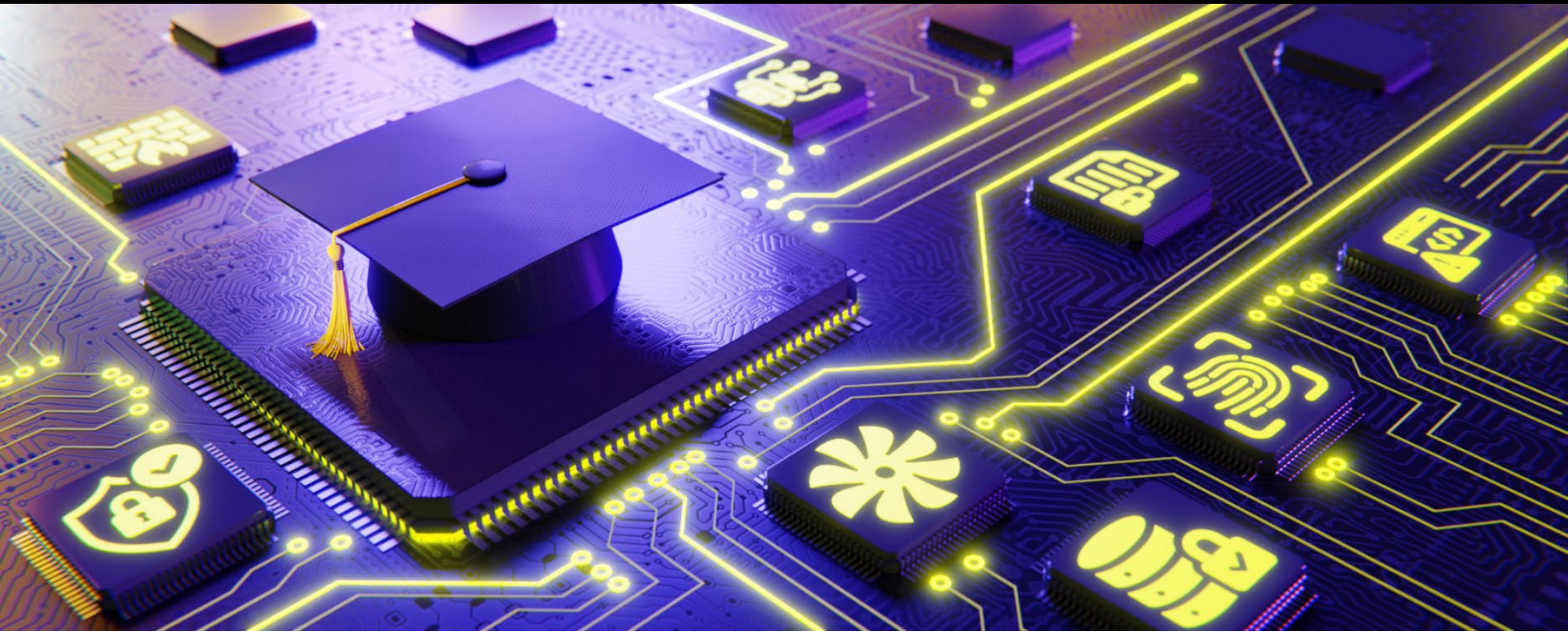
It's no exaggeration that Upton was convinced she was going to work at Hinkley Point C before she even went to university. The daughter of two schoolteachers—her dad taught geography; her mother taught English—Upton's family always assumed she would go into the arts. But when she was 14, Upton discovered engineering when representatives of a British company named [Bloodhound LSR](#) that was seeking to break the world land speed record visited her school.

"They went to lots of different state schools to try and encourage younger children to be interested in science and technology," said Upton. "I remember looking at their car and thinking, how is that thing going to go 1000 miles an hour? That blew my mind."

That initial instinct to figure out how something so challenging was possible ultimately led Upton to focus her secondary school studies on math and physics (and English literature for fun) and to also pursue an extracurricular research project about nuclear power, including next generation technologies. The research was so intriguing to Upton that she had a visceral reaction when she heard the news that Hinkley Point C had been approved in 2016. "I turned to my teacher and said this is amazing for me," said Upton. "I've got four years at university, and when I finish it is going to be 2021 and they'll have finished all the civil works by that point and will be going into mechanical installation. I want to be a mechanical engineer so I'm going to get a job there."

Which is basically what happened. After graduating university in 2021 with degrees in mechanical engineering and nuclear technology, Upton joined EDF, the company building Hinkley Point C. For her first year at EDF, Upton spent 10 weeks in various parts of the business before settling into her role as a commissioning engineer. For the next two years, Upton will be working in operations before returning to her commissioning role. Upton's career thus far has exceeded the high expectations she had when she was first imagining it in school.

"I genuinely love what I do. And I think what's amazing about my job at the moment is so much of it revolves around learning," said Upton. "I want to be here because this is the first time that we've ever constructed an EPR (European Pressurized Water Reactor) in the UK and I want to be at the front of it."



## Bridging the Gap

*As cyberattacks become more prevalent and sophisticated, EPRI provides training to close the skills gap utilities face in protecting generation assets.*

*By Chris Warren*

The electric power system is under near-constant attack by cybercriminals. Over the last several years, cyberattacks have resulted in the [disablement](#) of remote controls for wind farms and [data breaches](#) involving utility customers' personal and financial information. The number of hacking attempts targeted at the California Independent System Operator (CAISO) [number](#) in the millions per day. According to Verizon's 2023 Data Breach Investigations [report](#), nearly three-quarters of attacks involve a human element in the form of error, stolen security credentials, and social engineering.

While some cyberattacks go unreported, the International Energy Agency (IEA) [reports](#) there is an abundance of evidence that attacks have been on a dramatic upswing since 2018. The IEA believes that the increasing number of cyberattacks is due to a combination of factors, including the increased use of digital technologies to manage grids and power plants and the accelerating influx of distributed energy resources (DER) that provide power system entry points that criminals can exploit.

### Why Workforce Development Matters

EPRI has also conducted extensive research and collaborated with members and industry stakeholders on identifying cyber vulnerabilities and developing tools to address them. This has included a broad range of activities, including a [series](#) of educational and training videos on topics such as the use of artificial intelligence (AI) in electric sector cyber security as well as [videos](#) detailing cyber security first principles. EPRI also conducted [surveys and research](#) to identify cyber security knowledge gaps training should address.

While improved standards and technologies are critical to protecting the power system from cyber criminals, even the most innovative and impactful solutions will fall short if the industry lacks the trained personnel to detect and respond to attacks. "Cyber security training is such an important topic because of the risk associated with it and because most cyber incidents include some sort of human component," said Soomin Militello, an EPRI technical leader specializing in cyber security.



The human component of cyber security has many aspects, including staff who unwittingly aid a cyberattack by handing over sensitive information or information technology (IT) or operational technology (OT) access to criminals. "The talent acquisition and development in this space is challenging because you have to find people who know about cyber security as well as the utility industry and the operation of our plants," Militello said. "Those are very special skills."

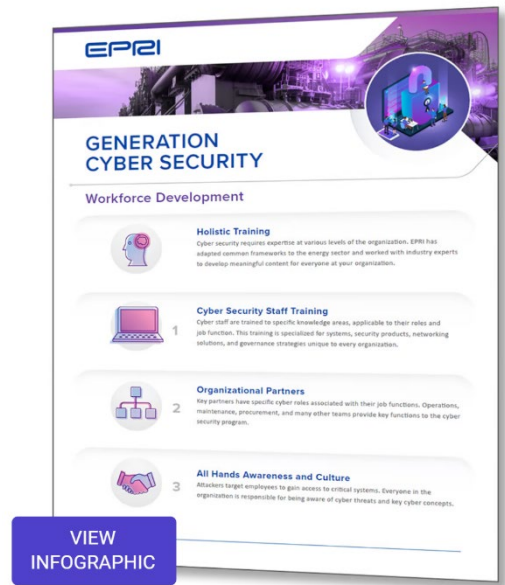
The reality is that virtually all industries are struggling to find cyber security talent. A recent [report](#) by ISC2, a member association for cyber security professionals, found that the global workforce of cyber security professionals reached 5.5 million in 2023, an increase of nearly 10 percent over 2022. While the workforce is growing, its expansion is not nearly rapid enough to keep up with demand. According to the ISC2, an additional four million workers are needed to fill open cyber security positions worldwide.

The wide gap between available and well-trained cyber security professionals and the demand for their skills comes at a perilous time. Indeed, 75 percent of cyber security professionals surveyed by ISC2 said the current threat landscape is the most challenging it has been in five years, which is hardly a surprise given the rapid advances made by artificial intelligence (AI). AI could make attacks more difficult to defend against, provide tools to defend against cyberattacks, or some combination of both.

## A Holistic Approach to Training Generation Staff

EPRI member companies understand that there are cyber security and talent acquisition challenges. In response, EPRI has developed a holistic set of training courses designed to bolster the skills of staff responsible for generation cyber defenses and to raise awareness of threats across the entire utility workforce.

In many ways, the utility industry starts from a position of understanding the seriousness of cyber security. "Our industry protects its systems rigorously not only because regulations require it but also because it concerns people's safety and the



critical infrastructure," Militello said. "Cyber security is taken seriously. Workforce development is always challenging because you can have the perfect cyber security program, but it serves little purpose if nobody's following it."

Utility-specific training also must consider some unique industry factors, particularly the need to prioritize the availability of electricity. "You really can't take a power plant offline just because you want to update a system," Militello said. "All cyber security practices are going to depend on prioritizing availability."

EPRI's generation sector cyber security training addresses [three areas](#). They are:

**Cyber security staff training:** [Training courses](#) for utility cyber security staff are designed to provide the specific education and skills necessary to perform their jobs.

This includes specific programs for security analysts who are charged with identifying cyber threats and developing mitigation strategies. Courses also equip network engineers and IT and OT specialists with the knowledge to harden IT and OT infrastructure, hardware, software, and network assets. Also covered are network defense and operations and cyber program management, which includes governance and training in making risk-informed decisions.

**Organizational partner training:** Beyond dedicated cyber security staff, specific roles have a significant impact on a utility's ability to prevent, detect, and respond to an attack. To that end, training is role-dependent. "One of the gaps we identified with existing training was that it was too generic and not specialized and specific to various roles," Militello said. In generation, that includes power plant operators, instrumentation and control technicians, procurement, and IT/OT staffers. "There are specific groups that have a more direct impact on cyber security than others," Militello said. "While power plant operators are mainly responsible for running a plant, they could also be the first to identify any indication of a cyberattack, and we want to make sure they have the training needed to respond quickly and effectively."

**Training to build a cyber security culture** One of the main lessons from successful cyberattacks is that robust security requires everyone in an organization to understand the threats and identify common strategies attackers use. Attackers use deception and social engineering techniques to trick people into handing over sensitive information. One

common technique is when a criminal poses as a vendor, company colleague, or leader in an email and requests information—a tactic known as phishing. EPRI's training seeks to build a strong cyber security culture by providing examples of recent attacks, describing scenarios that should raise alarms about cyberattacks, and common vulnerabilities that relate to non-security utility employees.

Currently, the training is computer-based, allowing learners to access courses at times and locations of their choosing. In response to member feedback, EPRI is also developing more hands-on training to take advantage of its cyber laboratory in Charlotte, North Carolina. "We have different devices from different vendors that people can tear apart without worrying about breaking their system and benefit from more active learning experiences," Militello said. "We want to be the industry's shared laboratory."

## EPRI Technical Expert

Soomin Militello



## The Future of Training at EPRI

*Why modern, learner-focused training is key to equipping the workforce utilities need.*

**Interview By Chris Warren**

Saving four weeks of training time for new plant technicians can be significant, both for utilities who hire them and for the employees eager to get up to speed and on the job. This was the case for Arizona Public Services (APS) in 2023. Their training team estimates total cost savings of \$160,000 for 49 staff members participating in the streamlined nuclear fundamentals training course APS helped pilot for EPRI along with other member utilities.

The course is part of EPRI's Common Initial Training (CIT) curriculum, featuring content delivered on a schedule convenient for participants and readily available instructor assistance. While the initial academic fundamentals programs were about eight weeks long, the EPRI program reduced the training time to about four weeks.

That four-week savings was critical to APS, said Lee Baker, Training Section Leader for Technical Training, "That number (\$160,000) does not even count what we saved by not having to hire supplemental instructors. In addition, EPRI's CIT program accelerated the learning experience and helped us

meet hiring challenges because students can enroll at any time. Now, we don't have to wait until enough new employees are available for a class."

In addition to cost savings, the flexibility provided through the CIT model helps improve the onboarding experience for new employees, an important benefit as utilities focus on attracting and retaining workers in a competitive environment. Pamela Schwenk, an EPRI principal project manager dedicated to CIT development and implementation, brings a unique perspective to this role through her own experience training as a technician early in her career.

Traditionally, individual nuclear power plants have developed and delivered their own training curricula, even though a common set of foundational skills and knowledge applies across the industry.

"This has meant there is a training burden on utilities that isn't necessary," Schwenk said. "Individual sites will always need to do site-specific training because each site has its own unique technologies and



systems to focus on. But you'd rather have instructors spending their time prepping for site-specific topics rather than the general instruction that applies to everyone."

A desire to remove a big part of the training burden utilities face and improve the accessibility, efficiency, and standardization of instruction led to EPRI's launch of the CIT initiative in 2020. The effort is part of a larger evolution to training at EPRI. It is informed by EPRI's decades of experience developing and delivering training to nuclear power personnel across the globe. Along with APS, member utilities Ameren, Dominion Energy, Duke Energy, and Tennessee Valley Authority (TVA) collaborated in the initiative by reviewing course materials, providing feedback, and supporting pilot programs of the training.

The initial CIT [curriculum](#) focuses on training new chemistry and radiation protection technicians before site-specific and on-the-job learning. The process involved with developing the curriculum for the four-week fundamentals course reinforced the value of standardized instruction applicable across job disciplines, geographies, and plant types. Once the fundamentals curriculum is completed (about four weeks), participants move on to the more specialized chemistry or radiation protection

courses, which require an additional 11–12 weeks and are offered with the same flexibility and support as fundamentals.

"We found that there were not only commonalities among the different sites across the industry, but there are also common requirements across the disciplines," Schwenk said. "So, there are things that were required for a maintenance person that were also required for a chemistry person, regardless of whether you were at a BWR (boiling water reactor) in North Carolina or PWR (pressurized water reactor) in Arizona."

### Meeting an Industry Need

Besides eliminating the time and expense individual nuclear sites have traditionally devoted to developing and updating basic training materials, CIT also helps address larger industry personnel challenges. A recent [report](#) by the International Atomic Energy Agency (IAEA) outlined the critical need for attracting, retaining, and properly training new employees to work in the nuclear power industry. The imperative to scale up hiring and training is particularly important because the nuclear workforce—like that of the utility industry overall—is aging and nearing retirement.



Existing nuclear power plants are also being relied on to produce carbon-free electricity for much longer than originally intended. In fact, the Nuclear Regulatory Commission (NRC) licenses reactors to operate for [40 years](#). Once a reactor has been in operation for four decades, the NRC can renew its license for an additional 20 years at a time. Most nuclear reactors in the U.S. were built in the 1970s and 1980s, and most have already had their initial 40-year license extended by two [decades](#).

All of which is to say that standardized and efficient training is more important than ever. Having EPRI host common training programs that the entire industry can access also makes it easier for workers to relocate to new plants without having to delay starting their new job for weeks to complete site-specific training. "If you're in chemistry, this certificate you get from EPRI ought to be able to follow you," said Angela Rucker, EPRI's manager of training and learning design, who has extensive experience in nuclear training during her time at Duke Energy. "It would mean something more versus a certificate from a single nuclear plant."

## Integrating the Science of Learning

Standardized, easily accessible common training programs that allow utilities to focus their time on site-specific and on-the-job instruction is important. But it's also essential that the content and delivery of the training is relevant and engaging to the employees it's designed to help.

Rucker and a team of instructional designers and technologists have been working to modernize training to make it as engaging and impactful as possible. "We've been trying to build out our learning management system with more modern training by making sure that we're not going more than five to 10 minutes without some engagement with learners," Rucker said.

The changes to EPRI's training development and delivery are guided by science. "There is lots of research on how the brain works, how it stores information, and most importantly, how it recalls information," Rucker said. "We have learned that smaller chunks of learning followed by an opportunity to process, apply, and validate that information is extremely effective and grounded in science." Rucker and her colleagues are currently

working on a white paper outlining insights and applications of the science of learning.

These and other insights are being incorporated into EPRI's approach to developing training. For example, with CIT, the program development began by gathering industry training requirements to ensure the technical accuracy of all the content produced. A subsequent step was to transform the technical information into digestible and engaging formats accessible at any time convenient for students.

## A Focus on the Learner

Each course also has practice quizzes for students to continuously reinforce what they have learned. Exams for each module can be distributed electronically so the students can take tests at their work location with a site exam proctor present.

Consistent instructor office hours also provide ample opportunity for students to benefit from personal instruction. "They have an opportunity to go into virtual office hour sessions on Webex, where they can see the instructor from EPRI, ask questions, go over content, and review exams," Schwenk said. "That's one of the places I think the program shines. Our chemistry instructor does a fantastic job during exam review, walking students through questions they missed and highlighting how that question applies to their job."

Tools to provide course or exam feedback are readily available. EPRI uses feedback from students and utility stakeholders to update and improve the content or correct any mistakes.



Integrating these lessons into future EPRI training programs is ultimately about answering one fundamental question—whether the training is for nuclear industry workers or those learning to install electric vehicle chargers. "How do we develop a workforce quicker and better that is focused on the job they're doing?" Rucker said. "We want to understand how we get the learner the information and the skills they need to work quicker and more effectively."

The answer to that question differs depending on the student. However, what increases the likelihood that training will prepare workers adequately is when those developing courses and exams view their work through the eyes of the student. "My team goes into every project as if they were the learner in the seat, and that's what guides how they develop content," Rucker said. "It's about going forward offering options to the learner that best fit their needs. Our approach is to build entire programs with the learner in mind."

### **EPRI Technical Expert**

Pamela Schwenk, Angela Rucker





## Why Utility Business Model Innovation Matters

*In a series of new white papers, EPRI examines the role of utility business model innovation in a decarbonized world.*

**By Chris Warren**

Much of the discussion about transitioning to a net zero electric power system focuses on technology. This is understandable. The shift from a system dominated by large central station power plants powered by fossil fuels to one that is far more decentralized and decarbonized can only happen successfully with significant technological advances—everything from more efficient wind, solar, and energy storage to improved load and weather forecasts to grid support from bidirectional electric vehicle (EV) chargers.

It's critical to continue to leverage research and development (R&D) to improve existing technologies and create valuable new ones. However, achieving 2050 net zero targets also demands significant utility business model innovation. The challenges and opportunities utilities face in adapting their existing business models to a rapidly changing energy landscape are significant and wide-ranging. Current utility business models depend on the regulatory environment companies operate in—some utilities

are vertically integrated and function in highly regulated markets, while others operate in more competitive deregulated markets. Business models are also heavily influenced by utility types, which range from independent power producers to distribution or transmission utilities or vertically integrated firms.

EPRI recently completed an exhaustive analysis exploring future utility business models. Over the next year, EPRI will publish [12 white papers](#) highlighting the challenges requiring utilities to evolve their business models and the opportunities that come from doing so. The papers also examine the factors that need to be assessed in making decisions to change business models and provide tools and guidance to help utilities make choices that maximize the opportunities and minimize the energy transition risks. The main purpose of the papers is to initiate discussion and debate among utility executives so that they can develop a business model strategy uniquely suited to their situation.



The first four papers were published in late 2023 and early 2024. [\*Perspectives on Transforming Utility Business Models: Towards Net Zero\*](#) outlines the landscape and imperatives driving change as well as the reminder that utilities have choices in how they navigate change and that those decisions should be guided by knowledge. Among the choices utilities must make is the role they want to play, what markets and customers they want to serve, and the types of products and services they need to develop to serve existing customers, attract new ones, and still serve societal goals.

The paper provides important context and frameworks utility leaders should consider as they assess business model evolution. Among these are the drivers and influences propelling the need to at least analyze potential changes to how utilities engage with customers and earn revenue. Primary among those drivers is the imperative to decarbonize, but other factors include energy security, equity, grid reliability and resilience in the face of increasingly extreme weather, continuously evolving technology, changing customer expectations, and policy and regulation.

The report then provides a preview of the 12 business model topics that are explored in EPRI's series of white papers. For example, two of the upcoming papers will delve into case studies from industries that have undergone similar transformational change now facing utilities, including the telecommunications sector. Over the past 20 years, a combination of deregulation,

technology advances, and customer demands have upended traditional models in the telecom sector. Geopolitical changes, cybersecurity challenges, and the fundamental importance of digital technologies to the economy and lifestyles will continue to pressure telecom companies to reinvent their business models. The sector's experience with transformational change may provide lessons for utilities.

Other papers will address questions that arise when utilities weigh the suitability of new types of business models. For example, one paper will assess the implications of energy being viewed as an integrated system—including electricity, heat, and liquid fuels—interacting in complex ways and with differing business models. Other topics previewed include business models that align with customer and policy drivers and the questions they raise. For example, models aligned to customers' expectations need to weigh the tangible changes required to reorient investments and operations to put the customer at the center of the energy system. Business models for resilience prioritize system resilience in the face of extreme weather and cyberattacks.

### **Horizon Scanning and Forecasting**

A crystal ball would come in handy to guide business model decisions because it would provide a clear view of the threats and opportunities utilities face. Since there are no energy transition crystal balls, utilities must do their best to gather insights and

information that present possible future scenarios. Fortunately, this can be done in a systematic, structured, and disciplined way, which is the subject of the recently released EPRI white paper [Horizon Scanning and Forecasting](#).

Rather than depending on hunches or informed guesses, horizon scanning utilizes a common set of characteristics to uncover likely industry developments and those that extend outside current planning and thinking. A structured approach to horizon scanning includes three components:

- **Looking ahead** involves collecting information that stretches beyond typical planning and decision-making timescales, such as how long-term climate change scenarios may impact electricity demand and grid resilience and reliability.
- **Looking across** means including information and trends from outside but adjacent to the utility industry. For example, the electrification of nearly all aspects of transportation has implications for electricity demand and grid reliability.
- **Looking around** is about expanding information to integrate into business model decisions beyond even adjacent industries, like transportation. This could include developments in artificial intelligence (AI) and machine learning (ML) to understand how they could both threaten and optimize electricity system operations.

When it is done, utility horizon scanning often takes place in a silo, with no connection to traditional modeling, forecasting, and planning exercises. The *Horizon Scanning and Forecasting* paper makes the case that these efforts should be linked and are particularly vital when a utility's business model faces considerable disruption. The paper also lays out specific horizon scanning techniques and ways information gathering can be incorporated into business model decisions. This can include feeding opportunities uncovered into utility innovation efforts to explore new sources of value or assessing newfound risks as part of mitigation strategy development. Done properly, horizon scanning helps utilities develop a comprehensive view of threats, risks, and options needed for strategic business model planning.



## Business Models for Innovation

Innovation has always been a constant in the electric power industry. Technology advancement is continuous, but innovation in regulatory frameworks, business models, and commercial offerings has accelerated in recent years as deregulation and the prioritization of decarbonization have intensified competition and the centrality of customers. Today, utility innovation is expected, although it occurs within unique policy and regulatory environments that may widen or constrain what is possible.

Regardless of the environment in which utilities operate, innovation is an important element in business model development and transformation. [Perspectives on Transforming Utility Business Models Paper 2: Business Models for Innovation](#) describes how different types of utilities can follow a model for innovation that helps them achieve their business objectives. This can be accomplished with effective innovation lifecycle management through its many stages. The paper describes each stage of innovation, from the scanning and scouting of innovation projects through their approval, funding, execution, and adoption as business as usual.

Given the rapid and unprecedented pace of change in the electricity sector, utilities must embed innovation into their business models, culture, and operations. How this is best accomplished will depend on each utility's unique circumstances. The paper proposes several approaches utilities seeking to advance innovation as part of their business can contemplate, including:

- **Making innovation part of corporate strategy** recognizes the importance of innovation to a utility's capacity to successfully adapt to the volume and velocity of change in the industry today.





- **Evolving energy system architectures** are inevitable as the prioritization of decarbonization and customer centricity promote the growth of distributed energy resources (DERs) and grid-edge technologies. This necessitates innovative approaches to grid balancing, security, and ancillary services.
- **Embedding innovation throughout the business** can start by standing up teams dedicated to innovation. But it's also important to ensure innovation professionals aren't siloed from the rest of the utility, but instead be strongly connected to the entire business. This helps identify new ideas that can be practically applied to improve utility operations and encourage the consistent sharing of innovation lessons across the organization.
- **Developing an innovation culture** is more likely when innovation is deeply embedded within a utility. It can be supported even more by tying incentives to innovative thinking.

## Business Models for Net Zero

[Perspectives on Transforming Utility Business Models Paper 3: Business Models for Net Zero](#) grapples with questions utilities face as they explore strategies to

manage the so-called energy trilemma of supplying safe, resilient, and affordable electricity while maintaining financially sustainable businesses. There are no easy answers.

The paper describes both the drivers of change—which can include the future viability of some utilities—and the extraordinary uncertainty faced by utility leaders, regulators, and other industry stakeholders. For instance, utilities may balk at making investments in existing assets that don't drive decarbonization and are at risk of being stranded in the future. Regulators, too, face difficult choices. Achieving net zero goals often threatens the affordability of energy, which is a challenge for customers and can result in political pressure.

The paper and an earlier EPRI study describe four future energy system transformation scenarios, which provide a framework for the self-assessment and debate needed to develop lasting and successful business models. The four scenarios are:

- **Utilities lead** is when utilities see an opportunity to proactively respond to government and societal needs, corporate drivers, and sector mandates in a transformative way and assume a leadership role and benefit from growth.

- **Utilities disrupt** describes a scenario when utilities see opportunities in transformation and actively and assertively seek to achieve value and benefit.
- **Utilities follow** is when utilities respond to mandates but primarily act in incremental and evolutionary ways, protecting their current business models where they can.
- **Utilities retreat** describes a future where utilities focus on their traditional strengths either by preference or due to externally imposed constraints in an environment of strong competition.
- **Real-time monitoring and predictive analytics** through deployments of smart meters, data, and artificial intelligence (AI) will help manage the complexity of a decarbonized and distributed grid.
- **Grid resilience** and adaptability will be critical to utilities navigating increasingly extreme weather and cyber threats.
- **Customer engagement and satisfaction** will be top priorities for future utilities, especially those competing for customers with new entrants.

These scenarios can spark discussions that ultimately inform business model decisions. Though utility business models will differ depending on factors like their geographic location and regulatory environment, it is likely that future business models will be significantly more diverse than today. The paper includes characteristics that may be common among energy utilities operating in 2035, including:

- **A heavy reliance on renewable energy**, such as wind, solar, hydro, and energy storage, to address the intermittency that arises with a dependence on weather-dependent generation.

With so many uncertainties and complexity, it can be a challenge for utilities to begin assessing how their future business models should change to drive decarbonization and remain financially viable. A good place to start is with a thorough self-assessment and use that learning to initiate internal conversations about appropriate business model strategies.

### EPRI Technical Expert

Neil Hughes and Francesca Bowden



## **About EPRI**

Founded in 1972, EPRI is the world's preeminent independent, non-profit energy research and development organization, with offices around the world. EPRI's trusted experts collaborate with more than 450 companies in 45 countries, driving innovation to ensure the public has clean, safe, reliable, affordable, and equitable access to electricity across the globe. Together, we are shaping the future of energy.

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