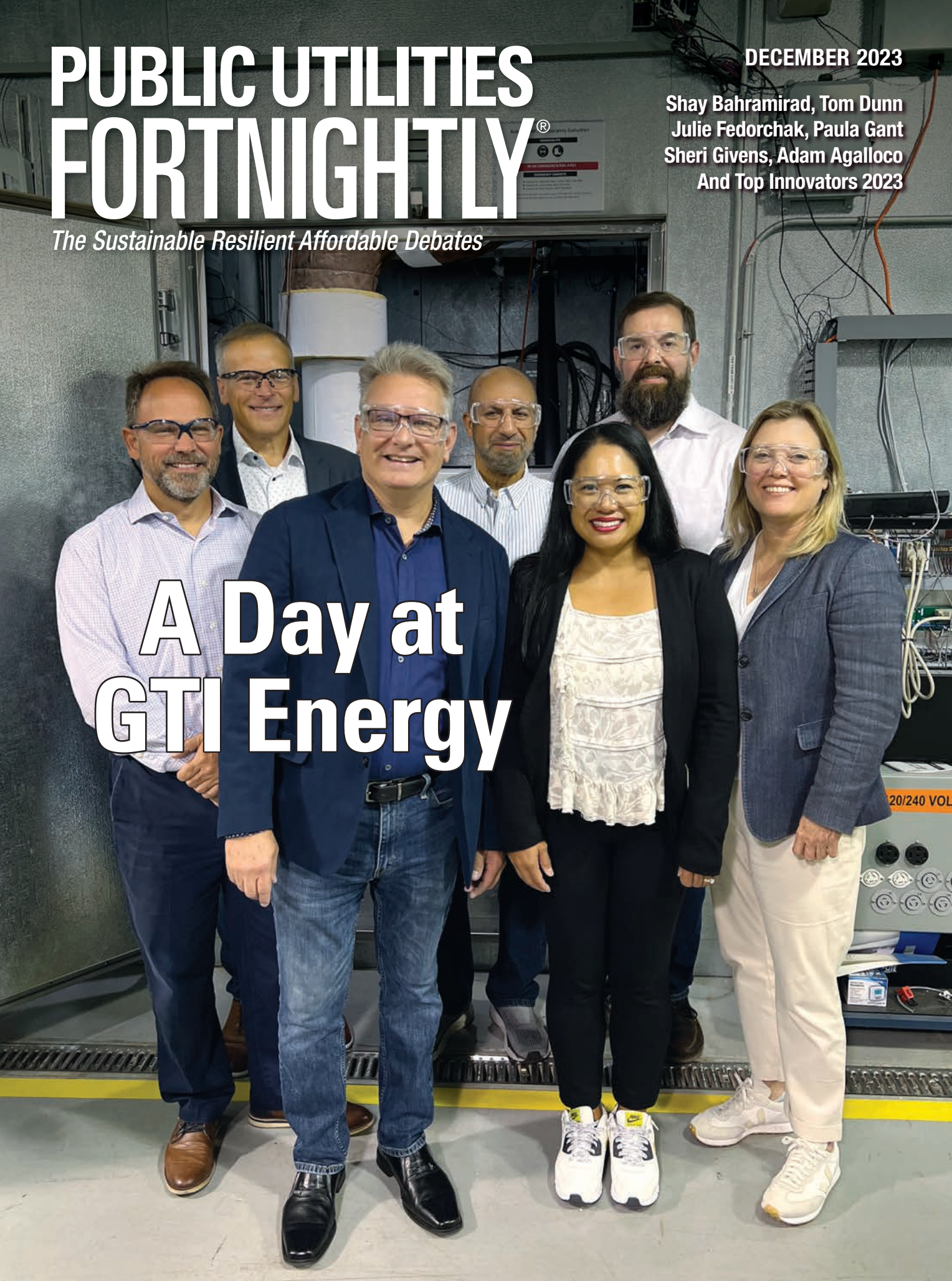
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The Sustainable Resilient Affordable Debates

DECEMBER 2023

Shay Bahramirad, Tom Dunn
Julie Fedorchak, Paula Gant
Sheri Givens, Adam Agalloco
And Top Innovators 2023



A Day at GTI Energy

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Christmas and Electricity

Santa to Slide Down Your Carbon Emission-Free Chimney

By Steve Mitnick, Executive Editor

It was the holiday season of 1880. Eleven months earlier that year, on the twenty-seventh of January, Thomas Edison had received the "electric-lamp" patent. Now, at his Menlo Park laboratory, he created a strand of lights and had them strung around the building. Visitors and those passing by were seeing the very first Christmas lights.

Christmas trees were commonly lighted, but with candles, notwithstanding the risk of fires. In 1882, Edward Johnson, who worked for Edison, strung eighty red, white, and blue electric lights around a Christmas tree at his townhouse at 136 East 36th Street in New York. Few followed his example, however. Then, a dozen years later, in 1894, President Grover Cleveland had the White House's Christmas tree decorated with multi-colored electric lights. A trend was started.

General Electric began selling pre-assembled Christmas light kits in 1903. Until then, lighting your tree electrically was expensive and the installation, complicated. But electric Christmas lights really took off in the nineteen-twenties, after Albert Sadacca vigorously marketed brightly colored and economical lights. His company virtually monopolized the market for the next few decades.

Toy electric trains, a favorite Christmas present in the twentieth century, started out as a store window display that would draw the attention of shoppers to the store. It was an idea of Harry Grant and Joshua Lionel Cowen, whose company adopted Cowen's middle name. Lionel train displays became so popular that the two men refocused their business on marketing toy trains.

Retailers still used toy trains to attract window-shopping customers, particularly at the peak retail season before Christmas. Before long, toy trains were

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Steve Mitnick has authored four books on the economics, history, and people of the utilities industries. While in the consulting practice leadership of McKinsey & Co. and Marsh & McLennan, he advised utility leaders. He led a transmission development company and was a New York Governor's chief energy advisor. Mitnick was an expert witness appearing before utility regulatory commissions of six states, D.C., FERC, and in Canada, and taught microeconomics, macroeconomics, and statistics at Georgetown University.

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A Day at GTI Energy

Conversations with CEO Paula Gant; GTI International President Ron Snedic; Director, State and Consumer Programs Dan LeFevers; Analytical Chemistry and Environmental Laboratory's Karen Crippen, Tekle Fida, Amanda Harman; Combined Heat & Power and Renewable Energy Laboratory's Tim Kingston; Residential/Commercial Appliance and Equipment Laboratory's Paul Glanville; Integrated Hydrogen Testing and Demonstration Facilities' Ted Barnes; Industrial Energy Systems Laboratory's Dave Cygan; Utility Infrastructure Laboratories' Blue Lab Green Lab's and Fabrication Lab's Jim McNelis; Utility Infrastructure Laboratories' Materials Testing Lab's Tony Kosari.

GTI Energy describes itself as an organization dedicated to advancing the economy-wide transformation needed to deeply decarbonize energy systems while supplying the energy needed to support rising standards of living and economic growth worldwide. The work produced at its state-of-the-art facilities shows that to be true.

GTI Energy embraces a vision for integrated, low-carbon, low-cost energy systems that leverage gases, liquids, infrastructure, and efficiency to meet the urgent challenges presented by climate change and global energy access. To fully comprehend these words, there is nothing like a visit to its eighteen acres of facilities close to Chicago, to take in the depth and breadth of what goes on at these specialized labs with equipment for design, testing, and analysis of advanced energy technologies.

Public Utilities Fortnightly's Executive Editor Steve Mitnick and Editor-In-Chief Lori Burkhart were fortunate to pass inside the gates of GTI Energy to view the future of energy. We engaged with CEO Paula Gant, as well as with scientists and engineers, to better understand several of their projects, which we share here with you.

Paula Gant
GTI Energy CEO

PUF's Steve Mitnick: Talk about the latest at GTI Energy.

Paula Gant: Starting with a brief look at our history. GTI has eight decades of experience working with the operators of energy systems to effect transitions in energy systems. We're adding new performance characteristics, gaining advances on existing performance characteristics. Those are safety, reliability, efficiency, and resilience.

Increasingly, we're adding additional performance characteristics like lowering emissions, water use, and impact on communities. These are performance characteristics we're adding for the greater transition of energy systems.

We have a lot of experience working with our partners and customers, whether that's government or industry, utilities, environmental organizations, or others to understand how to effect transitions.

Having an idea for a technological innovation or an operational improvement is wonderful, but people come to GTI Energy because we know how things work and how these systems work together.

PUF: The track record of the industry and GTI Energy is amazing, with efficiency gains over the decades.

Paula Gant: That comes from GTI Energy being where people go to collaborate and innovate. Whether competitors or industry contemporaries, we understand that you scale progress and faster by collaborating, engaging in open learning together, and de-risking experimentation.

Operators of existing energy systems come to us because we're at the intersection of tradition and innovation in energy systems. These are the people who are operating systems and trying to figure out how to integrate innovations, whether they're technological or operational.

Our view at GTI Energy is that when we're changing energy systems, it's important we're approaching the change from a systems perspective. It is important that we are collaborating.

The grace and complexity of our existing energy systems often get glossed over when we think about innovation and energy systems transitions for global decarbonization. We have to remember to be ambitious about what we want energy systems to deliver, but also pragmatic.

We should back up from that to figure out how we are going to get started. That starts with, how do things work? How do we bolt new stuff onto existing stuff? How do we integrate new technologies and new operational practices?

Energy systems are complex. They influence every aspect of the quality of our lives. We depend on them.

Our view at GTI Energy is that when we're changing energy systems, it's important that we're approaching the change from a systems perspective. It is important that we are collaborating to increase the speed with which we're learning and we're distributing those learnings as we seek to innovate.

PUF: Talk about your vision at GTI Energy.

Paula Gant: Our vision for the future of energy systems is part of why our partners and customers want to work with us. We

have a dual imperative for energy systems out to mid-century: we seek to shape systems that are low carbon and low cost.

That's important because we need to lower emissions from energy systems and lower their costs to make a difference for the planet and ensure that energy is widely accessible to all communities. Both are vital. We see our role as focusing on this dual imperative for gases, liquids, fuels, and infrastructure.

Any model that anticipates what energy systems might deliver or what we require from them out to 2050, even models that assume the most aggressive electrification, and these are global models for energy demand, indicate that at least sixty percent of final energy demand will be served by gases, liquids, or solids.

PUF: So much is written about electrification. That's going to increase.

Paula Gant: Thinking about all the energy that will be consumed out to 2050 and the broad uses of energy and fuels, these uses are bigger than those we can electrify alone.

The next decade is about focusing on how we decarbonize and continue to use molecules while continuing to produce electricity. As we're thinking about how we lower emissions from production and use of molecules, we must remember in North America and Europe, what underpins our economic system is the deliverability of our energy, and that's infrastructure.

In North America, we have this robust molecule delivery infrastructure, whether it's gas or liquid. There are more than 2.8 million miles of pipes in our existing natural gas system. The energy systems of 2050 and beyond are going to need energy storage, and they're going to need inter-seasonal storage.

Batteries, for example, will continue to advance and be a part of managing load and reliability at a local level, but not heavily relied on for inter-seasonal storage. Our current gas infrastructure, which is massive, is already able to move molecules from summer peak availability to winter peak demand.

PUF: Batteries being added to the electricity system can be used for four hours, and long-duration storage to eight or twelve hours.

Paula Gant: Our natural gas system is capable of eight weeks of storage. This is underground storage, above-ground storage, LNG, peak shaving, linepack, parking, lending, looping, all that. All that together, we have the ability, if production stops, to meet demand for eight weeks in this country.

It's a well-designed system and it's a transparent market system. It's accessible. Decades of regulation have delivered this. It's economically efficient and effective.

Play this forward with lower-carbon molecules moving through or interacting in those systems, whether low-carbon natural gas, and even carbon-negative natural gas produced from newly-scaled processes for making renewable natural gas. It might be hydrogen rich gas and ultimately just hydrogen.

It might be stored in different locations, and adding to that, ammonia being converted to hydrogen. That is increasing the storage capacity.

Now that GTI Energy has signed on to this bold vision, we are focused on systems thinking, innovation, and collaboration to get there.

Systems thinking is a focus on how things work. Any cool idea is great, but you're going to put it to use in a system of some sort, whether in a home, distribution system or industrial system.

Innovation means reaching beyond incremental improvements on these performance characteristics. It's being bold. It's being willing to entertain new answers to the same questions, and to ask different questions.

If it's easy, our customers could probably do it on their own. GTI Energy does the complicated work of asking and trying to answer these bold questions.

If it's easy, our customers could probably do it on their own. GTI Energy does the complicated work of asking and trying to answer these bold questions.

Third, and this is definitional for GTI Energy, we focus on collaboration. We are where operators and technology providers go to collaborate.

We operate over a dozen research collaboratives where companies put money together to do joint research, develop products, or create solutions to operational practices. Our operations technology development (OTD) and utilization technology development (UTD) are two examples of these types of collaborations. We have twenty-nine gas utility partners involved in OTD, and twenty-one in UTD, both serving millions of customers across the U.S.

GTI Energy also has collaboratives that focus on providing information to operators and market participants to evaluate different technologies. I'll give two quick examples.

Market participants are faced with this challenge of trying to evaluate the characteristics of different fuels, including their carbon intensity. How do you compare carbon intensity across fuels? How do you evaluate the carbon intensity of hydrogen across different production methods? There's not a great way to do it right now.

Similarly, in methane emissions reductions, there is not a lot of agreement on what practices and technologies will be most effective in reducing emissions from natural gas systems.

Once you get those technologies in place and start collecting data, how can other people trust that your data is quality, that you're getting the emissions reductions you're seeing?

We've created two collaboratives to address these questions: One is Veritas, which is focused on developing protocols to



Any model that anticipates what energy systems might deliver or what we require from them out to 2050, even models that assume the most aggressive electrification, and these are global models for energy demand, indicate that at least 60% of final energy demand will be served by gases, liquids, or solids.

accelerate evaluation and adoption of methane emissions, detection, and measurement tools.

These are protocols that help operators understand how to take information from these devices, turn it into greenhouse gas emissions reporting that compares to what they're doing currently, and provide it to regulators or investors. It also helps them evaluate what technologies are most effective and cost-effective to reduce emissions.

Our Open Hydrogen Initiative is a collaborative that is providing open-source, transparent tools to the market that will be transformational in giving market participants confidence to make decisions around carbon intensity of natural gas and hydrogen.

Veritas has already developed protocols for all six segments of the U.S. onshore natural gas value chain with thirty-plus operators involved, investment banks, NGOs, state and federal regulators observing. We're working with the United Nations Energy Program looking at how to take the next steps to become adopted internationally. The Open Hydrogen Initiative will follow a similar path.

These collaboratives are about building a community of practitioners who understand the value of developing one standard set of protocols versus seven competing sets of protocols in the market.

PUF: Talk about the different colors of hydrogen and why that is no longer useful.

Paula Gant: There is so much attention focused on the potential for hydrogen to serve a role in energy systems. The Bipartisan Infrastructure Law and the Inflation Reduction Act have sent a lot of money in that direction.

GTI Energy is involved in three of the U.S. Department of Energy Regional Clean Hydrogen Hubs selected for award negotiation in the Gulf Coast (HyVelocity), Midwest (MachH2), and Appalachian (ARCH2) regions of the U.S. These hubs are aimed at ensuring hydrogen to play a significant role in our economy, with the goal of hydrogen being low emissions and able to contribute to reducing overall emissions of our energy systems.

One of the challenges, however, of scaling hydrogen is that we don't have a good way of characterizing the carbon intensity of hydrogen at the point of production. So, hydrogen production ends up being characterized as a color wheel like turquoise, green, blue, and gray, which was useful to some extent in earlier days as people got their heads around how hydrogen can have different emissions profiles.

But it doesn't give the level of granularity to make regulatory, investment or purchase decisions about hydrogen. Our Open Hydrogen Initiative is building a community in collaboration, the tools by which the market will be able to calculate the carbon intensity of hydrogen at the point of production and thereby make decisions about investing in and deploying hydrogen as a vital and versatile energy carrier.

At the asset level, the carbon intensity of hydrogen will be informed by the production feed stock. That gives a granular level of information that allows us to compare molecules and make investment or purchase decisions.

PUF: Is there urgency to get to as low emissions as possible at GTI Energy for the industry as with other players?

Paula Gant: It's vital and imperative we take steps now to demonstrate and scale new solutions that will lower emissions and costs for energy systems. We have a lot of work to help our partners operationalize solutions that have already been proven to increase efficiency, seek to lower costs and emissions.

The EIA's 2050 analysis for net zero systems says, "Fifty percent of the emissions reductions that are needed in 2050 will come from technologies that are in the prototype phase." Fifty percent have not been demonstrated yet. There is an urgent need to rapidly scale demonstration of these technologies that are currently in prototype, many of which are focused on decarbonizing liquid use.

One example of liquids innovation is at GTI Energy's subsidiary, SunGas Renewables, which we created in 2019 to commercially deploy our U-GAS technology. The U-GAS technology turns biowaste into syngas to make gas, liquid fuels, and chemicals. We recently joined Governor Edwards of Louisiana to launch SunGas' Beaver Lake Renewable Energy Project in Pineville.

The Beaver Lake Project is a green methanol production facility for international marine shipping company, A.P. Møller – Mærsk A/S. This is part of Maersk's strategy to accelerate the scale-up of green methanol to power their ships to demonstrate leadership in reducing emissions.

Another example of innovation in liquid decarbonization and use is GTI Energy's Cool GTL suite. One of the applications is to produce Cool LPG, which takes biowaste locally and produces liquid propane gas that can be put into containers and distributed.

It's local production using existing distribution infrastructure for delivery to existing appliances. It can be a pathway for propane in decarbonization strategies in the developing world, and it can serve as primary fuel source in African nations that rely on it for home heating and cooking.

Our Open Hydrogen Initiative is building a community in collaboration, the tools by which the market will be able to calculate the carbon intensity of hydrogen at the point of production and thereby make decisions about investing in and deploying hydrogen as a vital and versatile energy carrier.

In hydrogen, we are innovating at our H2@Scale demonstration project in Texas. We are currently in year three demonstrating how different hydrogen production and use technologies can work by taking landfill gas and producing hydrogen and using hydrogen to power fuel cells to run a data center. It's pretty cool, and we're testing our hydrogen for powering drones.

Finally, I talked about the role that natural gas systems play as chemical storage. We have a new program launched this year called the Net Zero Infrastructure Program, or NZIP. We have fifteen industry partners in NZIP at the moment.

NZIP's mission is to examine the role of natural gas infrastructure in low-carbon energy systems, to conduct and share research, and to produce a live R&D roadmap to bring together collaborators and accelerate progress.

NZIP will map the most practical opportunities for integrating low-carbon solutions within existing natural gas infrastructure, including renewable natural gas, hydrogen, energy storage, carbon transportation, and carbon storage.

The plan is for NZIP to publish and annually update our R&D roadmap, and to look both nationally and regionally at the complexity and needs of the existing natural gas system and future integrated energy systems. ❍

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Analytical Chemistry and Environmental Laboratories

Karen Crippen, Tekle Fida, Amanda Harman

PUF's Steve Mitnick: What are you working on in this laboratory?

Amanda Harman: I've been working in this space for well over twenty years. We support the energy industry and decarbonization, as we're trying to enable renewable natural gas, or RNG interconnection into the gas grid. This lab is here to support GTI Energy's role in broader decarbonization efforts.

PUF: These are microbes, and they chew through the natural gas pipe?

Amanda Harman: Microbes can live nearly everywhere. What they're able to do is either through the external, the soil microbes, or if there's water internally, through their metabolic processes, degrade the integrity of the pipe material.

I have some specimens here, which are going through that process and degrading the diameter of the pipe. Inside, you have some remnants of biofilm which grow inside the pipe. GTI Energy's process allows you to take samples, whether a solid sample, gas sample, liquid sample, and isolate their DNA in the microbes so we can quantify their presence.

We can determine which of these microbes might be in the sample and if that could potentially be a part of the root cause of a failure. GTI Energy is one of the labs that the energy industry uses for that, and it's the only lab that's accredited.

PUF: There are liquids and gases going through pipeline infrastructure, but not everybody understands that microbes are in there too.

Amanda Harman: Exactly. The industries that carry the liquids through pipelines or have a large liquid component are well aware of this issue. There's a lot of research that goes into this space. But where GTI Energy is unique is in that we can provide this analysis for industry with any type of sample and determine and quantify the presence of these microbes.

PUF: I'm looking at this pipe and it has a hole in it. That's not good because there's a safety issue, but also emissions issues.

Amanda Harman: Yes, they're linked together. We're here to support the integrity of the infrastructure, make sure it stays intact, and that in a dry system like natural gas, make sure leaks and other safety issues are mitigated.

GTI Energy also has a large database where our Director, Karen Crippen, maintains all the RNG work. We've done a large amount of gas quality analysis on RNG, to understand what the implications are for utilizing the renewable resource.

One of the research posters that my colleague, Tekle Fida, is leading, is the underground storage of RNG and trying to understand the microbial community if we inject RNG in the underground storage formation. We want the microbes to be happy because they make RNG.



We can determine which of these microbes might be in the sample and if that could potentially be a part of the root cause of a failure. GTI Energy is one of the labs that the energy industry uses for that, and it's the only lab that's accredited.

– Amanda Harmon

PUF: What can be done? Do you look into that to make sure the pipe's integrity stays intact, and there aren't leaks?



These are microbe samples from the pipeline matter, and the water from the pipe, and then we inoculate to verify if the corrosion is from chemical or from microbe.

– Tekle Fida



We know there are chemicals that you can use to mitigate the corrosion from the microbes. There are a lot of enzymatic materials you can put in a pipeline for that purpose.

– Karen Crippen

Amanda Harman: On pipeline integrity, GTI Energy leads corrosion research like monitoring corrosion coupons, which are samples you can put in the pipe to determine over time if there's any corrosion going on. That helps understand the risk to the integrity of the overall pipe structure.

These corrosion coupons are made of the same material as the pipeline that are routinely installed throughout the pipeline infrastructure and they could be pulled at any point in time and then used in analysis to understand how the material is interfacing with the system, the gas or the liquid, et cetera.

It usually will stay in place. It's like part of the system. Then over time you can take it out and analyze it.

PUF: What kind of microbes are we talking about?

Amanda Harman: There's a whole host of them. The most implicated one is the sulfate reducing bacteria called SRBs. That's the most well-studied. Their unique characteristic is they like to produce hydrogen sulfide too. That's also a corrosion chemical that can impact integrity. There're a lot of different microbial processes that go on and it's exciting to see. Tekle's bringing some samples.

Tekle Fida: Amanda was talking about which microbe to put to the coupon. They also are used from not only the corrosion changing to sour gas, but also in hydrogen sulfide production.

That's what they do. They produce hydrogen sulfide that reacts also with the coupon. They form iron sulfide. That is black precipitate, and the iron sulfide gets rid of the carbon or the steel material and then corrosion progress is exactly what it looks like – control. This is what microbes are doing.

Amanda Harman: This is the media with the coupon and the negative control. Here, it's been inoculated with general bacteria. This was an environmental sample.

Tekla Fida: These are microbe samples from the pipeline matter, and the water from the pipe, and then we inoculate to verify if the corrosion is from chemical or from microbe.

Karen Crippen: There are things that we can do to mitigate it. We know there are chemicals that you can use to mitigate the corrosion from the microbes. There are a lot of enzymatic materials that you can put in a pipeline for that purpose. ❍

Combined Heat & Power and Renewable Energy Laboratory

Paul Glanville, Tim Kingston, and Ron Snedic

PUF's Steve Mitnick: What is going on here at CHPRE?

Tim Kingston: A number of projects are going on in this lab, but the first I want to talk about, and the reason why I'm standing out here is we have a microgrid test bed. Microgrids are systems that have controllable loads and controllable energy sources.

When we think about controllable loads, we think about flexible fuel. Our microgrid has electric-based space heating and water heating, as well as thermally based or fuel fired.

We have four air source heat pumps against the wall. Those electric-based air source heat pumps can provide space heating and air conditioning. We have four air source heat pumps because we have four buildings or units that we're simulating in the microgrid.

Thee microgrid could be either multiple buildings or multiple units in a multifamily. It's a test bed, we're testing on a smaller scale, so units in a multifamily.

You'll see units in the microgrid test bed. In addition to various loads that are controllable, we have various energy sources. We have a micro combined heat and power (CHP) system that's thermally powered for our fuel-fired power generation and heat.

But we also have what we call renewable CHP where you have the solar photovoltaic (PV) array that's generating electricity. Under those panels, there are solar thermal panels that are making hot water, as well.

And so, you have the combination of again, energy sources and fuel fired. It's integrated with grid power as well, and then integrated with renewable solar PV and thermal. That's providing all the energy sources for the microgrid, specifically air conditioning, the space heating, water heating, and power.

The microgrid is also powering two electric vehicle charging stations we have on site. Each station has two, so there are a total of four ports.

The microgrid integrates multiple energy sources like renewables, solar, CHP, electric/thermal energy storage, grid power, and controllable loads like electric-based and fuel-fired HVAC, and water heating equipment.



All the equipment we're working with is commercially available. The goal of testing it in a microgrid is to achieve annual efficiencies well over 100% on or off grid at GHG emission levels no more than 50% of the current average grid.

– Tim Kingston

There are four air sourced pumps and four bays in the microgrid testbed. Each one of those bays is simulating the loads in a microgrid. In each one of these bays, we have simulated space heating, water heating, and power generation loads.

That could be four individual units of a multifamily unit.



Everything we're doing here is trying to drive down capital costs and operating costs, increase efficiency, and reduce emissions. Combine all those together and how does that resilient energy supply compare to other resilient energy supplies in 2035 and 2050?

– Ron Snedic

We're simulating each of those loads in those bays. The CHP system is providing power and heat.

Heat is stored in the central tank, and that's distributed to each of the bays of the microgrid. In addition, we have the air source heat pumps outside, those provide heat to the air handler via refrigerant coils. That's providing space heating and air conditioning, as well.

PUF: What are you testing? What are you looking for when you're putting it through its paces?

Tim Kingston: All the equipment that we're working with at this point is already commercially available, including the CHP system. The goal of testing it in a microgrid is to achieve annual efficiencies well over one hundred percent on or off grid at GHG emission levels no more than fifty percent of the current average grid.



This is an off-the-shelf fireplace we're testing with a hydrogen blend. This is operating with a twenty percent hydrogen blend. A lot of our research focuses on equipment certified or designed for natural gas or propane today, but what are the impacts of operating with renewable fuel?

– Paul Glanville

So, we are striving for improved energy resilience, reduced emissions, and energy efficiency. Over the course of a year, we want this system to achieve over a hundred percent efficiency. The air source heat pumps enable us to achieve that goal.

PUF: You said, "Over a hundred percent." You didn't say a hundred percent.

Tim Kingston: Because we have air source heat pumps that can operate over a hundred percent efficiency. There are electric air source heat pumps that can generate heat at over a hundred percent efficiency. That was our goal and we achieved it.

We are also striving to get greenhouse gas emission levels of at least fifty percent better than current electric grid levels. We're leveraging energy efficiency, onsite power, and renewable energy, to achieve our goals.

PUF: What can utilities do with this information?

Tim Kingston: Our goal is to collaborate with our utility partners to demonstrate this system on various building applications. We're looking for opportunities to take this lab-demonstrated technology out in the field.

PUF: Is it economical now or does it get there, say in 2035?

Tim Kingston: It depends on energy costs. In some locations where electricity is expensive and fuel is lower, it's going to be economical. In other locations where gas is expensive and energy rates or electricity rates are low, it's more challenging.

Ron Snedic: Think about comparing this to other low carbon, low-cost alternatives of the future.

Don't just think about comparing these prices against today's energy prices, but how will this compare in the future? And how useful will it be at that time? These are the questions we are asking in the labs and hope to answer through field demonstrations.

PUF: How do you do that?

Ron Snedic: Everything we're doing here is trying to drive down capital costs and operating costs, increase efficiency, and reduce emissions. Combine all those together and how does that resilient energy supply compare to other resilient energy supplies in 2035 and 2050?

The work that we're doing is trying to compare that. That's where I was going with, it's not just about how it compares today's prices and today's available resources. But how will it compare in the future. How useful will it be?

PUF: Can this have a big impact?

Tim Kingston: When you consider the growing demands in power that are inevitable with electrification scenarios and the nascent EV market, the need for other power generation sources is going to grow. That's what we're thinking when we're developing onsite power technologies.

Paul Glanville: On emissions reductions, you can do energy efficiency with heat pumps. With CHP, you can help decarbonize the fuel supply.

This is a lab that focuses on buildings, but you'll see this topic show up in the industrial laboratory later. This is an off-the-shelf fireplace that we're testing with a hydrogen blend. This is operating now with a twenty percent hydrogen blend.

A lot of our research focuses on equipment certified or designed for natural gas or propane today, but what are the impacts of operating with renewable fuel? This is rated for natural gas, and we are testing it with the hydrogen blend to observe the impacts.

We want to see its emissions, are they changing? What about safety and functionality?

PUF: Are you going to increase the amount of hydrogen?

Paul Glanville: Usually we go in ten percent increments, and we go up to the point where we observe operating issues. A common issue we see with hydrogen because it's more reactive than natural gas as a fuel, is the flames will kind of pull back in a way that doesn't allow the system to operate correctly. They call it flashback. That can occur with different types of equipment.

It's because hydrogen has a higher flame speed. That's the term we use. Flames are faster and they can get out of balance with the flow rate. It's a common issue in combustion. But the benefit of hydrogen is it does not emit carbon dioxide.

The biggest question we're trying to address with our research at GTI Energy is what we can expect from today's gas systems if we're going to transition them to low carbon and low cost by mid-century?

If we are going to decarbonize our global economies by 2050, what needs to happen to the gas systems and infrastructure that exist today? Will they need to be replaced? What level of renewable and low carb fuel blending will suffice? These are big research questions.

* * *

PUF's Steve Mitnick: What will we be seeing here?

Paul Glanville: This is a carbon capture device not for power plants but sized for large buildings. These are operating in demonstrations in the U.S., Canada, and places like New York City where there is an explicit carbon price.

There are demonstrations underway to capture that carbon dioxide and produce some kind of value with it. This device converts carbon dioxide in the exhaust into a carbonate. That carbonate is used as an input to soap making and detergent making.

So, we are capturing carbon dioxide from the combustion process, and also avoiding the emissions from mining that carbonate where it normally comes from.

PUF: So, this captures the carbon dioxide from a boiler.

Paul Glanville: The idea is to utilize these existing assets, the boilers, HVAC, and heating equipment, et cetera, to further reduce carbon dioxide.

* * *

Paul Glanville: This is Solar Combined Heat and Power, or CHP, system. This is where we control the loads. This is where it's paired with a heat pump. We're analyzing this system as a solution for solar CHP.

This is the inside part of the sun drum. So, the heat is heating water. It's both photovoltaic (PV) to electricity and PV to hot water. The electricity generation is more efficient when you recover the heat during the cooling process.

However, sometimes there's loss when you convert the heat to electricity. What GTI Energy is doing is capturing some of that loss. And reducing the temperature of the panels also allows them to operate more efficiently.

PUF: How does that heat pump work?

Paul Glanville: It's standard water to water electric. So, this would be a hybrid system, as well. Not unlike the microgrid.

PUF: Can this get out to the field?



Paul Glanville: Yes. These heat pumps are able to operate in all four seasons of the year. The heat pump is serving HVAC loads, which are driven by the building and also driven by the outside climate.

* * *

PUF's Steve Mitnick: What will we see outside here today?

Tim Kingston: This is a system that we call a nanogrid. Instead of a microgrid, it's a nanogrid, so this system can go in a single building or a single home. This system here has a power generator on the top of it.

It's generating about eight kilowatts of power on the top, and then on the bottom is a tank for thermal storage. It also has battery power storage, and all the inverters and power equipment needed to connect to the grid. It's like a mini microgrid, all in one, because we can also integrate it with solar power.

A nanogrid can go in a home, for example, and it can provide power on or off the grid. It can provide space heating on or off the grid. It can even provide air conditioning on or off the grid because it has the power capacity to power the air conditioning.

The short description of this is similar to what we were trying to accomplish with our microgrid. It's high efficiency, over a hundred percent, and significant emission reductions, but with one single unit and a nanogrid configuration for a building. It's a hundred percent reliability resilience.

Instead of a microgrid, it's a nanogrid, so this system can go in a single building or a single home. This system here has a power generator on the top of it.

– Tim Kingston

PUF: That's because you're using power generation to power air source heat pumps outside, which you don't see.

Tim Kingston: We pointed to the air source heat pump, so across the street, there are the four. We also have an air source heat pump sitting out here. Just like for a microgrid, when all is well, which is less than a hundred percent of the time, you're contributing to the grid's sources.

You saw all the equipment across the street. It's all the integration of various commercially available equipment. This is all built into one system. I won't go into too much detail because it's similar to what we're doing across the street with the microgrid, it's just a nanogrid. ❍

Residential/Commercial Appliance and Equipment Laboratory

Paul Glanville, Tim Kingston, and Dan LeFevers





The next frontier for us is hydrogen natural gas blending systems. We're going to be working with partners in Europe where there are burners designed for hydrogen that we can work with and help bring to this market where appropriate.

– Paul Glanville

Paul Glanville: Now, we'll talk a little bit about burners. Much of the natural gas that's delivered to buildings is for cooking, space heating, or water heating.

As such, a lot of our work at GTI Energy pertains to burners that natural gas utility customers have in their homes. Burners can be designed to be ultra-low emission.

They can be designed to be compact by using metallic fibers. If you use high-temperature alloys, you can wrap these burners and get a high capacity and low emissions. We do a lot of work designing and working with our partners to design burners for advanced equipment, some of the thermally driven heat pumps.

In the forties, when we started up GTI Energy, a lot of people were still using town gas, and that was fifty percent hydrogen.

– Dan LeFevers

The next frontier for us is hydrogen natural gas blending systems. We're going to be working with partners in Europe where there are burners designed for hydrogen that we can work with and help bring to this market where appropriate.

PUF: If you put hydrogen through now, the appliances wouldn't work, like that fireplace, and they wouldn't be acceptable.

Paul Glanville: Yes. The way we like to think of it is that you can design hydrogen as a fuel. There are burners, there are blowers.

Outside of this blower here, which was designed for natural gas, everything through this full train is rated for hydrogen, and there are burners that are rated for hydrogen. There are

blowers rated for hydrogen. In some cases, these are only available within the last two or three years, just given the high interest and demand.

There are demonstration homes in the UK and Europe that are using hydrogen now. Most of our research around hydrogen as a fuel is looking at industrial and larger commercial applications.

However, we also work on designing for hydrogen in residential and light commercial applications. Some of these burners are examples of that.

We look at it in two ways from a research standpoint. About a hundred years ago, most parts of the U.S. had a manufactured gas network, and that fuel was usually forty to sixty percent hydrogen by volume.

Singapore and Hong Kong still have large, manufactured gas networks. Up to a million customers are using fuel with the same properties. So again, you can design for these types of fuels, but you're talking about the conversion.

The way the UK and Europeans have looked at this is for hydrogen-ready appliances/equipment. That's equipment that can tolerate a blend and then be converted in situ to a hundred percent hydrogen.

Dan LeFevers: In the forties, when we started up GTI Energy, a lot of people were still using town gas, and that was fifty percent hydrogen. Over time, over the next fifteen years, the transformation that you're talking about, took place, but in the opposite direction, for everybody in the U.S. So, it is possible.

* * *

PUF's Steve Mitnick: What kind of heat pump are we seeing next? It's not an electric heat pump.

Tim Kingston: Here we are testing thermally driven heat pumps. It's a fundamentally different cycle than an electric heat pump. We call it an absorption heat pump, but it works in that same way.

PUF: Is it efficient?

Tim Kingston: Yes. A thermally driven heat pump can double the efficiency, meaning, cut your emissions in half, relative to a boiler. They use a climate-friendly refrigerant, ammonia. Ammonia runs on natural gas or other fuels and is certainly better for the environment.

PUF: When people hear heat pump, they're wondering if their home is going to be warm enough?

Tim Kingston: Right. Air-sourced heat pumps can lose their capacity as it gets colder outside. However, that drop off is flatter for thermally driven systems, mainly because all the heat that's driving the process can be recovered.

PUF: For the colder part of the country, this could be a good solution.

Tim Kingston: Yes.

Paul Glanville: In 2019, during a historic cold snap in the Midwest, we tested these heat pumps at a number of field sites in Lacrosse, Wisconsin for the U.S. Department of Energy.

We measured negative thirty degrees Fahrenheit. Even that low, the unit continued to operate, it did not require backup, and it was basically a condensing boiler.

PUF: Talk about this next heat pump.

Tim Kingston: When we talk about hybrid systems, it's generally about an air sourcing pump, electric base air sourcing pump, and fuel-fired furnace, and how do those work together? More often than not, there're conflicting parameters where, if you're trying to operate that based on energy efficiency and emissions reductions, it's going to cost more and maybe be less comfortable.



A thermally driven heat pump can double the efficiency, meaning, cut your emissions in half, relative to a boiler. They use a climate-friendly refrigerant, ammonia. Ammonia runs on natural gas or other fuels and is certainly better for the environment.

– Tim Kingston

So, when you look at it from the perspective of homeowners, they want maximum comfort and lowest operating costs first and foremost. But the industry also wants to maximize energy efficiency and reduce greenhouse gas.

As such, GTI Energy has the hybrid system that's running the air source heat pump in the furnace, and we're trying to extract a variety of data points like electricity and gas prices, greenhouse gas numbers from the grid, performance of the equipment, et cetera. We will collect that information and then control the systems intelligently. ❍

Integrated Hydrogen Testing and Demonstration Facilities

Ted Barnes

PUF's Steve Mitnick: What are we seeing out here today?

Ted Barnes: This is the heart of GTI Energy's Hydrogen Technology Center – the Hydrogen Pad. We built the Hydrogen Pad, concrete walls, fireproof doors, gas detection, flame detection, and all this infrastructure, so we could safely and repeatably do testing on a wide variety of technologies. The reason we have this out here is we test with a lot of high-pressure, flammable gases.

That's why we're not going inside the enclosures, because both have gas in them right now. Tests will be running in these, and this fire door will be down, and we'll have a light on that shows you can't go in or it will shut down the test.

PUF: What are you testing?

Ted Barnes: I lead the Mobility Group at GTI Energy. Mobility is what you'd think with large vehicle demonstrations. We do component research on vehicles, from hydrogen-powered cars to heavy duty trucks like the class eight trucks.

We collaborate with the Port of Los Angeles, for example, to test class eight trucks running on one hundred percent hydrogen fuel. They work well, and are not just R&D trucks, they are running through a real-life cycle.

We've done that with natural gas hybrids, as well. We have worked with industry partners to test natural gas engines on electric trucks. The natural gas engine is used to create electricity and has essentially zero nitrogen oxides (NOx) emissions. Using renewable natural gas, the greenhouse gas total carbon intensity value is negative.

That can be used as a generator to drive an electric truck. Or hydrogen can be used with a fuel cell in a truck. Again, these big class eight trucks are essentially an electric vehicle with electric motors.

PUF: How is performance for those big class eight trucks?

Ted Barnes: The biggest has up to an eighty-thousand-pound hauling capacity. They're working very well. For hydrogen, we've had a demo of five of one kind and a couple of another kind, and they've operated well. Those demonstrations were successfully completed.

For natural gas, they've been doing it for decades. With hybrid natural gas, you can go essentially in a zero-emission mode when needed.

We do component research on vehicles, from hydrogen-powered cars to heavy duty trucks like the class eight trucks. We collaborate with the Port of Los Angeles to test class eight trucks running on 100% hydrogen fuel. They work well, and are not just R&D trucks, they are running through a real-life cycle.

PUF: Does a new truck have to be manufactured to do this, or are they converted?

Ted Barnes: The method for the class eight trucks right now is building new, using the large truck original equipment manufacturers. We work with OEMs to bring in advanced technologies like hydrogen. It's almost all newly built on the same production line, typically, but instead of putting in an engine, you'll put in a hydrogen fuel cell.

Then batteries are onboarded. There is gaseous fuel storage onboard the vehicle instead of liquid fuel. There is gaseous hydrogen onboard, up to five thousand pounds per square inch. It's five thousand PSI, even ten thousand PSI sometimes on light-duty vehicles.

At GTI Energy, we do component research – like research on fuel cells or engines or fuel storage – that builds up the technology, then we perform demonstrations to help these manufacturers get trucks into the market.

That's what we have in these enclosures here. We test gas cooling and gas dispensing, and all kinds of advanced thermodynamics needed to consider when doing high-pressure hydrogen and gas.

PUF: Will it be economical once these OEMs start offering them? Or expensive like school buses?

Ted Barnes: Right now, the electric school bus analogy is similar. Where the federal government is helping pay a large portion of that upfront cost, they're doing the same with hydrogen, a lot with investments from the Bipartisan Infrastructure Law and Inflation Reduction Act (IRA). The DOE Regional Clean Hydrogen Hubs, for example, will help fund production of clean hydrogen, which will bring its cost down.

When looking at the total cost of a truck, much of the cost is fuel because more fuel is used. A truck driver right now that has a multi-hundred-gallon diesel tank is putting in a thousand dollars or more per fill. In a year, that driver puts in more dollars in diesel than he or she paid for the truck. Getting that hydrogen price down is the key.

That's one of the goals of these Regional Clean Hydrogen Hubs. It'll bring down that hydrogen price, then the IRA will give credits for each kilogram of hydrogen produced. If you can get hydrogen clean enough, you can get up to three dollars a kilogram. A kilogram is about equal in energy to a gallon of gasoline.

If we can get that cost down to five or six dollars a kilogram with the IRA credits, that is breaking even on fuel costs and improving efficiency because hydrogen fuel cells are more efficient. That starts saving money over the long term because you have better mileage.



Our onsite engineers build up all our subsystems, from planning, to designing, to testing. It's just a flow of GTI Energy engineers and researchers coming up with ideas, building up the systems in our labs, bringing them into our test facilities for testing, and then putting them on a flatbed truck to be sent out to an end-user.

That's the path to getting heavy-duty vehicles to market. GTI Energy is behind the research and development of the vehicle components and new fueling stations.

We are working to rapidly scale new, efficient technologies. We are also working on making fueling connections smarter, so the vehicle can talk to the dispenser and the whole system is safe.

PUF: That's important because with electric vehicles, there are not enough charging stations, it takes a while to charge, and reliability can be low.

Ted Barnes: Right. Gaseous storage onboard vehicles are an important issue for security and reliability of the vehicle. If you look at this connection line in the hydrogen fuel cell vehicle, you see that it holds three kilograms of hydrogen. It's about three gallons of gasoline equivalent.

It's larger than a three-gallon jug, next to each other. Even at high pressure of ten thousand PSI, hydrogen is less energy dense to volume than diesel. Diesel is an energy dense fuel.

We work on many technologies to improve density. We work to get as much fuel in as possible. We have advanced dispensing to quell range anxiety. We are currently collaborating with the U.S. Department of Energy to make a smarter fuel gauge for smarter dispensing.

This device is a linear motor expander. It's taking energy out of gas while fueling up, which means it's taking the heat out, cooling down the gas. If you get nice, cool gas flowing into a pressure vessel, more goes in.

PUF: It's kind of like LNG.

Ted Barnes: It's the same idea. When you have all this energy coming in, it creates a lot of heat. You must try to remove as much of that heat as possible and make a very cold gas flow in so you can fill it up.

PUF: You must worry about safety, also.

Ted Barnes: Absolutely. Smarter filling, where your vehicle talks to your dispenser, you can understand your pressures and temperatures throughout the fill.

Then when you have low pressure or low temperatures, you're not overheating your tank. This leads to a safer, faster, more complete fill that makes drivers have less of that range anxiety. They know they have a consistent fill.

That's the kind of research we do at GTI Energy. We have these enclosures, and we're able to change the gas temperature. We can change the temperature of the whole test cell. This can go up to about a hundred sixty degrees Fahrenheit and down to negative forty.

Our onsite engineers build up all our subsystems, from planning, to designing, to testing. It's just a flow of GTI Energy engineers and researchers coming up with ideas, building up the systems in our labs, bringing them into our test facilities for testing, and then putting them on a flatbed truck to be sent out to an end-user.

When we're done testing, we want it to hit the market quickly, and we want to be able to come up with a product, be it a compressor, expander, or dispenser.

Industrial Energy Systems Laboratory

Dave Cygan

PUF's Steve Mitnick: Talk about what we are going to see here today.

Dave Cygan: We're about to go to the Industrial Lab. This contains bigger equipment, hence the industrial area. This laboratory is dynamic in the sense that if you were to come here six months from now, the landscape is going to look different because we have a small fenced small-scale area, and then we have large stationary pieces of equipment that stay no matter what.

In this corner of the lab, we're working on small burner developments. This specific burner technology I'm showing is a technology that we've developed and patented, and it's manufactured by 3-D printing or additive manufacturing. It wouldn't be possible to make this with traditional subtractive manufacturing approaches because of the intricate detail.

We're working with Oak Ridge National Laboratory because they're specializing in 3-D printing and additive manufacturing. We're learning together how to move that new fundamental forward. We sent them a design sketch, and they built this for us, and we test it in this area here. We'll peek behind that curtain.

Usually, we start out looking at an open flame, just having a flame, and then we put a quartz tube around it to contain the air around it. Then we'll go to a water-cooled vessel, and that gives initial data, and then we move it throughout the laboratory.

This platform could be for process air heating, boiler application water heaters. It's a broad breadth. What's nice about this is it gives single digit NOx emissions. It has a high turndown, and it has a low cost. Everyone's interested in higher efficiency with lower costs.

We are an applied research and technology development non-profit organization. We have a long list of customers who we call when an opportunity presents itself. Now, about 50% percent of our work is done in the lab, and the other 50% is at company sites.

PUF: What's a turndown?

Dave Cygan: Turndown means that you can go to maximum firing capacity, say two million BTU firing capacity. Then the turndown is if you have a four-to-one turndown, you go down to five hundred thousand BTUs. So that's a four to one, the range that you're able to fire.

We have a burner under test. We're doing a five-hundred-hour test on it, so we need to get significant run because it's ready for market.

I'm holding a porous matrix material, and the flame sits right on the top of it. It's new technology. That's what we're constantly looking at, is how to advance technology.

There could be incremental change, maybe three, four percentage point efficient, but then there could also be transformational change, where you might have ten or twenty percent.

As we walk into the lab, I want to point out another important

research area for us. This technology was conceived through a collaboration with the DOE's Advanced Research Projects Agency (ARPA-E).

ARPA-E had put out a notice that they wanted to increase the output from a typical parabolic farm, which is a solar field. They have these large mirrors, and then there's a pipe out here, and the solar indices come off the mirror pipes onto the pipe and heat up the fluid that goes through.

Conventional technology operates at four hundred degrees Celsius. ARPA-E wanted to increase the output. We tested this at six hundred eighty-five degrees Celsius.

That's a transformational change because we incorporated non-imaging optics in the traditional sense, only the small perimeter of that mirror was seeing the solar indices, but we added optics to the backside and the solar indices then saw the entire parameter, and that's how we got to the higher temperature.

The problem was that there's no heat transfer fluid that operates at those higher temperatures. You can use molten salt, but there's all kinds of corrosive issues with molten salt.

Typically, molten salt only goes up to five hundred sixty-five degrees Celsius. So, we developed our own technology using these particles, and conveyed these particles using that equipment through the system.

PUF: It looks like regular table salt.

Dave Cygan: It looks similar to table salt. We didn't get it right the first time. We evaluated eight different particle sizes. The way it works is you have a hopper full of these particles and then send it through a heat source.

In our case, it was the solar mirror. It picks up the heat and those particles transport the heat to the process. It transports it back to the receiving hopper and then a lock hopper. Because it's a batch process, meaning that particle travels through the entire system in twenty minutes, we have to recharge the particles over to the hopper and start over again.

ARPA-E wanted to focus on the solar field, however, there is also a significant market opportunity for industrial process heat. What we've done is install our particle rig next to an industrial furnace.

PUF: So, forget parabolic solar.



That's what we're constantly looking at, is how to advance technology. There could be incremental change, maybe three, four percentage point efficient, but then there could also be transformational change, where you might have ten or twenty percent.

Dave Cygan: There are tens of thousands of applications for this technology including parabolic solar and a variety of industrial thermal heat transfer applications.

PUF: So many things that we use every day. That equipment is made first with heating.

Dave Cygan: GTI Energy has proved that you can install this technology on an industrial furnace. Now we're moving into the next phase, which is figuring out where we're going to install it at a specific customer site for further testing.

PUF: What does this customer make?

Dave Cygan: They are a led smelter. It's a true industrial

environment, a nice application. But there're many other industrial sites that would be interested in harnessing some of the available heat that would otherwise go up the stack, and redirect it somewhere in their process.

PUF: Can this go commercial?

Dave Cygan: We are in the process of working to commercialize it. We're in discussions with a couple of companies to move forward. It's an exciting time.

This lab is meant to apply the technology to full-size equipment. So, we brought in a boiler, placed it on the floor, piped it up, moved our technology to the boiler, and improved the performance, because it's much easier to demonstrate a technology in an environment such as this with resources and staff.

So, when the technology leaves GTI Energy, we want to be assured that it's going to be installed and operating with minimal activity in the field.

PUF: So, you're shipping out something that's going into use?

Dave Cygan: Yes, all the time. That's our mission. It's to bring new technology to the market, and end user, that is safe, reliable, and efficient. The last boiler we shipped out went to a legume processor. They installed it at their facility and it's still operating today.

We have an array of furnaces that we operate in different environments. Behind this curtain is a gas turbine. We also do research on gas turbines used in power generation.

For the technology, I've looked at taking the exhaust from a microturbine such as this, and developing a burner that will use that energy as available heat, like a combined heat and power system. I have a unit operating in the field.

It's been operating for multiple years now, and we're scaling up the technology. I was just awarded a project recently to develop a 1.4-megawatt system.

PUF: You're not the kind of lab where you do research, write a paper, and put it on the shelf, and move on to the next thing. You're shipping product out.

Dave Cygan: We are an applied research and technology development non-profit organization. We have a long list of customers who we call when an opportunity presents itself. Now, about fifty percent of our work is done in the lab, and the other fifty percent is at company sites.

Right now, we have demonstration projects at two breweries, a distillery, and a die caster. The industrial area is broad, so we have many opportunities to apply newer, more efficient technologies that we're developing here at GTI Energy. ❍

Utility Infrastructure Laboratories

Blue Lab Green Lab, Jim McNelis

PUF's Steve Mitnick: What will we see here?

Jim McNelis: Our safety testing is focused on developing smarter systems for detecting gas leaks to save lives and reduce emissions. We are collaborating with manufacturers to develop smarter systems that have a sensor, which could be mounted in the home to identify a gas leak and can communicate back to the utility company to alert them of the issue.



GTI Energy helped develop and perfect this technology and now Con Ed in New York currently has two hundred thousand of these installed.

GTI Energy also developed and patented a remote shutoff valve that is now on the market. We call it the HaloValve. It's basically a breakaway valve.

Without that, if a car hits a gas meter set, the piping's going to break somewhere and a gas leak may occur. With this technology, if a vehicle hits a gas meter set, for example, there's a mechanism where once the piping breaks and you have no downstream pressure, there's a spring-loaded mechanism that'll shut off the gas to stop the leak.

Fabrication Lab, Jim McNelis

PUF's Steve Mitnick: What are we seeing here?

Jim McNelis: GTI Energy's Utility Infrastructure Laboratories are about energy systems infrastructure, which is upstream of the equipment you've looked at today.

A highlight of our Infrastructure Lab is our temperature chambers. Typically, gas meters are non-sophisticated instruments. They just measure the volume of gas going through.

What manufacturers want now are temperature testing chambers. Ours is half the size of a normal gas meter, and it's got electronics inside of it, instead of located outside of the meter.

PUF: It's an Itron gas meter.

Jim McNelis: This is an ultrasonic gas meter that is different from your typical gas meters, which just have a rubber bag inside. This is ultrasonic, it's fully electronic. This technology is new on the market and many utilities are beginning to adopt.

PUF: What does it do that's better? It's like a smart meter?

Jim McNelis: Exactly. So, it's electronic. It's got smart, intelligent features inside of it. With typical gas meters, you can't shut them off. You must have an external valve.

This has an internal valve that can shut off the gas. You can send a command to it or stand there and locally give it a command, like internally shutting off the flow.

It can measure the flow; it can monitor the pressure and tell you when you've got too much pressure. The meter can advise that something ought to be done about it and send a signal to the utility company. It's far more intelligent than a traditional gas meter.

But as this smart technology has come out, utilities have come to GTI Energy to ask to review and test the technology to ensure performance and understand, can it withstand the range of climate conditions in the various regions in the U.S.?

That is why we developed temperature chambers. We can work with meter manufacturers and utilities to run through a whole battery of tests with different temperatures and variables.

We also use the temperature chamber for things like testing leak wrap tape that can be wrapped around a leak on a pipe in all climate conditions. We recently had a GTI Energy lab technician in the temperature chamber wrapping a pipe with wrap tape at zero degrees to simulate real-world conditions for field technicians in the winter.



It can measure the flow; it can monitor the pressure and tell you when you've got too much pressure. The meter can advise that something ought to be done about it and send a signal to the utility company. It's far more intelligent than a traditional gas meter.

Nikola Tesla's AC induction motor is among the greatest inventions. He later wrote: I was enjoying a walk with my friend … reciting poetry… I knew entire books by heart, word for word. One … was Goethe's Faust. The sun was just setting and reminded [a] glorious passage… As I uttered these inspiring words the idea came like a flash of lightning and in an instant the truth was revealed… I cannot begin to describe my emotions. Pygmalion seeing his statue come to life could not have been more moved.

Materials Testing Lab, Tony Kosari

PUF's Steve Mitnick: What is your role here and what do you do?

Tony Kosari: I'm an R&D manager, and I also manage several of our materials testing labs, including GTI Energy's pipe testing facility.

We test all kinds of pipe samples for moving gases. Polyamide, for example, is a new engineering material that's been gradually introduced to the market in replacement of polyethylene because it's a stronger material. Polyamide has a higher crush tolerance.

PUF: Talk some more about benefits of the pipe.

Tony Kosari: In addition, these types of materials are a lot more chemical resistant than polyethylene. Our customers come to us and ask, "What's the strength of my material? Tell me how long this pipe is going to last in the ground."

So, we test pipe samples in a variety of simulated environmental conditions, then develop models based on failure times. It gives us a reading for customers that shows end-use conditions and how long the pipe can be expected to maintain its integrity in the ground.

This information guides customers regarding their replacement program, especially if they are investing in exhuming old pipes installed in the ground in the sixties. They would know how long they've got before they'd have to go in and fix them.

PUF: Everybody's moving to these new materials?

Tony Kosari: Many manufacturers and developers are moving to these materials because they're lighter. People are surprised to learn that plastic piping has been in the ground since the late 1960s.

Gas companies have been, and continue to be, in the process of trying to figure out, is it time to replace them? How long do I have to have to replace them? Do I have to replace them tomorrow or do I have five years before they start failing?

PUF: What are you finding?

Tony Kosari: One important measure is testing that mimics aging. Basically, it is the test of time. You've got to get the pipe to fail in testing, under varying pressures, over time, to get an indication of the strength of the material to figure out if it may be time for replacement. PUF



We test pipe samples in a variety of simulated environmental conditions, then develop models based on failure times. It gives us a reading for customers that shows end-use conditions and how long the pipe can be expected to maintain its integrity in the ground.

October's Consumer Price Index was reported on the fourteenth of December. The overall CPI, for all goods and services, was up 3.2 percent as compared with a year earlier – October 2022. This follows the recent trend of moderating inflation.

Prices for energy services were down 2.3 percent. Why? Well, the average price for utility natural gas service was down 15.8 percent as compared with a year earlier. And the average price for utility electric service was up 2.4 percent, well less than the overall CPI increase of 3.2 percent noted above.

A key reason is that the prices that powerplants pay for the natural gas that many plants combust to generate power continue to fall and was down again in October, 0.8 percent, as compared with a year earlier. This according to October's Producer Price Index reported on the fifteenth of December.

Coming Next Month



NARUC's Annual Meeting

As If You Were There, at Fortnightly Top Innovators 2023

Excerpts from panelists, Xcel Energy SVP System Strategy, and Chief Climate Officer Alice Jackson; Fortis VP Innovation and Technology Kevin Woodbury; EPRI Innovation Hub Manager Dan Killoren; Washington Gas SVP Strategy and Innovation Mallik Angalakudati; GTI Energy VP Zero Emission Systems Erin Blanton; Entergy VP Business Data and Insights Andy Quick, Eversource VP System Planning Digaunto Chatterjee; GE Vernova Chief Product Officer/Grid Software Sean Moser; Guidehouse Chief Innovation Officer Rod Fontecilla; Eversource VP Strategy & Policy Roger Kranenburg; Rocky Mountain Power CEO Gary Hoogeveen; Southern Company SVP R&D Mark Berry; Avista Chief Customer Officer Latisha Hill; Puget Sound Energy Director Strategic Energy Initiatives John Mannetti; EEI VP Customer Solutions and Institute for Electric Innovation Executive Director Lisa Wood (retired); Guggenheim Securities Managing Director Power, Energy & Renewables Allen Otto; VEIR CEO Tim Heidel; Dominion Energy Chief Innovation Officer Mark Webb; Xcel Energy VP Corporate Development Justin Tomljanovic; and Quaise Energy Co-founder Matt Houde.

The top innovators were there, as were more superstars of the energy and utilities industry. At the Fortnightly Top Innovators 2023 in Washington, D.C. at the historic Willard Hotel held October 10 – 12, it was the place to learn, trade ideas, and network.

It's not too late to go to the Fortnightly Top Innovators 2023 website at pufinnovators.com and scroll through the extensive list of speakers who were there. The agenda was full of keynotes, roundtables, and working sessions with formidable minds of our time.

Public Utilities Fortnightly captures here not enough of what went on over that three-day period but offers words and photos sure to whet your appetite for next year's Fortnightly Top Innovators 2024 to be held October 6 – 8, again at the Willard Hotel. Mark your calendars.

GTI Energy as a Factory of Innovation

Washington Gas SVP Strategy & Innovation Mallik Angalakudati
GTI Energy VP Zero Emission Systems Erin Blanton

PUF's Steve Mitnick: Is there something going on at GTI Energy that is going to be impactful?

Erin Blanton: We've started putting a lot of value on collaboration with our industry partners, which are key, and well beyond.

A lot of innovation is not just about the technologies and the people behind them, it's also about consensus from across sectors on what we're collectively trying to achieve. We started to understand that having collaborations that bring in academics, NGOs, investors, and a wide variety of participants can help alleviate polarization.

We've put a lot of our focus into building these collaborations. One collaboration we launched this year is the Net Zero Infrastructure Program (NZIP). In fact, Washington Gas is one of many partners.

NZIP is looking at how we can focus on the value of existing natural gas infrastructure and systems as a means to getting to net zero. At GTI Energy, we're excited about NZIP because it pulls from our decades of experience in collaboration and innovation in gas, liquids, fuels, and infrastructure. We test renewable natural gas integration, carbon capture of hydrogen, and a wide variety of technologies and components that enable existing infrastructure and systems to have a significant role in energy systems transitions.



A lot of innovation is not just about the technologies and the people behind them, it's also about consensus from across sectors on what we're collectively trying to achieve. Having collaborations that bring in academics, NGOs, investors, and a wide variety of participants can help alleviate polarization.
– Erin Blanton

But we think it can help with these conversations around how difficult it is to permit new infrastructure, and, as such, how important and valuable the current infrastructure is, from its resiliency and reliability to the cost efficiency.

To be able to prove that and have a collaboration that's pulling in all these entities, can help shift that conversation, and hopefully accelerate efforts to

transition to net zero systems and make real-world impact.

PUF: Mallik, what excites you?

Mallik Angalakudati: As a public utility, it's not a one-dimensional problem. We want to make sure that the infrastructure is safe, and with reliability and resiliency. Most gas assets that operate tend to be 99.999 percent reliable. We also provide affordable energy.

But we are not decarbonized as electric systems now. So, how do we solve this extremely complex challenge to provide reliable, resilient, safe, and sustainable service?

As we look to the future, solving this collaboratively, with the gas industry, biofuels, and academia and research institutes, is an exciting challenge. I look forward to doing it with my colleagues.

PUF: We hear from various forums about, "Let's get rid of all fossil fuels as we don't need that in the future." How does innovation address that?

Erin Blanton: Any 2050 projection you look at will show you that we still see a strong role for gases, liquids, and fuels. Yes, there are going to be lower-carbon molecules flowing through our systems, but there is a need for molecules, certainly from a storage perspective.

That's not just saying, "How do we reduce the emissions across the system?" Getting better at measuring them, monitoring them, mitigating them. There are ways we can help do that.

We believe there will be more hydrogen, more renewable natural gas integration, and there'll be carbon capture, utilization, and sequestration, but natural gas molecules will still be part of the energy systems of the future.

PUF: In D.C., Maryland, and Virginia, where does gas fit in the transition?

Mallik Angalakudati: In peak winter days, our natural gas system carries five to six times more energy. When you're at twenty degrees outside and putting your thermostat at seventy, or seventy-five, that much energy has to flow through pipelines. Guess who's powering PJM's stack?

No matter what you hear, the truth is PJM is only ten percent renewable at this point. Most of it, if you separate nuclear, comes from fossil fuels. To transition in a pinch is impractical.

What would be more pragmatic? Innovate to make sure you have two complementary systems with molecules coming through pipelines and electrons coming through the electric system. That's what you would need.

That would require considerable need for business model innovation, not just technical innovation. How do you share revenues? What's the insurance value of gas infrastructure?

There is increasing interest in biofuels and low-carbon fuels among young people. I would suggest to everyone in the gas industry, get out, talk to people, be open to possibilities, and you will attract sustainability-minded young people.
– Mallik Angalakudati

How many communities say, "Yes, I want a massive electric transmission facility in my backyard." Not happening. When people think about, "I'm going for solar and wind," one solar megawatt of capacity requires five acres. And you would need tens of thousands of megawatts of capacity.

We need to be pragmatic. Not only will you have ever-expanding renewable energy, but we need transmission lines to move the energy. PJM needs that.

You need innovation in both systems. I was listening to the latest developments for the electric system at the NREL Partner Forum. There are great differences in standards between different parts of the grid. There's a long way to go, and we need a unified approach.

PUF: Is there a focus in the gas industry on having an innovative culture, on attracting innovators to companies, promoting them, and supporting them?

Erin Blanton: With our Gen Z team members at GTI Energy, for example, we see that they want to believe they are part of something meaningful. They are driven by knowing what impact they can have, and they need to really understand the mission.

These things are important for us to set our sights on and be clear about where we're heading and why. The impacts we want to make in the world. With that, we can attract ambitious, purpose-driven talent.

I've been impressed with what I see within these companies, the people they're bringing in, the thought they're putting into the technologies, and the solutions they want to deploy. Many of our industries have long legacies and decades of experience in designing energy systems; we can do more to showcase the innovation ecosystems we create within our organizations when we empower the next generation of innovators to bring their creative and diverse perspectives to the table.

Mallik Angalakudati: I'll make two comments. Necessity is the mother of invention. Especially if you're in a progressive state and if you are working in a gas utility, you wake up every day and know transition is now upon you and you need to think differently to survive.

I can tell you that we are fine. We will be around for another one hundred seventy-five years. People need natural gas.

The second part is, I recruit from top schools. We attracted from top MBA programs, the students, scientists.

There is increasing interest in biofuels and low-carbon fuels among young people. It depends on how you position your company and your future. We are members of the MIT Energy Initiative. We were the first gas utility.

We also work with National Labs and GTI. When you do that, when young people see you are not just talking, but actually doing things, they come to you. I would suggest to everyone in the gas industry, get out there, talk to people, be

open to possibilities, and you will attract sustainability-minded young people.

Erin Blanton: That's a good point. We've been able to attract a lot of innovators through having partnerships with academic institutions and the National Labs; it opens an applicant pool we would not have access to otherwise. A key point is if you're able to form these partnerships and be visible, it does help attract innovation.

PUF: Four goals of utility service on the electric side are clean, safe, reliable, and affordable. Those words also apply in gas utility service. Talk about reliability and resilience in gas.

Erin Blanton: It goes back to Mallik's point about the need to have both systems working together as reliability backups for each other, accelerating progress to decarbonization and ensuring resiliency along the way. It's understanding that because of what we're seeing in extreme weather and natural disasters, we need gas systems as a backup.

We're seeing a lot more discussion on whether the infrastructure is ready and able to withstand more extreme temperatures. What does that mean on a demand and supply basis? Again, the more we can have these two systems working together, the more we can provide that resilient and reliable energy system in times when we need it most.

Mallik Angalakudati: If you look at facts and stats, gas systems tend to be at least one, if not two orders of magnitude more reliable. Mostly because they're all underground.

The resiliency challenge is demonstrated in California. If you live in northern California – I can't say bad things about PG&E, I used to work for them – but the truth is they shut electric supply off frequently.

The only backup they have is gas. Ironically, in the State of California, the gas throughput has been going up, not going down. Because what do people do? They just get generators as backup.

Reliability and resiliency are an absolute advantage of gas systems and that's the argument for integrated energy systems.

When it comes to affordability, fossil gas tends to be cheaper compared to other sources of energy. But as we look to decarbonize, renewable natural gas and hydrogen are not cheap. They are multiple times more expensive than natural gas.

Our ability to decarbonize is contingent upon finding niche markets that would pay for those low-carbon fuels. That is where innovation is needed.

I can't mention their names, but there are certain dedicated power plants that don't rely on the grid because they can't even tolerate a couple of seconds of disruption, like biotechnology, as an example.

We see innovation around gas companies basically increasing efficiency and reducing emissions across the system. That's one of the things we've been putting a lot of our research and development into over the years.
– Erin Blanton

They need multiple energy sources. That's where they're willing to pay three, four times more of the price for low-carbon fuels. Maintaining affordability with low-carbon fuels will be a formidable challenge for gas systems. Reliability is no problem.

PUF: Talk about gas energy startups that you work with and find interesting.

Erin Blanton: GTI Energy is a nonprofit, but because we also develop technologies within our labs, we have several subsidiaries that are for-profit that we spun out from technologies that were developed by GTI Energy.

Mallik was key to one of those companies in doing the research with us around what became SunGas Renewables, which is a subsidiary we stood up in 2019. There's a lot of technological space in the natural gas system, and we see a lot in terms of emission space technologies to monitor, and to do a better job of finding out where there are leaks and where we can mitigate and resolve them.

We see innovation around gas companies basically increasing efficiency and reducing emissions across the system. That's one of the things we've been putting a lot of our research and development into over the years.

Mallik Angalakudati: I'll give a couple of examples. When I was at PG&E, we worked closely with a company that provides advanced leak detection. They drive a car around with devices and it's able to figure out leaks by reverse engineering using machine learning algorithms. They advanced their technology quite a bit.

There are a lot of startups in that area, which is exciting. They're combining sensing technologies with computational technologies to help us be more efficient in figuring out where leaks are.

If you work in a gas utility, we spend a lot of time trying to figure out where that leak is. You send people, they sniff around and still can't find them. If there is snowcap, good luck trying to find it. These technologies are allowing us to advance leak detection significantly.

On the hydrogen side, we are lucky to get funding from the federal government as part of the startup called GKN Technologies. They offer hydrogen storage in solid state. That's an exciting technology.

Honestly, there is a big challenge for startups. To work for utilities as a first application you need to make sure your technology is extremely reliable and safe. If you're not doing that, you haven't even passed through the first step.

PUF: There's some innovation going on with hydrogen. What's going on?

Erin Blanton: There's a lot going on with hydrogen. The big development is hydrogen hubs. In the same way that we saw DOE invest a lot of money recently in reducing methane emissions, the historic Bipartisan Infrastructure Law investment in Regional Clean Hydrogen Hubs is

going to make huge impacts for advancing the hydrogen economy.

GTI Energy is pleased to be part of three Hydrogen Hubs in the Gulf Coast (HyVelocity), Appalachian (ARCH2), and Midwest (MachH2) regions of the U.S. We're getting a lot of government funds that allow us to then leverage our work, industry, and start to move the needle on reducing this cost.

Mallik Angalakudati: We are part of the hub application in the DMV. You need all the incentives you can get, and it still doesn't work in most cases.

> Innovate to make sure you have two complementary systems with molecules coming through pipelines and electrons coming through the electric system. That's what you would need.
> *– Mallik Angalakudati*

Having said that though, I'm excited about hydrogen in transportation especially for the buses. Buses make sense because when you essentially get free buses from the government, then you can pay for hydrogen. It makes the numbers work.

Also, trucks make sense. Again, you would need subsidized trucks. With all the federal incentives you can make it happen. ❍

End of Day Discussion, Digital, AI, Planning

Eversource VP System Planning Digaunto Chatterjee
GE Vernova Chief Product Officer/Grid Software Sean Moser
Entergy VP Business Data & Insights Andy Quick

Sean Moser: What do you think about what you've heard today, and what jumped out at you?

Digaunto Chatterjee: A lot is being asked of utilities and at a very fast pace. The internal structures and organizational design of utilities inherently aren't designed to move fast.

We have quite a few silos because of good reason, specialization in different areas. Someone in utilities needs to step back and reassess. Are we even organized or designed correctly to be able to reach outcomes?

Andy Quick: What stood out for me was the beginning of an autonomous beginning. Because the key to innovation is reimagining how work happens and how we approach things.

We're an old utility, and sometimes I watch the way we work, and how we operate the business. Innovating means reimagining, reinventing, as opposed to just adding cool ideas to integrate into the business.

Sean Moser: We can relate. General Electric is over a hundred thirty-plus years old. All of us are going through changes as we figure out how we deal with the energy transition, and the transformation underneath that. What are your biggest concerns?



> You've got a lot of engineers in this industry, and in this room. We tend to gravitate toward technology problems. But technology's the easy part. It's the people who are always the hardest. It's hearts and minds, and culture.
> *– Sean Moser*

Digaunto Chatterjee: This industry is so fragmented right now. We spend so many hours talking about how to make that industry successful. As a system planner, I'm looking at rooftop solar industry, separate from ground mount solar.

That's separate from offshore wind industry. It's separate from competitive transmission developers, separate from energy efficiency. That's separate from equity and environment justice communities and separate from electric vehicle.

We just published in Eversource, in Massachusetts, our first ESMP, Electric Sector Modernization Plan. We serve about half of Massachusetts. We go from six gigawatts to seven and a half gigawatts in ten years, to fifteen gigawatts by 2050.

We serve Massachusetts now with a hundred substations. We're going to need seventeen new substations, upgrades to twenty-six substations. An upgrade of a quarter of our assets and adding about seventeen percent more assets on the system.

The innovations and planning to get to that point, coincidence factors of electric vehicles, time-of-use rates, locational electric vehicle demand, how many miles residents are driving in what towns, a solar irradiance cloud-based forecasting, we're

running distribution planning models on a probabilistic scale of models.

We're probably the only utility running transient stability analysis, electric analysis on the distribution system at scale, all in-house. That is not even the start of it.

The submission of the ESMP now translates the electric infrastructure to household-level electrification capacity. What does that mean?

An average energy efficiency guy has to think, "Oh, I can't just hand out coupons. I have to focus on the grid capacity, and the system planner's telling me to go there." That's just one aspect.

Think about stakeholder outreach, project services, construction crews who have to work through a community. Think about every aspect of rate design. TOUs may help but aren't the ultimate solution.

We're going to go from six gigawatts to fifteen gigawatts. If anyone thinks we aren't going to need to double the infrastructure, and the cost will be significantly increasing, we're fooling ourselves.

How do we think about completely changing the rate design construct? The utilities need to recover massive infrastructure costs. How do you recover that accurately so you're not forcing your costs onto the most disadvantaged communities?

Every aspect of what a utility does today needs to be revamped and rethought. That worries me, that we are thinking in a compartmentalized way.

Sean Moser: There are a couple of things I want to unpack there. These are interesting stats for people who like interesting stats:

From 1980 up until 2020, the population went up by almost eighty percent. Electricity demand went up by three hundred percent. From 2020 to 2030, population growth is actually going to nearly flatten. But the electricity demand is going to go up by another three hundred percent.

When you look at telco or banking and those transformations, those are all networks. We are running the largest network in the world. To put this in perspective, ninety-one percent of the human population has access to electricity, while only sixty percent to the internet. Every other network's gone through a transformation. This is the last one.



It's having locational pricing at a community aggregation level and being able to actively participate in a retail market and bring your products and services to the table, to provide real value to the grid by lowering demand, and the grid operator needs that demand to be reduced. That kind of innovation if it can happen, is a game-changer.
– Digaunto Chatterjee

In every one of those instances, there was massive infrastructure buildout, but that came later. You dealt with digital first. That's an opportunity for us: how do we use digital to manage the flow while we do the physical stuff? Andy, what are your big concerns?

Andy Quick: Culture is where I would start. It's the spirit of innovation conference. But it's with the internal orientation to how you run the business, because there is a lot we can do to reimagine AI solutions. There are ways we can run the business differently, a lot more efficiently, productively, and with a more human workforce.

For the external orientation, in utilities, we like to talk about stuff. External innovation starts with the customer, and the customer challenges, the customer frictions, et cetera.

Culturally, my biggest challenge is helping the business rethink how we give customers experiences, how we run the business differently. Yes, it's all these cool technologies.

But the hard part is the cultural change in getting people to think differently about how we operate, as opposed to the technology itself. Culture is the challenge.

Sean Moser: I very much agree with you. You've got a lot of engineers in this industry, and in this room. We tend to gravitate toward technology problems. But technology's the easy part. It's the people who are always the hardest. It's hearts and minds, and culture.

When you work with people who have long tenure in this industry, and introduce new stuff, they might ask, "Well, where's my value? Do I still matter?"

We talk about talent acquisition. This should be the most exciting mission on

the planet right now. If you want to attract talent, there shouldn't be anything more important that anybody going to university right now should be thinking about than joining your teams.

What's better than this? You get to change the world, and there's new money flowing in. There's nothing that shouldn't be attractive about this, and yet it's not quite there yet.

When you acquire this new talent, and they come into our hundred-year-old companies they might say, "Oh, no. What did I sign up for?" We need to create a space for them to make a difference, and where they can break it and then fix it.

What excites you about the opportunities, or what is happening in your companies? What excites you about what is happening in the whole space?

Digaunto Chatterjee: We have planners who are now building predictive models of where we are going to see demand show up at street level, chronologically by year, clustering the customers in different segments. We're doing this by scouring through hundreds of public databases. That's the planning piece.

But when that moves to an operations phase, and we build the infrastructure, and build the DERMS platform, what excites me is retraining of the operations workforce. Because my team's young, less than five years in the industry, probably fifty percent of my staff.

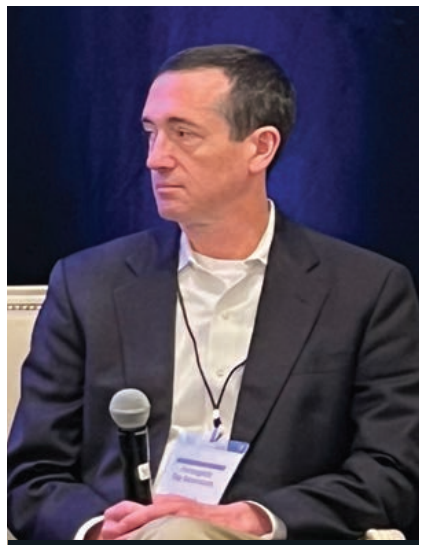
Most of the staff, the other fifty percent, range from fifteen to thirty-five years of service in being a planner. But if I move outside of planning to operations, that's probably skewed in the other direction.

There is a sense of me that feels like, "If we do this right, we can move some of these younger people throughout the organization and percolate them as they get more planning experience, then going to rates, get some regulatory experience, then moving to accounting, finance, and to operations would create a kind of utility utopia." All these young, budding engineers.

Andy Quick: AI is one of most exciting things, with ChatGPT coming out in November 2022. AI has shown up in a big way.

I'm excited because we have a lot of sponsorship. Our CEO is interested in taking advantage of using this in any way possible. It is going to be a transformative tool.

In the circles I run with, other folks who do what I do at utilities, we're in the early days of considering adopting AI.



In the circles I run with, other folks who do what I do at utilities, we're in the early days of considering adopting AI. When I say AI, I don't just mean the generative AI, it's GPT, data science, robotic process automation, big data, software, et cetera, and everything else.
– Andy Quick

When I say AI, I don't just mean the generative AI, it's GPT, data science, robotic process automation, big data, software, et cetera, and everything else.

Digaunto Chatterjee: When I think about how ISO jurisdictions evolved over twenty years, I think the distribution system's going to evolve in that journey in five years.

It's having locational pricing at a community aggregation level and being able to actively participate in a retail market and bring your products and services to the table, to provide real value to the grid by lowering demand, and the grid operator needs that demand to be reduced.

It sounds simple on a transmission system. It's been around twenty years. But that kind of innovation if it can happen, is a game-changer.

Sean Moser: If I have fifteen million times the data load and I'm dealing with a massive amount more variability, which we're all experiencing in our environments, then the obvious conclusion is it's not going to be manageable anymore.

So, the need to build technology, or the need for AI, and automation, shifting the load more toward upfront planning, and then automated response, versus active management in the control room, these concepts are coming at us quickly.

The challenge then becomes less about creating the technology, and more about preparing the organizations and people for that transformation. What do you think about this?

Digaunto Chatterjee: I struggle when grid operators make AI for grid operations sound cool. We're in a catastrophically dangerous business. We have to remind ourselves of that.

Manhole explosions are real. We had a fatality last year. The underground network systems of most utilities are about a hundred years old. The cables underground, most of them, are old.

We have to be careful. We have an asset base that is old. We have a workforce that is not very new. We have technology that is brand new.

We have to see how we traverse that without jeopardizing safety. The way to do that is by making sure we have different tiers for decision making. At the end of the day, the operator's got to do what the operator's got to do.

Andy Quick: In terms of preparation, looking ahead, we talked about data, sort of net digitizing everything we do too little of. The data we have are billions and trillions of records of data and information.

How do we strategize on how to store that data? How are we going to access and maintain that data?

When the data's coming, it can be challenging to wrangle it to make decisions if we don't have some kind of strategy.

With further digitization, it's preparing people to work differently. Because a lot of things will be automated and digitized.

We see AI showing up in the control room of a nuclear power station and in every part of our business. We see AI integrating to help improve customer experiences. If you believe the future is that people are going to have to work differently, jobs will change as well.

Sean Moser: We're all getting together to work on these problems. One of the cool things about this industry is we're not competitive. What do you expect from your partners, vendors, and peers that will help accelerate and deal with some of the challenges?

Andy Quick: We've gotten so much value out of sharing these problems, solutions, what worked for us, what worked for you.

We were working on a transformer prediction model, as an example. We were trying to figure out how to look at this voltage data. Our partner said, "Oh, we did that two years ago." I literally came out of a call and gave it to my team. That crashed the schedule of that project by orders of magnitude.

That was an easy button from an external vendor perspective. Finding the use cases, I found to be the easy part. It's more difficult around the execution.

Digaunto Chatterjee: One of the easiest things you can do is start to grind through looking at regulatory dockets that are in all states. Trust me, we're all dealing with the same issues. Some are a little ahead; some are a little behind.

If we're being forced into doing remote sense vegetation management to reduce the budget, everyone else is, and some have already done it. So, when we pick a vendor, the first question we ask is, "Who else uses it?" The second is we make some calls. I think everyone in this room has done that.

Then, there needs to be a better avenue for all the innovations happening in each utility, by utility. Then, cross check where they are in the goal scale that accelerates where we need to go in the short term.

Sean Moser: I'll tell you one of mine. I was shocked when I came into this industry. I've worked with governments, conservative banks, and a lot of industries.

The desire is, "I don't want to run the latest version. I want to run a version somebody else is already running. But I want to customize it." Well, then you're not running the version somebody else is running. You're running an old piece of software you've turned into a unique island and you're now the only company sitting on it.

It's a dynamic that as a group, we need to understand. Because it introduces risk and danger in a way that people don't appreciate. As we all move forward, we've got to figure out how we change that part. If we're going to embrace technology to solve problems, we need to embrace technology to solve problems in a different way. ❍

Culture of Innovation

Southern Company SVP R&D Mark Berry
Guidehouse Chief Innovation Officer Rod Fontecilla
Eversource VP Strategy & Policy Roger Kranenburg
Rocky Mountain Power CEO Gary Hoogeveen
Avista Chief Customer Officer Latisha Hill
Puget Sound Energy Director Strategic Energy Initiatives John Mannetti

Rod Fontecilla: There's a lot of growth, you're building renewables, and there is a debate about modernizing existing infrastructure versus completely building brand new. What are your thoughts and how do you bring innovation into that?

Mark Berry: We shouldn't be having that conversation as an "or" conversation, but an "and." Existing natural gas infrastructure, especially infrastructure that's going into homes that provides heating, is important infrastructure.

Many refer to gas as a bridge fuel to the future, that bridge is like the bridge to Key West. We need to figure out how we leverage that infrastructure where we're going to have RNG, maybe synthetic methane, or even mixing hydrogen in terms of leveraging that infrastructure.

We're going to move from twenty percent electrification to forty percent to sixty percent. We talk about renewables and think about it in terms of replacing what we already have, but now we're doubling or even tripling the amount of energy that we have to serve.

There's so much investment we are going to need that we shouldn't be having an "or" conversation, but an "and" conversation.



Whatever innovation you're going to do involves a bit of risk, most likely because it hasn't been proven. How do utilities effectively link their innovation strategies with risk management?
– Rod Fontecilla



I view a lot of what we're doing on renewables and things like that as, we must be doing all that because there's so much uncertainty in fusion, but it can't be the forever solution. If you look at the mineral consumption of the path we're on, it can't be the forever solution. We shift from fossil fuel dependence to mineral dependence.
– Roger Kranenburg

Latisha Hill: With natural gas in our region, we are mostly clean. Avista is about sixty percent clean, all green. Then we've got this chunk of natural gas, which serves an important purpose.

When we peaked last winter, two thirds of our load was served by natural gas. That's significant because if that goes away without a thoughtful backup plan, it has an impact on the people we serve.

You can build as much renewables as you want, but if you can't get it to people, that's a problem. Few folks want transmission lines in their backyard or farmland. That's why the conversation has to be bigger than just the utility trying to solve climate change on behalf of the planet. It has to be, how do we all, as humanity, solve this problem we're all working through together?

John Mannetti: We will all agree on the value of the gas system on this panel. I love the two-thirds comment because that's the same in our service territory, and replacing all that energy is a monumental task.

We've done study after study on regional decarbonization and what each one has shown is the value of a hybrid approach. You have to use the gas system to serve the peaks and the electric system to help decarbonize in the meantime.

What we need is dispatchable clean capacity but that doesn't exist right now in a meaningful way. The alternative is you fire up a combustion turbine to serve the additional electric load, which increases emissions because it's more efficient to burn that gas in the furnace.

Gary Hoogeveen: Dispatchable energy is the key, that's true. But first, you're going to build as many renewables as you can, as fast as you can, to decarbonize.

In our service territory, we're about forty-two percent coal. That's not popular with some people, but it is popular with others. We serve the reddest of red states and the bluest of blue states in our six-state service territory.

At Rocky Mountain Power, we're partnering with TerraPower to build the Natrium project, which is a sodium cooled advanced nuclear technology. It has the promise to provide low-cost, safe, and reliable power, and also has storage built into it.

You can turn it on and off, you can turn it up and down. When we talk about rising to meet the challenge and innovating to get there, we think you must include advanced nuclear in the conversation.

Rod Fontecilla: That technology, has it been proved already?

Gary Hoogeveen: It is included in the Department of Energy's Advanced Reactor Demonstration Program or ARDP, which is funding fifty percent of the demonstration project.

ARDP will fund half of the first commercial plant for two companies. We are partnering with TerraPower, and X-energy is building the other one in Washington State.

To answer your question, they are proven at pilot scale and at the labs around the country, but are they commercial



We have gas infrastructure. We also have geology in the southeast that would support carbon sequestration. To continue to use combined-cycle units, but to decarbonize, we are investigating carbon capture and storage. Over the past 20 years, we've done a lot of work to understand geology in the southeast is conducive to storage.

– Mark Berry



To decarbonize and pull away from coal, if you build more gas, then the issue is over what period do you depreciate that gas asset? Do you think it's going to be around for another 35, 40 years that you typically depreciate a gas asset? I would challenge that. If it's more like 10 or 15 years, then it's expensive for your customer.

– Gary Hoogeveen

scale? No. That is what is meant to happen by building this demonstration project – building the first commercial scale advanced nuclear units.

Of course, once it's commercial scale, then serial number two isn't going to be funded fifty percent by the Department of Energy. So, how do you get from serial number one, its half funded, to serial number N? Is that going to be financial and economic for the utility to build? That's the innovation we need to get from serial number one to N.

Roger Kranenburg: In terms of culture, I've had the pleasure of digging into fusion and in many conversations, people are like "Ok, Mr. Crazy." But I've gotten the chance to tour a fusion reactor in MIT.

There's a company called Commonwealth Fusion in Boston that's building a magnetic confinement fusion reactor; serious, billions of dollars behind it. Then I got invited to go to the National Ignition Facility at Lawrence Livermore National Lab, where they demonstrated a Q value of 1.9, which means they created ninety percent more energy than they put in, albeit for a tenth of a billionth of a second.

I view a lot of what we're doing on renewables and things like that as, we must be doing all that because there's so much uncertainty in fusion, but it can't be the forever solution. If you look at the mineral consumption of the path we're on, it can't be the forever solution. We shift from fossil fuel dependence to mineral dependence.

Coming back to the gas issue, I explain to folks, don't think of it as a gas business. Think of it as a good energy distribution business that you've already paid for mostly and we've got to figure out how to evolve it.

The same with transmission and distribution when we nail fusion. A banker said to me, you still have to get it to the point of consumption, which is your business.

If you look at these ubiquitous transportation infrastructures, we just evolve and use them differently. There're many examples in other transportation areas of re-utilizing these transportation systems in different ways over time.

Mark Berry: What Roger is saying here, and I think he's pointing to this evolution of energy, is that we can't look at it in a static sense. Southern Company, like Berkshire Hathaway, is working with TerraPower on advanced nuclear technology.

I don't see a future if you're doing net zero in the near term without nuclear energy, but we're going from gen three to gen four, and fusion is out there even further with unlimited energy supply. There is a transition going on and we can't think of solutions in a stagnant way. We have to acknowledge this evolution we're going through.

Rod Fontecilla: Let me drill into the transition of gas. How did you envision the interplay between wind energy and the transition to gas? What is the innovation occurring there?

John Mannetti: It's utilizing gas to

serve the peaks. We can build all the wind and solar we want, but especially in Washington State, that resource is not always there on a cold day. It's dark on a cold day and during cold high-pressure systems, it is not windy either.

The gas system is the ginormous peaker that we have already built. The alternative is building a lot of electric infrastructure and turning on gas turbines to serve that load, which is not an emissions reduction, it's far more efficient to use the gas in the furnace.

Mark Berry: There is a regionality to clean energy. If you think about the southeastern part of the United States, we have a wind resource, but that for us is not cost effective. In terms of wind speed, for us, you don't get to forty percent capacity factor unless you're at a hundred sixty meters tall.

Right now, we can't cost effectively get to a hundred sixty, but at some point, we will, so wind energy now for us is bringing it from out west, probably high-voltage DC lines.

For us, wind is in that evolution. We have tremendous gas infrastructure in the southeast. We also have great geology in the southeast that would support carbon sequestration.

If you want to continue to use combined-cycle units, but we want to decarbonize, one technology we are investigating heavily is carbon capture and storage. Over the past twenty years, we've done a lot of work to understand the geology in the southeast and it is conducive to storage.

Gary Hoogeveen: Again, it's regional for the west. We have about twenty-five percent of our capacity in natural gas. To meet new load, to decarbonize and pull away from coal, if you build more gas and renewables with batteries, the issue with gas is then, over what period do you depreciate that gas asset?

Because do you think it's going to be around for another thirty-five, forty years that you typically depreciate a gas asset? I would challenge that assumption.

If it's more like ten or fifteen years, then it's expensive for your customer. Then do you just build batteries? Because batteries are more costly, but you don't have that risk. You do have to replace them every ten, fifteen years. The technology isn't proven to last longer than that. All that you've got to work through.

Rod Fontecilla: Whatever innovation you're going to do involves a bit of risk, most likely because it hasn't been proven. How do utilities effectively link their innovation strategies with risk management?

John Mannetti: You've got to partner with your regulators and stakeholders so you can vet some of these solutions, whether they're pilots, utility scale resources, new distribution, all of it in advance.

The commissioners did a nice job talking about the importance of that because they're dealing with all of these changes coming to them from the utilities they regulate. Being able to bring them solutions that are acceptable to a broad coalition of stakeholders is a super important way to de-risk innovation.

Latisha Hill: You have to find so many partners at the table because then you're sharing the risks. We have a project called Catalyst, which has an eco-district. It was the largest commercial cross-laminated timber building built. It's net-zero. But we didn't do that by ourselves.

We got together with several partners, public and private. We brought their people in, our people in, to design a building. We brought the community in because we did this in an underdeveloped area, which had other risks associated. It was complicated, but when it was done, we came in under budget.

We opened in 2020. It was exciting. Then we put in an innovation lab so folks who want to engage on the grid and test concepts on the grid in real time, could do that.

We engaged multiple levels of students, private businesses, because we have a people challenge. We wanted to get this pipeline of engineers and others engaged in energy innovation as soon as possible.

Because we were invested as a utility and a subsidiary, we get to see the entire value proposition from the meter all the way inside the building and optimize that system.

We have to get outside of our buildings or what some in the field call the glass towers. We've got to get out of those glass towers and work with people to solve complex issues now.

Roger Kranenburg: A big part of the innovation process is sort of a collective genius, bringing a lot of different minds and perspectives throughout the organization and community together.

For example, engaging with the community and engaging early. Going through that broad collaborative process to identify the risks.

There are certain risks that are not tolerable. You cannot shut down the eastern interconnect. That's not a tolerable risk.

If you haven't read the biography of Elon Musk, you should. He has the luxury of making a gut calling, "Yeah, send the rocket up," and it blows up. Okay, that didn't go so well.

That might seem like a catastrophic event. If NASA did that, it's a catastrophic event. For Elon Musk, he's like, "We're just learning," and part of that risk is taking those learnings and reintegrating it back into the organization to the point of culture, not tarnishing people, like you blew that rocket up, you're done.

We blew up that rocket. We made a conscious decision. Okay, now let's integrate what we've learned and keep building on top of that. Those are some of the ways I think about risk in our business.

Mark Berry: First-of-a-kind risk is significant. Who carries that risk? As a regulated utility, I would look to my commissioners and they would say, "Well, customers do not need to bear that risk."

Then shareholders are going to look at me, and say, "Mark Berry, we're not willing to share that risk." Who is willing to share this risk in terms of the transition?

These are unknowns. If a society wants decarbonization, we have to incentivize the first mover to take the risk.

Right now, I would say the tools we have



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You've got to partner with regulators and stakeholders so you can vet solutions in advance. The commissioners did a nice job talking about that because they're dealing with these changes coming from utilities they regulate. Being able to bring them solutions acceptable to a broad coalition is super important to de-risk innovation.

– John Mannetti

need improvement. The Department of Energy has been willing to do fifty percent, but then they're going to say, "That's it," and who's going to carry that? We need more tools; we need innovation not from the technology side, but from a risk perspective.

Gary Hoogeveen: In the west, we've got to talk about wildfire, and to innovate around the risk is going to take innovation with regulatory commissions. Perhaps it's with the legislatures as well, but it's at least the regulatory commissions. I heard someone say it earlier, the regulatory compact is broken at the moment.

We can't get commercial liability insurance anymore. We've gone from paying roughly ten million dollars five years ago for about a half a billion dollars in coverage for wildfire liability insurance across our six states.

So, ten million in premiums for five hundred million in coverage five years ago. And now we're paying a hundred twenty million in premiums for three hundred fifty million in coverage, and we can't find any more. There needs to be a solution where we go to our regulators and ask our customers to help us with that. I don't see another way.

Or there could be other ways, maybe with legislators, and something like AB 1054 in California, to backstop the risk for the IOUs. But we operate in six different states and getting six states to agree to the same legislation, that's nearly impossible.

Or maybe it's a federal solution. Now you're talking about getting Congress to do something.

Rod Fontecilla: How do you work with consumers, how do you bring innovation there, and where do you want to take them?

John Mannetti: The consumers are going to undergo a massive transformation, as well. They're going to have solar panels and batteries in their homes.

I don't know if our customers care about us that much and I don't think they should have to. We talk about spreading customer joy and delight, but what they want is reliability and affordability.

We need to help them change how they use energy. How do we make it easy for our customers, make it seamless, how do we understand how to bundle things, make it so they don't have to think about us, or care about us, but we both still get what we need to achieve our goals?

Latisha Hill: What we've done is go to the customer. There's a lot of conversation on the future of technology, but I'm more interested in the future of the customer.

Customers are changing. By 2030 we'll have more elderly people than we have people under five in our country. That's never happened before. Data like that should inform how we design our systems because resilience and reliability will matter even more.

We met with some leaders at our hospitals to ask, "How are you thinking about the future of the hospital industry?" We had a CEO who said, "Latisha, when we have an outage, you try to restore the hospitals as quickly as possible. But it's not helpful because we have backup generation."

What happens is then you don't restore

power as quickly to the lower income neighborhoods or places with health inequities. After three or four days, depending on how long the outage is, those folks flood the hospital, and we're not staffed for it. It's those types of insights we get by sitting with our customers.

Mark Berry: About five years ago, this customer conversation was, "We want price first," but we're now hearing, "We want clean energy, but price has to be there, as well."

In the State of Georgia, we have changed our growth projections. We've had over twenty billion dollars of net investment into the state where it's solar manufacturing, battery manufacturing, electric vehicle manufacturing, aluminum. We've seen so many people come to the southeast, but they're also demanding clean energy. You have to put the customer first.

Gary Hoogeveen: All the electric vehicles that are coming are giant batteries. What if we could use them? We have a pilot project in Utah where we have, perhaps, two hundred fifty megawatts of batteries from our customers that we have helped them buy.

We've paid them to put them in their garage and we get to charge and discharge them. We use them for our frequency reserves. That has saved tens of millions of dollars for our customers. ❍

Innovation and Customer Affordability

Xcel Energy Chief Planning Officer Alice Jackson
EPRI Innovation Hub Manager Dan Killoren
Fortis VP Innovation & Technology Kevin Woodbury

Dan Killoren: Alice, you look at and assess technologies, what are the types of technologies you think would have a meaningful impact in the three-to-five-year time horizon?

Alice Jackson: What has come to the forefront, especially with the Inflation Reduction Act being passed, is the economics associated with battery storage. That change is in the forefront with activities ongoing in Colorado inside of Xcel Energy's portfolio, and that's exemplified in the electric resource plan we just presented to the commission in September.

The timing was good because we were in the process of making a request for proposals for technologies and energy resources needed when the IRA came out. It ended up significantly shifting what we expected to be acquiring in that jurisdiction from a battery storage perspective.

We're able to take advantage of the IRA and over ten billion dollars in benefits will be coming to customers in the State of Colorado. We nearly doubled the amount of battery storage we had expected to get and that allows us to integrate more renewables into the system.

We're anticipating roughly eighty-three percent of kilowatt-hours for our customers in Colorado by 2028 will come from a renewable facility. That's a significant reduction in carbon emissions, as well as maintaining affordability.

The other piece is around software. There's a big software investment in innovation that we need in the next three to five years that would be significant for our customers.

Dan Killoren: Kevin, how about you?

Kevin Woodbury: We're doing similar things in Arizona and I'm going to step to outside of the U.S. and Canada and talk about the impact of technology in a place like the Cayman Islands, where we run a local utility and where we're implementing batteries to save customers significant money.

Fuel prices are high, and it is an innovative approach that our team is taking to install batteries on our system and save customers money. We're using them for spinning reserve, so we will be saving fuel costs. And we are locating the batteries on the system such that we're also enhancing resilience, so there is stacked value.

On an island, the installation of batteries is not as cheap as it may be on the mainland, but the innovation and technology are providing savings for our customers.

Dan Killoren: I want to talk customer perceptions versus utility reality because we've seen the cost declines often lag for customers in ways that they may see technology as being ready, but it's not showing up as a meaningful bill impact. Where are some gaps between perception and reality?

Kevin Woodbury: We heard it yesterday. Tom Fanning, in his introduction, talked about balance and the need to communicate with our customers so they understand we can make this transition in a smart way. It's affordable for customers, takes advantage of the technologies and the systems we have.

Inside our company that has been a guiding light for us. We've talked about our carbon-reduction goals, making sure we have plans, that we do our best to communicate with our customers around those plans as we move forward.

One of the places that we're seeing where customers' expectations may be ahead of where the technology or the cost is, it is a bit in the electric vehicle space, but that's changing, because with the technology getting cheaper, the opportunities are greater.

Now it's important as an industry to make sure that our customers and regulators understand that there's a need more than ever for a robust utility role in

planning, managed charging, and that we're doing this transition in an affordable way for our customers.

Alice Jackson: When you read the news over the past several years, it's been wind and solar is cheaper than the existing facilities we have on the system. Well, that hasn't always been the truth.

If we go back over the past ten to fifteen years to the 2004 to 2010 timeframe, I still have wind assets operating on my system that are over seven cents a kilowatt-hour, but the ones I'm getting today are one and a half to two cents per kilowatt-hour.

There's a huge difference. Yes, the cost curve has come down, but we've had to buy as the cost curve came down, whether it's because of renewable portfolio standards in our states or other initiatives, but that's how innovative technology works.

The first of a kind and the second of a kind typically are not the cheapest. Those early assets are going to be expensive, but they don't go away when cheaper ones come around. They sit on our systems, they're usually twenty-, thirty-year assets, and you do straight-line depreciation.

That impacts on our costs to customers over time. They do not come out of our rates when the lower-costing items come in.

Solar's the same way. I still have solar on my system across my eight states. There's over a hundred sixty dollars a megawatt hour, sixteen cents per kilowatt-hour, and that's expensive. But today we're acquiring those assets at two to three cents, depending upon whether it comes with storage or not.

That's a different set of equations, but those assets again, do not go away. There's this complexity of how the power world works.

The expectation of the customers when they read the media is, "These things are less expensive. I should be seeing the benefits on my bills right away." That's not the reality of how our world of regulation works.

The difference between the two is not fascinating to the general population. We end up in situations where there are misunderstandings, misperceptions, and



We've seen the cost declines often lag for customers in ways that they may see technology as being ready, but it's not showing up as a meaningful bill impact. Where are some gaps between perception and reality?
– Dan Killoren

frustration, and it's not a soundbite that gets picked up.

Dan Killoren: Even if the technology is available at a cost and performance that meets expectations, sometimes there are integration challenges. Alice, how do you think about integration of new technology across the utility value chain?

Alice Jackson: There're two important components. It's the physical integration in the system, interconnecting it, having a technology operated in a way you expect it to, or it's forecasted.

The second is that software side. Integrating into our energy management systems, our outage management systems, what does that look like?

From the first component of getting new technology set up on the system, if it's going to behave differently than the ones we've had before, that takes more work from a standards and safety perspective of getting it integrated, but also from an operations point. What should our operators who haven't ever seen this type of device before expect?

Then when it deviates, because inevitably it will, whether it's better or worse, how do you then update, set new expectations, trial, and error? That comes into proof of concept.

We're partnering with Form Energy to put the first long-duration battery storage into two of our locations. We're putting in two, ten-megawatt iron-air batteries that have a thousand-megawatt-hour-type environments with multi-day energy delivery.

The Department of Energy announced they're going to help fund it and that brings down the cost, but the integration piece is important. Where does it fit in the stack? Is it an ancillary service asset? Then the question becomes, how does it show up in the energy management system?

Kevin Woodbury: I'll throw on top of that the cybersecurity concerns and making sure that as we integrate new technologies and systems that we're not creating new vulnerabilities.



I hold some respect for artificial intelligence in this space. It's not there yet. But ensuring that our regulators and customers understand that we need to make these investments in software and in technology that might look proactive today, but will save money over the long term, is a bit of a switch in theme.
– Kevin Woodbury

That we're not mismanaging the number of alerts and how we respond, and we're resourced appropriately for all those pieces. That unfortunately, can sometimes be a barrier to innovation, it can be perceived as that, but I'd like to turn that around and say it's an opportunity for innovation in cybersecurity.

I always challenge our technology folks as we're looking at integrating new software and technology, how might we use other new technologies to support ensuring that the system is safe, and information is secure?

Dan Killoren: Batteries are put forward as part of the Nirvana state for operations across the system, but we've seen safety issues, and for buyers there are challenges and integration issues. Do you feel your organizations are prepared to fully optimize and use batteries of all types across your system?

Alice Jackson: The biggest trouble we face now in figuring out what is the best way to optimize our system is the software. My team is responsible for the modeling, not only for our transmission system, but also for distribution, the energy supply side and our gas business.

This is a new organizational shift that Xcel made about a year ago to pull all these planning teams and the modeling activities outside of each of the verticals to inside our organization and consolidate them into one. That is because we recognize each of these areas are now impacting each other more than before.

That is, with the investment in distributed energy resources, you're seeing more backflows of electrons from the distribution network to our transmission network. With the optimization around home heating, potentially converting to electric home heating, the optimization of how the pipeline system on the gas side of the business can't be shut in if we're going to be closing off parts of those pipes and transitioning them over to the electric distribution grid, is more important than ever because this comes back to affordability.

You can't shut in a pipe until every customer is off. You can't have any cost savings on safety and maintenance operations unless you have transitioned those customers off. But those customers don't line up perfectly with the electric distribution side and the wires that are overlaying that area.

You may have different utilities even providing those two different services. We do not have tools that enable us to optimize between that type of scenario. We don't have software tools that enable us to optimize choosing whether we should be putting large-scale generation on the transmission system or optimizing on the distribution side.

We've had conversations for years that we need to be investing more on the distribution side and in generation, but the problem is we do not have tools that allow us to go, "How do we optimize in real-time when we're hitting peaks during the summer, how do we dispatch on that distribution system so we're not breaking the physics of the distribution system at the time we need electrons for customers on different parts of the system?" Those tools do not exist.

Some of you likely in this room, I know you all are working, but when you go to ESIG, the Energy Systems Integration Group, you talk about those tools, it's an iterative process. There's no easy button you push. You pick up one tool, put it to the next tool, you're guessing, "Does this look good?" If it doesn't, we make tweaks, and start again.

This is where innovation has to happen, if we're going to save customers money on this energy transition. These tools have to be put in place because we have existing foundational systems we have built over eighty years that we are going to transition

in the next twenty-three. That is the gap we have today.

It's got to start with software because that gives us the initial indication of where we need to make the investments, where our gaps are, what additional innovation we need on the physical side to close those gaps.

Dan Killoren: The headline: "Utility seeks to recover on large software integration" is not what we're expecting to see in the local papers. How do you communicate this to regulators, the public stakeholders who do not understand what you just said? Kevin?

Kevin Woodbury: The technology, the software, the planning capabilities we need will save customers money in the next three to five years, in the next thirty years, because it will enable us to put the right assets in the right place at the right time.

I hold some respect for artificial intelligence in this space. This is going to be one of those use cases when ten years from now, we're going to look back and say, "How did we ever do that before we had this?"

It's not there yet. But ensuring that our regulators and customers understand that we need to make these investments in software and in technology that might look proactive today, but will save money over the long term, is a bit of a switch in theme.

Dan Killoren: For customers, is it about enabling decarbonization, greater resilience? They associate with the need to improve technology to get these resources on the system. What drives the narrative? It could be different by service territory and geography.

Kevin Woodbury: Yes, it is different by service territory and geography. Our model is decentralized, for anybody who's unfamiliar with Fortis, as we have ten operating companies across North America. Each operates independently with its own management team, and majority independent board of directors.

Our philosophy behind that model is driven by making the right decisions close to the customer and the regulator. It's local decisions, everything is local.



If we go back over the past 10 to 15 years, I have wind assets operating that are over 7 cents a kWh, but the ones I'm getting today are 1.5 to 2 cents per kWh. Yes, the cost curve has come down, but we've had to buy as the cost curve came down, whether because of RPS or other initiatives, but that's how innovative technology works.

– Alice Jackson

In a general sense, based on what's going to happen between now and 2050 with the amount of energy supplied by the electron, going from maybe twenty percent of end-use energy to forty to sixty percent, then it's not just a conversation about what's your electric bill? It's a conversation about what's your energy bill and the impact on the environment overall, because of that shift over time.

That's a story not being told well by industry yet, but it's a story we're going to have to tell well because that's a big part of the affordability discussion. Along with that move to more electrons is a move to more efficiency, less use of energy overall, and a lot cleaner world.

Alice Jackson: The eight states where we have the pleasure to serve customers, have a variety of politics, interests, and types of industry. What is not different across those eight states is when you survey our customers, what they put as number one, they want reliability. Number two and three switch back and forth depending upon political views, and those are affordability and sustainability.

The majority of our locations now, sustainability is higher than affordability. Which means you ask customers the willingness to pay question, "Are you willing to pay more for electricity in order to make this transition?" The answer is usually, yes. You ask, "How much?" But the number is very small.

For a long time across this country, we have been misinforming customers. Many believe that electrons generated in the middle of the day at the hottest part of the year cost the same as electrons generated in the middle of the night.

That is simply not true. But that is what we've been telling customers by how we billed them for a long time. Now we have

time-of-use rates and other things that are coming out to inform them, but that relationship is going to have to continue to evolve as we move forward with the clean energy transition.

That is going to be a challenge because a large swath of the population doesn't want to worry about how much energy they're using in their homes. That's where technology has to step in and help alleviate some of the pressures on getting to that last five to ten percent of clean energy.

That's where our customers have to come to the table to help us with the equation if this is what they truly want as the outcome. That will have some cost impacts, both from what they see on their bill, but also what they feel in their home. ❍

Innovation in Tough Tech

VEIR CEO Tim Heidel
Quaise Energy Co-founder Matt Houde
Guggenheim Securities Managing Director Power, Energy & Renewables Allen Otto
Xcel Energy VP Corporate Development Justin Tomljanovic
Dominion Energy Chief Innovation Officer Mark Webb
EEI VP Cust. Solutions and Institute for Electric Innovation Exec. Dir. Lisa Wood (Retired)

Lisa Wood: We're all looking at electricity usage increasing significantly over the decade. About ten-ish or so years ago, we started to see major growth from wind, from solar, and now we're seeing new growth in storage. But those technologies are not enough to move the clean energy transition forward.

We need two more things. First, we need clean energy technologies that provide firm capacity. We're going to talk today about small modular reactors, and also large-scale geothermal.

Second, we need transmission technologies that ensure we can deliver clean energy to customers. That's what we're going to cover in this panel. Transmission, SMRs, and large-scale geothermal.

We'll hear the technology company perspectives, and then the utility company innovation officers will comment on what it takes for utilities to demonstrate and adopt a new technology.

I'm going to have each of the panelists say a few words about their technology or their role in their company regarding innovation and new technology.

Tim Heidel: I'm the CEO at VEIR, which is developing a new generation of high-temperature superconducting-based transmission lines, where our core differentiation is a new approach to system design and cooling, which enables us to deploy overhead for the first time.

The core innovation allows us to achieve higher reliability and lower cost relative to past approaches in building high-capacity transmission links using superconductors, so we can go after moving the needle on bulk transmission.

We started the company about four years ago, recognizing that every decarbonization study ever published says we need to double to triple the scale of transmission networks.

We enable you to fit five to ten times more power capacity in the same right-of-way space as conventional conductors. That reduces space needed to transmit power and deploy transmission capacity at lower voltage, where it faces less opposition, uses less land, has shorter towers, and can be built faster than conventional connectors.

Earlier this year, we staged an outdoor end-to-end demonstration of the core technology, and that's unlocked us to start designing the first generation of our product capable of being deployed up to sixty-nine kilovolts carrying four hundred megawatts. We're starting to prepare for demonstration projects in the years ahead to gain experience to show we can achieve affordability, safety, and reliability.

Allen Otto: I'm a Managing Director at Guggenheim Securities, a full-service investment bank. We cover the whole value chain in energy, power, renewables, and are currently highly focused on small modular reactors and advanced nuclear technology.

We need to get to net-zero emissions, and we're not going to do it in this country without a significant shift toward advanced nuclear technology. Recently, we've worked with a number of the emerging technology companies to raise capital and fuel their growth.

These companies include both Gen III+ advanced light water reactor companies, as well as fourth-generation companies focused on high-temperature gas-cooled and liquid metal fast reactor technologies, among others. Standard plant design for these various pathways ranges from three-hundred megawatts and above to micro reactors as small as fifteen megawatts and below.

We think these differing nuclear technologies can all coexist because they have different end uses. For example, the high temperature gas cooled technologies like X-energy are particularly suited to address both clean electrons and clean industrial



How do we drill so we can access high-grade heat at 3, 6, even 10 miles underground? We're pursuing this solution, millimeter-wave drilling, developed by at the MIT Plasma Science Fusion Center. We're utilizing nuclear fusion technology to replace conventional drilling.
– Matt Houde



We need two more things. First, we need clean energy technologies that provide firm capacity. Second, we need transmission technologies that ensure we can deliver clean energy to customers.
– Lisa Wood

heat needs. Micro reactor technologies like Oklo can address the needs of various smaller customers that require clean baseload power, including the data center community, which is a huge part of their market.

At Guggenheim Securities, we are currently focused on helping our clients, investors, and key stakeholders de-risk the equity financing component of commercialization. We have a DOE loan program office, for example, ready to finance actual projects. That's essential, but utility companies need additional assurances around equity risk for their investment before deploying one of the new advanced reactors.

Institutional investors, they're waiting to see the demand signal in the form of customer orders. Customer orders aren't going to come until somehow the equity piece is addressed.

Who's going to help solve that risk?

What is the pathway to socialize that equity risk? That's what Guggenheim Securities, along with clients and constituents, are working on now. The moment we finance and build the first, second or third advanced nuclear project, we're going to see institutional capital start to flood in.

Matt Houde: I'm a co-founder of Quaise Energy. We are developing a novel deep drilling technology we call millimeter-wave drilling for the purposes of unlocking large-scale geothermal, so we're seeking terawatt-scale geothermal, the same scale we use energy as a global society today.

Geothermal hits a lot of the same points as with SMRs. It's clean, firm power, it's complementary to intermittent wind and solar resources, it can be a source of industrial heat, it minimizes land and the mineral intensity of what a purely wind and solar-based energy system would require. It can also take advantage of the oil and gas industry, for deploying and rapidly scaling up the geothermal capacity to that terawatt level.

The problem is that geothermal is restricted to niche locations where you have a combination of three factors, heat, water, and permeability. That's why geothermal only has about fifteen gigawatts worldwide capacity, so there are two parts of the equation to how we change that paradigm.

One is seeking heat and deploying similar hydraulic fracturing techniques that have been used in the shale revolution for oil and gas for creating an engineered reservoir. It's what we call enhanced geothermal systems, or EGS, so you simply drill wells, create those fractures, connect with both wells, and flow water between those fractures.

Even with EGS techniques, we're still restricted to locations where you can find that heat at relatively shallow depths because of drilling costs. We also need to solve the drilling side of the equation.

How do we drill much deeper than conventional drilling can today so we can access high-grade heat at three, six,



We enable you to fit 5 to 10 times more power capacity in the same right-of-way space as conventional conductors. That reduces space needed to transmit power and deploy transmission capacity at lower voltage, where it faces less opposition, uses less land, has shorter towers, and can be built faster.
– Tim Heidel



I like smaller pilots, as you can learn earlier, and build that information into resource plans and other grid planning. Learning up front is preferred so you're not spending a billion dollars to figure out how often we are going to use this technology and if costs and benefits make sense for customers.
– Justin Tomljanovic

even ten miles under the ground? We're pursuing this solution, millimeter-wave drilling, developed by a researcher at the MIT Plasma Science Fusion Center. We're utilizing nuclear fusion technology to replace conventional drilling.

Today, we are still in the lab but looking to rapidly scale up into our first field trials in the next few years. We foresee this geothermal-anywhere solution where we can go to existing power plant assets or other locations where it's possible to drill and access high-grade heat independent of location, which is a game-changer for geothermal.

Lisa Wood: We have two electric utility execs on the panel. Mark, as the chief innovation officer for Dominion, you look at technology every day. When you think about evaluating these technologies, all in different stages, what's your first step?

Mark Webb: The first step we're looking at is what stage is it? We categorize it in terms of, is this year-term or long-term? Once we've done that, we ask what's the value, what need is it solving?

On our electric side, are we solving a need? We have a forecast that we're going to need thirty percent more electrons in the next six years, five percent growth per year to serve data centers and electrification.

That means more electrons. We're building solar and offshore wind. That alone is not going to meet our needs, especially beyond 2028. Then how do we transmit it?

Building transmission is hard. Is the new technology the right technology? That's to be determined. We know at least that the gating issue is whether it would solve a need and provide value to customers.

Next is the cost. Not just the cost of the demonstration, but the ultimate cost. We have cost forecasts, but until a scale demonstration is built, we don't know what the cost is and who bears the cost.

The last is scalability. Doing a one-off project that doesn't solve any ongoing needs doesn't help us. We need technology that can meet our needs and our customers' needs for reliable, affordable, and clean energy going forward. SMRs fit that bill.

Lisa Wood: Justin, as vice president of corporate development for Xcel Energy with oversight of innovation, you're looking at technologies all the time. What's critical for you in evaluating and demonstrating technologies?

Justin Tomljanovic: I think about affordability, the business case. For geothermal and nuclear baseload power, you somewhat understand what you're getting based on the megawatts of power and cost.

For long-duration storage, and even transmission, there are broader questions of how often am I going to operate this storage on our system? How much multi-day storage, twenty-four-hour, ten- to twelve-hour, and four-hour storage will you need?

That's why I like smaller pilots, as you



Oklo was talking about micro, and their business model might solve a little of this challenge. They plan on building the plants themselves. They are small, $50 million construction costs that they finance, and then we're talking about a PPA. It's easier for utilities to sign up with the PPA.
– Allen Otto



We don't have much coal left. We've retired a lot already. But because of existing infrastructure – not necessarily the turbine blades – but the transmission infrastructure, some of the security infrastructure, they're also prime sites potentially for SMRs.
– Mark Webb

can start to learn earlier, and build that information into your resource plans and other grid planning. Learning up front is preferred so you're not spending a billion dollars to figure out how often we are going to use this technology and if the costs and benefits make sense for our customers.

Being able to build a business case for these new technologies and understand things like, if we're going to build a nuclear plant, is it going to be dispatched enough? And if other technology comes in at lower cost, and it takes me ten to twelve years to build this, is it still going to be the best value for my customers once I finally have it in service?

Lisa Wood: For the three representative technologies, you must demonstrate the technology and the utilities – your potential customers – want a business case, so it's a chicken and egg, but you have to figure out how to move forward. How do you do that?

Tim Heidel: Every one of the investors that I speak to today wants to see demonstrations. In reality, they do not want to see demonstrations, but they ask about demonstrations.

What they really want to see is commercialization of scale, and they know that the necessary stuff in any industry that has safety critical aspects to it, that has affordability constraints and expectations of reliability, must start with demonstrations.

The conversation we have with our investors constantly is, when are you going to scale, and as evidence you are on the path to scaling, when are you going to do your first demonstration, and when are you going to sign up for that first demonstration?

We're out in the market today trying to sign up early customers to move us down that road toward the first demonstration projects. A large part of why we do that is, one, to prove the technology works and can achieve the costs and reliability we believe it can, but it's to convince our customers that it's there.

One of the challenges is that most investors have opportunities to invest in other industries. They can go after drug discovery, aerospace applications, or power plants, and unfortunately, the reality is our industry does not have a great track record relative to those other sectors of converting demonstrations into commercial scaling.

Lisa Wood: Matt, you are doing a demonstration in 2024 in the field in Texas. What are you looking at in terms of next steps and partnering to do potential demonstrations?

Matt Houde: There are two tiers of demonstrations, and a big one for us in near-term demonstrations, we need to get out in the field and just drill, drill, drill.

We are always going to encounter unexpected challenges, so we need a playground where we can prove out and optimize the drilling process in the same setting, similar to the tracker conventional drilling in certain

formations, where over time, if the drills work, they begin to optimize, improve, and reduce the drilling cost. That near-term demonstration is something we're targeting to start in the first half of next year.

We're starting to receive some of the first equipment we can use to package the first mobile drilling unit that can go out in the field and do this drilling at a site where we have basic rock granite just outcropping at the surface for us.

The second demonstration, we want to drill and produce geothermal heat, and we want to do this with multiple locations. One, so we aren't just isolated to one spot and have only one shot on goal, but to prove the scalability, we need to show that this process works in a variety of geological formations, as well as different depths.

Lisa Wood: Who do you expect to be your first demonstration customers?

Matt Houde: We're targeting existing power assets. We know there're hundreds of gigawatts of coal that're going to be retired in the next ten, fifteen, twenty years.

We'll provide the steam, and you can keep your power plant, all the infrastructure right there. We're just going to replace your boiler with a well field.

What we want to take advantage of with an existing coal- or fossil-fired asset is the site, the interconnection, the water that is available, because we do utilize water, and that is a big unknown that we also want to address in these demonstrations. What are the water usage requirements and how does that restrict us or maybe enable us to go to other locations depending on the water resource?

Lisa Wood: Mark and then Justin, what are your plans for coal plant retirements? What do you think about geothermal or other clean energy technologies?

Mark Webb: We don't have much coal left. We've retired a lot already. We have some in South Carolina and we have a large plant remaining in West Virginia.

Because of existing infrastructure – not necessarily the turbine blades – but the transmission infrastructure, some of the security infrastructure, they're also prime sites potentially for SMRs.

Both technologies could be well suited, but at particular locations, the question will be which one has the most immediate value to us? We did look at the geothermal in a different context, somebody approached us, but with a different approach with using existing LDC infrastructure to supply heat in order to preserve the value of the gas infrastructure. That was interesting. But I think that would be a hard transition.

Justin Tomljanovic: We're in Colorado, and West Texas, so water is important. Our coal shutdowns, as we redevelop them, we think about the resources that are there, like transmission and water.

In Colorado, some of the water rights at retiring coal sites can hopefully be used more effectively, for geothermal or for hydrogen. In Texas, we're finding issues at coal plants with limited water. So that's why when we look at technology ideas, one of the first things that we ask is, what is the water usage?

Thermal heat storage is something also to take seriously at retiring sites because you can reuse existing infrastructure. One of the other benefits is by keeping investment at the site, you keep the tax revenues in the community, and can create new jobs.

Lisa Wood: You talked about SMRs. When you're thinking about the ideal customer, what do you think about? What is the path forward?

Allen Otto: The universe is broad. It's not just utility companies. We're looking for a real firm contract, not just an MOU; that's what investors are looking for, a real customer that's signed up.

X-energy has that announced, but they've got some things to do before they get to where it's real. That said, there's kind of a history there, and granted, these are new advanced designs. Oklo has a history of delivering commercial power to the grid for many years, X-energy has a similar commercial tracker that they can point to around the technology.

That said, we're not going to build a demonstration plant, we've got to build these plants in their actual scale, and it's less about using technology to work, it's going to be about the budget.

Oklo was talking about micro, and Oklo is interesting, because their business model might solve a little of this challenge, which is, they plan on building the plants themselves. They are small, fifty-million-dollar construction costs that they finance, and then we're talking about a PPA.

It's a lot easier for utilities to sign up with the PPA. That makes it easier for someone to sign up with the customer PPA in place and get that financed. We like that pathway to the market, and it's a little harder to get to the three-hundred-megawatt unit. PUF

It was on the fifteenth of April 1892, that Thomas Edison's name was taken off the company he founded. The Wizard of Menlo Park was apparently not pleased. On that date, when the merger with the Thomson-Houston Electric Company took place, the consolidated firm became the General Electric Company; eventually, GE.

Exactly a hundred and thirty-four years later, on the fifteenth of April this spring, Public Utilities Fortnightly will be hosting Edison Congress 2024. As at the inaugural conference last spring, it will be held at the Hotel Washington, six hundred and sixty feet from the White House's East Wing. And it will be held in concert with the historic organization for the industry's operating and engineering leaders, the Association of Edison Illuminating Companies. AEIC's first meeting was back in 1885. It was presided over by none other than Thomas Edison himself.

Fortnightly Top Innovators 2023

Memorable Moments at the Willard Hotel



Exelon Chief Strategy & Sustainability Officer Sunny Elebua gives the Welcome Address.



Southern Company Executive Chairman Tom Fanning gives the First Day's Opening Keynote Address.



PUF Executive Editor Steve Mitnick welcomes everyone to Top Innovators 2023.



The Tuesday audience.



Tech Fueling the Energy Transition, Part One, from left, Moderator and Energy Impact Partners Managing Director Research & Innovation Evan Pittman, Singularity CEO Wenbo Shi, eSmart Systems Chief Customer Officer John Daniels, Arcadia Director Utility Pertnerships Ben White, TRC VP Digital Solutions Sales Sachin Gupta, and GridX CEO Chris Black.



Innovation in Transportation Electrification, from left, Moderator and Energy Impact Partners Senior Associate Mobility & Transport Bryant Ebright, National Grid VP Transformation Programs Carlos Nouel, BGE Senior Manager Smart Grid & Innovation Kristy Fleischmann Groncki, Guidehouse Director Mobility Solutions Derek Jones, Con Edison Director E-Mobility Britt Reichborn-Kjennerud, and Arizona Public Service Director Customer to Grid Solutions Kerri Carnes.



Tech Fueling the Energy Transition, Part Two, from left, Moderator and Energy Impact Partners Managing Partner Anthony Oni, Sitetracker Global Head Product Marketing Melissa Morgan, Charger Help Account Executive Brett Steudle, Sparkfund CEO Pier LaFarge, and flo Global Head Utilities Frank Fata.



Tuesday End of Day Digital Discussion, from left, Moderator and GE Vernova Chief Product Officer/Grid Software Sean Moser, Eversource VP System Planning Digaunto Chatterjee, and Entergy VP Business Data & Insights Andy Quick.



Energy Impact Partners Managing Partner Anthony Oni and Sitetracker Global Head Product Marketing Melissa Morgan.



Energy Impact Partners Managing Director Research & Innovation Evan Pittman.



Energy Impact Partners Chief Utility Officer Kevin Fitzgerald.



"Bright Moves" author Tom Flaherty.



Virginia SCC Chair Jehmal Hudson.



Innovation and Customer Affordability, from left, Moderator and EPRI Innovation Hub Manager Dan Killoren, Fortis VP Innovation & Technology Kevin Woodbury, and Xcel Energy Chief Planning Officer Alice Jackson.



Duquesne Light Director Advanced Grid Systems & Grid Modernization Elizabeth Cook.



Making the Regulatory Case for Innovation, from left, Moderator and former NARUC President Paul Kjellander, Indiana URC Commissioner Sarah Freeman, Washington UTC Commissioner Ann Rendahl, Virginia SCC Chair Jehmal Hudson.



Exelon Director Innovation, Technology & R&D Ankush Agarwal.



Senior Innovation Leaders Roundtable, from left, Moderator and Bright Moves author Tom Flaherty, Spire Inc. Chief Strategy and Corporate Development Officer Mike Geiselhart, Duke Energy SVP Enterprise Strategy & Planning Swati Daji, Ameren Sr. Director of Strategy and Enterprise Risk Jaime Haro, and National Grid New England President Steve Woerner.



Gas Value Chain Innovation, from left, Moderator and Energy Capital Ventures Cofounder Vic Pascucci, Sapphire Technologies CEO Freddie Sarhan, Highwood Emissions Management Director Molly Reyes, Actual Systems President Karthik Balakrishnan, Osmoses CEO Francesco Benedetti, Cemvita VP Legal Affairs Cindy Jimenez Turner.



Innovation in Power Transmission and Distribution, from left, National Grid VP Transformation Programs Carlos Nouel, Kansas City KS Board of Public Utilities GM Bill Johnson, Tri-State G&T COO Barry Ingold, Sense CEO Mike Phillips, and Rappahannock Electric Cooperative Chief Strategy, Technology & Innovation Officer Peter Muhoro.



Culture of Innovation, from left, Moderator and Guidehouse Chief Innovation Officer Rod Fontecilla, Eversource VP Strategy & Policy Roger Kranenburg, Rocky Mountain Power CEO Gary Hoogeveen, Southern Company SVP R&D Mark Berry, Avista Chief Customer Officer Latisha Hill, and Puget Sound Energy Director Strategic Energy Initiatives John Mannetti.



Innovation Strategies, from left, Oncor Electric Delivery VP Corporate Strategy Geoff Bailey, Eversource VP Strategy & Policy Roger Kranenburg, New York Power Authority Chief Innovation Officer Daniella Piper, and CenterPoint Energy SVP Utility Operations Support Steve Greenley.



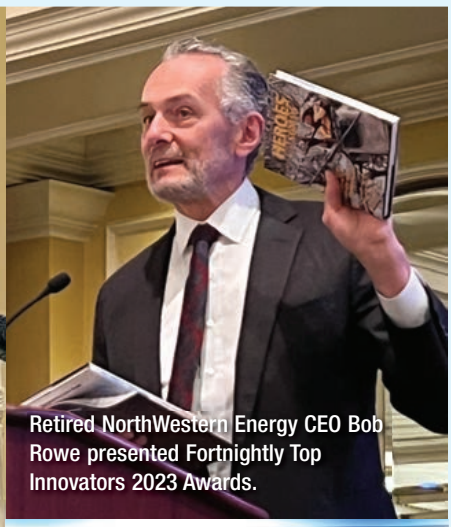
National Grid VP Transformation Programs Carlos Nouel.



Culture of Innovation, from left, Moderator and Guidehouse Chief Innovation Officer Rod Fontecilla, Eversource VP Strategy & Policy Roger Kranenburg, and Rocky Mountain Power CEO Gary Hoogeveen.



Culture of Innovation, from left, Southern Company SVP R&D Mark Berry, Avista Chief Customer Officer Latisha Hill, and Puget Sound Energy Director Strategic Energy Initiatives John Mannetti.



Retired NorthWestern Energy CEO Bob Rowe presented Fortnightly Top Innovators 2023 Awards.



AES CEO Andrés Gluski gives Wednesday's Opening Keynote Address.



EEI CEO Tom Kuhn.



The Wednesday audience.



Indiana URC Commissioner Sarah Freeman.



How We Think About Innovation, from left, Moderator and PUF's Steve Mitnick, EEI SVP International Programs Lawrence Jones, and BGE Principal Innovation Specialist Alan MacAnespie.



Rappahannock Electric Cooperative Chief Strategy, Technology & Innovation Officer Peter Muhoro.



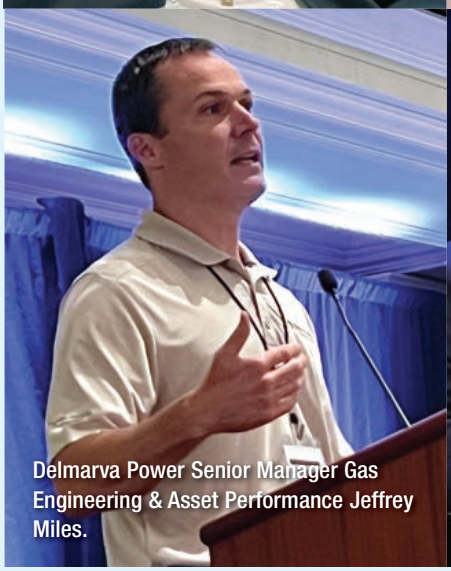
Washington UTC Commissioner Ann Rendahl.



Kansas City KS Board of Public Utilities GM Bill Johnson.



Innovation in Power Transmission and Distribution Moderator and Mike Beehler & Associates COO Mike Beehler.



Delmarva Power Senior Manager Gas Engineering & Asset Performance Jeffrey Miles.



Tri-State G&T COO Barry Ingold.



Anterix Executive Chair Morgan O'Brien.



PUF's Steve Mitnick opens the closing day.



From left, EPRI Director READI, Sustainability & Ecosystem Stewardship Morgan Scott, and EPRI Director of Transportation Britta Gross.



U.S. DOE/Loans Program Office's Leslie Rich.



EPRI CEO Arshad Mansoor gives Thursday's Keynote Address.



EEI SVP International Programs Lawrence Jones.



EEI VP Customer Solutions and Institute for Electric Innovation Executive Director Lisa Wood (retired).



EEI Director Clean Energy Technology and Policy Huiyi Jackson.



Innovation in Customer Solutions, from left, Moderator and Institute for Electric Innovation Executive Director Adam Cooper, National Grid Director Customer Energy Management Chris Porter, and BGE Director Clean Energy Solutions Divesh Gupta.



FERC Commissioner Allison Clements.



Eversource VP Strategy & Policy Roger Kranenburg asks a question.



Innovation in "Tough Tech," from left, Moderator and EEI VP Customer Solutions and Institute for Electric Innovation Executive Director Lisa Wood (retired), Guggenheim Securities Managing Director Power, Energy & Renewables Allen Otto, VEIR CEO Tim Heidel, Dominion Energy Chief Innovation Officer Mark Webb, Xcel Energy VP Corporate Development Justin Tomljanovic, and Quaise Energy Co-founder Matt Houde.



EPRI as a Factory of Innovation, from left, EPRI Senior Director Nuclear Strategy, Execution & Engagement Tina Taylor, Moderator and PUF's Steve Mitnick, EPRI Director READi, Sustainability & Ecosystem Stewardship Morgan Scott, and EPRI Director of Transportation Britta Gross.



BGE Principal Innovation Specialist Alan MacAnespie.



PG&E Senior Director Grid Research Innovation & Development Quinn Nakayama.



BGE Director Clean Energy Solutions Divesh Gupta.



Copper Labs CEO Dan Forman.



From left, AES CEO Andrés Gluski and EEI CEO Tom Kuhn.



The Thursday audience.



Innovation in Generation and Storage, from left, Southern Company Director Research & Development Nick Irvin, Form Energy Senior Project Manager Jessica Nyquist, U.S. DOE Office of Electricity Technology Manager Vinod Siberry, and Moderator and EEI Director Clean Energy Technology and Policy Huiyi Jackson.



U.S. DOE/Loans Program Office's Leslie Rich with PUF's Steve Mitnick.



FERC Commissioner Allison Clements with EPRI CEO Arshad Mansoor.

State Regulators Leading the Way

Conversation with NARUC President
Julie Fedorchak

North Dakota Commissioner Julie Fedorchak ascended to the Presidency of NARUC in November at the Annual Meeting in La Quinta, California. 2023 also marks her decade on the North Dakota Public Service Commission, so she has much to celebrate.

That celebration might be short, however, as much work awaits in the top position at an Association faced with challenging times in a changing energy and utilities industry. Fedorchak has the background to guide NARUC, as she serves on EPRI's advisory board, and has held numerous leadership roles, including president of the Organization of MISO States, vice-chair of the NARUC Gas Committee, and vice president of GTI Energy's advisory board.

As this new NARUC President shines a spotlight on her theme of Focused on the Future: State Regulators Leading the Way through challenging issues, she will be backed up by two dynamos. First Vice President Tricia Pridemore of Georgia and Second Vice President Ann Rendahl of Washington.

PUF's Paul Kjellander: What excites you most as you begin your new role as NARUC President?

President Julie Fedorchak: I've been on the North Dakota Commission for ten years now. The work has always been fast paced.

We've permitted ten billion dollars in new energy infrastructure in that time, while also regulating six multi-state electric and gas utilities, a growing body of work in two Regional Transmission Organizations, overseeing our state's coal mining and reclamation industries, railroad safety, pipeline safety, and weights and measures.

Our team of forty-two full-time employees is stretched. Thank goodness they all kick past their coverage. In the last two years the work has shifted into an even higher gear.

State staff are busy with state work and a bunch of federal regulatory and policy agendas, as well as vital regional collaboration. Now more than ever, state regulators need support to effectively manage all these demands. We really need to be plugged in, equipped to ask tough questions, find the blind spots, and make sure we are supporting the right choices and investments at the proper pace.

I'm excited to assume this role because my experience and perspective give me the confidence now to do this job justice, to help highlight the big and sometimes controversial issues that need our attention. It's crystal clear to me that state regulators play a vital role in ensuring a smooth evolution, and to do that we must be tireless in focusing on the fundamentals of the industry: reliability and affordability.

The industry faces incredible opportunities, as well as real challenges right now. Decarbonization goals and federal environmental regulations are driving policies faster than the technologies, supply chains, natural resources, workforces, and regulatory processes can deliver.

Those are the five high hurdles, if you will. They are not barriers because I believe they are surmountable, and we will overcome them. But they are significant challenges.

That's why I chose the theme, Focused on the Future: State Regulators Leading the Way. We can and must work with our utilities and state policy leaders to manage the pace of this change, so reliability and affordability are not sacrificed.

We need to clear them to reach our goals. But we haven't trained enough yet and these high hurdles will trip us up if we don't properly prepare. They already have – Storm Uri, Storm Elliott, summer power outages.

In addition to these lived experiences, warning signs are coming consistently from NERC. Its most recent nationwide reliability assessment again shows that two thirds of the nation is at an elevated risk of being unable to satisfy power needs if demand is high when production from wind and solar is low.

These warnings aren't coming from biased stakeholder groups with a vested financial interest.

NERC is the third-party watchdog charged with safeguarding reliability. We need to heed these warnings.

Our nation is infinitely blessed with energy resources. Running short of power for our people is simply not acceptable. I believe state regulators are uniquely positioned and responsible to address these challenges.

That's why I chose the theme, Focused on the Future: State Regulators Leading the Way. We can and must work with our utilities and state policy leaders to manage the pace of this change, so reliability and affordability are not sacrificed.

PUF: As you look at this energy transition, how are affordability and reliability a piece of the broader subject areas you want to look at as President of the Association?

President Julie Fedorchak: Cost and reliability are baked into all the sectors in NARUC. I've already talked about electricity,



Reliability and affordability will be center stage this next year, and I have encouraged committee chairs to address these issues in meetings. I look forward to healthy debates about different approaches to decarbonization, new methods for resource planning, permitting, and construction challenges, workforce shortages or proposed EPA regulations.

but water, telecom and gas are all part of intricate braids of vital services citizens need. Aging infrastructure, technology changes, and cybersecurity are impacting all of them.

At NARUC, we don't solve the problems. We bring people together to consider solutions, we equip our members with tools, resources, and information to help them address the big challenges in their states.

We collaborate with industry and stakeholders to improve awareness of key issues and facilitate problem solving. We use our collective voices to educate policymakers about the challenges and opportunities in these sectors.

We have a number of tools to use. Obviously, NARUC's three national meetings are a great platform.

Reliability and affordability will be center stage this next year, and I have encouraged the committee chairs to address these issues in their meetings, as well. I look forward to healthy debates about different approaches to all our challenges, whether pathways to decarbonization, new methods for resource planning, permitting, and construction challenges, workforce shortages or proposed EPA regulations.

Second, we just launched a collaboration between NARUC and industry, called Gas Electric Alignment for Reliability or GEAR. This zeroes in on one of the greatest risks impacting reliability and cost for both the gas and electric systems.

It will build off the yearlong NAESB effort on Gas Electric Harmonization led by Bob Gee, Sue Tierney, and Pat Wood. That outstanding report outlines specific areas that need to be addressed. GEAR will bring together regulators, utilities, grid and pipeline operators, producers, and suppliers to advance solutions wherever possible.

Obviously, harmonizing the gas and electric industries before we increased their interdependency would have been better. But the gradual evolution didn't allow for that. So now we must do the hard work necessary to ensure that the systems our utilities and their customers depend on for their life-sustaining energy supplies are up to the task.

The third focus is member education and training. NARUC has a significant number of new members. My goal is to equip the committees with a full slate of chairs and vice chairs. This will help flatten the steep learning curve for new state regulators and create a strong bench of future NARUC leaders.

Additionally, a new and improved website will enhance member education. It'll be simpler and more intuitive, so members and the broader NARUC community can readily access the organization's resources, including the world-renown library of education and training materials for regulators. Also, front and center on the website will be information on the vast array of conferences, events, and seminars hosted by NARUC and organizations we endorse.

State commissions are under pressure to address a complex array of issues at a very rapid pace. NARUC can help bring new members and staff up to speed as quickly as possible in this dynamic time.

PUF: The average tenure of a Commissioner is three and a half to four years. You're going to push people into leadership roles sooner. How can NARUC play a better role in helping them transition to somebody who must sign their names to tough orders?

President Julie Fedorchak: Being a new Commissioner is a daunting challenge. I remember sitting at one of my first NARUC meetings when a longer tenured Commissioner said, "It took me three years to get up to speed."

I thought, "I can't wait that long. There's too much work to do now." One of the best things that happened to me was then-Chair of the gas committee Barry Smitherman of the Texas Railroad Commission urged me to get involved in the gas committee right away.

He appointed me Vice Chair and promptly assigned me to moderate a panel on a topic I knew nothing about. The quickest way to learn about something is to have to speak about it, so, I did.

I certainly wasn't an expert, but I was conversant enough to lead a discussion and could understand at least a majority of the acronyms. That was a great lesson, and I will use it to engage our many new members.

The NARUC Ambassador Program is another tool. Commissioner Mary-Anna Holden [New Jersey] is doing a fabulous job matching new members with ambassadors quickly so they can make introductions, provide advice, direct them to resources, and hopefully demystify NARUC.

NARUC has talented staff and an amazing wealth of information. Like others before me, my goal is to continue building on NARUC's strengths, so it is an effective resource for Commissioners who are helping lead these vital industries during a time of unprecedented change, opportunity, and risk.

PUF: You've already put a lot of effort into the leadership team at NARUC by moving up from Second Vice President to First Vice President and now President. How has that helped you prepare?

President Julie Fedorchak: The training for this role is very deliberate. When I decided to seek this position, I called every Commissioner in the MARC region to get their thoughts about NARUC. Over and over in those conversations colleagues sang NARUC's praises, especially the educational information, policy discussions, and networking.

On the Executive Committee for the last few years, I learned the nuts and bolts of the budget and staffing. Last spring, working with Michael Caron [immediate Past President] we conducted a survey of members and stakeholders. Those results helped me set priorities for my presidency.

We just launched a collaboration between NARUC and industry, called Gas Electric Alignment for Reliability or GEAR. This zeroes in on one of the greatest risks impacting reliability and cost for both the gas and electric systems.

I know from other leadership roles how quickly twelve months passes. Once you assume the role, your time for strategizing and thinking intentionally about what you want to do is past, and you have to start doing it. I'm as ready as I'll ever be.

PUF: We have three strong women stepping into leadership roles. Are you seeing common themes? Are you seeing a theme for yourself as you look at where you're headed that will help others follow you?

President Julie Fedorchak: I'm really excited about this team and our executive committee as a whole. Working with Commissioner Tricia Pridemore [Georgia, NARUC First Vice President], who will follow me as President, and Commissioner Ann Rendahl [Washington, NARUC Second Vice President] who follows Tricia, is truly an honor and one of the highlights of my professional career.

These are just smart, solid people, and so much fun. We're working together so there is a seamless transition between leaders on the big issues we face.

After ten years as a Commissioner and inside observer of the utility world, I'm aware that state regulators sit at the intersection of the thorniest challenges and problems. Fair, informed, clear-headed leaders are what the utility space needs most to get us through this critical time.

State regulators can and should fill that role. We should, Lead the Way – shameless plug for my theme.

(Cont. on page 83)

NARUC Annual Meeting

Memorable Moments in La Quinta

NARUC held its Annual Meeting and Education Conference November 12 – 15, closing out its three years of the theme, "Connecting the Dots, Innovative/Disruptive Technology and Regulation." The weather in La Quinta, California was perfect and the numerous committee meetings, general sessions, and opportunities to learn made the conference a resounding success.

Enjoy these memorable moments and look for more on the conference in the January issue of Public Utilities Fortnightly.



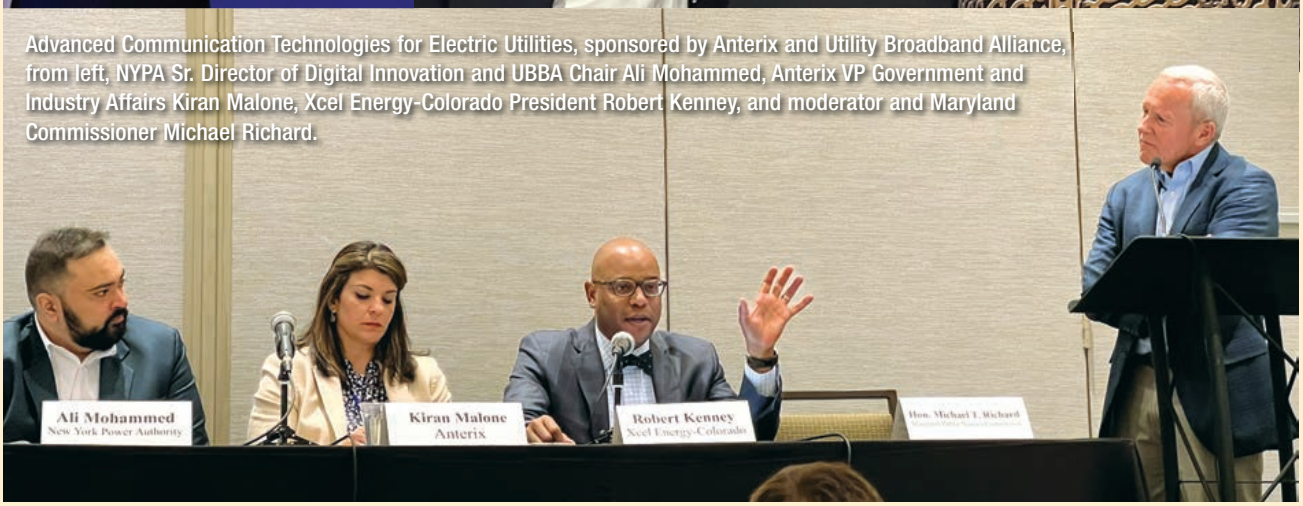
FERC Commissioner Allison Clements.



NARUC President and Connecticut Commissioner Michael Caron.



NARUC made history at La Quinta electing all-female leadership, from left, the newly installed Second Vice President, Washington's Ann Rendahl; NARUC President, North Dakota's Julie Fedorchak; and First Vice President, Georgia's Tricia Pridemore.



Advanced Communication Technologies for Electric Utilities, sponsored by Anterix and Utility Broadband Alliance, from left, NYPA Sr. Director of Digital Innovation and UBBA Chair Ali Mohammed, Anterix VP Government and Industry Affairs Kiran Malone, Xcel Energy-Colorado President Robert Kenney, and moderator and Maryland Commissioner Michael Richard.



Current Operational Challenges in Our Bulk Power System, from left, PJM Interconnection CEO Manu Asthana, MISO CEO John Bear, NERC CEO Jim Robb, and moderator and NARUC President-elect Julie Fedorchak.

Committee on Critical Infrastructure, from left, CPI Deputy Director Lynn Constantini, District of Columbia Chair Emile Thompson, and Staff Subcommittee Chair David Alexander.



EEI Alternative Regulation for Emerging Electric Industry Challenges Breakfast Panel, from left, moderator and PEG Research President Mark Lowry, Baltimore Gas and Electric Sr. VP Governmental, Regulatory and External Affairs Alex Nuñez, Alberta Utilities Commission Vice-Chair Kristi Sebalj, Duke Energy Deputy General Counsel Jack Jirak, and Rhode Island Commissioner Abigail Anthony.



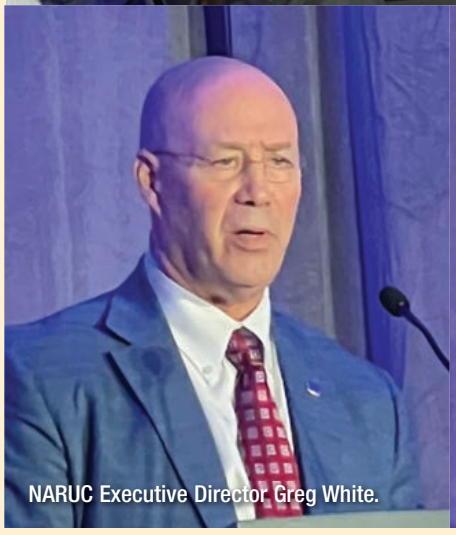
NARUC President-elect Julie Fedorchak in a lunch and learn discussion with President Michael Caron.



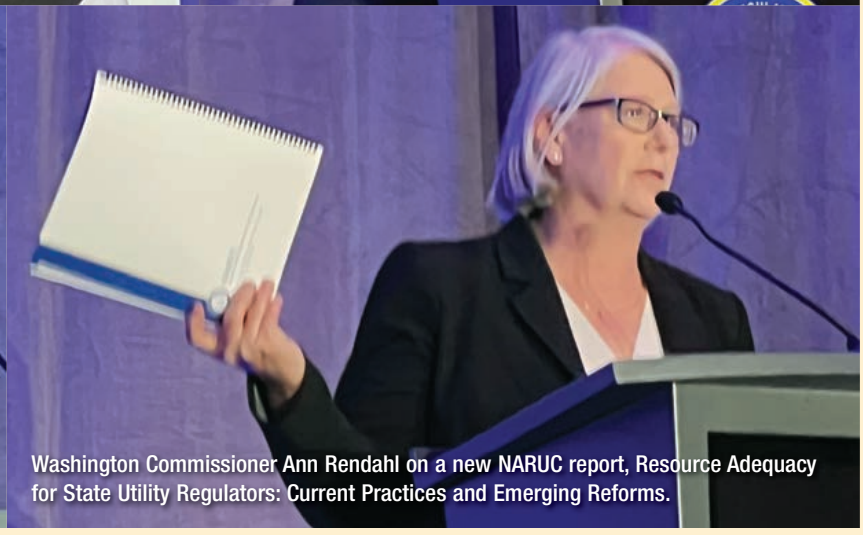
NARUC's Elliott Nethercutt on Resource Adequacy report.



Missouri Commissioner Jason Holsman.



NARUC Executive Director Greg White.



Washington Commissioner Ann Rendahl on a new NARUC report, Resource Adequacy for State Utility Regulators: Current Practices and Emerging Reforms.



Canadian regulators were represented at NARUC, from left, Alberta Utilities Commission Vice-Chair Kristi Sebalj, Nova Scotia Utility and Review Board Member Jennifer Nicholson, and Canada's Energy and Utility Regulators Executive Director Jocelyn Fraser.



Reimagining Transmission Development Processes, from left, AEP VP Transmission and Telecom Planning, Kamran Ali, Invenergy EVP Transmission Shashank Sane, CAISO VP Infrastructure and Operations Planning Neil Millar, Citizens Utility Board of Minnesota Executive Director Annie Levenson-Falk, and moderator and Michigan Chair Dan Scripps.



Integrating tomorrow's tech: A critical look at Integrated Resource Planning, from left, EPRI VP of Corporate Affairs Katie Jereza, Minnesota Chair Katie Sieben, EEI Executive VP Clean Energy Emily Fisher, and moderator and Michigan Commissioner Katherine Peretick.



California Commission President Alice Reynolds welcomes attendees to the State.



North Carolina Commissioner Kimberly Duffley and FERC Commissioner Allison Clements.



EPRI Executive Director Government & External Affairs Lola Infante.



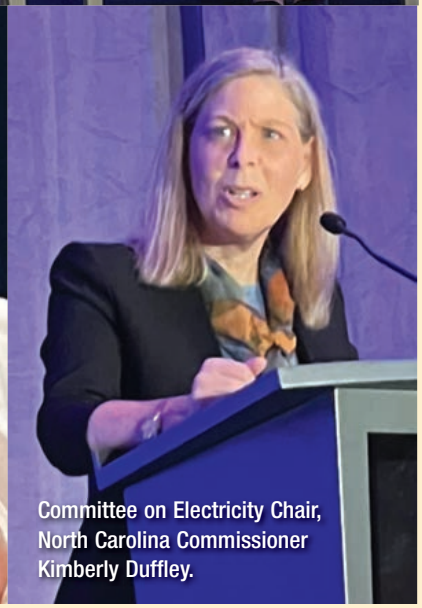
Partnering on the Clean Energy Transition: A fireside chat, with DOE Infrastructure Under Secretary David Crane and Washington Commissioner Ann Rendahl.



On the eve of her NARUC Presidency, NARUC First Vice President Julie Fedorchak gave remarks and used a snowflake to represent reliability.



Rhode Island Commissioner Abigail Anthony.



Committee on Electricity Chair, North Carolina Commissioner Kimberly Duffley.



Measuring What Matters: How Regulators Can Leverage Multi-Metric Resource Adequacy Framework, from left, ESIG Director of System Planning James Okullo, Tri-State Generation and Transmission VP of Planning & Analytics Lisa Tiffin, Texas PUC Senior Market Economist Werner Roth, NERC CEO Jim Robb, and moderator and Washington Commissioner Ann Rendahl.



The Terry Barnich Award was presented to Washington Chair David Danner, on left, by Missouri Commissioner Jason Holsman.



NARUC President-elect Julie Fedorchak presented President Michael Caron with an appreciation gift.

IEEE PES Meeting in Puerto Rico

Perspectives of Two Key Execs There on Resilience

The 2023 Conference on Innovative Smart Grid Technologies - Latin America, sponsored by IEEE Power & Energy Society, took place in San Juan, Puerto Rico on the sixth to the ninth of November. The theme was: disaster recovery and network transformation in times of climate change.

The conference included plenary sessions, panel discussions, and forums on engineering a more resilient path forward. The week was spent navigating the top tools, training, and modeling used to enable increased resilience and generation planning, how emerging technologies can advance the climate change fight, and how the rest of the world can learn from these lessons as climate change fuels the growing effects of increasingly extreme weather. Puerto Rico's unique experience with disaster preparedness and recovery in the wake of Hurricanes Irma and Maria was a notable topic of discussion for the convening engineering and climate change experts.

The Public Utilities Fortnightly team spoke with two of the conference participants, Shay Bahramirad, senior vice president for engineering and asset management at LUMA Energy, Puerto Rico's power company, and Tom Dunn, CEO of Vermont Electric Power Company. See their perspectives below.

As many PUF readers know, IEEE PES is the leading provider of scientific and engineering information on electric power and energy for the betterment of society and a trusted resource dedicated to the technical, informational, networking, and professional development needs of its members. PES now has over forty thousand members around the globe.

Shay Bahramirad

LUMA Senior VP of Engineering, Asset Management and Capital Program

PUF's Steve Mitnick: What do you do and what is LUMA?

Shay Bahramirad: LUMA Energy assumed operation of the transmission and distribution grid in Puerto Rico in June 2021. We inherited a system that was neglected and broken for decades, and after several disasters, like Hurricane Maria and Hurricane Irma, earthquakes, and numerous tropical storms, the reliability of the system was a few hundred percent worse than the worst utility in the continental United States.

The system today has fundamental flaws, and we have to construct and build it in such a way that it would be aligned with modern standards and public policy. For example, on public policy, the people of Puerto Rico have decided they want a hundred percent renewable energy by 2050.

When we took over, within a few months, we had connected more residential solar than in the past ten years. In two years, there are more than one hundred thousand residential customers connected to our grid, and that puts Puerto Rico fifth in the country per capita.

Then there is the historic commitment by FEMA, as much as sixteen billion dollars, to rebuild and transform the power grid in Puerto Rico. My job is to make it happen. I'm the senior vice president of engineering, asset management and capital program, so my team is responsible for designing the system. So, it's quite a fun job.

PUF: Is it a doable job? You've really taken on a big job. You said there are fundamental flaws in the existing system.

We are in the process of building a network microgrid; two islands in Vieques and Culebra, two microgrids, and connecting them with the submarine cable. There's a network of microgrid.

Shay Bahramirad: Is it doable? Absolutely. There is a sense of urgency because people have been promised improvements many times and there is not much patience to go through this process again.

But the sixteen billion dollars of funding that is coming through the federal government has a lot of associated commitments. A part of it is in the Stafford Act, which requires us to do what we need to do, build the system per industry standards.

So, we have been designing a transmission line and the substations per NERC standards and IEEE standards. Already, we have improved the reliability of the system by thirty-five percent in the first two years of operations.

It's quite a record in the United States for any utility. It would be hard to find any that have improved by thirty-five percent in two years in frequency of outages, and twenty percent of duration of outages in comparison to the previous year.

We have more to do, of course. We've entered an agreement

with the federal government with the support of the local government that we are eligible to do a one-time vegetation clearing and setting the rights of way for sixteen thousand miles of vegetation.

Today, when you fly over the lines, there are no rights of way because there has never been vegetation clearing done. The trees are all grown, so you can't see the lines, and it's going to improve the reliability of the system by an additional forty-five percent in only three years.

Then, we have an extensive program for substation modernization. We have twenty percent of our substations in a flood zone, and we are either relocating and/or elevating to the point that they won't be affected by floods.

We had a Category 1 hurricane last September and saw some of the issues in the system. We have formulated and initiated one hundred forty-one projects with FEMA that translate into over eleven billion dollars.

One hundred and five of them are completed or under construction. For the first time, we have visibility into the transmission system, including by the optical sensors we have installed.

PUF: Most of the population and load is in the north and the generation in the south, so crossing from one to the other was tenuous. Talk about that challenge.

Shay Bahramirad: Yes, Puerto Rico is an electrical island, so it doesn't enjoy the redundancy that exists in the mainland. In the continental United States, the connectivity of the grid that provides the inertia; Puerto Rico doesn't have that. To stabilize the system, we have bigger challenges to maintain frequency stability.

That means that when we are going through this process of integrating a hundred percent renewables, storage is going to be important to provide stability. Otherwise, clouds come and go, and the system starts oscillating. We have a hundred megawatts for four hours of energy storage in the pipeline to provide grid resiliency and stability needed because of renewables.

You touched on the north and south. There are transmission lines that go for thousands of miles in the United States. A hundred or two hundred miles from the north to south is not something I would think about.

Here, we are thinking about other methods. We are evaluating submarine cable that connects the east of the island to the west of the island. It enables offshore wind and helps with the renewable portfolio standards, the RPS, the goals that the island has.

We get hurricanes, earthquakes, tropical storms, floods, and everything in the mix of extreme weather. So, we are evaluating different options among undersea cables, undergrounding, and hardening the system for at least a hundred sixty mile-per-hour events.

PUF: Is the debate, restore the legacy grid and then worry about a grid transformation, or do it at the same time, realizing that might slow it down? How did that come out in planning?

Shay Bahramirad: I keep reminding my team we are building a plane while we are flying it. We are making fundamental changes in the design of the system to be aligned with NERC standards and eliminate a single point of failure in the system.

But that will take a few years, and, in the meantime, we are committed to doing everything we can to improve reliability for our customers – we have already reduced the frequency of service interruptions by thirty-five percent in the first two years of operations. So, we are doing both at the same time.

The short fixes in the grid, for example, the clearing of sixteen thousand miles of hazardous vegetation from the area around powerlines and substations, is something that is going to help right now. But we are also building six new substations on the grid that provide redundancies that have never existed.

We have improved the reliability of the system by 35% in the first two years of operations. It's quite a record in the U.S. for any utility. It would be hard to find any that have improved by 35% in two years in frequency of outages, and 20% of duration of outages in comparison to the previous year.

It's all going on at the same time. We have installed two thousand two hundred fifty automation devices and that provides reliability right away. We have repaired or replaced almost ten thousand poles and we have a substation modernization program where we change breakers and transformers.

Then for a number of other substations we completely rebuilt; we changed the design to a more robust one. It all goes hand in hand.

We are in the process of building a network microgrid; two islands in Vieques and Culebra, two microgrids, and connecting them with the submarine cable. There's a network of microgrid.

It's the same in the mountainous areas to build a microgrid, so there's a nexus between water and electricity. Some materialize quickly. The other ones will take eighteen months, considering the supply chain challenges, maybe longer.

PUF: Talk about LUMA. Are you bringing in new people and outside partners? What's the overall team that's doing all this work?

Shay Bahramirad: We have nearly forty-five hundred LUMA employees. Day and night, we are working on construction, outage management, system improvement, and customer service.

We have lots of contractors and continue to look for new partners, contractors, and suppliers. This is not a journey we can go through alone, and for many substations, we are looking into a

modular substation, so they are built outside the island, similar to an offshore model.

Other utilities would take six years to build a substation, but this approach is faster. We want it to be modular, built outside, configured outside, and just get it installed. We are going through that right now.

There are constant RFPs out there. We have hosted a supplier summit, and we are going to do that again to talk with the market to show what's coming.

There's a bankruptcy in Puerto Rico, and there's a historical lack of payment or many different aspects that are part of the work to attract partners, suppliers, and contractors to come to the island.

PUF: You worked at Commonwealth Edison, the Exelon company. Why did you come to LUMA and how is it for you?

Shay Bahramirad: There is never a dull moment. I cannot think of a better place than Puerto Rico if you want to make an impact in this industry that changes people's lives.

As part of our streetlight initiative, you're spending and investing about a billion dollars on streetlight modernization. That is quite important to our municipalities and people because of the public safety impact. I get to go when we start the construction to meet with the community, and the excitement is quite something from simple things, such as fixing the streetlights and modernizing them.

It's a lot of investment and in some instances, we are skipping two generations of technology and are redesigning the entire grid. It's a lifetime opportunity for anybody from engineers to leaders to be part of this transformation.

PUF: Can you think of some stories that you've experienced that were rewarding or interesting over the last year or so?



LUMA Energy assumed operation of the transmission and distribution grid in Puerto Rico in June 2021. The system today has fundamental flaws, and we have to construct and build it aligned with modern standards and public policy. On public policy, the people of Puerto Rico have decided they want 100% renewable energy by 2050.

Shay Bahramirad: I was the system incident commander during the twelve-hour night when Fiona hit, the Category 1 hurricane. After the shift, I would go into different communities and visit our working crews.

Those days and nights get very long, and I stopped at a coffee place in one of the municipalities in the southwest of the island that was hit quite hard. I had on my LUMA shirt, which has the logo of the company.

The coffee shop worker told me, "Thank you so much for everything you do." He didn't charge me for the coffee. I was expecting to hear a complaint, but a small appreciation made my day. These are the small things that make it worth it.

PUF: What should our readers know or take away from what LUMA is doing in Puerto Rico?

Shay Bahramirad: There is a lot of learning on how to deal with disasters and recover from disasters. As for public policy, it doesn't matter how much technology leads.

At the end of the day, policy rules. It's the public policies, either in the form of regulation or statutes, which are the foundation to tackle the big problems of humanity that we are dealing with in addressing the impact of climate crisis.

PUF: In addition to your role at LUMA, you are also the president-elect for IEEE Power & Energy Society. What is so important about this organization?

Shay Bahramirad: IEEE PES is the leading provider of scientific and engineering information on electric power and energy for the betterment of society. We bring together over forty thousand technical experts from around the globe, representing every facet of the electric power and energy industry.

Truly, we are comprised of the best minds out there. So, we are at the forefront of the rapidly changing technological advancements that impact everyone's future, which is incredible when you think about it.

This week, PES members from around the country have joined us here in Puerto Rico for the 2023 Conference on Innovative Smart Grid Technologies, Latin America – just one of many conferences that bring people together and allow them to learn about innovative technologies and to share transparently best practices and pain points.

We're talking about disaster recovery and network transformation in times of climate change and what better place to do that than here, where we can all learn from Puerto Rico's unique experience with disaster preparedness and recovery in the wake of Hurricanes Irma and Maria.

It's been particularly fun chatting with folks throughout the industry who are so passionate about spotlighting the importance of engineering in navigating climate challenges.

For me, as the president-elect of PES, I think there's tremendous opportunity for the organization to make a real impact on the future of disaster recovery and resiliency. PES is in essence a collection of experts who represent every portion of the electric industry, from the students learning the discipline, to the researchers developing the next generation of innovations, to the utility professionals deploying these technologies to serve communities across the world.

IEEE PES is the leading provider of scientific and engineering information on electric power and energy for the betterment of society. We bring together over 40,000 technical experts from around the globe, representing every facet of the electric power and energy industry.

Our focus must be helping these professionals succeed in their objectives, which also encourages more people to get the benefits of membership. We need more than just conferences to inspire the global action needed to educate, train, and empower the next generation of engineers.

We need our political and business leaders, at all levels and all backgrounds, to help raise up the next generation of engineers to design the resilient solutions our world will need. And together, we can move forward with rapid speed to a solutions-based and expertise-based mindset. If anyone can do it, this group can. ❍

Tom Dunn

Vermont Electric Power Company CEO

PUF's Steve Mitnick: Talk about your company and position.

Tom Dunn: I'm the president and CEO of Vermont Electric Power Company. A couple of notable things about VELCO: We are a transmission only company, and there're only a few of those around the country.

We were set up in 1956, to import hydropower from the St. Lawrence projects. That was a requirement that NYPA had to share some of the output with bordering states. We didn't have a transmission system, so the utilities got together and formed VELCO.

What's interesting about the ownership, it's owned by investor-owned, co-ops, and municipals, literally all the utilities in Vermont are owners of VELCO. So, they're both owners and customers.

We are a for-profit company; we make our money by making investments in the transmission system. The profits go back to all our owners, who are then required in Vermont to use it as a credit against their revenue requirement.

We're like a co-op from a financial perspective. Having everyone at our ownership table makes a difference, in terms of how we operate and the perspective we take in meeting requirements of providing reliable, secure transmission service.



ISO New England is the regional planner, and we work closely. They've identified in 2050 that they expect the winter peak in New England to double. What that means for VELCO and many other transmission owners in New England is line upgrades.

PUF: It also means a lot of bosses. Are there conflicting ideas you bring to the table as part of your job?

Tom Dunn: For the most part, board conversations are robust. What comes through on occasion is the fact that with different sizes of utilities – we have Green Mountain Power as the largest owner, we have smaller utilities, which don't have as many resources – often there are conversations about how fast we are going in certain areas.

What is good for us is, there are things we do that can be helpful to all our owners, regardless of where they are relative to innovation and issues like that.

But VELCO has been a great model for Vermont. The financial returns are helpful in mitigating rate impacts to a degree.

We've used fiber optics for at least twenty years. That's been a huge part of maintaining and providing reliable transmission service.

That network does a lot in addition to helping us run the transmission grid, such as moving around large amounts of data. Increasingly that's important for our owners, as they go about their work in decarbonizing and integrating renewable energy and storage.

PUF: You had resiliency challenges this summer, in dealing with water issues.

Tom Dunn: The summer of 2023 was the wettest ever on record, in both Vermont and New Hampshire. An incredible amount of rain fell throughout the summer. We had flooding in the town I live in, Montpelier, the neighboring community of Barre, Ludlow, and several others.

Most of the communities in Vermont are located next to rivers. That's where a lot of flat land was available, that's where the roads were built.

Unfortunately, when you get extreme weather, like we had this summer, you see the damage that flooding can do to the downtowns. Montpelier's downtown had five feet of running water in it.

PUF: Has that affected thinking among you and your partner organizations about response and planning even ten, twenty years out?

Tom Dunn: Everyone in Vermont is focused on climate change, and what are the implications.

From VELCO's perspective, a significant wake-up call was Superstorm Sandy, in 2012.

During that event, we had ten inches of rain in less than twenty-four hours. It washed out one of the bridges on our major highway in Vermont. We saw a river move about two hundred yards from its original location, and it took out about a half mile of our transmission lines. There were boulders the size of garages rolling down these rivers.

It was a big job, to get that transmission line rebuilt. We have been looking at the location of all our substations and structures, to ensure at least the substations are outside of the floodplain.

We've been working on a structure replacement program for the last eight to nine years. We are never going to have all our structures out of the floodplain, but we're taking extra steps to ensure that they can withstand the effects from floods.

We're using steel poles more often, and that's more commonly happening in the industry. It makes a difference. Also, we're doing a lot of substation refurbishment work, and we now build concrete control buildings at our substations and are replacing the protection and control systems.

There's the vegetative management program. We have had a robust program for years, but we've doubled our focus on those areas, making sure our corridors are done the entire width.

One of the things that's changed in the last few years is the effects from invasive species. We're seeing the emerald ash borer, and unfortunately, it's an invasive that is attacking ash trees.

We have embarked on a program to remove tens of thousands of ash trees proactively, because it kills the tree, but you can't tell that the tree is dead immediately. We have been removing these ash trees before they fall and affect our lines.

Then when we're doing structure replacement work, the corridors with transmission lines are rugged, steep hills. We make sure we build good roads in these transmission corridors, using rocks, bridges, and culverts, so we have access to our corridors under all conditions.

That makes a difference because we need access while we're replacing a structure, but we also need that access in responding to storm damage. These roads are robust and with all the rain we had this summer, they held up.

PUF: Do you feel like you're innovating to try to do something, and strengthen, but also in an affordable and cost-efficient way? Where do you find solutions?

Tom Dunn: That's always a struggle. You have tension between wanting to make the system as strong as it can be, but recognizing there's a limit to how much you can spend.

For example, when we embarked on our structure replacement program, we did a thorough inventory of our structures, to assess which are the ones that need to be replaced, to make sure when we are doing this work, it's the ones in bad condition.

It's expensive to get out with machines and equipment, making sure we replace the structures we need to do within the next five years. Steel structures require less maintenance than wood.

When we're doing structural work, we're thinking about whether we need to make this investment, what's the nature of the investment? What kind of investment should we make?

We have one project built in the '60s that we're going for permitting on, and we knew we had a significant investment to make. It was in a part of our state where there's more renewable energy generated than our system can carry.

The future is going to revolve around data. The system is going to change from 300 power plants in New England to tens of thousands. We are deploying fiber to get information from those resources and bring that back to VELCO.

When we looked at this transmission segment, we said, is there a way we could do a little more work, but strengthen the system to help alleviate some of these restrictions? What we're doing is replacing an H frame transmission line, that's a two-pole line with a cross arm and putting up a single pole in its place. When we do that, we're also going to add larger conductors.

We spent a lot of time maximizing that investment, making sure we are addressing the asset condition, and adding real value in terms of increasing the ability to site more renewable energy in northern Vermont, maximize what's already been made. We're going to create an additional space in our corridor for the potential for a second transmission line in the same right of way.

ISO New England is the regional planner, and we work closely. They've identified in 2050 that they expect the winter peak in New England to double.

What that means for VELCO and many other transmission owners in New England is line upgrades. It's right sizing, creating space in existing corridors for the future, which is going to involve increased electrification of heating and cooling, transportation, and at some point, we're going to see loads increase.

We brought our plans to the ISO, and to the various committees, and we've got a positive reception about this idea of, let's maximize these investments for not only addressing asset condition, but creating a grid that is ready for the future.

PUF: You are looking at conductors, making more use of existing right of ways, because it's hard to put in a new right of ways. To get permitted.

Tom Dunn: Yes. I have experience in my career as a project manager, of acquiring rights of way, and that is difficult work. Twenty years ago, VELCO embarked on some of its first transmission projects in more than twenty-five years, and we had a lot to learn. We were disruptive to many communities. The good news is we did learn lessons, and we got better.

We just got a GRIP award from DOE, in partnership with EPRI, to put a flow control device on one of our transmission lines that connects Plattsburgh, New York with Grand Isle, in the northwest part of Vermont.

This power electronics device will allow us to have better control over the flows that come in from New York. The system in New York is electrically quite strong. It has robust transmission connections to Plattsburgh.

There's quite a bit of wind located up there, so we have a phase-shifting transformer that tries to hold back that flow, and it's an electromechanical device. We've had one failure of it, about three or four years ago, which is disruptive to both VELCO and our operations, but also for New England and New York.

In New York, in the last twenty-five years, that piece of equipment has failed two times. What we want to do is use power electronics to work in cooperation with the phase-shifting transformer.

The power electronics will provide variability and control of the flow, and the phase-shifter will basically be set in one position.

It's in partnership with EPRI. This is going to maximize the use of that transmission line, facilitate the ability to bring in more renewable energy between New York and New England, and preserve our assets. The phase shifting transformers are complex pieces of equipment, so replacing one of these would be about ten million dollars.

This power electronics device will extend the life of the phase-shifting transformer. It's a device from Smart Wires that can be used even if the line is upgraded from one hundred fifteen thousand volts to two hundred thirty thousand volts. There are a lot of positives.

PUF: What is VELCO going to look like five years to ten years from now?

Tom Dunn: We're always going to be focused on our role, which is to provide safe, secure, reliable, affordable transmission service. But the real future is going to be one that revolves around data.

Right now, we have a project to expand our fiber optic network by about another seven hundred miles. Today, we have three times as many miles of fiber as we have electric transmission.

We'll have somewhere in the order of twenty-two hundred miles of fiber.

I raised that, in tying it to the data, as what we're doing is deploying fiber to collect information from all the distributed resources of a hundred fifty kilowatts and larger, located in Vermont.

Right now, Vermont has five hundred megawatts of solar. We are a thousand-megawatt system.

The system we're operating today, and the system we're preparing to operate in the future, is going to be one that has changed from three hundred power plants in New England to one that has tens of thousands of power plants.

They're smaller, intermittent resources, and important for the transmission operator, is they're not connected to our system directly. We are deploying fiber to get information from those resources and bring that back to VELCO.

The future, but we're working on it right now, is creating IT systems and the capability to leverage that data to help us operate our system reliably. Because one of the key tools for our system operators is the contingency tool. That tool is only accurate with good information going into it.

PES is a large global ecosystem of technical experts who recognize the growing importance of making energy decisions correctly. We need technically sound information to solve the timeliest issues impacting our communities.

We're going to use the data we're collecting, feed that into our contingency system, make sure our models are accurate, and then I hope we'll be able to continue to provide reliable service. We don't brag a lot, but we have a reliable system.

The challenge in being able to do that in the future is going to be tied to our ability to leverage data, collect the data, bring it back to our systems, and a big part of this is going to be in cooperation with all our distribution owners. We have innovative companies in Vermont, which are going full steam on creating a clean energy future.

We've doubled the investments in both telecom and data in the last few years. We're going to bring in people with talent, with the skills we need with our data and developing IT capabilities.

There're at least fifty megawatts of distributed storage on our grid today. It does a great job of knocking our peaks down. I heard Jim Robb [NERC CEO] recently, and he made a point about how we're losing spinning mass. We need a lot of the characteristics that support the grid, so we're going to have to find ways to get those.

It'll take new converter technologies and things like that. But long-term storage is going to be a big one, particularly in New England, where we have challenges that ISO New England's working on in terms of energy supply concerns during extended cold snaps. Things like long-term storage will be important to help us mitigate that.

(Cont. on page 83)

SEPA's 5x25 Initiative

Locking in our Clean Energy Future

By Smart Electric Power Alliance CEO
Sheri Givens

Now that I have been leading the Smart Electric Power Alliance (SEPA) for over a year, it is clear to me that one of the things that makes our organization so unique is the collective power of the numerous energy industry stakeholders – utilities, corporations, technology companies, regulators, policymakers, advocates, community-based organizations, academia, and others – that we bring together to focus on the key levers needed to achieve a carbon-free energy system.

We take great pride in our ability to amplify not only the expertise of our one thousand one hundred members but also the greater energy community.

This is why we are announcing our 5x25 initiative, which will be rolled out in early 2024, focusing on five areas where our industry will need to find practicable solutions for over the next two years to ensure we meet our carbon reduction goals. Why the next two years? We believe these upcoming investments and initiatives, which will be around for decades to come, will be critical to achieving our ambitious climate change mitigation targets.

The 5x25 initiative is spurred by the sense of urgency we feel as the impacts of the climate crisis grow more severe. There is no need to remind you of the severe weather events our nation, and world, experienced in 2023. In the wake of these events, it is impossible to ignore the gravity of the situation and the imperative to take bold, expedient action.

As each of us plan for the clean and equitable energy transition, the first step is to find consensus around the exciting opportunities we face as an industry. Our members and the broader energy community are best positioned to accelerate a clean energy transition when our goals are aligned. SEPA's 5x25 initiative identifies five crucial focus areas – resilience, transportation, storage, emerging technologies, and policy – to provide our entire energy ecosystem, including affected communities, with a clear path forward.

We are announcing our 5x25 initiative, which will be rolled out in early 2024, focusing on five areas where our industry will need to find practicable solutions for over the next two years to ensure we meet our carbon reduction goals.

Resilience

As extreme weather events become more common and more severe, ensuring the reliability and stability of the electric power system is crucial. Clean energy technologies, such as grid- and customer-scale distributed generation and storage provide new options for improving resilience.

As you, your company, community, region, and state work to incorporate resilience into your clean energy journey, SEPA is here to help. Through one-on-one project support, multi-client studies, distributed energy resources for resilience feasibility studies, programmatic and regulatory support, stakeholder facilitation, consumer engagement, benchmarking, and thought leadership, SEPA is supporting industry-wide resilience efforts. We have also published reports and articles addressing resilience planning, microgrid standards and controls, and resilience and microgrid policy.

Transportation

Reducing the negative climate impacts of transportation will be crucial as we work toward our collective, carbon-reduction goals. In the United States, the transportation sector is responsible for nearly thirty percent of greenhouse gas emissions, making it the largest contributor of all sectors in our nation.

The transportation transition to low- and no-carbon vehicles is paramount to reducing the nation's total emissions. Electric vehicles also offer benefits, including lower transportation costs and improved air quality. SEPA supports the industry with resources including load modeling forecasts, technical analysis, strategic guidance, general best practices, and stakeholder-specific recommendations.

Storage

Energy storage will be paramount to providing consistent, clean, and reliable power as we harness the full potential of non-emitting generation such as wind, solar, and other renewables.

The energy industry will need to bring increasingly more intermittent, clean energy online and prepare the grid to handle the increased load of new electrification efforts to meet our climate goals and customer demand.

Energy storage helps address these issues. SEPA's energy storage work spans a broad array of technologies, end uses, audiences, and durations, including long-duration energy storage, which presents its own unique opportunities and challenges.

Emerging Technologies

Most of our nation's carbon reduction will come from technologies that are already available in the market today; however, achieving

Sheri Givens is CEO of the Smart Electric Power Alliance.



SEPA's 5x25 initiative identifies five crucial focus areas – resilience, transportation, storage, emerging technologies, and policy – to provide our entire energy ecosystem, including affected communities, with a clear path forward.

our national decarbonization goals will require new technologies across a wide range of applications. The carbon-free transformation requires integrating clean energy resources while balancing grid security, flexibility, reliability, and resilience.

SEPA members are leaders in green hydrogen, carbon capture, long-duration energy storage, and other key technologies, including advanced distribution management systems, distributed energy resources management systems, and virtual power plants. Additionally, SEPA convenes a cohort of its members annually for an international fact-finding mission to discover technologies other countries are advancing on their clean energy journeys.

Policy

The U.S. federal and state policy and regulatory landscape is a patchwork quilt of decarbonization aspirations, goals, and mandates. Innovative policies, regulations, and business models could be the key to accelerating clean energy solutions nationwide.

With expertise and insights in understanding the uniqueness of our communities, states, and regions, SEPA assists our members and other energy stakeholders in navigating the myriad of potential policy solutions through engagement, education, research, and facilitation.

We look to 2024 as an important year to showcase best practices, build new partnerships, and recognize new allies on our path to a carbon-free energy system. Decisions and investments in our energy future made over the next two years will determine the speed and success of our carbon-free transition over the next two decades-plus.

SEPA is committed to sharing and expanding our members' work, and your work, on these critical topics as we plan for 2025 and beyond. By bringing experts together, facilitating needed conversations, and increasing overall industry awareness on these five areas, we can scale new climate solutions more quickly and efficiently.

Collaboration allows us to capitalize on the expertise of the strong and growing clean energy sector. Please join us and go to our website, sepapower.org, to learn more and sign up for updates on SEPA's 5x25 initiative. PUF

The fourteenth of December is the eighth anniversary of the current Public Utilities Fortnightly team, with additions since.

State Regulators Leading the Way

(Cont. from p. 65)

PUF: At the end of your year as President, what would you like to look back on and say, "This is the one thing I wanted to move forward on and did?"

President Julie Fedorchak: Fixing some of the alignment problems between the gas and electric industries is one of the most important ways to improve reliability. That effort, if successful, will offer huge dividends and I have great confidence and appreciation for the people who have agreed to work on it.

Beyond that, my mission is to bring the core issues of reliability and affordability to the forefront as the industry works to address all the other policy priorities in our states such as fleet change, infrastructure development, decarbonization, electrification, and the like. This work affects everyone and everything.

We must never forget that the big, exciting goal is sustainability. And no plan can be sustainable if it isn't affordable and reliable.

Former NARUC president Rob Paulson once referred to it as, "Doing the Boring Good." There is so much truth to that.

We can't get distracted with the sexy new things. We must be thoughtful, intentional, and even passionate about proceeding at a pace that ensures these core principles. So, I guess what I'm saying Paul, is my presidency will be successful if I have made boring sexy. PUF

IEEE PES Meeting in Puerto Rico

(Cont. from p. 79)

PUF: As we're chatting, you're actually on site in Puerto Rico at the 2023 Conference on Innovative Smart Grid Technologies, Latin America, which is sponsored by IEEE Power & Energy Society. What does being a member of IEEE PES and attending conferences like this one mean to you as an engineer, as the CEO of VELCO?

Tom Dunn: PES is a large global ecosystem of technical experts who recognize the growing importance of making energy decisions correctly. We need technically sound information to solve the timeliest issues impacting our communities, like how to allow for the planning of large-scale grid decisions and the forms of clean energy technologies to support.

The global partnerships that PES forms are so important in ensuring that our work is relevant to the broader community and supporting PES members' goals to have the impact that their work deserves. That's why coming to conferences like ISGT here in Puerto Rico is such an amazing opportunity to have for us as members of PES – we get to come together and learn from each other's professional experiences and ideas and shape what our future solutions can be. PUF

The power electronics will provide variability and control of the flow, and the phase-shifter will basically be set in one position. It's in partnership with EPRI. This is going to maximize use of that transmission line, facilitate the ability to bring in more renewable energy between New York and New England, and preserve our assets.

Christmas and Electricity

(Cont. from p. 4)

a top seller for a present under the Christmas tree, electrically lighted of course.

Every community has a few houses whose lights during the holiday season are over the top and worthy of driving by for a look. What's the electric bill like for these spectacular displays?

Assuming the lights are on for five hours a day and for thirty days during the season, and assuming an electric rate of 11.3 cents per kilowatt-hour, one website – christmaslightsetc.com – figured out the electric bill for what they called the typical enthusiastic user. That is, "if cars line up outside your house to watch your display, you are classified as 'enthusiastic.'"

That enthusiastic user would be billed by its utility an extra $310.73, if the Christmas lights are incandescent bulbs. But if they're LEDs, that homeowner would be billed by its utility an extra $40.15. That's how much you save with LEDs over incandescents.

Whether you are an enthusiastic user of Christmas lights or not, indeed whether you will be celebrating Christmas or enjoying this holiday season otherwise, the Public Utilities Fortnightly team wishes you a merry break from utility regulation and policy. Those dockets will still be there when you return from the holidays. PUF

Three Super Solutions Could Make Net Zero by 2050

Conversation with ICF's Director for Climate Change and Sustainability, Adam Agalloco

The ICF Climate Center recently released an important report, "Zeroing-in on climate change: Three 'super solutions' could put the U.S. on a path toward a net-zero economy by 2050." It finds that while the Bipartisan Infrastructure Law and Infrastructure Reduction Act will move the U.S. about halfway toward its 2030 and 2050 greenhouse gas reduction goals, there is a pathway to go the rest of the way.

Using ICF's tech platform, CO2Sight™, the ICF Climate Center modeled a path toward achieving U.S. decarbonization goals with three solutions, which are critical pieces of those two federal laws; transportation electrification, buildings, and clean energy. ICF dubbed them, "super solutions," whereby the U.S. could eliminate more than forty percent of GHG emissions by 2030 and nearly ninety percent of GHG emissions by 2050.

PUF's Steve Mitnick talked to an author of the report, ICF's Adam Agalloco, to dig deeper into what this all could mean for the future of decarbonization. Be sure to check out the report online at the ICF Climate Center.

PUF's Steve Mitnick: This is an important, quantitative report on the road to decarbonization. You were one of the prime movers, so what are the important takeaways?

Adam Agalloco: The most important takeaway from a high level is that we have solutions to reach the ambitious goals in the U.S. around decarbonization. Those are a fifty percent reduction in emissions by 2030 and carbon neutrality by 2050, achieved with three big, what we're calling super solutions, via existing technologies.

We can cut emissions close to meeting those goals. That's what our research is showing.

PUF: Stop there because that's a big one. You are saying these goals are achievable. Also, there are three super solutions.

Adam Agalloco: Achieving them is steep, it's challenging. There are a lot of complexities along the way to those solutions, but yes, it is possible.

We focus our work on transportation electrification, building decarbonization, and clean energy. Those are the three super solutions that we've looked at in this study. Our research shows it is possible to get close to a ninety percent reduction in emissions by 2050 by deploying those in a robust manner.

PUF: Are you implying there are barriers that need to be overcome to reach those goals?

Adam Agalloco: That's right. Our research is showing that we can reach these goals by deploying these solutions. Are there barriers? For sure. With transportation electrification, that's going to require the deployment of infrastructure that supports that work, including charging and electrical infrastructure.

It's also going to require a lot of folks changing the way they view EVs and EV ownership. What we're proposing, what we're outlining, are the benefits associated with doing that.

We will need to electrify not just the light-duty vehicles, but also look at public transportation electrification or other types of vehicle traffic, whether it's through electrification or low-carbon fuels.

PUF: ICF used heavy quantitative analysis and modeling in each of these areas, the EV, transportation electrification, building decarbonization, and generation side. Give a sense of that.

The most important takeaway from a high level is that we have solutions to reach the ambitious goals in the U.S. around decarbonization.

Adam Agalloco: We can look at the super solutions one at a time. We can group transportation and buildings together a bit.

In those sectors we look at equipment, be it a vehicle, boiler, heat pump or air handling unit, and use what we call a stock rollover model, meaning that each piece of the equipment, each vehicle, has a useful life. As that equipment reaches the end of its useful life, there's a choice that needs to be made.

Do I replace that with the same or similar piece of equipment that I have? Do I go to an alternative that uses a different fuel? Our modeling looked at the opportunity analysis associated with that stock rollover and asked, "What if different choices are made?"

Then, we looked at it from the standpoint of what would support those choices being made. This is in alignment with available data sets from the National Renewable Electricity Labs.

So, aligning our assumptions as to what folks might select as their equipment, then allows us to understand what that looks like from a stock rollover perspective. We can do the same for energy efficiency, in addition to electrification. That's the cornerstone for the transportation and the building sector.

For the electricity generation and the clean fuels aspect, we use ICF's Integrated Planning Model IPM®, which is ICF's tool to look at a least-cost capacity expansion for the electricity generating sector. Through the model, we set a carbon-emissions goal to make sure we could achieve a decarbonized grid, and used IPM to understand what that grid could look like based on that selection.

PUF: When you model, is it based on economics, or do you



Aligning our assumptions as to what folks might select as their equipment, then allows us to understand what that looks like from a stock rollover perspective. We can do the same for energy efficiency, in addition to electrification. That's the cornerstone for the transportation and the building sector.

consider institutional aspects such as behavior, being able to get financing or politics?

Adam Agalloco: First to clarify, we did not model costs associated with these solutions, but cost is an important factor in a decision process for what happens at the end of a useful life for equipment.

So, built into the different deployment curves that we have for transportation, building electrification or building energy efficiency is embedded in that economic trigger to inform how a decarbonization decision is made.

Essentially, what we've said is that a supporting set of policy solutions, technological advancements, or incentive structures, that different aspects all play into those decisions.

To some extent when we look through this work, our research is showing that if you deploy a range of those influencers, you can reach high levels of penetration of both electric vehicles in the transportation sector and different decarbonization solutions in the building sector.

PUF: Are there problems that need to be solved? Bad things can happen that would slow this down.

Adam Agalloco: We've outlined a lot of those throughout the report. We talked a bit about electric vehicle deployment and that infrastructure question being one of the key issues.

In the building sector, our research is showing there are barriers with scalability. Decarbonizing more broadly is going to require additional financial incentives of different types.

In the grid and clean electricity space, particularly land-use availability is going to be a huge challenge.

The economic viability and looking at challenges associated with materials is true for electric vehicles, as well as for some of the other clean energy solutions. For example, sourcing, refining and scaling copper, cobalt, and all the different kinds of metals needed for use in various decarbonization technologies are challenging.

Layered on that is industrial decarbonization. It isn't just a matter of getting those materials and building those decarbonizing pieces of equipment. It's also necessary to decarbonize the way they're being made in the industrial processes associated with them. All big challenges.

PUF: In these studies, people look at the role on the generation side of nuclear and natural gas. What's the role of gas and hydrogen or other low-carbon fuels? How did you resolve that?

Adam Agalloco: We talk about our diversified goal scenario as a combination of not trying to be, I'd say almost too heavy-handed with one solution, but more objective. There are lot of trade-offs and uncertainty.

I want to note that the diversified pathway that we outlined is not the only pathway. There are many ways that one could

reach decarbonization goals. We selected one that we thought, again, provides a bit of an objective pathway and some balance across the solutions.

PUF: What team worked on this study and why did ICF decide to take up this study?

Adam Agalloco: The team works on our CO2Sight decarbonization platform, which is ICF's set of tools, models, and data that we use with all our decarbonization projects. The folks were primarily connected to the local and state government decarbonization work, as well as folks who do a range of our power sector work.

We developed this report as part of the ICF Climate Center, a climate think tank within ICF that we created to help answer big questions about climate change.

We talked about this study early on from a standpoint of providing context for the two big federal bills, the Bipartisan Infrastructure Law and Inflation Reduction Act and said, "Okay, how much do they contribute to carbon goals?"

We also tried to provide a bit of simplicity. It's not simple, but we tried to make this easier for somebody to understand what it would take to meet our emission goals.

Hence, we tried to bucket solutions into these big super solutions that we can more easily communicate around. It was a little easier to say that as opposed to, "Hey, there are all these things that need to happen. And our research is showing that you can reach decarbonization with a handful of solutions." Not to say that's the only way to do it.

PUF: What should readers look for and maybe their role in this?

Adam Agalloco: First, the U.S. has made some important strides toward climate goals. Our analysis shows that legislation does a lot.

But the main thing we want folks to know is that there are practical pathways, and they can look at this within their area of interest and start to understand how some of these solutions might fit for them.

Then have insights as to some of the challenges we've talked about, whether its scaling infrastructure, battery manufacturing, grid upgrades for peaks of electricity demand or other issues associated with supply chain constraints. But there are real challenges out there too.

PUF: How optimistic are you?

Adam Agalloco: It is not my role to be optimistic or pessimistic. It's my role to look at the numbers and show what our analysis means and how it provides context.

Our study shows that there are pathways for the U.S. to meets its goals, but obviously, there's a lot of work that needs to happen. There are a lot of risks associated with that, but there's a pathway for this to work.

PUF: What are you up to next?

Adam Agalloco: Our work is continuing with a lot of state and local clients, as well as some federal clients, to help them understand how this fits within specific context, and what solutions make sense for them.

The main thing we want folks to know is that there are practical pathways, and they can look at this within their area of interest and start to understand how some of these solutions might fit for them.

A key part of a lot of IFC's work is connecting to stakeholders and understanding not just what makes sense at a high level, but what resonates and what works with community members. That includes what is going to benefit disadvantaged communities to ensure there's an equitable transition. That is a priority for us and our clients.

We're taking the research we did through this study and applying it to some of those clients. While we're doing that, we're gaining more insights in terms of what this looks like on the ground for state, local government, and utilities. Whoever it is that's asking us.

PUF: What was the most rewarding or fun part of the project for you?

Adam Agalloco: I enjoyed looking at it from a national perspective and compared to what could happen. Most of my clients are local and state governments, and certainly they have a huge role to play, but to take a bigger picture view and understand how that fits for the U.S. was rewarding. PUF

The Public Utilities Fortnightly team hosts four events each year. In 2024, Edison Congress is on the fifteenth to the seventeenth of April. It will be held at the Hotel Washington, steps from the White House.

Two others are first-day luncheons at NARUC national meetings. Our Winter Summit State of State Regulation Luncheon will take place on the twenty-sixth of February, at The Westin Washington, D.C., Downtown. And our Summer Summit Soapbox Luncheon will take place on the fifteenth of July, at the West Palm Beach Convention Center.

And then in the fall, the PUF team will again host the Fortnightly Top Innovators conference. It will be held at the historic Willard InterContinental, also steps from the White House. Top Innovators 2024 will be on the sixth to the eighth of October.

Mark your 2024 calendars accordingly.

A Year in Review and the Path Ahead

Column Anniversary Celebration

BY EEI INTERNATIONAL SENIOR VICE PRESIDENT LAWRENCE JONES

Throughout the electric power industry, every individual and organization play a pivotal role in advancing global electrification and the clean energy transition. The role of EEI International Programs is to provide avenues for global energy leaders – each with their own set of challenges and opportunities – to connect, foster innovation, and develop solutions to obstacles. We empower our audiences and stakeholders to understand the global energy landscape and to learn from global thought leaders.

Our monthly EEI International Public Utilities Fortnightly column, initiated in December 2022, enables us to provide insights on global energy developments.

In this special one-year anniversary edition of the EEI International column, we look back at the key topics covered in the past year, from navigating extreme weather to working with local communities – and we look ahead to 2024. Over the next year, our column will explore key emerging issues as we do our part to enable our readers to better anticipate and adapt to the shifting trends shaping our industry.

In the coming year, we will provide opportunities to follow and contribute to the global dialogue on critical issues shaping the clean energy future. Through participating in EEI's Global Electrification Forum in April and signing up for the EEI International Engagement Hub, stakeholders can engage directly with our programs – which all are aligned with our commitment to share knowledge through Power by Association℠.

The global energy landscape is undergoing an unprecedented transformation, with companies around the world focused on delivering resilient clean energy, while complying with their local and regional operating conditions and regulations. We can power progress together by learning from the different regulatory and political contexts, and by following the innovative ways that companies are investing in energy grid adaptation, hardening, and resilience.

As EEI's member companies continue to power the communities they serve, they also are prioritizing energy equity, ensuring all customers, including those in underserved and unserved communities, have access to clean, reliable, and affordable electricity. Universal access to electricity will continue to be an important theme in our programming.

Looking Ahead to 2024

Global energy trends, as well as outlooks and predictions, are changing year by year. In 2024, this EEI International column will continue to serve audiences with timely insights and foresights on the changing world. Key issues we are watching include the availability of critical minerals for the energy transition, workforce development, artificial intelligence, the supply chain, resource adequacy, managing and mitigating extreme weather risks and liability, innovative private-public partnerships, resource adequacy, and more.

We will dive deeper into energy transition economics and how industry can attract capital to invest in the infrastructure for greater electrification.

In the coming year, we will provide opportunities to follow and contribute to the global dialogue on critical issues shaping the clean energy future. Through participating in EEI's Global Electrification Forum in April and signing up for the EEI International Engagement Hub, stakeholders can engage directly with our programs – which all are aligned with our commitment to share knowledge through Power by Association℠.

Lawrence Jones is Senior Vice President of EEI International Programs.

We also will continue exploring taking a system approach, which creates an opportunity to discuss the interdependencies of electricity and other major infrastructure, human factors, and the role of our industry as enablers of societal progress.

Thank you for being a reader, and we hope that you will continue to connect and engage with EEI International's programs and platforms in the coming year. PUF

Effective Asset Management

(Cont. from p. 90)

Richwalski says some information is shared from independent system operators but, beyond that, many utilities rely on vendors to provide equipment performance data. In either case, the data is typically siloed or incomplete and not universally available.

To address this challenge, the EPAC is seeking to understand the specific needs of utilities and what each is doing to maximize the life of their assets and the value of those assets to the company and the customer.

"All utilities have different processes and approaches, so we want share knowledge and experiences and create a better understanding holistically across the industry around what's driving strategic asset management decision-making," said Essix. "Bringing utilities together to have these conversations and to compare notes is an important aspect of what makes this committee so valuable."

The group is also reviewing standards from the International Organization for Standardization (IOS) and the Institute of Asset Management (IAM) to develop requirements and criteria that can be applied across the industry.

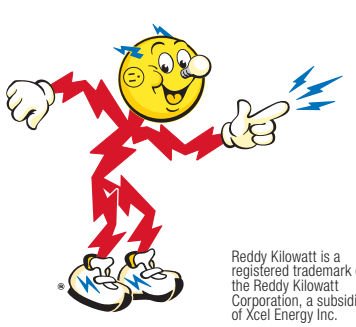
"We plan to meet every other month to gather real-world experience and perspective from peer utilities and industry experts about their approaches to asset management," said Richwalski. "Together we're going to help evolve and build that criteria to help guide asset management so that we have a much better and more universal understanding of best practices for electric utility industry."

In addition to gathering insights from utilities, the EPAC also schedules time to meet with vendors to better understand the latest products and technology advancements available to the industry.

"One of the things we talk about a lot is how will equipment and new technologies conform to meet the demands of grid transformation," said Essix. "We want to pay close attention and work directly with vendors to ensure we have good quality products that meet the evolving needs of the grid and will last a long time."

The EPAC's philosophy is that the industry can and must work together to proactively and voluntarily advance its own standards, rather than waiting for mandates to be imposed. "Who better to create asset management standards than the subject matter experts in the utility industry?" said Essix. "If we all agree that we should have standards that will benefit the entire industry, then we should create them ourselves." PUF

Ongoing supply chain issues brought on by the pandemic, increased weather and environmental impacts, and widespread grid transformation initiatives are creating greater urgency and pressure on utilities to manage their assets effectively. Along with an increased focus on asset management has come a heightened awareness of the need for industry standards.



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Effective Asset Management

Setting the Standards

BY AEIC CEO STEVE HAUSER

Asset Management has always been an integral function of electric utility operations. The ability to procure, deploy, monitor, and maintain the parts and equipment needed to operate the grid is the backbone of every utility's duty to keep the lights on and is essential to improving efficiency, reliability, and safety while managing costs and environmental impacts.

However, ongoing supply chain issues brought on by the pandemic, increased weather and environmental impacts, and widespread grid transformation initiatives are creating greater urgency and pressure on utilities to manage their assets effectively. Along with an increased focus on asset management has come a heightened awareness of the need for industry standards.

"We're seeing the shift within our industry to the importance of asset management," said Chad Richwalski, Manager of Electric Asset Management, Northern Indiana Public Service Company (NIPSCO), one of the six energy delivery companies of NiSource. "However, one of the challenges we face is that, while individual companies are focusing on what's important to them as they replace an aging fleet or modernize a plant, the standardization across the industry is lacking."

This lack of standardization applies to an incredibly wide range of utility assets, from existing grid components such as transformers and breakers to new apparatus and equipment, including advanced metering infrastructure (AMI), line-sensing technologies, and drone fleets. The absence of standards can cause day-to-day challenges for the routine maintenance and reliability of the grid, particularly when supply chain issues make critical grid resources scarce.

Often, utilities aren't able to source compatible parts and components from each other or even from different operational areas within their own company. When a utility has a storm outage event and mutual aid crews from other utilities come to assist in restoration efforts, they may bring with them different assets and equipment. This can delay restoration time and also introduces a lot of potential risk that could be avoided through increased standardization.

"The inherent problem is that our systems can be very different across utilities," said Chris Jarnigan, Principal Engineer, Southern Company. "But we've got to start somewhere. We need to start working together if we're ever going to achieve standards that benefit us all."

While the Institute of Electrical and Electronics Engineers (IEEE) does define standards for end-of-life indicators for grid components, the industry's overall operating guideline has essentially been for each utility to inspect and maintain its system as it has seen historically fit. As a result, utilities may use different equipment and different approaches to inspection, maintenance, and refurbishment or replacement. This means there is no universal method or best practice for managing assets and measuring performance over their lifecycle, making it hard to gather data to drive decision making.

"It is hard to make improvements and to perform benchmarking activities without standards," said Yvonne Essix, Power Delivery Shared Services General Manager, Alabama Power Company and Chairperson of AEIC's Electric Power Apparatus Committee (EPAC). "Right now, there is no basis to measure how well assets are performing."

(Cont. on page 89)

EPAC's philosophy is that the industry can and must work together to proactively and voluntarily advance its own standards, rather than waiting for mandates to be imposed.

Steve Hauser is CEO of the Association of Edison Illuminating Companies.

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Julie Fedorchak, NARUC President



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