

POWER PANEL DISCUSSIONS Green Energy: An Evolution, not a Revolution

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Alan Ross: Hi, I'm Alan Ross, I'm the managing editor of Power Systems Technology and Transformer Technology. I'd like to thank my guests. Denis Phares from Dragonfly Energy, Bud Collins from AESI, and Kevin Schneider from PNNL for joining me today for this Power Panel discussion.

ARE WE AT A TIPPING POINT?

At the RE+ Conference this past September, it felt very much like a “tipping point”, the point at which an idea becomes so powerful that the speed of change becomes virtually unstoppable. It is when the momentum and the weight of change pushes through previous barriers. I believe we saw that at RE+ and our guests can address this tipping point since they are all experts in the field.

Denis, your thoughts please?

Denis Phares: Yes, I agree with you, Alan. I think that we are very much at a tipping point,

or an inflection point that, I would say, was largely driven by the onset of the electrification of transportation.

There has been a focus on designing batteries for propulsion, for vehicles, as they become increasingly popular. But a by-product of that is we're transitioning a lot of that power from the internal combustion engine to the grid.

This creates more stress on the grid, so there are two things that happened with this transition in transportation. First, the development of better batteries. And second is the transition of a lot of this power onto the grid, so the combination of that creates the question, how do we stabilize the grid? How do we do so in a way that we're not producing more gas or coal plants, but how can we incorporate more renewable energy?

And, of course, the answer to that is you need a buffer, and that buffer is storage, and that storage is typically lithium batteries, because vehicle batteries have demonstrated that we can bring



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Denis Phares



down the cost. We can have more cost-effective solutions than we've ever had in the past when it comes to lithium battery storage.

In my view, now that we've hit this tipping point, we're looking at batteries differently than we have before, when it was strictly for propulsion. Now we're looking at batteries for how to lower the levelized cost rather than increase the yield, or decrease the charging time or increase the range. How do you lower the levelized cost of the storage such that when you combine it with whatever renewable source you want to use so that you have a stable renewable source of electricity that it is cost competitive or even cheaper?

And ultimately, the big change happens when it makes financial sense. So that's where we are right now: how do we make this cost-effective to deploy on a wide scale? This is related to the availability of the natural resources, particularly lithium. How do we make manufacturing more cost effective? And how do we improve the chemistry in order to have long cycle life?

Because the levelized cost is basically the manufacturing cost amortized over the life of the battery.

AR Excellent insight, Denis.
Bud, same question.

Bud Collins: First, I very much agree with what Denis said, about revolution, pushing the requirements for change, and how we generate electricity and how we distribute it. But I also think that there's some other factors at play when you look at the cost of storage as if it's a part of the grid.

You know, back in the early, the late 2000's, we saw many utilities that were forward-thinking allowing storage to play a role in frequency regulation, and, at that time, we were talking about a \$1,000 a kilowatt hour for a system.

Today, we're talking about \$165 a kilowatt hour for a system, so prices have come down tremendously.

As costs have come down, you can look at other opportunities. We passed the time of being able to replace a gas peaker plant cost effectively with storage years ago.

As we continue to develop new chemistries, we can make better systems that last longer to make it more reliable for deploying storage in a variety of other use cases; it becomes a viable business offering.

In the last three years we went from a very nascent industry into it being a real game now. It's a real business with a lot of new entrants. As you said at the show last year in 2023, we saw 2500 exhibitors.

There are a lot of people getting into storage, whether it be manufacturers, developers, IPPs, even some of the traditional fuel companies. The oil companies are getting into storage. So, we're excited about the industry. We're excited about the growth.

But I don't think that anybody has really figured out how much storage really will be needed, because I think the proliferation of electric vehicles is just starting.

Also, the change from fossil fuel, heating your homes, to pure electric, and those things are going to put a tremendous strain on the distribution networks, the transmission networks. Everything is going to change in the next 10, 15, 20 years.

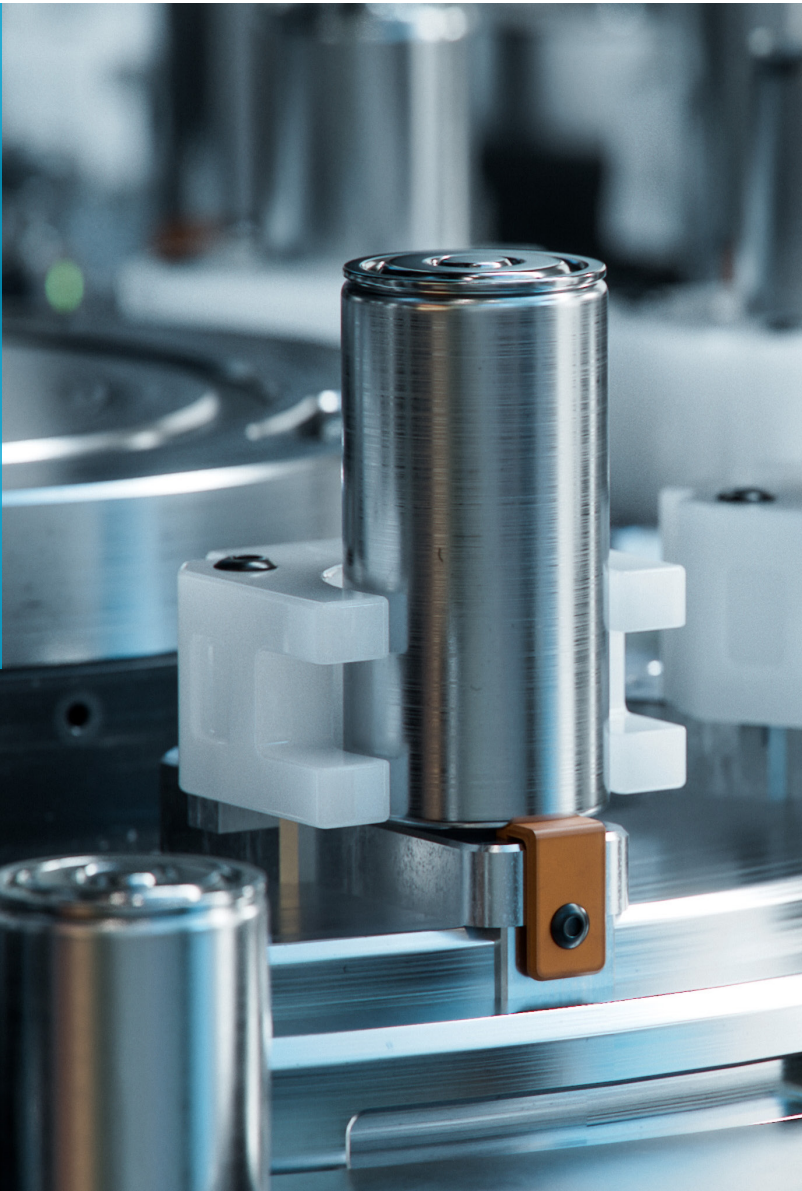
AR Excellent Bud, thank you. Kevin, share with us what PNNL, and you specifically, are doing within this space.

Kevin Schneider: I would say that I think the key is how we take this from an academic exercise and transition it into something that will work. Not just in the laboratory, but at scale, because this goes back to your earlier comment of grid scale. People don't always understand the actual scale that we're dealing with when you talk about a full inter-connected power system.



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Bud Collins



When you look at this inflection point, in my mind, it's really due to three things that have been hit on a bit here.

The first is that the technology is advancing. There's more dedicated research going on where we are riding on the coattails of mobile phones, as lithium-ion batteries were being developed there.

A number of other areas such as electric vehicles where the technology, on its own, is advancing.

The other one is the regulatory and policy environment. It's slowly changing because we've always needed energy storage. The technology is starting to show that we can have more things we could do, but until the regulatory and policy catches up and says, *You can't do it*, that really doesn't manifest itself.

And then finally, the third one that brings it all together, is the business case.

If you have the technology, the regulatory and policy environment, then you can build the business case.

Then you have the tipping point because multiple stakeholders can take this new technology with ways to make money with it, solve problems, and that's what really differentiates it from a DOE funded field demonstration to a mature technology that spins off companies that stand on their own and have growing quarterly earnings.

WHAT ARE POSSIBLE DANGERS WE COULD FACE DURING THE GREEN TRANSITION?

AR Let's move on. When you're looking at the industry as a whole, you can see at how far we've come.

In the TV show *Lost in Space* there was a robot, and every time there was any danger the robot's arms would flap, and it would say: *Danger, Will*



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I don't understand why the rest of the industry hasn't done what they should do to solve the problem [of battery safety].

Bud Collins

Robinson, danger! And then you'd have to wait until the next episode to find out what that danger was about. Well, let me flap my arms at you all and say, *danger, gentleman, danger!*

What are the dangers that we face going forward? Some of the things that are the unintended consequences of our actions or just, hey, we did not see it coming?

Bud, let's start with you. Talk about the future and the dangers we face in our industry, specifically related to storage.

BC One of the things, and it was mentioned before, I think both by Kevin and Denis, is some level of sustainable domestic production. It is necessary for security, and in general, for our economy. We've got to make sure that we have the governmental tempo and guidance, and structure support. If we don't have that domestic production, then we'll be in danger, relying on maybe still be China, maybe it will be another country. That's one thing that poses a risk.

Every day, when I wake up, the first thing I do, I check the news feed and I say, did I have enough? Did somebody have another fire or an explosion in energy storage? To me, that is, A, unacceptable to have, and, B, I don't understand why the rest of the industry hasn't done what they should do to solve the problem.

We took a completely different approach with our system.

We're looking forward to not having the issues that other people have had, because it causes a problem with trying to get something permanent locally. The people with the pitchforks come out and say, *No, you're not going to put that in my backyard, because I saw that Tesla burning down the street, or, I heard about a fire in New York, and I don't want that in my street, in my town.*

I think it's really up to the industry to self police itself. It's not going to be standards or NSBA standards, it's going to be the industry itself that says, *Dammit, I don't want to have thermal runaway.* It's more than one cell in a system, because that's manageable and then we push the cell industry to not have thermal runaway period.

AR Excellent. If you all remember, it was what about 20 years ago where the largest lithium-ion utility scale in Hawaii melted down to the ground.

BC That was lead acid. I Had a conversation with the with the woman who chose that company, that supplier over lithium and sure, we were laughing about it,

but it's not very funny that the people that owned it lost the money. But it wasn't the technology. It was absolutely application of the technology and how it was operated. Lead acid batteries are perfectly fine. You just have to treat them nice.

AR All right, it was a mess. I worked on behalf of an insurance company which insured that facility. The company that made it went out of business, I believe.

Denis, you mentioned solid state battery. Let me follow up on that, because you mentioned safety. One of the things that you all have been working on is the idea of using technology to create a safer system. Talk a little bit about that.

DP Batteries can be made very safe, especially with lithium-ion phosphate cathodes you can really reduce the possibility of a thermal runaway which of course it is each time it happens, it's awful for the industry as a whole.

We look at it from a different point of view - if you have a large installation in a home, then it's not just the potential for thermal runaway, but the flammability of the electrolyte itself. And so, we are looking at how we can remove the potential for even the contribution of the batteries to an existing fire. Because in homes you can get electrical fires and, if you've got a large battery there, then that fire is that much harder to put out. Therefore, we've been focusing our efforts on solid-state batteries.

The research on solid-state batteries is not focused on those metrics. You know, you put in a solid electrolyte to block dendrites and allow for lithium metal anode, or even an anode list battery, and all of a sudden, you got really fast charging and very high energy density. So it's a little bit of a different way that we look at it in terms of our approach, and it really is the reason we did that. Because of the manufacturing process, the powder coating process just lends itself perfectly to a ceramic-heavy composite electrolyte, but I also want to address your question about danger ahead.

I don't look at it like that, as much as the opportunity that awaits. It's historically huge, in terms of that we can change the economics of this country if we can keep things domestic.

This is the future, you know. If we go back to a fossil-fuel-based economy globally, then we're playing with fire. Literally.

But the fact that we could actually take the lithium-ion battery, or just storage in general, which is an American innovation anyway, and just lead the world again and drive the economy,



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You need to have enough trust between the manufacturers and society... We're moving fast, but we're making sure we take the due diligence regarding safety concerns.

Kevin Schneider





Microgrids - I love them, I think they're going to be a part of the future... the technology of microgrids with batteries is here today.

Kevin Schneider



I think will put this country back on a path of innovation and profitability as a country that I think we are, we desperately need right now.

AR Excellent, excellent. So, Kevin, last to comment on the danger.

KS I think it goes back to what Bud said about building trust, because you're dealing with something inherently has a lot of energy. It's never going to be 100% safe. There's always going to be an instance or two of a risky situation, or there'll be a certain challenge.

But you need to have enough trust between the manufacturers and society that they say, *OK, it happened, but we know that these folks are doing their due diligence, doing the proper engineering so that we can move forward.* Because what we're looking at as an industry, it's going to have to move very fast to get to all those things that Denis was talking about, building local capacity.

All the new technologies are going to have to move fast. And then these devices are going to reside there. This is going to be happening on utility scale for 15, possibly 20 plus years. Over that timeframe, there will be events that are going to have negative press, so how do we make sure that we build that trust between the developers that say *no*?

Yes, we're moving fast, but we're making sure we take the due diligence regarding safety concerns. We're looking at new chemistries, and how do we build that together? That's going to be tough, and I think it's going to be one of the things that we really have to focus on, in order for it to be successful.

AUDIENCE QUESTIONS

AR We've got a lot more questions than we have time to answer. I'll go through the ones I've got really quickly.

Is there documentation showing that BESS implementation is a lower cost solution compared to a gas gen solution? Let's start with you, Bud, what does that mean?

BC Like I was saying earlier, you when we crossed that thousand-dollar-per-kilowatt-hour threshold, which was years ago, that's really the threshold where you don't put in a gas peaker. The battery can provide that. We're not talking about gas generation for baseload, we're talking about a peaker plant. I know you're talking about 2-4 hours worth of storage. We're already there.

AR Fortunately, we already have a lot of gas peaker plants and shale oil pumping, we're trying to get gas to become so cheap that you saw a lot of utilities get those peaker plants. When we started closing down coal plants, you had to now use some of them. They weren't just peaker plants anymore, some of them. You had to get your normal generation from them.

But good point. Anybody else, comment on that?

KS I guess I would add one thing. Bud is absolutely right. There are economic cases where it pencils out right now. But I would also look at extreme events, resiliency type events.

People are used to situations where a big storm comes through, and they are blacked out, maybe, and you've got enough backup fuel on hand for a little bit of time. But if you have these hybrid systems that have some solar and batteries, they can operate not necessarily indefinitely, but they can go a lot longer.

I'm up here in Seattle, one of the big concerns we have is a Cascadia earthquake event. We're 100 years past due, if that ever hits, you will not be able to get fuel in, probably for weeks. Not that solar is necessarily the perfect resource in Seattle, but in summertime you could possibly run 24/7 because you've got storage and some renewables.

It is, as I say, not an either-or, but right now there are some cases where the batteries went out, hands down.

AR You just hit on one of the other questions, I want to stay on it.

The question is, and the question was posed more in a negative way, how does the advancement of large-scale, utility-scale storage impact the resiliency, reliability, and stability of the grid?

So, you might have just answered it, but it's talked about more than just resiliency.

KS I'd break that into two parts. One is your local resiliency. If you have a big storm that comes by, energy storage could power up a house, or a small community.

We saw this down in Florida during one of the big storms, where they had a whole plan developed that rode through on batteries and solar the whole time.

That's one example, but if you start talking about very large scale, gigawatt-scale energy storage on the bulk system, I would say it has the technical potential to significantly improve the system. When you've got technologies like grid-forming inverters, there are very fast controls. They can stabilize instabilities in the system, and they can be a real benefit.

The real challenge with that, though, is that once you have a single utility, we've got multiple utilities operating the system. There are different power plants in different locations, so co-ordination becomes an issue. So where I'm going with this is that they have the technical potential. They can absolutely stabilize the system, if we don't learn how to do it in the context of the larger system that could actually cause instabilities in the system, which is true of any large-scale resource. So that's an opportunity, but also a caution.

AR Thank you, Bud, Denis, comment on that.

DP I would agree that the resiliency is really optimized when you have distributed generation and distributed storage.

We've talked about the grid edge before, Alan, and the fact that you can generate and store at the edge means that locally you have more resiliency.

AR What is the role of storage in micro grids? How important is it and what have we done, and what are you seeing out there, because there are more and more opportunities?

I know there's a bakery in California, they have six plants. Bakeries usually emit heat, right? And they are off the grid. One of the big reasons they're off is because of storage. They use primarily solar, some wind, but storage is the most significant. They're not using Southern Cal Edison or PG&E anymore, and I know that's bad for those utilities, but it is good for us, and good for us who eat bread.

Let's talk about the future of these microgrids and why storage will play a role in it, and how storage is already playing a role on it. Let's start with you, Bud.

BC When we talk about microgrids, you can go from having a small cluster of homes or a cluster of businesses, or a microgrid could be a 10-megawatt type generating system.

One of the biggest things about distributed energy storage are really the regulations. California continues to lead in setting markets and allowing for storage to participate in grid-scale activities. So, now you have things that are behind the meter; a lot of businesses, large buildings, they've got storage deployed for their systems to give them resiliency. But that's an asset sitting there that could earn some money, and now they can participate in grid activities. That's a unique opportunity in California. We want to see that all across the whole country.

All utilities that allow that participation do so because that will give us that resiliency. If you look at the amount of money that it's going to take to strengthen the distribution network and change the distribution network to bring double the power to the homes, because they're going to have EVs, and they're going to be all electric, that's not going to happen very quickly. There's a lot of capital. It has to be deployed. So, storage plays a big role in fitting in there, and cutting down on the need to do those big upgrades, where storage can handle those peaks, those long periods of time when the grid is just overstressed, or there's no power grid.

AR Same question, Denis, and we're coming to an end here, so you're going to be our last, Kevin, on this one.

DP I apologize for pre-empting that question, because that was my point in terms of the distributed nature of it.

But just to expand on that, I think the exciting part of it is the ability of these distributed and micro networks to contribute to a very smart grid, a software-driven grid, where we can optimize and minimize transmission and optimize efficiency. I think that's the world where we're headed. That's the grid that we're heading towards when we start to talk about distributed generation and storage.

AR Excellent. So, Kevin, we're at the end here. The last word.

KS Microgrids - I love them, I think they're going to be a part of the future. It's not an either-or. I think we're going to have a bulk system that provides us a lot of economic benefit. Microgrids can help us during local

events, as well as be collaborative partners in that.

I would say that the technology of microgrids with batteries is here today. I've toured Duke Energy's Mount Hollie microgrid, all inverter-based, transition is seamless, you can't tell it. I toured a ship yard in Hawaii that 95% of the time ran off batteries and solar. That's a shipyard, a heavy industrial environment, and they were able to do it.

I'm not going to say it's turnkey off the shelf, but it's something that can be bought today, and the technology is quite advanced.

AR We've come to an end. You mentioned this whole concept of inter-operability, which is using software, making grid smarter, and being able to level throughout the grid. This requires a lot of collaboration between a lot of organizations from the federal government to the municipals and the co-ops and the IOUs. I think it's going to be driven by economics, and, as you said, Denis, we've got to have a secure nation that we can supply.

This, to me, is Henry Ford, when he created the assembly line. If he didn't have a national program to build gas stations across the country, no matter how many Model T or Model A Fords he built, they wouldn't have been able to get anywhere because Stanley Steamer had everything he needed - water and wood. It was all around. You didn't have gas stations in Peoria, and they had to make sure that they're there, and it was a national project. Of course, Standard Oil had a lot to do with it, the Rockefellers, and so on. That became a national mandate in order to create what we now live with, which is a modern transportation system powered by gas. That's where we are. That's my last word.

Kevin Schneider from PNNL, thank you so much, brilliant. Denis Phares from Dragonfly Energy. Once again, I appreciate you, brother. You always bring great perspective and insight. Bud Collins from AESI, thank you for joining us. You guys have been brilliant, and we appreciate it very much. This has been a Power Panel discussion from APC media. Thank you all for joining us.



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