MEREDITH: Ladies and gentlemen, we are going to begin in just a moment here. In the meantime, on the screen, we’re going to share some more success stories from DOE investments that helped solve the industry’s energy storage challenges.

Well, welcome back for our next session. This is the Rapid Operational Validation Initiative: Industry Roundtable. Please join me in welcoming Eric Hsieh from the Office of Electricity to kick off this discussion. Eric, I will turn it over to you.

ERIC HSIEH: Thank you, Meredith. And if you can hear me, my name is Eric Hsieh, I’m the Director from Grid Components and Systems at the Office of Electricity, and I’m also one of the co-leads for the Storage Earthshot. If we could go to the next slide, I will be very quick and get out of the way. You’ve heard this morning today about the larger administration goals, and all of the tools we have to achieve the Storage Earthshot.

And I want to talk about one specific problem. There is a mismatch in time in terms of our potential ability to deploy things fast enough to achieve the decarbonization goals for the grid by 2035. So, power purchase agreements are the contracts that often finance and build new clean resources, and they typically run 15 to 20 years. If you allow enough time for manufacturing, permitting, interconnections, construction, in order to be operational by 2035 any new technologies would probably need to be ready for them by 2030.

So, under any scenario of achieving this goal, there’s less time on the calendar between now and deployment than the time these technologies would be in the ground. So this panel is dedicated to how we could breach that gap. So the ability to validate technology faster than time runs on the calendar. And so to introduce the rest of this panel, I’m going to turn it over to the other Eric.

ERIC DUFEK: All right, thank you, Eric. I’ll wait here just for a second, so I can share. All right. So, thank you. I’m going to talk a little bit about kind of where the National Laboratories actually fit in, within the Rapid Operational Validation Initiative, a ROVI kind of framework, and if we can go ahead and move on to the next slide. One of the problems that’s kind of been highlighted throughout the day today is that we’re really looking at kind of an evolving grid where there’s a lot of different complex demands that are emerging. Whether it’s integration of more clean energy, or whether it’s the advance adoption of electric vehicles, kind of did it.

The grid as we know it, or as we used to know it, is different now, and it going to continue to evolve. So we need to find a way to actually bring energy storage continually into the mix and really know what the performance of that storage is going to look like, so that we can have both an efficient and robust design. But also be able to help all the industry and everybody else on the deployment side as well as the development side. So that’s kind of where I’m going to focus a lot of my discussion today.

And then the other thing that is kind of key to this discussion is that if you look at how we’ve typically done stuff in the past—in terms of developing, validating, and understanding performance—characterization and validation tends to be slow and it tends to be a bit expensive. It takes a lot of time and human labor and effort to actually get. And it can be iterative when you go from material development to kind of the component all the way out to full-system validation.

So kind of what we’re looking at, and this is kind of a group of several different people across the entire DOE National Lab complex, is that there’s expanding artificial intelligence and machine learning toolsets and capabilities that are actually able to, or we feel will be able to, do rapid, accurate, and cost-effective performance characterization and provide the quantitatively reliable certainty to everybody that is both developing and deploying different assets.

And one of the things that’s kind of central to this theme, is that while the National Lab is considered as maybe critical leaders in terms of how we do the tool development and go through the process, there really needs to be a coherent public/private kind of coordination in this effort because there’s a lot of different things that actually are going to be needed. If you go ahead and move on to the next slide.

What we can see, and Eric just actually touched on this, is that if we wanted to see deployments in 2035, by 2030 we need to actually know performance with uncertainty, and we need to really understand flexible use cases. And I can’t really stress the use case in understanding how systems are going to be used enough, in part because a lot of what we see for performance is directly tied to how you use the system.

So we’re going to need a lot of data and understand how a lot of that data emerges that is coordinated and controlled as we move from kind of the current state of the art all the way out to the deployment. So where does that put this now? So right now, as you start thinking about how to develop the frameworks, how to identify the use cases, and how do we start to use existing data and methods from kind of some of the current and near-emerging technologies so that we can actually develop kind of the framework to a more broad and widespread set of technologies that are going to continue to emerge over the next 10 years or so. So if we move on to the next slide, please.

Some of the gaps that we actually see, and he kind of hit on this a little bit as well, is that there are data needs that we have to address. I’ll talk about that more in the next slide. And then we also need to understand how we transition kind of across an iterative live-testing cycle. So how do we span length scales and kind of time scales as we move forward? Next slide, please.

All right. So how do we harness the capabilities across the lab? And if you kind of look at the large blue circle that says, “Data Needs,” this is where a lot of the National Labs actually have a lot of very good capabilities that allow us to coordinate how we use data, in both an open setting, so open would be a complete open source, people can see what all the data is, all the tools that are available, and also in a restricted-access setting.

So, if something is proprietary and not necessarily something that you want the entire world to see, we can also deal with that data. But we can clearly link and coordinate between those two sets so that we can continue to evolve the entire system without actually developing or creating the need to develop a specific tool for every single activity.

I’ve also kind of highlighted here that within this large framework of kind of data there is the ability to develop tools that can transition between different types of storage. And I’ve just called that three here. It’s by no means inclusive of every type of storage. But really the ability to have these tools in the datasets across systems is something that we’re very effectively coordinating in creating data hubs that allow both open as well as the protected or controlled data.

And when we capture this data, we really use it to find use cases that I had mentioned as well as do a lot of performance characterization, failure mode analysis, at a component level as well as at the system level, so that by 2030 we have those final performance projections and validations kind of moving forward. So on the next slide, we also look and see that there’s a lot of capabilities to span length scales. So the data that we’re generating and needing has to align with different stories and use cases, or different technologies, as they go from kind of the fundamental and even molecular or atomic level on the left side of the screen, all the way out to the full-system level on the right side.

So in this instance, if we understand that our capturing data as new materials are developed, we can actually harness that information as we go through maybe high throughput formulation, prototyping, and then evaluation. And if we know what the key degradation aspects are at the materials level, we can actually bring that into our analysis, so we have a much finer level of understanding and the ability to actually apply physics when we use the machine learning and the AI techniques. All right, so, next slide.

So, one of the areas, and this is kind of one of the last kind of high-level slides in terms of talking about technical work, is that the labs have already started to develop a lot of the artificial intelligence and machine learning skillsets and toolsets that are already needed. And I highlight three here. These are not completely inclusive, but I highlight them for a few reasons.

So in the first one on the left, the ability to actually look at different types of data, in this case spectroscopic data, allows different components to be clearly identified, and that allows us to understand how different components interact and maybe play a key role within the overall performance of the storage device. Kind of in the middle, one of the things that I highlighted pretty early on is that a lot of the current framework for doing validation of performance is very labor intensive.

So in this set of work, there’s already been tools that have been developed that reduce the amount of test sets that actually need to be developed. So you can actually go in, reduce your design of experiment so that you can actually very specifically target the areas that you need to do, so you can use that for projections. And then on the far right, the ability to use synthetic data, or digital twinning, discern different systems is extremely important.

So what’s kind of shown here is that there’s the ability using a very fine physics comb to actually project what the different failure modes are going to look like to generate tens of thousands of different datasets for analysis. And what that does is it allows us to capture a lot of the base information that we need in weeks versus years of actual testing so that we can actually move things very significantly forward and align that with actual experimental data, whether it’s at the component or the actual system. Next slide, please.

All right, so we’ve got a lot of this. I talked about the life performance and failure mode prediction. We can also do something very similar if you’re starting to think about safety or abuse response. Design and performance optimization as well, if you have the physics aligned, you automatically have a lot of the information to think about how you design a system, and also doing the materials discovery. I’ve listed a few of the technologies as well that are already aligned.

And this is, again, not completely inclusive, but this is where we already have existing data that we can start to build tools off of. And then on the last slide, I believe, I’ve listed a few of the different open sources of data that we actually have kind of already within the National Lab framework.

These aren’t completely inclusive, but they kind of give the view that we already have some of these tools openly available. We have other tools that aren’t completely open, or they maybe—they’ve restricted access on them. But we already have kind of the base of tools that we need to move forward. I believe that’s the last slide, and I’ll hand it over to Sue Babinec.

SUE: We can begin in a minute. Whitney, did you want to put up the questionnaire?

WHITNEY: Absolutely. The poll will show up here in just one moment.

SUE: Okay. All right. And then if we can move—there we go. Did you want to describe it, Whitney?

WHITNEY: We’ll have a poll up on the bottom right hand of your screen. We have got several questions in there for you. So please take a couple of minutes. We’re going to have it open for the majority of the rest of the session. So you can go and answer your questions when you have a moment. And then I’ll turn it back on over to you, Sue.

SUE: All right. Perhaps if we could put the cover slide up. And the second one, go one before that, please. Now there should be a cover slide. Keep going. Forward. I think you were missing the cover slide. Oops, somehow we lost the cover slide. Is that correct? If you go one back to that, Whitney. All right. Well, perhaps we can move forward. We will? What I’ll do is I’ll begin.

Thank you, everyone. I’m Sue Babinec, hello there. We have a problem right off the bat. Our cover slide is missing, so we don’t have the names of our really wonderful speakers, but let’s begin.

This is the ROVI Industrial Panel. And first of all, many thanks to Eric for stepping us through that really complicated story with a lot of clarity. Now, we’re going to go to the panel for industry feedback. The good news is we have a tremendous panel. You can’t see their names unfortunately, that slide has been lost. So that’s the good news. The bad news is that, despite the tremendous insights and sophisticated perspectives these folks have, we’ve only got 20 minutes. So we’re going to try to trim it down to just a few questions on the ROVI.

So let me first introduce our speakers. We were to have Lola Infante [phonetic], but she became ill this morning, and our hero Ben Kaun has stepped in. Ben began his career as an engineer, and then he got an MBA in Energy from Stanford University. Today, Ben Kaun is a Program Manager for Energy Storage and Distributed Generation at EPRI.

Our second speaker, not listed here, is Brentan Alexander. He’s a scientist with a PhD in electro-chemistry from Stanford. Brentan is the leader focusing on creating the ecosystem which is receptive to new technologies, which are also a part of ROVI. Today, Brentan is the Chief Commercial and Science Officer at New Energy Risk, where they provide insurance solution which enable new technology deployments.

And last, but of course not least, is Craig Horne, a very well-known member of our community. He’s got a broad range of experiences leading now to his position as Managing Director at Energy Storage at Wellhead Electric Company. This is in the Bay area, where now he is building and deploying energy storage hybrids for complicated use cases.

So my apologies to our speakers because their names were not up there, but let’s get right to it. Since ROVI is a new concept, I thought I would just quickly step through what it is in three bullets. Number one, the problem is an information gap problem. Designing deployments and then running them requires accurate understanding of the energy storage durability in various use scenarios.

There’s three parts of this problem. Number one, by this picture here, there are many, many use scenarios, this is, of course, just the tip of the iceberg. The second part of that problem is this diagram on the right here in red. Using lithium ion as an example, the durability versus use case is a complex and very path-dependent feature. We need to have that in order to do the designs and to operate the systems.

The third part, not shown here, is the fact that generating this critical information takes, frankly, years. The estimates we’ve been using are insufficient. This is the information gap. The solution, as Eric said, is we’re going to apply AI and machine learning, which intuitively makes sense. Everybody feels comfortable with that. We have already established in the National Labs that this actually works. But in order for it to address the complexity that we’re talking about here, it needs to mature in order to reach its full potential.

Now in order to do that, as Eric said, the National Labs are leading this, but we need more data and that is where you come in. It won’t be all open data of course, so we need to build on this to get the right approach. So now, what we’re going to do is we’re going to get into the three questions that I’ve listed here. I think, Whitney, if you would like to put all of our speakers up, our panelists. I think that’s what we were going to do. All four of us, we’ve got Ben, Brentan. Whitney, are we going to have everyone all at once?

WHITNEY: Everyone is on my screen. If you cannot see it in the audience, if you could click the layout button in the top right-hand corner, and click “grid,” you’ll be able to see everybody at the same time.

SUE: Okay. All right, so I’m not going to worry about the fact that I can’t really see it. But let’s begin with the first step. This is what we want to talk about, is the information gap. This is the problem. How things work today, how much of a problem is there, what is the characterization information you’ve got. How are you doing it today?

So let’s begin with Ben, who is with EPRI, representing many people in industry, thinking about them. Ben, if you think through the characterization data today and the stories that you hear, the gaps, the problems, can you talk to us about this information gap from your point of view?

BEN: Yeah, so, can you hear me all right? As Sue mentioned, my role is that I manage the research program and storage at EPRI, and in that role I work a lot with electric utilities, so I can speak better to that segment of the industry than the others. But starting out with energy storage, utilities are used to very long-life assets, 30 to 50 years.

Battery energy storage technologies that are available right now typically are guaranteed for 10 to 20 years. So it already kind of raises some eyebrows for the stakeholder group. As a result, and in addition, there’s only been a few years in most of these technologies of actually in-the-ground experience, so we haven't even had the chance to prove out 10 to 20 years.

Put on top of that, continuous technological evolution. So today’s batteries are different than five-years-ago’s batteries. This creates a situation where there’s some insufficient predictive data about what’s going to happen to these assets in the future. As a result of that, some of the business implications are—first of all, there’s going to be a tendency to conservative overdesign, which is going to over potentially increase the cost of pollution.

Usually, the utilities want to push any risk due to this uncertainty back onto the supplier. And so they’re buying performance guarantees and warranties. It’s unclear what the right price is for those things, so they may be overpaying. And then, as you put these systems in, if you have these strings attached, then now, on top of that, there could be the potential for inflexibility of what’s supposed to be kind of the consummate flexible asset in energy storage.

So you want to be able to adapt to whatever is happening out in the world, but now you have strings attached. So we’ve had some experience with this, dealing with data from systems up to this point. Some of the findings we’ve had so far is that the data is not standard. It can be difficult to get it because of various agreements that are in place.

What we’ve been trying to do is create some templates to make it more standard so that the next systems that get procured might have a better chance at being evaluated and consistently compared, so we can help to feed an initiative like this and help to get where we want to get, which is predictive planning operations, maintenance, capabilities, incorporate degradation.

SUE: Well, that’s really interesting. The part that’s very interesting—so you are constrained. Information gap does seem appropriate based on what you just said. So let’s go next, we have to sort of whip through these different speakers. Craig, let’s—I’d like to talk to you next. As you and I were preparing for this panel, we several times got into discussions not just about the degradation profile but also about the many use cases and relating that to projections, which is quite a big deal. Can you talk us through it, this problem in your point of view, please?

CRAIG: Yeah, happy to do, thanks. So at Wellhead, we operate over 10 different power plants here in California. We’ve been in the CAL ASO market—well, we’ve been in California before, it wasn’t CAL ASO—so Wellhead has been heavily involved and experienced in the evolution of the markets here. So as you look to deploying these new technologies, energy storage, whether lithium ion and especially so with what we call next-generation technologies, one of the challenges is the markets are evolving as we’re going through this energy transformation. And we know that the CAL ASO market is going to be substantially different towards the latter part of this decade versus where it is today.

So you put that, map that to the dilemmas that Ben just talked about and the data that’s there, you really have now a two-fold problem. Where you have a limited amount of data that predicts performance, and then a limited amount of insight as to how that performance needs to manifest in order to bring in revenues and provide service to the customers out there. So I think that’s a challenge. And where you have data that, an initiative such as ROVI can come in is help give confidence that even given the clarity or the lack of clarity we have in how these systems would operate, we could see that no matter how that use case may evolve, that we can get a high degree of confidence that this storage asset would be able to respond appropriately.

SUE: So just very briefly, before we go to Brentan, if you were to sort of give like a pie chart where it adds up to 100, how much of this lack of information is causing you to hold off on your deployments versus just design them in a much more conservative way, if you think of those. Does it actually stop you, or you just have to be more conservative and spend more?

CRAIG: Those are conceptually two different pieces of pie, but they actually end up in the same thing because when you go more conservative, you’re increasing your cost, right? You can build in redundancy to get more confidence that you’ll meet certain availability requirements, but that’s driving up your cost. So that can make projects un-economic. So you ultimately kind of end up with the same result. It gets into some things, you know, in terms of financing and there’s different financing structures out there. And so it is an impediment to these projects moving forward quickly.

SUE: All right. Well, thank you very much, and speaking of finance, let’s next move to Brentan. Brentan, if you could just briefly summarize for everyone what your company does because I think that is somewhat new to folks perhaps in this audience. And then get on, if you can reflect on what you’ve heard from Ben and from Craig, and what that means when you’re trying to bring new technologies forward that have zero track record at all.

BRENTAN: Yeah, sure. So I mean, at New Energy Risk, our entire goal is to make more of these technologies bankable and be able to access lower-cost capital financing on the back of the investment grade balance sheets of insurance companies. So transfer risks, whether it’s technical risks or commercial risks, that low cost to capital lenders, institutional lenders, are unwilling to take. And so that takes two forms.

For the lithium ion type grid scale storage stuff, we provide sort of a revenue backstop which, to get to Craig’s point, means we’re taking risks around how the market is going to evolve over time, but it’s also taking risks around how is that battery going to be able to perform in the evolving market and how is that tech going to degrade and change over time.

We also, for new technologies, provide backstops, but it’s a little bit of a different question for those guys. Because it’s less of a question of what’s your capacity fade going to look like over 10 years, and it’s more of a question of am I going to have a really expensive paperweight in 5 years?

And so the data we’re looking for to be able to underwrite insurance solutions to stand behind those is different in both cases. Because the concern of the capital provider, which given for the new technologies is more of a private equity or VC as opposed to an institutional lender, there are different questions.

SUE: That’s really interesting. We’ve been—for everyone out there—this panel and I, we’ve been talking about this for over a week, and every time that we go through it, it’s—more is revealed. But certainly there is an information problem. But let’s get to the second point now, which is really the solution. I mean, AI, machine learning, today everyone says, yes, that makes sense.

But let’s get right down into some of the meat of this. What exactly does it take for the machine learning and the AI to work for you, and are there any barriers? So, each one of you, I’m going to give the same question. We’ll start, we’ll go back to you, Craig. What are the top three things you need from ROVI, from this initiative and how big could this be? Could it make a significant difference in your deployment rate? Thank you.

CRAIG: Yes. So, I think the—if I had to say that for the top three, you know, let me do a little thinking on my feet here. But number one is just understanding how the core materials within the system, how they will hand up within the environment that they’re in, both chemically and from ambient temperatures.

And I know, not so much here in California, but other places, other projects I’ve been involved with over time, you can see some real temperature extremes. Very, very hot, which, actually, you know, we do have that at a project site right now where we’re, you know, temperatures are above 100 degrees for the last month, down to below freezing and stuff.

So I think getting confidence in how these materials will behave in the face of that is very useful. And then just how the different ways that that system will be used when it’s charging, discharging, standby, you know, how that system will respond. Are there any states that will cause damage to that system, or other things that need to be done, where that system has to be taken offline to go through stripping cycles, other things like that and how we can minimize that. That’s another important aspect.

And then, I think the third thing really is then understanding interaction. Because, you know, especially with flow batteries, thermal energy storage, things like that, there’s a lot of materials interaction. There’s a lot of different interfaces than you would encounter in something like lithium ion. And so understanding how those interfaces behave. And they’re not all just material interfaces. Some of those are going to be mechanical interfaces as these things get to scale and stuff. So those are, I think, three things that will be very important to get a handle on.

SUE: Very good. Well thank you so much. Let’s move next to Brentan. If you think about it, just sort of what are the features that you really would need to have? What are perhaps the metrics? What are the level of assurance? What do you need out of ROVI for it to work for you?

BRENTAN: Yeah, well, I probably would echo a lot of what Craig said. I mean for particularly our revenue protection product, which is looking out over the 10, 15 years of a grid-scale asset. Understanding how that technology is going to degrade over time, depending on which market conditions you assume exist in terms of which grid services that battery may go after, which may change over time. How are those different use cases, evolving use cases over time, going to impact the performance of that battery?

And equally important as new chemistries come into the mix, how can we predict the performance of those new chemistries in a similar way, to really short circuit the amount of time that new chemistry has to spend on tests before we can really stand behind it as an insurer in terms of its performance over time? I mean, on our end, we’re all about trying to reduce that cost to capital. So the more we can narrow performance uncertainties over time, that’s reflected in a lower cost product that we can provide, and that’s just for these projects.

SUE: Okay. So that basically, having that information means you can be more precise in your design, which takes the cost down, and with keeping the risk constant. Okay.

BRENTAN: Correct.

SUE: That’s really excellent. So, let’s take that third question to Ben from EPRI. You’ve seen a lot in the role that you have. What are the things, what sort of metrics, what accuracy do you need? And then, what do you need to actually take this information and have folks use it to help their deployments?

BEN: So, you know, I agree with everything that Craig and Brentan said. I’d add, you know, one area where we’ve noticed deficiencies and challenges in our demonstrations of storage to date is that there’s a lot beyond chemistry degradation. So there’s various components in the system design that can go down and result in downtime resulting further in grid-reliability challenges.

So I think looking at failure rates as well as just degradation of chemistries is really important. Ultimately, the outcome we would hope for for an initiative like this would be better tools to support planning and life estimation to evaluate operational decision making, and then to plan proactive maintenance to avoid unplanned maintenance and downtime at the worst times of the year. You don't want your battery going down when it’s 110 degrees in the summer. You want to take it down in the winter when you don't really need it.

SUE: Yes, yes. Okay, so maintenance is a new one. Yes, and certainly based on, Eric and I work on the details of—this planned maintenance is certainly an aspect that would part of this. All right, we have just a few minutes left. Let’s go to the third question, which is the third leg of this stool, which is about data sharing. So as you’ve heard, the idea of AI machine learning for life prediction basically works.

We’ve got demonstrations, but in order to get it to really fine-tune it for this rich deployment landscape that we have coming up, we need more data and we’re going to need some of it from those in industry who are actually out there doing this work and being able.

Really, the question that we want to talk about to just give DOE some initial feedback is, when you think about it, data sharing, is this something that seems like it’s a possibility, or does it seem foreign? And given that all that question, the context of full sharing, of course, is not going to be required, as Eric went through. But what’s your reaction to sharing, and what would it take for you to participate? Let’s start with Brentan, please.

BRENTAN: Yeah, on the insurance industry side, we love data. Insurers vacuum up as much data as they possibly can to better underwrite risks. So they employ armies of statisticians to comb through this stuff. And they’re used to entering into industry or academic relationships to encourage that anonymized sharing of data because it’s important for the industry to have the best data it can to underwrite their risks. So for the insurance industry, I think it’s a win-win. It’s just a natural part of how they do business.

SUE: Okay, great. Ben, from EPRI, what’s your reaction? What do you think, speaking on behalf of both yourself, your perspective, and those that you work with every day? How do we make this work?

BEN: So I think depending on the type of entity, there’s going to be different kinds of sensitivities with sharing data. But looking at utilities and EPRI, we’re a collaborative research organization, so we’re used to sharing research across entities. So a lot of what comes in, the intention is to have some amount of sharing. Electric utilities, I think, look at data primarily—sharing data primarily as a risk. You’ve got to avoid things like personally identifiable information, critical infrastructure information, anything that’s confidential.

And so there’s a governance process that needs to happen to gain the confidence. That’s something that we’ve put a lot of effort in the last couple of years just trying to figure out how do you intake and steward this data so that it can be used for research and different purposes.

You know, so I think that it’s something—there’s definitely interest to do, particularly if there’s some value coming back. So providing data in return for special insights like along what we were talking about, up to this point. How can I plan better, how can I operate better, how can I maintain better if I have new insights based on my data. So definitely see big interest.

We’ve been doing these kinds of collaborations and trying to, as I mentioned earlier, standardize data templates so that the information can be more valuable to help with downstream degradation. But it’s going to take time. We need to get more of these projects built upfront with data sharing kind of considered at the front-end so that it can come out at the end. If we’re coming in at the backend of a project, it’s much more difficult to unwind various confidentiality agreements.

SUE: Thank you, Ben. That’s part of the thing is that there is going to be this huge uptick in the amount of deployments. So no better time to grab hold of this than before all of these deployments start. So let’s finish up here with Craig. From your perspective, you have a real interesting point of view on this with the type of work you do, how likely is it that you’ll be able to participate in this sharing world?

CRAIG: Well, you know, we don't create—we purchase systems from OEMs, folks that are developing the technology and put them in the ground and turn these into power plants. So part of the data sharing would have to be in alignment with that provider, so we are not violating any confidentiality agreements. But outside of that, you know, we’re a commercial organization, so as Ben said, it takes an effort to share data. It has to be managed, that data. So we look at what in return.

And I guess what I’d say what we could get in return is helping, having access to that database, you know, helping us make better decisions that basically can increase our bottom line would be the motivation for doing it.

One other thing that I’d say about data sharing is, I think, a lot of times we get into this focus of okay, the information that’s worthwhile sharing is, like what is the sell to age, what’s the material degradation. But having been through a lot of different aspects, I think there’s a lot of anecdotal information, so to speak, at the project level that could be worth sharing.

So, for example, I had a flow battery company. We put a megawatt-hour flow-battery system out in the field about 6 years, 7 years ago now. And we installed that kind of in the colder months in an almond orchard. And we had to use, electrolytes were heated, hot water temperature. So they were insulated tanks. And all of a sudden, I got reports after they went after about two weeks that there were woodpeckers that were boring holes into the insulation to move in because it was warm, right. So it was a natural repellant that we sprayed the tanks in that scared them away.

But that type of feedback, stuff like that, I think, can also really help when they go outside the lab. There’s a lot of different practical things that you encounter when you turn these technologies from demonstration level, lab scale, when you get to that TRL where you’re putting it out into the field.

SUE: Well, thank you, that’s like a really great story. I mean, nothing like field deployment to get some really good stories. So it sort of all makes sense, but there’s complexity there. The DOE is aware of it, the National Labs, as Eric mentioned. We’ve got processes and ways to work through this, but it helps everyone in the end. So that’s a good part of that. I think before I ask any more questions, let’s pause now. My colleague Vince Sprenkle from PNNL has been monitoring the chat to see if there’s any questions. Vince, do you have any questions that we should bring up now or we can ask some more—

VINCE: We’ve got a few coming in. I think one of the questions came in about, questioning about validating the digital twin concept out there, and whether we need a dedicated system out there that we can validate it. And so I think one question, we know digital twin has been used in other industries. What’s the level of confidence that in your industries and your sectors with the digital twin in there, what do you need to see from that? And, I guess, that gets back to that level of validation for the digital twin concept.

SUE: Okay, so Vince, are these questions meant for the panelists? How comfortable are the panelists with the digital twins, or is this meant for Eric and I?

VINCE: I posed it to the panelists.

SUE: All right, well let’s have at it. Ben or Craig, Brentan? Do you work with digital twins now?

BEN: From the EPRI perspective, my short answer is not really. We don't have any digital twins for the systems that we’ve demonstrated up to this point. It’s something where, I think, you need buy-in from the OEMs to help understand what the real designs are to digitize. And we’ve still been struggling getting the various data points that we need at a granular level, which is a lot less information, I think, than a digital twin would have about the details of construction of those systems.

SUE: Okay. I would say that digital twinning is going to have to happen. And I think Eric of Idaho and I have spoken about that several times. The granularity that you need to have to do the predictions and the information that you need for AI and machine learning is very good at the cell level. It’s more difficult when you get up to the system level. So there has to be some of that that has to be part of the plan to move forward. And I think Eric mentioned that in his slides.

CRAIG: And for us, we would really look at that OEM to provide that digital twin for us to feed in, and, I guess, from everything through the DC level at least if we’re talking about a battery technology. So what we’re putting in this year in this project where I’m at, that’s different than the technology package that we put in at a battery project last year. So we can’t build a new digital twin ourselves for all these different options out there, but they would be extremely valuable, as I said, in predicting behavior in the face of uncertain market conditions and getting comfortable with that with our financiers and stuff.

SUE: Brentan, do they use digital twinning in new technologies?

BRENTAN: I think I follow what Craig says, is we rely on the OEMs or the startups or whoever we’re running to provide us that kind of information.

SUE: Okay, Vince, any next questions?

VINCE: Yeah, I’ll try to summarize here a little bit, but raised the question around the focus of ROVI is validating that these technologies are going to last for the desired timeframe. We have a new technology, we can’t wait like lithium ion for 40 years for it to become mature enough that people are comfortable with. But we do have a long-duration storage shot goal of five cents per kilowatt-hour. So how much of this work needs to be start looking at, in addition to that validating the performance, having the cost element in there? Or is that something that we’ll work out separately, well, once you have kind of the performance validated, you make that decision almost independently.

SUE: So, in this question, they want to talk about is cost as a part of the performance?

VINCE: The question was around us hitting the levelized cost of storage goal with it.

SUE: Oh, got it.

VINCE: Whereas the ROVI’s really is focused on validation. So I was trying to merge that into, you know, it’s not necessarily built in at a cost, and being able to hit that cost goal.

SUE: Oh, I see what you’re saying, yeah.

CRAIG: How could ROVI help then? I mean, I guess I would say, you know, having designed a bunch of different storage projects, something that, you know, the data that you have from ROVI would help you optimize that design, so you could reduce the amount of overbuild or redundancy you have in order to still meet your obligations for power capacity, duration, availability, and efficiency. Which are probably milestones for any project.

BEN: Yeah, and I would add operations, you know, optimizing operation, dispatch choices as well as that planning maintenance appropriately. It’s all the downstream costs that affect total cost of ownership, maybe not as much the upfront. Well, Craig did bring up the overbuild thing—so, overbuild and then these other degradation-related costs downstream.

SUE: Brentan, did you—

BRENTAN: And I would add, more confidence in all that moving forward, which lowers the soft costs of actually getting stuff in the ground, which is all part of the same equation.

SUE: Yeah. My two cents are it helps both the numerator and the denominator. As Craig was saying is, if you have more accuracy you can more effectively design your system. There’s less overbuild, so the numerator, that cost, will be smaller because you have a greater certainty. And then the denominator, the number of cycles you have, you will be able to optimize that better because you’ll have better knowledge and the better ability to relate that performance and that design to what’s going to happen in a particular use case. It’s an interesting question. Okay, any others?

VINCE: Yeah, I notice that we’re running at the end here. Sue, did you want to follow up, an end question, or do you want me to ask another?

SUE: Well, actually perhaps I will ask one follow-up question. I think we have just two minutes. And it is a twist. I’ve spoken to our panelists about it. If you think about everything that we’ve discussed so far, and we could have discussed, of course, at greater length, that’s taking the world as we know it and looking forward based on what we know.

If you take that same framework and now you add climate change to it, okay, there’s going to be greater uncertainty, the averages are moving in a different direction, the number of extreme events due to weather, or the demand on heating, or the demand on air conditioning will change. The demands are going to change. All these changes that are going to occur related to climate change.

If you rethink what we’ve just discussed, is there any part of—which metrics or which action, you know, which features are more important to you in order to help deal with climate change, than if we had a baseline situation? Who would like to go first? Go with it, Ben.

BEN: I have a quick answer. I think understanding extreme weather events and kind of combining the point of actual downtime with degradation, understanding those potential concurrent failures would be important. For example, what happens if lightning strikes your system, and it’s 110 degrees out, and you roast your batteries, what kind of impacts would you expect from those kind of longer-tail events?

SUE: Okay. Excellent. Craig?

CRAIG: Yes. I guess I would add in there, you know, flexibility, right? Do I have a system that’s flexible where I can add power, I can add duration with that, what would be the complications to doing that? And then, what happens if I’m cut off from supply chain, so I can’t compensate for degradation as much? Right? That’s one of the things with lithium ion, you do have to bring in fresh product to make up for that degradation. So if I don’t have to do that, that gives me more optionality in how I operate that system in the face of uncertainty.

SUE: Okay. So, flexibility’s important. That totally—it’s just very intuitive. And our final answer from Brentan, do you have anything you’d like to add about climate change from the role that you play, or actually any perspective?

BRENTAN: Yeah, well I mean, the insurers are always worried about the tail risks, to pick up on what Ben said, the ability to understand what that tail risk looks like, and put some bounds around it. Particularly around performance of the batteries, you know, potentially above and beyond what has been shown to date using some of the underlying machine learning and physics there, to get better prediction of it. It just, again, helps to lower the uncertainties in the underwriting.

SUE: Okay, all right. Well, I think that perhaps we should stop now. I’d just make a few comments here. First of all, I’d very much like to thank our panelists, Craig, and Ben, and Brentan, thank you very much. And I think that Whitney or perhaps Meredith would like to say something before we walk away about the polling that we have. Would you like to take it away?

MEREDITH: We are going to be calculating all of the polls, and we will be sharing those out afterwards. But we do have everybody here on this screen, all of our panelists for this great discussion. We really appreciate it, and all your valuable insight. As I’ve said throughout the day, we will get back to you all with some additional Q&A. But feel free to reach out to the team that is here. So we are going to take our final break of the day. Stretch your legs, get your afternoon pick-me-up, or lunch depending on your time zone. We are going to start back here at 3 p.m., noon Pacific Time, for our final session of the day. So thank, you everyone.

**[End of File]**