MALE: That, I thought was fantastic. I think – if you all remember the clean tech boom that we saw in the mid-2000s, late 2000s, I think everybody, venture capitalists, including people like me, misunderstood how hard it was to commercialize hard tech. We've learned a lot of lessons, and I think that panel has sort of walked us through things that we ought to be doing differently now, because we've learned all those lessons of 15 years ago.

 We should keep moving. Remember to the go to the commercialization breakout in 45 minutes if you're interested. Now, before you get to commercialization barriers, we've got to think about the technology, right? We'd better have these diversity of technologies, these different, I guess, horses for that race that we're interested in. So let's bring out the next panel that is going to be very interested in talking about, how do we incentivize developing those technologies? My colleague Vince Sprenkle from Pacific Northwest National Lab is going to be the moderator. He's a Strategic Advisor for Energy Storage at PNNL, so Vince, the floor is yours.

VINCENT SPRENKLE: So welcome to our panel today, talking about partnerships to propel technology R&D. As Venkat [phonetic] mentioned, I'm Vince Sprenkle from PNNL. I have been leading the technology development group for the Energy Storage Grand Challenge Grand Laboratory team, along with Michael Starke at Oak Ridge.

 What we really wanted to focus this panel on was, how do we move the conversation from having 1,000 different voices saying, "This is what we need to grow our storage developments," to being able to consolidate and find the most important things within the industry and being able to move that, especially as we're looking at very aggressive 2035 goals for a lot of these long-duration storage technologies? So we've assembled this panel to talk about – these are examples of where people have been – where companies have been able to collaborate. How do they find that common ground to move forward? And we wanted to explore what works, what doesn't work, and just kind of go in depth a little bit more.

 So what we'll do is, we will turn this over to each of our panelists, give them about five minutes to – sorry, I'm getting a little feedback – give them about five minutes to go through and introduce themselves and talk about the collaborations they've been involved with, and then we will have a round of questions that we'll ask here. So with that, Jim, I'll turn it over to you first.

JIM GREENBERGER: Great, thanks a lot, Vince. My name is Jim Greenberger. I'm the Executive Director of NAATBatt International. NAATBatt International is a not-for-profit trade association. We're about 14 years old. We have just coming up on 250 corporate and research institution members. NAATBatt does a number of things. We put on programs. We have our annual meeting coming up in February of next year. We do workshops. We have a database of Lithium-ion supply chain companies in North America that was assembled for us by NREL that's publicly available. We've done studies of the Chinese recycling market and a bunch of other things.

 But really, fundamentally, what NAATBatt is is, NAATBatt is a networking organization, and the background of that actually goes back 20, 30 years. I actually have no background in batteries. I sometimes wonder why you invite me to these things. I'm an attorney by background, and I was practicing law at a large law firm in Chicago in the technology area doing venture capital and merger and acquisition work. And in the early 2000s, I thought it was wonderful with the information technology boom, with all sorts of new companies forming up, and I kept sitting in my office in Chicago waiting for my phone to ring off the hook, but the phone wasn't ringing. And I tried calling my friends and former law school classmates in California to ask them what they were seeing in Silicon Valley, but I couldn't get through, because their phones were basically off the hook.

 And I realized that a lot of other colleagues of mine in Chicago were having that same issue. And so we started doing a study of what was going on in Silicon Valley, what made Silicon Valley different than what was going on in Chicago and New York and other established markets, and we came up with a number of conclusions as we looked at that problem. But the one conclusion that really I remember most clearly of all and that has really been the basis for what we do in NAATBatt today was that there was a culture in Silicon Valley, a culture of interconnectivity that, when you move to Silicon Valley, it was said that you wanted to meet somebody, you'd get an introduction. You wanted to know who was doing what, you could find that information. It was a very open community and a very interconnected community, which was very different than the way things worked in Chicago and other established markets, where you could be an insider or you were an outsider, and if you were an outsider you could become an insider, but it would cost you a bunch of money. There were lots of people out there who would charge for that.

 So when we thought about what we would do with NAATBatt and why we would form that and what the value proposition was, it was really to try to create in this new industry of energy storage that cultural phenomena that we saw exercising so effectively in Silicon Valley 20 years, 30 years before – not so much to create this activity and this culture in this specific geographic area, but to try to create it in an industry itself, and to make it just very industry – for anybody coming into the energy storage industry to meet who they want to meet, to understand who's doing what and to get introductions, just for asking, to who it was that we need to know. And to date, I think, I hope we're being very successful.

 Without belaboring the point, I did want to speak very briefly about one important project that NAATBatt has been involved with over the last several months, together with our partners at NY-BEST and New Energy Nexus, and that's the Lybridge [phonetic] initiative. The Lybridge initiative really rises out of a realization that the Department of Energy had at the end of last year that we had a major problem in the United States. We have – about 25 percent of the vehicle fleet of the world is in U.S. The automotive industry is our second-largest employer in the U.S. after healthcare. It accounts for somewhere between 3 and 4 percent of the gross national product of the country.

 And yet, as we see the transition going in automotive and vehicle technology from internal combustion engines to electrification, a transition which, by the way, is driven by a lot more than just climate change – there are a lot of drivers and a lot of reasons why this is occurring – we take a look at the supply chain and we realize that we make about 0 percent of the cathode active materials, some fractional percent of the electrolytes, 8 percent of the cell production, almost all of that at Tesla, and we realize that, as a country, we have the problem, we have to stand up that supply chain and make it more robust to at least service those 25 percent of the vehicle fleet that we have.

 So NAATBatt, NY-BEST and New Energy Nexus were asked to facilitate industry engagement in that under the supervision, I'm happy to say, of Argonne National Laboratory and Venkat, who's been invaluable in facilitating this project. We, in turn, hired Boston Consulting Group, one of the foremost management consulting firms in the United States and in the world, and pulled together and tried to identify 40 to 50 of the leading companies in North America with expertise in Lithium-ion battery technology to really participate in this think tank, if you will, to come up with a strategy for the United States to build an effective, robust and sustainable Lithium-ion supply chain in North America.

 We're coming to the conclusion of the initial stage of that project. We expect to be issuing a set of recommendations and a white paper in November and then to follow that up with an ongoing initiative to make sure that we build that sustainable and effective supply chain going forward. So thanks, folks.

VINCENT SPRENKLE: Thanks, Jim. Tim?

TIM ELLIS: My name is Tim Ellis. This is American Battery Research Group, which comes at it from a completely different tangent with what Jim was talking about. I represent the lead battery industry. The lead battery industry is kind of interesting. It did all the heavy lifting on electrochemical rechargeable storage for about 150 years. Each one of you out there owns about 150 pounds of lead batteries in the economy somewhere. It's kind of different than a lot of the stories you hear around here. We have domestic manufacturing that exports about 10 percent of its products overseas. We have a completely circular economy. We have integration in just about every energy storage application that you can think of, but we're only using 35 percent of the theoretical capacity of the lead battery. That's our big bogey. And that's how we got involved with the Department of Energy.

 A little bit of my history – I was brought up, as I like to say, in a Department of Energy family. My father did his doctorate under an atomic energy commission grant before there was a DOE. I did my PhD at the Ames Laboratory at Iowa State University working on nickel–metal hydride batteries, among other things. Interestingly about that, I had one of the first three [inaudible] on batteries that the DOE actually did. I didn't know anything about batteries, nor did I care. I was a metallurgist, and I worried about materials.

 What we looked at about 13 years ago was to say, okay, we're starting to feel threat for the first time, a legitimate threat from lithium. What does lead need to do? Well, lead has recycling. Lead has domestic manufacturing. Lead has integration engineers. Lead needs to figure out how to make better batteries with the materials they had. Where's the best place or one of the best places to go for material science in in the world? The U.S. Department of Energy, because they have the toys.

 So we set up a series of meetings with George Crabtree, who is hiding somewhere around here, and Venkat to say, you know, you guys have been doing a lot of work on JCs [phonetic] or on lithium batteries. Can we get access to that technology to basically try to understand how the lead battery works so we can make a better lead battery? And they were extraordinarily helpful. They opened the doors and said, "Absolutely." So we went back to the industry and said, "Dear industry, give us some money, because we have access to the National Laboratories."

 The silence was deafening, because the lead industry was firmly convinced that the Department of Energy was anti-them, didn't care about lead, was never going to spend a dime on lead. And I said, "Well, that's kind of stupid. I still think DOE does research for dollars. I mean, I think that's what they get paid to do." So we put together that 13 years ago, and we've been very, very effective using not only the facilities here at Argonne – we've done work with Sandia, we've done work with Pacific Northwest Laboratory. Thank you, Vince. Those programs have stretched out.

 And right now, I think we're spending, as an industry, probably around just short of $3 million, backed up of course by DOE's access to the various [inaudible] facilities. We have three general [inaudible] that I work on specifically. One is a [inaudible] between 16 people in the lead industry, suppliers and the major battery manufacturers. That's done in a pretty competitive cooperative research manner, and Vince is going to go through a lot of questions. I can tell you, we delivered them all, as you know, and how do you do all the IP and everything else?

 There's second sub-[inaudible] that got spun out of that, which – six companies in it that was interested in more of a – well, let me call it developmental approach or a developmental project, versus a – let me call it a basic science, basic understanding. Of course, if you've got an active industry, you need all of that. And then we have another program which is actually a point-to-point program with Oak Ridge National Lab actually working on the recycling processes and, how do we adapt some new technologies to the recycling of lead acid batteries also? But remember, the battery recycling industry did exist in the U.S., which is – lead is a big one. We get every battery, and we have to deal with every battery. So all of the experiences that new companies are experience – have we been experiencing for probably the last 25 years, and how to deal with them now – there's various and sundry – I'm not going to get into the business stuff, because that's an individual group business issue.

 But this is an integrated economy, and I was talking to several people this week – historically, battery development has been chemistry competing with chemistry. There are some good reasons for that and some good opportunities, and it fits, basically, the alignment of the R&D structure in North America and Europe. But there's another one here. We have to talk more about product architecture. In other words, physically when you assemble a battery – because if you're going to build an industry – I spent 15 years in the semiconductor packaging industry – you need equipment, and you need production lines, and you need access to materials. As we talked in the materials breakout session yesterday – manufacturing breakout – you need all of that, and the more you can leverage that manufacturing stream and that industry structure stream and that capital equipment investment across multiple chemistries, the better off you are.

 Because, frankly, battery companies that I know of are in the business of making money. They're not really solid on any one particular chemistry. They'll transition chemistry if they know how to make money from it and how to support their stockholders and the people that go to work every day – that's the whole thing. So you need a whole, complete industry, and I think what's being talked about here is actually incredibly important if we're actually going to cross over that valley of death. We're not going to cross over the valley of death by duplicating or buying our equipment from other places.

 When I was semiconductor, I spent some time working with the Semitech model in Semitech out of Austin for the semiconductor industry, and the point there was, in these cooperative programs with the Department of Energy – and I think the Department of Commerce is in there too – was to allow the U.S. semiconductor industry to leap one generation ahead in technology, because chasing what somebody is already doing today is a fool's game, because they're always one generation ahead of you. And I think we're actually very actively in pursuit of that with this discussion. Maybe it's not an absolute topic that's being brought up. And it's doable. It is extremely doable. And it'll benefit everybody who has a particular chemistry or a particular architecture in mind to do that, and a material supply base to support all that, because, again, those people have to figure where they're going to place all those products.

 So anyway, I'm looking forward to this. I've been waiting about 13 years to have this discussion, actually.

VINCENT SPRENKLE: Thanks, Tim. Chris?

DR. CHRISTOPHER TENNANT: Okay. Another completely different tangent, I think, is where I'm coming from. My name's Christopher Tennant, Chris Tennant. I'm with the Coordinated Research Council, which is a research association that's been around for 100 years. We started out as a committee of the Society of Automotive Engineers. We incorporated in 1942 as part of the war effort. Throughout that history, we have been primarily a place for fuel providers and automobile manufacturers or equipment providers to get together. And I say equipment – that includes aircraft and heavy-duty diesels and the whole like.

 So we're organized in that sense, and I think my role here is just perhaps to talk about an example of how that cooperative research can work and what works in our space. We're different from a lot of other nonprofits in that we have multiple industries represented, and that leads to some very interesting effects, because we're so focused on the science and the projects that we do. We're very careful to avoid doing any sort of advocacy work, which is outside the scope of our mission. But we want to be very relevant to rule-making and also to standard-setting.

 So that's a little bit about our philosophy, and talk a little bit about who we are – we have 16 auto and oil members that make up what we call the sustaining membership that kind of keep the lights on at CRC, and so there's four committees that operate under them, and those are all focused on various technical aspects of making sure that we understand what happens with fuels and cars. As was mentioned, we're in the middle of a great, big shift right now in terms of transition. Making adjustments to reflect what's going on in the world is part of what an association does. So we're doing that. We've added a new committee called Sustainable Mobility, and it is focused on all aspects of the decarbonization of mobility. Our practice is to have working groups that operate under the technical committees, and right now those working groups focus on electrification, of course, as a major topic, but also the work that's still going on in fuels, whether they be low-carbon or zero-carbon. Carbon reduction strategies that are outside the work scope [inaudible] those other aspects. And then finally, just life cycle analysis, so trying to figure out what's all being accomplished.

 And I realize, just getting a feel from this great meeting, that there's a lot of focus here on commercialization and scale-up issues that maybe don't quite hit where CRC is, but I hope that we can offer some good experience in terms of, how can you get collaborations and partnerships to work? And I should mention that, going all the way back to 1919 when we started operations, our laboratory space was the National Bureau of Standards, so we were with the government from the very beginning. Our incorporation in 1942 reflected the need to have a space to do top-secret research for the military to make sure that our planes and Jeeps and motorcycles and everything we used in the war effort – that the fuels that went into those – that everything worked very well to support our effort in the war. And that was a massive scale-up for us. And so throughout that chapter of our history, we were closely working with the U.S. military.

 And then, as we transitioned in the fifties and sixties and later into doing air quality research, we developed close working relationships with California Resources Board and EPA, and DOE also came into the fore, as our most recent committee before we started Sustainable Mobility last year, was the advanced vehicle fuels and lubricants committee, which spent about three months being called the PNGV committee, which was actually a DOE program at the time, just to reflect our close working relationship with DOE.

 So where we stand now in terms of supporting collaborative research and adjusting to the changes going on in the world is, I'm spending a lot of time thinking about – I'm talking to new members of our new committee or potential new members – what's the secret sauce that makes collaborative research really work? I've encountered a whole lot of other nonprofits working in the electrification space, and trying to figure out, well, what's our method, and what's different? And I think what's key is that we build our research focus around getting all the stakeholders involved up front. You know, you can't just look at – maybe if you're just one industry or a part of an industry and you try to say, "Okay, what's the research that's going to help us?" you can get so far, but I think you have some hazards there, because you don't have those other perspectives, wherever your industry is going to be involved with, whether it be other industries or other stakeholders, might be the regulatory space or the standard-setting bodies or areas like that – and if you try to move forward without that voice, you're not going to have the best research that you possibly could.

 So I think our focus is about getting all those folks together and then developing consensus about, what's the most important thing that benefits everybody else, that benefits all of us, and I should say, as part of that, we're not a consortium. All the research that we do is headed to the public domain when everybody is ready for it. And so that really creates sort of a filter for doing the right kind of projects. You get the different industry groups together. Then you know that that's going to be out there for the public good. So, okay, now, in that context, what are we going to work together that makes sense? So I hope that's good enough introduction, but if you get me going about CRC, we'll run out of time, so –

VINCENT SPRENKLE: Thank you, Chris. So, as you look at the Energy Storage Grand Challenge, it's really taking a holistic view of energy storage, moving from, how do we support the materials development, especially for battery systems, but looking at prototyping, manufacturing, all the way up to, what are regulatory barriers, and how do you – what's the value of storage once it goes out into the field?

 So we've heard from your introductions of work that's more fundamental science-directed. We've heard supply chains. Wanted to get your opinions on, where do you see these collaborations working? Are there certain areas where it doesn't work, or is it on the fundamental science side, or – where do you see the most traction, kind of in that development cycle? Chris, do you want to start?

DR. CHRISTOPHER TENNANT: Oh, okay. Well, I will say that, because I'm not working the technical space, I'm sure these answers will be a lot more relevant, but I talked about the need for getting the various stakeholders involved. Don't stick to maybe your core group if there's going to be interaction with another industry or engagement overall. And I think there's two key areas – I think basic science might have a role, but the – course there's a lot of reasons why you have to be really careful about that.

 I think, more in line with the kind of work that we do for cooperative research – looks at, is there a regulatory process that needs to be based on better information? If there's regulations out there that need to be done right, then you need a research space to do that, and you need it to come from not just one voice, one company or even one industry, because you have to wonder about where that's coming from. But if you get all of the stakeholders in, including the regulators at the technical level, and you get them involved, you can get some really good science out there that everyone can agree – okay, we have the same starting point. We understand that, and we can move forward.

 And a somewhat analogous place there is, are there standards that are required to make your equipment – to make what you're building work? And if you need those standards to be – so that everybody can really operate, then you need that to be informed, in many cases, by good scientific research. And the people working in the standards bodies and our committees – they're the same people – they go over there, they work at ASCM and SAE and other places, NCWM – they come over and they sit in our committees, and they say, "Well, we've got a research project." All the other stakeholders get to put that input in, and then they move forward. So by the time you get to setting the standard, you have a really solid foundation to build upon.

TIM ELLIS: I guess the answer to that, Vince, is yes. All of the above. I think what DOE's biggest mission – or can really help, at least from my experience – is, yes, the fundamental research, the fundamental technology, the APS, the neutron-scattering devices, the advancements in analytical chemistry, the advancement in materials modeling and stuff – all that stuff that, frankly, though cute, we don't have a Bell Labs anymore, because it just doesn't fit modern American corporate structure.

 You know, the joke used to be that the CEO stands up and says, last year, R&D improved our profitability 20 percent. This year we're going to improve it another 20 percent by eliminating research and development. And there's more truth to that than you care to address. I think the one – let me say DOE is what I'll call the universal arbiter and open forum to work all this stuff out. On projects that we've done with the people at PNNL, a company can publish all sorts of data about product performance or recycling attributes, whatever you want, and once you get beyond your customer saying, "Well, that's just a bunch of marketing hooey," somebody has to say, "No, that's right," and know those standards are being universally applied.

 Particularly in this like the circular economy – you know, you've developed the technology. Now you have to put it into a circular economy. Well, who best understands how to get the materials back? It's the people that developed it in the first place. But that's not – not into that.

 I think the other place, because of DOE's wide mission, is then also to engage with regulators ahead of time to ask them – not just environmental, but actually guys like FERC – "What do you need to know to allow this technology to come to fruition at the speed of society?" Because there's no other place to do it. Individual companies can't do it, because then FERC just says, "Well, this guy said that" – and I'm picking on FERC. I mean, you could – and then it gets even worse if you derivatize that into states or local regions. With all due respect to people on the far left coast in California, we ran a plant in – they still run a plant outside of LA – we never knew who was in charge, and what's the dataset necessary to satisfy all of these local, state and federal regulators, and all of them are asking important questions, but nobody can validate what you're saying and say, "Yes, it fits in the modern motif of how you – would you address those problems."

 And I think DOE really is the only organization out there that can do that, frankly. But we need more conversations like this, because, again, we don't want to leave DOE in the dark about what all those problems are, because they don't see them, you know? It's a different metric.

JIM GREENBERGER: So to get to the question of what collaborations make sense, I think we have to look at what the core purpose of the Department of Energy is. And the core purpose of the Department of Energy, in my view, is it's all about capital allocation, resource allocation. And its mission is to address a very fundamental flaw in the free market economy of the United States. And that fundamental flaw is that, for anything that somebody can make a buck on by making an investment that will make a return within five years – and you can kind of pencil it out. I come from a venture capital background. You've got to make your return within five years. Doesn't matter if it's a great investment or a great company or you're going to make a lot of money one day. It's got to return within five years in order to justify the upfront investment.

 And within those parameters, the American economy and capitalist system is the most efficient allocator of resources anywhere in the world. Chinese can't touch us. The Europeans are behind. It is amazing if we can put something within the wheelhouse of American industry. The problem is that, beyond five years, beyond something that cannot return investment within five years, it's ultimately starved for capital and starved for resources, and that's where a different kind of investor has to step in, and that different investor, at least in the energy space, is going to be the Department of Energy and the funds allocated to and by Congress.

 So I guess the point of collaboration and the value of collaboration between the DOE, which is really looking at funding projects or incenting projects outside that envelope of comfort for the free market economy, is to incent greater communication between the DOE that has to deal with sort of one area of investment and private industry that deals most effectively with another type of investment and to try to move as many things into the sweet spot of the free economy as possible.

 And, in order for there – the purpose of the collaboration of getting industry to really talk to DOE and DOE to talk to industry is so that the DOE better understands what industry needs to see in order to bring private capital on board, because, at the end of the day, we really don't want the DOE to be spending money. Every dollar we spend on batteries is a dollar we're not spending on schools and hospitals. So it is the goal of everyone in the Department of Energy and indeed of everyone in this room, including private industry, to make sure we have to spend as few of those dollars as possible, and we do that by trying to push as many of these research opportunities as we can onto the private sector by making them commercially attractive for private investment as soon as humanly possible. So that's the basis, I think, of successful collaborations between DOE and industry.

VINCENT SPRENKLE: All right, thank you. Tim, I'll put you on the spot for this next question. You'd mentioned in your introductory – the Semitech model, and I think it's one of those ones, I think, that people recognize [inaudible]. So as you look at that, and, again, with your experiences, what's worked well, in terms of these partnerships where we're bringing industry together to kind of – here's the R&D agenda we need, and then they can communicate that to DOE or other stakeholders? What works, and then are there examples you've seen where it doesn't work?

TIM ELLIS: Yes. I think what worked really great about Semitech was, it originally went in saying – it had a mission. It had a direct – following what Jim just said, it had a direct understanding of where the U.S. was falling apart when it came to being competitive, and really, it turned out in the semiconductor industry, it was falling apart that we didn't have the physical pieces of equipment to drive chips to finer pitches, which was the performance metric for pitches.

 By the way, anybody that thinks any battery's going to follow the Semitech model doesn't understand the physics, because a battery is mass-derived device, i.e., if you're going to have so much energy, you need so many atoms. Chips are the other way around. The smaller you make stuff, the faster they operate.

 So that worked very, very well, and I'm going to use Semitech – Semitech fell apart, and I'll be right in there where you were just talking about, Jim – Semitech fell apart when it came to be looked at as a venture capital funding outfit for the next 15 years. And the trouble was, it got all chunked up into little tiny pieces. All of them were subcritical. The technology that was being developed in Semitech was highly fungible, and therefore people that were trained at Semitech left the United States at took it with it. You know, we always talk about people copying our patents – they take our graduate students. It's a lot faster, quicker and easier.

 I am a little bit concerned – and I've spent quite a bit of time running an international research group worldwide, but did a lot of European research – sometimes I think in the European system it's too prescriptive, and it actually kills innovation. Everybody starts writing their proposals, their ideas and their structures about telling people how it should be done, and the innovators get squashed out. It's because you end up doing more of the same, and that's not good. I think one of the things the DOE can really help with on that is, DOE buys a lot of stuff itself. You know, we're here at the APS. It has a power system that backs it up. We know what it is. We know what it should do. Therefore, you know, that's not a bad test case. At least it's a known test case.

 I think the other problem is, too – is that, particularly in the battery industry I think in the United States, we need to continue [inaudible] workforce development. We need to attract young minds that look at chemistry and physics and product architecture different than we do. We tend to do what we did before. You know, I think that we in the United States and other places – we've been able to bring in a lot of talent from a lot of places around the world, and that's fantastic talent. We just don't get it across the valley of death, using that talent, and that's hard. Nobody's good at it, really. Even the Japanese and Koreans spend a huge amount of money, and the Chinese, to do that – still spend way more money than, oftentimes, the bang for the buck turns out. I don't know if that answers your questions, but that's what I think.

VINCENT SPRENKLE: Oh, thank you. Jim, Chris, any additions to that?

JIM GREENBERGER: Sure. One of the things that we discussed at Lybridge fairly extensively were ways that the Department of Energy can better structure incentives to private industry to more effectively leverage public dollars and make them both politically more palatable and more effective in applications. And one of the concepts that had some attractiveness to those involved in the discussions was looking, again, to sort of the Semitech model, in a sense, and saying that, really, where we need help, or many companies in the United States need help, is really more in the process and the architecture, as you said, and the tooling and equipment, than the technology itself. We've sort of traditionally focused government aid in this area as grants or loans to specific companies to build specific technologies, and maybe what we should be considering is, instead, almost a form of in-kind aid by setting up, as we've started I know now in the State of New York, pilot lines for manufacturability of new technologies, whereby U.S. companies, rather than getting money, would essentially book time the way you'd book time at a university on an electron microscope, and that way the DOE is not so much put in a position of having to pick winners and losers, at least not optically, and you get a form of resource that's fully developed that companies, particularly mid-size and smaller companies that don't have access to those resources – not unless they get tens of millions of dollars from the DOE – could actually exploit and use to validate the manufacturability of new technologies.

 So expect a focus on pilot lines to be one of the primary recommendations that is going to come out of Lybridge, and, in any event, we're all thinking hard about how we can better do these collaborations and how we can better and most effectively – more efficiently – utilize the resources that Congress and the President have so graciously allocated to us.

DR. CHRISTOPHER TENNANT: Okay, and in brief – and maybe tangential to this, because it's not as specific – we do have several active cooperative research and development agreements with the DOE National Laboratories, and the way in which we've accomplished the objective of building those partnerships with government has evolved several times since I've been with CRC for 17 years, but I'd say right now what's happening is, it's kind of a matchmaking process. Our industry members have priorities, and they have to go through amongst themselves in the different industries and say, "This is the stuff that's most important to us."

 And then we start to have that conversation sometimes – we put things out for bid. But I think we're learning, when there's a unique capability at a National Laboratory that could really fit into this, then it's not so much about, "Here's something we'd like you to bid on," an overly prescriptive approach, but, "Here's a problem we're working on. We'd like to know what you can bring to bear on that." And what we can bring to bear is the industry participation and a mechanism to kind of put it all together and to provide that calibration, if you will, to the DOE effort.

 And I'd say right now there's just so much going on that that matchmaking process is a lot to keep up with. I think I would just hope that the folks on the government side, which are running – they're trying to run really fast to deal with those very aggressive goals – that they do kind of take time to check in with industry and get that calibration and say, "Okay, these are the things that we actually need to be working on." It might not be exactly the way we envision it, but I think it works a lot better when they do the work to make those things converge.

VINCENT SPRENKLE: All right, thank you. I think we're getting towards the end here, but I wanted to give you each an opportunity and a – kind of any closing comments or recommendations that – things maybe that DOE hasn't looked at or the labs or anything else? So Jim, I'll let you take –

JIM GREENBERGER: All right. I'll leave you with four words – and maybe it's not quite four: Make energy storage cool. That is, in a sense, we have the opportunity to really capture public imagination, and the Department of Energy is actually really interestingly situated. It is the coolest federal agency out there. It's dealing with the most interesting problems, has some of the brightest people in the country working for it. And I know – and by pointing to an issue that we have in Lybridge – we took 45 people out of industry to basically volunteer time to work on a problem of national importance, and they were all happy to do it. But I know, having worked in private industry myself, that they're all going to go back for their annual reviews, and, bottom line, they've done good things, but how much money did you make for the company?

 And unless they are recognized, unless the Department of Energy really blesses and recognizes – uses its prestige and its coolness to recognize the contributions that people are making to work on this important national problem, we're going to start seeing some leakage, some people not being willing to step up and make those contributions that we all need to be made going forward. But the DOE, with its tremendous prestige, really has the opportunity to do that. It doesn't cost it any money to do, but it really ought to be playing more that card, because it's a more powerful card than I think people that work in the DOE on a day-to-day basis, and in the National Labs on a day-to-day basis, really realize, how much power and status and prestige you have in the larger community. So let's leverage that even better than we have.

TIM ELLIS: I guess if I had my dream, it's, please invent a new element that fixes all the problems we have with every technology we have. I think that DOE is really the only organization worldwide that thinks broad enough with the depth of expertise and the depth of – I'll call it education and openness that you don't see anywhere else to do it.

 I was talking with a couple of guys this morning – one of the things I'd like to do that I think DOE could really help – it seems a little esoteric, but if you could bring in a DOE scientist, give them all the eight-week course in how to run a small business inside of a larger organization – because that's what they do – because, not that they're all going to be entrepreneurs, but the translation of science into a business case to allow us to speed up that adoption and that transition would be incredibly important. And the fact that DOE cuts across all the universities, essentially, industries, essentially – it's just such a rich menu that can be done, and we just have to do it. I mean, it's not a lack of knowing how to, you just got to, which sometimes is the hardest problem, just getting it done.

DR. CHRISTOPHER TENNANT: Tough act to follow here in sum-ups, but I'll say I – almost set aside the CRC question, speak personally – I just hope that – we're up against enormous challenges, right, as a society. We're trying to change a lot, and there's a lot of stuff going on down at the granular level. But at the big picture, I hope that we'll just continue to be driven by science. I've heard it a couple of times that the government's role here is not to pick technologies but to be technology-neutral and just move the science forward, and that's the thing that I think will give us the long-term prospects of success, is, don't think that we have figured things out first. Let's do the science first and let that guide us to what we need to do to move everybody forward.

VINCENT SPRENKLE: All right, thank you. Sorry we didn't have time for questions, but I think we're around at lunch. Please catch us if you had any questions for the panel, and we'll do that. But please join me in thanking our panelists once again for sharing their insights, and then, Venkat, we'll turn it over to you.

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