Battery + Storage Podcast: Leading the Lead Revolution With the Consortium for Battery Innovation
Host: Bill Derasmo
Guests: Dr. Matt Raiford and Dr. Alistair Davidson
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Bill Derasmo:

Welcome back to the Troutman Pepper *Battery and Storage Podcast*. I'm your host, Bill Derasmo. And today on the program, I'm very pleased to have Dr. Matt Raiford and Dr. Alistair Davidson, both from the Consortium for Battery Innovation. Welcome to the program, gentlemen.

Alistair Davidson:

Hi, thank you very much for having us in an invitation to talk today.

Matt Raiford:

Yeah, thanks a lot.

Bill Derasmo:

Absolutely. Great to have you both. You are, as I said, the Consortium for Battery Innovation. The audience can find all the information they want at batteryinnovation.org, by the way. Gentlemen, why don't you just give me a little bit about yourselves and the Consortium and then we can have a conversation?

Alistair Davidson:

Yeah, sure. I can kick things off about the Consortium and then hand over to Matt to talk about some of our research. I'm Alistair Davidson, I'm director of the Consortium for Battery Innovation. We are a pre-competitive research consortium dedicated to improving lead battery performance. You hear a lot about lithium ion, other technologies, which are all fantastic technologies, but our consortium is focused on lead batteries. We think there's a lot of opportunities for lead batteries in the future. We are a membership consortium. We have over 120 members and partners all over the world. We have a big footprint in the US where we have between 40 and 50 members. Likewise, a similar number in Europe, but we are seeing an increasing number of members in South America, Asia, and we are partnering with some companies and research institute in Africa as well. A major focus of CBI is conducting research to improve lead batteries.

I'll let Matt talk about that in a bit more detail, but a lot of people when they think about lead batteries, they think about maybe a battery that was in your car that you have to top up with water to start your vehicle. That is not the lead battery of today. We've seen real performance enhancements, that means that we're seeing them widely used in star stop and micro hybrid applications. Virtually all of these vehicles use lead batteries. We see them used as safety batteries in electric vehicles, backup for data centers, hospitals, use in motor power, things like forklift trucks. And something that I think we'll talk about more today is we're seeing an increasing use of lead batteries in utility and renewable energy storage application, something that lead batteries are very well suited to. CBI is focused in funding research in those areas, but

we've also been doing a lot of work partnering with governments around the world, developing lead battery projects. For example, we won a project with the European Commission recently from Horizon Europe, their flagship funding initiative to develop lead batteries for micro good systems in Zambia in the Ivory Coast.

Lead batteries are very well suited for those applications, and we've also been working with the US military in Missouri using lead batteries for tactical microgrids. We really do a lot of work, but it's all focused on lead batteries developing from the future but also highlighting there's lots of great stuff underway on industry and were used in a wide range of innovative applications.

Bill Derasmo:

Well, thank you, Alistair. Matt, do you have anything to add? And let's get an introduction about yourself as well.

Matt Raiford:

I'm Matt Raiford, I'm the senior technical manager for CBI. My background is in chemistry, that's what I got my PhD in from UT Austin. Great department over there. And I've been in the battery world in some way for probably the last almost 15 years. From research in grad school to I worked for the world's largest recycler of batteries, Ecobat. They're headquartered where I'm at, Dallas, Texas, and then also working now for CBI. Alistair talked about energy storage at large and really and truly it's a golden age for batteries. This is, I think, built on the fact that decarbonization and electrification are such vital pieces of both governmental and private institution investment and policy. Our perspective really is “all hands on deck.” We believe that LED batteries provide a highly sustainable, high performing solution for many different applications. Lead batteries are present in over 80 applications.

This can be something like a submarine battery. These are massive batteries that serve two purposes, right? They can do silent watch, so they can actually be used to power some of the engines to backing up nuclear reactors. They also act as ballast weight; these are large batteries. To the small little batteries that work in emergency lighting in hospitals, to backing up data centers, to all sorts of things. If you were to look at a map of North America, there'd be over 750,000 sites where lend batteries are used for stationary storage. At CBI, we focus on market driven research. And so we have our technical program and our membership fees go towards these kinds of programs. This includes things like looking at fundamental science, so how led batteries operate to all new brands, new applications, looking at residential ESS, all sorts of things. And we've conducted this kind of research as an organization for the past 30 years. We have a library of different improvements and things that the lead battery industry has worked into their technologies. CBI's focus is research, but also really communicating this, communicating the benefits of the technology.

We believe because it's so sustainable, cost-effective and reliable, that it is really a crucial, crucial piece to things like energy storage systems for utility grids and providing this circular solution for these kinds of applications.

Alistair Davidson:

And one of the things that Matt talks about, sustainability, and the reason that lead batteries are so sustainable is the recycling rate, which I think a lot of people are often surprised to hear is that in Europe, North America, about 99% of lead batteries are collected and recycled at the end of their life for use in new batteries. They're kind of the perfect example of a product designed

for end-of-life recycling and the perfect example of a product that operates in a closed loop. That's one of the reasons that we bang the sustainability drum is that people are not aware of this and it's a really strong attribute to lead battery technologies.

Bill Derasmo:

That's a great lead in and contrast to a number of other guests that we've had on the program where obviously the recent focus has been on lithium-ion technology. I mean, we have had other technologies and battery chemistries discussed as well. Things like vanadium, iron have gotten some play and so it has been a mix, but this is great to get the perspective on lead batteries. I think in terms of sustainability, one of the concerns that is a big concern in recent years and with respect to lithium-ion batteries is in terms of the rare earth elements involved and the minerals and the mining and all that. If you could maybe speak for a second on the abundance of lead and the sourcing as compared perhaps to other battery chemistries.

Matt Raiford:

Yeah. Historically, there used to be, I would say, distinct lead mining operations run like any other commodity metal. Now I bring this up to say that nowadays, mining just for lead doesn't really occur. Lead is a byproduct of zinc mining primarily. When you pull zinc out of the ground, it's almost always with lead. All these concentrates, these ore bodies, these mining operators sell lead simply because they're pulling it out of the ground with everything else. And lead comes not only with zinc but with copper, with silver, gold and some platinum group elements as well. It's permeated throughout a lot of the geological deposits that miners go after. But really and truly, for instance in the US, about 86% of needed lead is provided by North American recycling operations. When we think about commodity metals, whether it's lithium or cobalt or nickel or zinc or copper, lead is a unique one because of the sustainability loop.

If you look at things like the London Metal Exchange and you look at price volatility for these kinds of things, which really motivates these markets, lead stays steady for the most part. Of course there's instances where it hasn't, but I think this is primarily because of just such a strong sustainability profile. Nowadays in Europe, US and the number is growing dramatically in other areas of the world, well over 80% of the demand is met by the secondary streams. It really, beyond the recyclability, it's at such a mass scale now that the supply chain is incredibly insulated by this closed loop.

Bill Derasmo:

I think that's a critical issue and it's one of those things where I know enough to be dangerous. I suspected that the answer might be along the lines of what you said in terms of contrasting it with perhaps other battery chemistries and that 86% figure is something else. I mean here in the United States, that's a big issue is the reshoring of operations and supply chain concerns. There's a variety of reasons why that's just such a huge issue. And then when you talk about the recycling aspect to it too, it's impressive and it explains why lead's coming back into the picture, never really left, but in terms of the things that I am focused on on the grid scale side, why don't we turn to that for a second and tell me about lead's place in terms of grid scale applications because as you know, the push in terms of the energy transformation is on for renewables, and renewables are intermittent and so there's a push to pair them with batteries, of course.

It's already happened quite a bit, but beyond that, I think the next stage with that is not only just pairing them with some kind of battery storage or other storage technology, but long duration

because it's one thing to have a lithium ion battery that can click on for two hours or four hours at the peak and that's great. It can do wonderful things, but now the push is on and states like California especially are pushing prolonged duration. If you could speak to me about the grid scale applications for lead batteries and if you could talk a little bit about the duration picture, that would be great.

Alistair Davidson:

One of the reasons why we're particularly bullish, before we go into detail why we're bullish generally about lead battery for energy storage, is because we're seeing climate change targets all around the world. The US, Europe looking to reduce greenhouse gas emissions and set net-zero goals, and I think it's pretty clear that they can't be met without battery energy storage. That's a key part of that. We've talked about lithium ion, wonderful technology, real strengths, but one of the issues is that lithium-ion batteries can't be used everywhere. They can't be used in your electric vehicle, in your mobile phones, your laptops, your power tools. Lithium batteries do have supply chain issues. There's no way that they would be able to scale up to meet the demand. And if you look at the markets at the moment, the rechargeable battery markets, about 97% of the overall rechargeable battery market are lead and lithium, lead to about 40% of that, and that's not predicted to change out until 2030.

If we're going to meet the demand and deliver on these targets we're setting, then the technology that's going to help do that is lead battery because, as I'll hand over to Matt to talk about, very well suited to many of the applications that we're talking about in utility and renewable energy storage. That's really the background about why we think there's such an opportunity for the lead battery in the future.

Bill Derasmo:

Let me add one other distinguishing issue perhaps is fire risk, and if you could speak to that as well.

Matt Raiford:

Yeah. I can dive into your long duration energy storage question for sure. To be honest, one of the first instances of utility grid storage was actually a lead battery facility in Chino, California. This was back in the eighties. The way that they built this facility was for research, it was SoCal Edison. This was, I would say, before its time I bring that up to say in that research facility, they explored things like voltage support and frequency regulation, but also things like long duration. And one of the virtues of lead battery technology is that long duration usage profile really lends to the abilities of the lead battery. Long discharge times coupled with some artful ways to charge, I believe that lead batteries could be a very suitable solution for this and we actually see it in other areas of the world. We track energy storage systems across the world.

We know of many large ones in Germany and places like India, China where lead batteries have been deployed on these scales where we're talking gigawatt hours of batteries, over 100 megawatts, truly a 10-hour plus long duration type usage profile. And that long duration is so crucial to our utility grid. I think it's difficult for someone to fully understand what it would mean to rebuild our utility grid, that's just not on the table. The level of investment to really revamp something that was really built out in the 1950s, battery energy storage is crucial. That long duration cycle really provides the kind of stability and the kind of energy storage that helps people with, at the end of the day, their bottom line. But in other areas like California, it helps actually keep the lights on.

There's instances of this with lithium and from my perspective, just the sheer amount of, I'll get into a science term, the moles of a electrons, the mass that is needed, it'll require lithium, it'll require flow and I strongly believe that lead could be a very suitable solution as well here in the US. And like I said, we've seen it in other areas. It's been working for a while and we're working to get these kinds of systems up off the ground here as well.

Bill Derasmo:

What I was going to ask next is really going in the other direction because we talked about long duration and its suitability on that side. As folks on this program know, I have a pet interested in the other end of the spectrum, things like primary frequency response, frequency regulation, and so I was wondering if you could speak for a second on the ability of lead batteries on that side of the spectrum.

Matt Raiford:

There are definite examples of lead batteries providing solutions for this, both stateside, US, and Europe, all over the world. That frequency regulation aspect is so important, especially as things like renewable energy become a greater part of energy generation. That advantage of renewable energy, solar and wind is great, but there is a disruption. The volatility that it can create and energy production, that frequency dysregulation. We have systems in Germany, for instance, based off of battery technology from Murata, which is one of our member companies. They have three systems that provide this kind of functionality in Northern Germany and Leipzig and Waddeweitz, these systems are about 25 megawatt hours, about 16 megawatts. That profile is very interesting from a battery perspective because we're talking about very small cycling regimes, right? Very small utilization rates of the battery.

Lead batteries, lithium batteries, they all act really well in these applications. This frequency response is, I would say, maybe not as talked about as it once was about five years ago, but it's still vital. There's kind of a staggered adoption rate of renewable. US and Europe are ramping up, but so are other areas of the world. India, even Africa, parts of South America and maintaining frequency is going to become more and more important. I mean I live in Texas where we have wind, solar, gas, tiny bit of coal. The grid wasn't really built for renewable energy. Before batteries were put in, there was all sorts of issues, but now that batteries are hybridized to some of these big renewable buildouts, it really has helped stabilize that frequency and mitigate some of the issues that we've dealt with. Same goes for California, New York, a few other areas as well.

Alistair Davidson:

Matt touched on other areas of the world and we are global. We're active all over the place, we've just been in Asia and one of the things that we've had feedback is the way that the Chinese are approaching energy storage, which I think is quite an interesting way of doing it. They've started to understand that they need to utilize lithium in very specific applications because of its many strengths. And now they are particularly showing preference for developing lead battery energy storage projects and are not approving lithium-ion project because they think that those technologies should be used in other applications where their strengths are more of an advantage.

Bill Derasmo:

It's fascinating. I worked with a project in Indianapolis, it ended up being a FERC regulatory case, but the utility really utilized it for primary frequency response and that's how I really learned about the issue. And the lithium-ion batteries deployed in that case were unbelievably efficient at arresting those frequency excursions or deviations. I mean unbelievable, right? In the old world you used to use inertial response, literally the friction of the turbine, it's slowing it down to deal with it. Now you don't do that because we've taken a lot of those resources out, but it was just an interesting use case and really fascinating to learn about. But why don't I ask about in terms of the consortium, tell me about some of the work that's being done. I understand it's a pre-competitive research organization, but what about in terms of advocacy, getting the lead story out there more because obviously you led into the discussion with how ubiquitous lead battery applications are, the 750,000 sites across the US, but I think at our little corner of the world where we talk about grid scale applications, lithium seems to have a PR advantage, to be honest.

Alistair Davidson:

This is the general problem that we have. It is that people are either not aware of lead batteries or if they think about lead batteries, they think that they're a mature technology that was used in vehicles and that there's no scope for further performance enhancements. This is a bit of something that we often come up with and as I said before, the lead battery today is far improved from a lead battery 10, 20 years ago. Things like improvement in dynamic charge acceptance is why we're seeing them widely used in micro hybrid. And we're also seeing improvements of cycle life, which is particularly useful for energy storage applications, but it isn't. Why do we know? We know that the car companies are aware of this because virtually every vehicle on the road from a conventional combustion engine through to an electric vehicle uses a lead battery. They're aware of it, but in the energy storage sector, it's just people aren't aware.

And so we do a lot of work banging the drum, providing technical information and about successful projects saying that it's not just lithium ion, as we say, it's a great technology, but lead batteries can meet that demand. We also do a lot of work with governments, the department of energy, department of defense, UV emissions, highlighting that they have a gap here and that they set all these ambitious goals and targets and if they actually want to deliver on those goals and targets, they need a range of technology to do so. And as I said before, there's only one other technology other than lithium ion that's available on a mass market scale and that can meet the demand and that's lead batteries. A lot of our work is actually trying to highlight, there's so much potential in their batteries.

They can already meet the demand, but we can improve them further and really banging on that message. And perhaps one of the other things, this is a high level, but we do a lot of fundamental research into lead battery technologies and we've got a project where we work with the Department of Energy using sync on radiation in Argonne, the APS, looking at the fundamentals of lead batteries. And from my point of view, you would think that a batteries that's been around for 150 years, most of the discharge, recharge, reaction, the fundamentals are understood in lead batteries, but this project is actually showing that there's a lot that's not understood, and I think for me, really highlights the potential there is to maximize the performance of lead batteries further. And I think that's one of the exciting things about our chemistry.

Bill Derasmo:

Let's talk for a second about that. In terms of how the lead battery actually works, and I'm sure that there are many, many variations. We've talked in past programs, but it's mainly, I think, been in the context of the more dominant technology lithium ion that everyone's talking about. But what about the components, for instance, the separator, anodes and cathodes, I mean, how does that work on the basic lead battery versus the lithium-ion battery?

Matt Raiford:

Lithium batteries work through ion absorption processes. The actual processes occurring in a lithium battery are more physical phenomena. In a lead battery, it's actually a chemical transformation. If we were to take a step back and look at each electrode, so the negative electrode and the positive electrode, they're governed by many different reactions, but primarily on the negative. It's the transformation of a spongy lead active material that's at full charge. And as you discharge, you transform that lead to lead sulfate. Now the sulfate comes from the electrolyte. Most of the electrolyte for lead is water, but some of it is sulfuric acid and that's what provides that sulfate. You move from a metal sponge to almost a ceramic. On the positive, similarly, you go from a lead dioxide, a semiconductor, to lead sulfate as well. As opposed to some of the other chemistries, it's both electrochemical phenomenon, eroding electrons. As you transform to lead sulfate, you move electrons out of the system, but you're also chemically transforming them.

Now classically, that's offered multifaceted benefits. What I mean by that is if you construct a lead battery a specific way, it really wants to discharge and that's great for, say, black start applications or cranking an engine. You can get a massive shot of power from a lead battery. Now there's other types of lead batteries, of course. Those used in stationary, they're more well-suited for those kinds of applications. There's newer advanced lead batteries that also incorporate a large amount of carbon or the electrodes are built out of high surface area carbon textiles, or in some cases it's a bipole battery in which instead of current going from the bottom of the electrode all the way to the top and then it's connected in series that way, it actually goes through the thickness of the plate. Bipolar is, I would say, not just a lead innovation, this is being scrutinized in other types of battery chemistries as well. But that's kind of what happens in a nutshell.

You're really just moving lead on the negative, the lead sulfate and lead dioxide, the lead sulfate on the positive. There would probably be about 100 battery scientists that would pipe up now if they were in the room, be like, it's way more complicated than that, and it is, but...

Alistair Davidson:

One of the things Matt's talking about the chemistry, but it's actually fairly simple and all the different technologies are fairly simple. They're really simplified. Just lead, lead compounds are separated the plastics from the acid. And that's one of the reasons they're much less complex than say other technologies that have a range of lithium-ion and these are all different. And that's one of the reasons why we have this high recycling rate because all the different lead batteries can all be recycled in the same way. And that's one of the things that contributes to our closed vehicle recycling.

Matt Raiford:

That's a good point. And really and truly, if you look at a lead battery, about two thirds of it is made out of lead, about 12 to 15% is made out of plastic, less than 1% is separated, and then the balance would be the electrolyte. We really do design products that are recycling. I mean, it just works out pretty well.

Bill Derasmo:

You said that you would have a lot of scientists raise their hand, it's way more complicated. Remember, you're talking to a lawyer, so you got to boil it down, but even though I'm a lawyer, I could listen to this kind of thing all day and people would probably look at me and say, what's wrong with you? But in any event, including my kids and my wife. But that being said, I, for one, appreciate the explanation. I like to understand how the different battery chemistries work. You keep mentioning the recycling point. I haven't brought that up, but obviously that's a key point, right? When I talk just in cocktail party talk and people ask what kind of things you're dealing with, you talk about batteries and stuff. One of the questions that's starting to creep into the conversation or the consciousness more and more is, okay, but what are we going to do with all these batteries?

And especially on the transportation side. On the grid scale side, it'll be an issue too, but a little bit-

Matt Raiford:

Different, yeah.

Bill Derasmo:

Yeah. That issue about what do we do with these batteries, we've had a couple of past episodes that dealt with that in one way or another. We've got Megan O'Connor and her wonderful company Nth Cycle, which can take the black mass and pull all the useful minerals out. I mean, it's a really interesting story. And then you've got Freeman Hall and B2U facility out in California where they take the batteries and use them from the OEMs into a grid scale. Sort of a second life type of story. But I think the recycling is obviously going to be a huge piece of this, it has to be. I was wondering if you could just expound upon that a little bit because I do think it's top of mind now more and more as we move into this new era of mass adoption of battery technology.

Alistair Davidson:

The lead battery, the recycling infrastructure is incredibly efficient, certainly in Europe and North America. Vehicles come to the end of life. People collect the batteries; they are all recycled and most of the materials are recycled for reuse in new batteries. We've actually been doing some work looking at how we can use the lead battery recycling infrastructure and chain as a blueprint to help other technologies improve their recycling. We know that there's issues being economically and technically viable to recycle lithium to this certain extent. We know certainly in Europe, the new battery directives from the European Commission is driving higher and higher recycling rates for all battery technologies, and that's something that will help stimulate the recycling of other technology. But certainly we know that it's still a big issue for other technologies, and at the moment, they don't come close to the very high recycling rates that we see for lead batteries.

Bill Derasmo:

What percentage would you say, it probably varies, I'm sure by region, but what percentage would you say of lead is deployed from recycled material?

Alistair Davidson:

We often say that if you take a typical lead battery for all applications, about 85% of a lead battery will be made from recycled material.

Bill Derasmo:

Wow, okay. Okay. That's impressive.

Matt Raiford:

And I think just to build on what Alistair said, I have no doubt that other technologies will rise to the occasion and find suitable solutions. Lead's just probably 40 to 50 years ahead in that area, but keep in mind, the lead battery and lead production industry is much more distributed versus other chemistries. I would estimate that well over 120 countries do either lead production, lead battery manufacturing, or both. I mean, there's lead production and lead battery manufacturing on Fiji. And what that really means is if we think about what the infrastructure looks like, it's not just mature regulations and standards and best practices. In the US, there's thousands of scrap collectors and distributors and there's major recycling hubs, and these hubs deal with pallets, huge quantities of these scrap batteries. In North America alone, there's probably three million tons of lead batteries that are recycled every year. This is trucks and this is people loading these bundles onto trucks and getting them to these places, and this is a big footprint in America.

The industry is over $32 billion in terms of economic impact, and the battery manufacturing and the recycling are hand in hand. A lot of manufacturers have recycling sites in their portfolio of companies. It's just so strongly integrated and that's a big benefit.

Bill Derasmo:

I think it's a great story to tell for people who care about these issues and listen to this type of program. I can't emphasize that enough because I just see that recycling issue growing and growing and growing. And so if lead is already there, it's a great story to tell. I have to geek out on one more issue and then you guys have given us a lot of time, but you mentioned black start and you mentioned the usefulness of lead in that application. Black start is not something we talk about, and just for the uninitiated, it basically means when the grid really goes down and you have to start bringing it back up to life, there are certain generators who have that ability and it's called black start, and it's a very important, what the United States, we would call ancillary service, but it's extremely important when you have a black swan type event where the grid goes down. Talk to me for a minute about black start because again, you're speaking my utility industry language.

Matt Raiford:

I'll first talk about maybe a small-scale example and then I'll bring it up to utility scales. When you turn on a diesel generator, there's usually two red top batteries. That's what the slang term is. It's 24 volts of battery, and this is what gets the generator spinning so that it can start to produce power and consume diesel. To get that generator going, you have to have energy, you

have to have power, and that's what the batteries are doing. Now, if we were to scale this up to a black swan event, we're talking about banks of batteries, we're talking about very low gauge copper wires. We're talking about a lot of power suddenly, and that's what most people think about when they think of this ancillary service. Let's say a metroplex, I live in Dallas. Let's say the metroplex went down. You would have to do a series of events where you start up energy generation, so you would black start there, and then you would have to black start subsequently as you move through the transmission network.

These kinds of things take time, but if you don't have energy on hand to do it, it moves from something that takes hours to weeks. This is the big problem with things like hurricanes and flooding, is that it interrupts the ability for the grid to do this properly, and that's when you get outages that aren't hours and people gripe and they're irritated, or they think it's novel and they light candles, but they have outages for days. And that's when things like water sanitation and other things start to become a big issue. Lead batteries are distributed to provide this service. They're also broadly used, not just for black start as a stationary thing, as an ancillary service. They provide this for all sorts of just commercial, industrial applications as well. Data centers, telecom, this is kind of getting into the weeds, but there's the small channels of five G that's handled by lithium, but some of the massive facilities are handled by lead, and this is really what keeps our cell phone networks open.

This is what keeps almost every form of communications that we use stable.

Bill Derasmo:

I think what you're saying is in order to avoid a zombie apocalypse, we've got to adopt lead. That's bottom line.

Matt Raiford:

Yep, that's right.

Alistair Davidson:

That should be our new tagline.

Bill Derasmo:

Well, on that note, gentlemen, I really appreciate all the time that you've taken. I appreciate the conversation. Why don't I turn the mic over to you for any last words, messages and tell people how they can learn more about the Consortium for Battery Innovation.

Alistair Davidson:

Thanks so very much for having us on today. It's been a real pleasure to chat with you. What I would say is that what we've been talking about here is really a fraction of CBI's work. We've got many more projects, many more communication things. People are interested in our work, then visit our website, batteryinnovation.org. Reach out to me or Matt, and we'd be very happy to provide more information to any of your listeners.

Bill Derasmo:

Again, we really appreciate it. I know I learned a lot today, and appreciate you guys taking the time. And until next time, take care.