

---

**BATTERY & STORAGE PODCAST, S03 EP03**  
**JUNE 27, 2022**

Bill Derasmo:

Hello, and welcome back to the Battery and Storage Podcast. I am your host, Bill Derasmo. Today, our guest is Connor Hund, who is the director of business strategy and operations for NanoGraf. Connor has his bachelors degree from the University of Illinois in business and he has an MBA from the University of Chicago. Connor, before getting involved with NanoGraf, has a background in wind, solar and storage. Today, we're very excited to talk to Connor about his company NanoGraf and their technology in the lithium-ion battery space. But why don't I turn it over to you, Connor? Maybe you could just expand upon your background a little bit and let us know how you got to NanoGraf.

Connor Hund:

Yeah. Absolutely, Bill, I appreciate it. Like you said, I have a business background from undergrad. I've worked in the business world in leverage finance and then was really interested in clean energy. Was able to sell my experience financing data centers and other telecommunications' infrastructure as relevant for financing wind and solar projects. Moved out to Boston, worked for an Enel Green Power out there doing wind and solar. Decided the time was right to get my MBA, and while getting my MBA at University of Chicago, I worked in grid-scale energy storage at Key Capture Energy based out of New York and Texas.

Connor Hund:

And part of really getting my MBA was about moving to earlier stage ventures and earlier stage technologies within clean energy. And I had also interned at a venture capital firm during that time. NanoGraf is a portfolio company of that firm, Energy Foundry, and they're commercializing, scaling up, fundraising and it was kind of a perfect fit to bring in an MBA and join the couple of PhD leaders of the company to drive things forward.

Bill Derasmo:

Fantastic. There's one name that jumps out and people who are devotees of this podcast, to the extent we have any, will recognize the name Key Capture Energy, because we interviewed Jeff Bishop, the CEO of Key Capture Energy. And so I just click on that as they say for one second, I don't know if you wanted to just talk a little bit about your time at Key Capture. Like I said, they are a guest and fan of this podcast as well.

Connor Hund:

Yeah. Absolutely. Jeff's a fantastic guy, fantastic leader. That's actually how I got connected to Key Capture, was Jeff is an alum of Chicago Booth's MBA program as well. He's done a great job, along with Dan Fitzgerald, founding that company, scaling it up. They were really early in the grid-scale storage market. They were kind of a year or two ahead of most folks. And what I was helping them out with was a lot of market research, looking at new markets.

Connor Hund:

I know, Bill, you have a background in a lot of transmission, folk related policy matters, everything in that industry and market dynamics as well. So it was looking at the opportunity and new ISOs saying, "Hey, how can storage be profitable here in five years when you'll be able to bring projects online?" So that's a lot of what I was doing on the financial and development sides, merging those worlds within Key Capture.

Bill Derasmo:

Turning to NanoGraf, which is now your company you're working with and involved with it's in the lithium-ion space, but it has a unique chemistry or technology, as they say, a silicon-based anode. And I was just going to start with the basics about what makes that different than the other lithium-ion batteries that may be in the marketplace?

Connor Hund:

Yeah. Absolutely. And I'll start real high-level. Your listeners may already know, the anode is the negative side of the battery. Cathodes tend to get a lot of attention. You hear them a lot in naming conventions of NMC, LFP, NCA. The anode's the other half of things. And anodes and lithium-ion batteries are traditionally made of graphite, which is a very cheap material. It has excellent performance over a long cycling period. But silicon as a material holds 10 X the amount of energy that graphite holds.

Connor Hund:

So as there's been a big push within lithium-ion batteries into new applications that want more duration, you talk range anxiety for electric vehicles, other applications as well, how long is the battery going to last on a single charge? Silicon holds a lot more energy and therefore has a lot higher capacity. So there's been a big push, there's a lot of silicon anode startups out there, we're one of them. Everybody's got their own secret sauce of how they do things. The challenge is silicon suffers from gassing and fragmentation as you increase the amount of silicon in the anode, but there's a lot of potential and there's a lot of folks going after this market.

Bill Derasmo:

Very interesting. You hear the term energy density a lot. And so I was reading some of your material before we got on here and you have an energy density advantage it sounds like.

Connor Hund:

That's absolutely right. We're in the process of commercializing, but in terms of testing and performance, we've built the world's most energy dense cylindrical battery cell. There's three types of cells. There's pouch cells, there's prismatic, which you could think of as a nine volt battery and then there's cylindrical cells which is similar to double A or single A battery, but we're talking about rechargeable here. So the energy density of those batteries, we're pushing 800 watt hours per liter, and that really is the driving force behind the benefits of our technology and we're continuing to push that energy density horizon forward.

Bill Derasmo:

Seems like that would be critically important as you talk about the mobility space and automobiles in terms of applications for your silicon-based anode technology, maybe you could just talk a few minutes about where you see your company playing a key role.

Connor Hund:

Everybody's focused on electric vehicles, and for good reason. And that's certainly I'd say the medium to longterm vision for our business. The challenge in electric vehicles for silicon anodes is graphite's really cheap. So to get cost competitive with graphite on a dollar per kilowatt hour basis, we have to be higher than a thousand tons per year of our material that we're producing. Now, the benefit we have is most of our competition has to be higher than 10,000 tons per year, but we're still talking very large manufacturing numbers.

Connor Hund:

And so it's helpful for us to focus on other markets as beachhead markets to enter while we scale up to those EV quantities. And that really, number one for us is the military. That's been our big focus and we can talk more about some of the funding we've gotten there actually to develop this sell. And then there's other

---

applications; medical, consumer electronics with higher prices, higher margins, and a little less cost competitive than electric vehicles.

Bill Derasmo:

Well, that's a great segue into the defense part of the picture. I noticed a March 2022 announcement for a contract with the department of defense. But why don't you just talk for a minute about your interactions with military applications and some of those exciting developments on that front for NanoGraf.

Connor Hund:

Number one, we're a great fit for a lot of soldier-worn battery applications. Most people don't know this soldiers, going out in the field, carry about 100 pounds of weight in their packs when they're going out on missions. 20 to 25 pounds of that are just batteries alone. You've got a lot of products from two-way radios night vision goggles, that require battery power. And it's really key when you're out on a mission you want long enough run time to operate that radio for the duration that you're out in the field as a soldier. And that's really the benefit of our technology, is increasing that run time above eight hours for soldiers, which is a requirement they haven't been able to hit until our battery has come along with our level of energy density.

Bill Derasmo:

That's interesting to hear. I would imagine most of our listeners do not realize how much soldiers actually carry with them. The long duration issue is critical to so many applications. It's interesting that you guys are coming at it still in a lithium-ion based battery, because I think some of your competitors, they're trying to attack it with some different chemistries. We had a CEO of a company that has a vanadium-based product. There's been some iron type products. So it's interesting that you guys are still in the lithium-ion space for long duration. I was wondering if you could talk to that a little bit more about where you guys see things going with lithium-ion.

Connor Hund:

Yeah, absolutely. I think those other materials have a lot of promise, a lot of future potential. I think it's really tough to scale up and compete with lithium-ion on price. I hope they're successful. But there's also a lot of room to improve within lithium-ion and I think that's something that gets lost sometimes in the discussion about different chemistries, as well as about solid state batteries. We could have a whole separate discussion about them, but there's also a lot of improvement to be made just in lithium-ion batteries, in batteries that are out in the field.

Connor Hund:

And if you're thinking about segmenting the market, I think you could put us on the side of a material and a production process that's lower cost and that's more easily scalable and also that drops into existing chemistries and manufacturing processes at the cell level. So that's really the important thing for us, is if you are going to produce solid state batteries or vanadium-based batteries, that's going to be an entirely different manufacturing process. Whereas we can go to existing lithium-ion cell manufacturers and say, "Hey, you drop our material into the anode rather than the graphite you've been using or somebody else's first generation silicon oxide and it'll improve the performance." And that's really the near term opportunity that we're taking advantage of.

Bill Derasmo:

That's a critical point. Because I will be honest, in preparing to interview you. I didn't appreciate that, but that sounds really critical for everyone to understand, that you can take your anode and essentially insert it into existing uses. That's your critical niche in this space. And that sounds really important for people to understand.

Connor Hund:

Yeah, that's absolutely right. I think everyone wants to talk about innovation and new technologies that folks are excited about that come out of research labs, and as they should because everything starts there, but there's a long, long road between that initial prototyping, initial development and getting stuff out in the field, manufacturing it at scale, having component materials that are scalable, that have large markets, that have multiple suppliers, not needing complex manufacturing equipment. Our process, that we use, uses commercially available processes that are used in other industries. We have an aqueous based solution so water is a big part of our process. We're not using complex solvents and solutions, and that all drives us towards the space of that really is the reason we're the first ones to commercialize an advanced, really high energy, higher silicon anode penetration battery into the field while a lot of other folks haven't achieved that yet.

Bill Derasmo:

Your CEO, Dr. Francis Wang, he talked about the supply chain issues that the country is facing, but the Biden administration's pushed to try to improve that and possibly invoke the Defense Production Act, which they ended up doing. But now I think I understand, and maybe you can speak to this a little bit more, what he meant by how NanoGraf can play a role in that, in improving the United States' domestic supply chain and domestic production of lithium-ion batteries with your anode as one of the key components. But I don't know if you want to talk to some supply chain issues, because it's a hot topic right now.

Connor Hund:

It absolutely is. So I think it's been challenging across a lot of industries, batteries as much as anyone I would say. There's different levels within battery production. And I think we've seen a lot of investment in the US go into raw materials mining. In the US and in North America, I think that gets a lot of attention. Battery cell manufacturing as well. You've seen the Asian majors announcing 10 plus gigawatt hour plants in several states, in the US, even just within the last year. I think that's all very exciting, all very necessary. The part that maybe gets lost a little bit sometimes is the steps in between mining the raw materials and building the battery cell.

Connor Hund:

And that comes from refining and processing those raw materials and then forming them into the components that go into the battery. And that's really the part we do at the anode level. And then you see it at the cathode level as well. There's also electrolyte separators, current collectors. So there's these different components of the lithium-ion battery. And I think everyone needs to recognize a little bit that we need to think holistically about onshoring all of those parts of the supply chain and not maybe a little overly simplistically about you get the raw materials and then you can make the battery cells. There's actually a couple key steps in between there.

Bill Derasmo:

I'm really glad you walked through that because it is been an education for me. We have other clients, entities we talk to that are in the separator space for instance. And so you've got an anode and a cathode and a separator. And all of those components are important, as you said, to the overall supply chain. And I think there's all these different pieces that have to fall into place if we want to shore up our supply chain. But I'm glad that the administration has been focused on it, and it seems like we're making some positive strides.

Connor Hund:

I should mention, and I don't want to make it sound like there's no attention going into our part of the process. You mentioned the military earlier and some of their funding for our projects. They are funding, also, our scale up into a new anode production facility in the west loop of Chicago. That's a really big step for us. They've been tremendous partners. We've gotten great support from DOD. So not only did they

fund the development of our first commercial battery cell, but they're also funding that scale up in manufacturing and production that we're going through. And I think that's what's really necessary to bring these processes to scale. There's a lot of things that have done well in the lab and in prototypes, but that's the investment that we need, and I think we've been really encouraged by that support that we've gotten.

Bill Derasmo:

That's fantastic. And maybe you could talk for a minute about just the nuts and bolts of where NanoGraf is and where you guys are located, that kind of thing.

Connor Hund:

We are at 15 full-time employees with a couple part-time, based here in Chicago, but we're graduating to our first big boy manufacturing facility later this year, and so that's what I was just speaking to. That's located in the west loop of Chicago. We'll be able to produce 35 tons per year of our anode material, which is a great size for that military beachhead market that I've talked about, along with a few other customers and commercial applications we'll start getting into. But that's all in motion. These things take time. I think the supply chain issues that you've talked about, we've seen that with some of our equipment and some of our order and lead times getting pushed out, but we're excited to get into that facility and really start commercial production. And we expect to be in commercial batteries in Q2 of 2023. So that's what we're driving towards right now.

Bill Derasmo:

Sounds like the military is going to be really important to you guys. Maybe you could just talk a little bit more about not just the March announcement, but just the overall picture and where maybe you see things going in the future as well.

Connor Hund:

The military has been great partners for this company really from the early days. I mentioned it a little bit earlier, but they funded specifically the development of our 3.8 amp hour cell. And that's what makes them a great customer, is being able to fund that development with us as the future customer of that sell. I think all the military pack makers we talk to are excited about it, and I think that's part of the larger vision. So there's a couple things that are important to the military there that should be recognized more from a national security perspective. The military is a smaller market for batteries and that tends to get them a bit less attention, but there's the national security angle of right now, frankly, we're buying batteries for our soldiers from Asia.

Connor Hund:

And we've only seen global conflicts increase over the last year. I think probably not a lot of folks recognize that. And then the other part of it, which I think we'll probably touch on more, getting back to electric vehicles is that's where everybody in cell manufacturing is focused right now and the military and other applications are asking, "Hey, are we going to have cells? Are we going to have a reliable source of cells in two to three to five years that we can count on? And it might not be coming from those Asian super majors, but are there US companies that can guarantee us that supply?" And that's why they've really been big supporters of us, and we have a kind of shared collective vision of that future.

Bill Derasmo:

Sounds like the whole big picture comes together with all this, because not only is it the security of the supply chain for the batteries, for the applications you talked about. But with gas prices where they are, and certainly the administration I think has tried to make the point, that decreasing our reliance on gasoline and fossil fuels, traditional fuels and moving more towards electrification of the transportation fleet is important. And certainly in the military space too, I'm sure the military is interested in increasing its use of electric vehicles, decreasing its use of gasoline powered vehicles. And I guess we haven't really thought

---

much about that as a society, but I'm sure the people within the defense industries and the department of defense and you guys are mindful of the fact that we need to probably move towards greater electrification of the military mobility. And if you guys can play a role in that, then that's an exciting place to be.

Connor Hund:

Yeah, I'll just make one comment. The military, the army soldier worn power folks that I work with a lot were just telling me a couple weeks ago that one reason they're really excited about our technology is it decreases the need for fuel supply convoys. The stat they told me is at least half of soldier deaths in Iraq and Afghanistan have been fuel supply attacks, because that's really an area where America's enemies on those battlefields can attack those convoys. And electrification is a huge part of eliminating that risk. So I think there's a climate perspective, there's an emissions perspective, but there's also just that safety perspective that is really valuable for them.

Bill Derasmo:

Thanks for sharing that, because I will tell you, I personally did not realize that vulnerability and that statistic about Iraq and Afghanistan, but it makes sense. It's a supply line issue as they say in the military. Even in the Ukraine, Russia conflict, which we're not involved in, but just based on news reports, that is a vulnerability for both sides in that conflict, the supply line issues. So for our military, it's interesting to hear and good to hear that at least people are thinking about how best to address it in the future going forward.

Bill Derasmo:

If I could shift gears for a minute, we've talked a lot about the silicon-based anode and different applications with the military and everything. I would just ask personally for you in your career arc, what's it like now working in the space that NanoGraf is in as opposed to maybe the space that I'm more familiar with, which was the space around Key Capture Energy and wholesale energy markets, what I guess people in the battery field called the stationary applications for batteries? Maybe you could just compare and contrast those two areas that you've had exposure to.

Connor Hund:

I think they're both great spaces. I like to say I've gone from very large battery applications to very small ones, both interesting markets, both commercializing. We could actually talk a little bit about some of the demand tensions between those two markets, because I think those certainly exist. I would say the stationary storage market is very exciting. It's actually probably harder to figure out or to figure out the mechanisms by which you make money in that market. I think that's probably the largest challenge that you have, is across the different ISOs within North America, everyone has their own rules about how you can make money.

Connor Hund:

Energy storage is a very strange resource that they haven't really contemplated often. A resource that can be both a demand side and supply side resource. Often the market rules aren't set up to accommodate that. And that's a lot of the challenge you're figuring out is, okay, can you make enough money off frequency regulation? Can you run energy arbitrage swaps? That's probably the holy grail. Where are the opportunities you can do that and do it reliably for 10 to 15 years? And there's other services you can provide as well but there's a lot of uncertainty around all of them. I think moving to the transportation markets or the military market that I'm in now, it's much more, hey, there's this huge demand wave coming.

Connor Hund:

There's going to be a lot of winners in this space, but there's a lot to be figured out, and it's really difficult to make these battery cells. That's one thing we can talk about as well that I don't think people realize. And so you see all these projections about electric vehicle demand and it's huge and there's a lot of announcements about supply coming online. I think the challenges here are less about figuring out market

---

mechanisms. It's a less regulated market, so it's more about figuring out supply constraints, manufacturing scale up. It's really a lot of execution based tasks on this type of business.

Bill Derasmo:

That is fascinating to listen to as someone who grew up in the regulated space. If you look at my background, as you alluded to, I'm more about wholesale energy markets and RTOs traditional utility background, to some extent. And then when you got into storage, that was my entry into this overall storage space. Well summed up on your part, and I appreciate that perspective and I could see how it's very different in that sense. The challenges are more maybe traditional business challenges. So you don't have to solve the business challenge and then also figure out, okay, but given this market construct, how do we get revenue?

Bill Derasmo:

Which is sort of what the Key Capture energies of the world, I guess, face is then you have to figure out, okay, but how do I monetize all the different things that I can do that this Swiss Army knife... Or it was always talking about monetizing the value stack so to speak. If I can get money off of ancillary services, maybe I can get credit for capacity and of course I can make energy sales, but how do I do all that? With NanoGraf, you guys are out of that space, but you're into more of a traditional business challenge. Okay, how do I get my materials? How do I make my product? How do I sell it? And so it's very different.

Connor Hund:

I love the energy storage space. That's the other place I'd be working if I wasn't here, the grid scale storage space. It's a fascinating industry and a fascinating market. You probably know more about it than I do. But I think it would be better for the industry if it were a little less fascinating and you didn't have 10, 20 different sets of rules, depending where you're operating and different mechanisms that are difficult to rely on in the longterm. The difficulty of understanding it makes it interesting and it really drives the challenges.

Bill Derasmo:

That could be a conversation that we would spend a whole other episode on. But what I would say is that with that, you hit on a point that a lot of people feel strongly about, and that is you've got these different regional markets. And generally speaking, the regional markets, it's great in terms of an improvement over where things were, but it'd be even better if we could get alignment in some of these market rules especially in the middle of the country where you've got Miso and PJM overlapping so to speak.

Connor Hund:

That's right.

Bill Derasmo:

And that was my entry into the space as we've talked about maybe in some past episodes, was when we took the complaint on behalf of Indianapolis Power and Light and we complained about Miso's market rules and the rest is history. But there's more work to be done, no doubt, on that front. One thing you could be thankful for is you don't really have to deal with that part of the equation. So that's perhaps helpful. The last point I was going to make is where the things cross over. And we've also alluded to this a little bit in some past episodes, is I don't know if you've done any thinking about the second life market.

Bill Derasmo:

If you've got a battery that plays a role, for instance, in an electric vehicle and then it can be used again in a stationary application as part of a grid scale installation. And I don't know if you've done any thinking about that or NanoGraf has, but that would be my last question for you. And I'm sorry, because you probably



didn't prepare for that one, but it's just one last thought that occurred to me. So I don't know if you had any thoughts on that at all.

Connor Hund:

I'll mention maybe two things and I'll try not to take too much time here. I think the interplay between the two does come from those second life applications. I'll be really interested to see. That's something there's been a lot of talk about over the past few years and I'm interested to see who the first parties are stepping up and saying, "Yeah, we'd love batteries that are starting at 80% of their initial capacity." That's a challenge that I don't know if it's been thought about enough is who's going to do that. Who's going to step up and make that happen. I think there's other components to it as well.

Connor Hund:

We've seen a big shift towards LFP over the last year or so. LFP is great for a lot of solutions, but nickel-based cathode chemistries have three to five times the recycling value. So I think LFP, that hasn't been considered enough and that's probably emblematic of a lot of different components of production processes and manufacturing in the Western world is not thinking about that end use and recycling responsibility. But I will say, I think second life batteries, how I'll tie that in is I think there's going to be a lot of potential there because you're really starting to see tensions between that grid scale market and the EV opportunity in that there just aren't enough batteries to go around, particularly lithium-ion.

Connor Hund:

And really where you're starting to see the smoke, the canary in the coal mine, is energy storage developers talking about not having access to enough batteries and projecting that forward. And we've seen projects canceled over the last year. I think 2021 capacity additions were only 70% of expected. That's gotten worse in 2022. And as they project forward, they're starting to look at chemistries that you talked about and it's less because they need them for long duration, they do need them for that, but it's more just a lack of access to lithium-ion. And I think second life batteries really do hold potential there.

Connor Hund:

And it is something we've thought about at NanoGraf because most of our applications will stop using the battery when we still have 80% capacity remaining. And that's a lot of battery capacity that can still be used for applications that don't have the same high end range usage requirement that something like electric vehicles or military applications needs.

Bill Derasmo:

I can give a plug for one of our past guests, Freeman Hall and the folks at B2U storage, California. They're one of the first movers on this. They are trying to take on that challenge and they have a facility in California. But I totally agree with you that it is a natured space and there's not a lot of movers yet, but I think there will be. Because as you say, when you have... And I didn't know that the figure was say 80%. But that's a lot of battery life, whatever the figure is, if it's around that.

Bill Derasmo:

And so it's too much to ignore. And I know some other folks that are facing the challenge of trying to come up with how you would do a marketplace for this as well between the auto companies, for instance, and the people who are interested like Freeman and trying to do something on the utility side. And I'm sure there'll be contracts, but some people are also trying to set up a liquid marketplace for all this stuff. It's an exciting possibility. And it's an exciting time to be looking at those sorts of challenges and you guys are right in the middle of it.

Connor Hund:



I think it is a very exciting thing. It's exciting. Anytime you have a problem, that's more of a business model problem or a market making problem, that's solvable in some way. And I think we're, in the US especially, very good at solving those problems. And it also is a conservation effort that we should be better at throughout our economy and throughout this space. I think as clean energy leaders we should look inward at ourselves and say, "Hey, what's our waste profile of our products and how can we reuse things better?" And I think that's a great place to start and batteries have a lot of potential. And I think it is a challenge that'll really have a lot of progress made and a lot of solutions come to bear over the next five years or so.

Bill Derasmo:

It's been great talking to you. I appreciate you taking the time to come on our little podcast. And I really enjoyed listening to both your story and NanoGraf's story. Really appreciate the time. And I'll give you one last chance. Anything else you want to say, you want to add? And then I think we should probably wrap up.

Connor Hund:

I'll just say, I think this has been a great conversation. I really appreciate it. I appreciate the work you're doing with the podcast and branching out beyond stationary storage and those markets into this type of space. I'll say it's a complex space, there's a lot of nuance to it. But the thing that I'll say to end is I think there's so much talk about who's going to win, who has a better solution to these different challenges. Even within silicon anodes, there's so many competitors.

Connor Hund:

I think one thing I'll say that folks outside the industry should recognize, the battery demand shortage that's coming does not get talked about enough. It may well be worse than the semiconductor shortage going on right now. And so I think everyone could probably go for a little less talk about who's going to win and who's going to lose and more of an acknowledgement that I think there's going to be a lot of winners in this space and that's what makes it so exciting. And that's why we're excited about the future here at NanoGraf as well.

Bill Derasmo:

I like that positive message, Connor, and I think we should end there. All I'll say is I think a number of other people in this area have had a similar message. In other words, there's room for a lot of winners here, that cooperative spirit and friendly competition spirit as well. I think that's a good place, positive place for us to end. And I'll just say one more time, thanks very much for being on the program and thanks everyone for listening. That'll do it. Thanks.

Copyright, Troutman Pepper Hamilton Sanders LLP. These recorded materials are designed for educational purposes only. This podcast is not legal advice and does not create an attorney-client relationship. The views and opinions expressed in this podcast are solely those of the individual participants. Troutman Pepper does not make any representations or warranties, express or implied, regarding the contents of this podcast. Information on previous case results does not guarantee a similar future result. Users of this podcast may save and use the podcast only for personal or other non-commercial, educational purposes. No other use, including, without limitation, reproduction, retransmission or editing of this podcast may be made without the prior written permission of Troutman Pepper. If you have any questions, please contact us at [troutman.com](http://troutman.com).