Season One, Episode Five: Alternative Energy

SPEAKERS
Sarah Webb, Asegun Henry, Brandon Wood, Leslie Dewan

Sarah Webb 00:00
Hello, I'm your host Sarah Webb and this is Science in Parallel, a podcast about people and projects in computational science. In this episode, we'll be talking about alternative energy with Leslie Dewan, Asegun Henry and Brandon Wood. They focus on technologies including advanced nuclear reactors, heat transfer, hydrogen production and energy storage. They are all alumni of the Department of Energy Computational Science Graduate Fellowship Program, often abbreviated to CSGF. And coincidentally, all of them studied at MIT.

Sarah Webb 00:40
But they’ve each taken a different career path to work on these problems. One is an entrepreneur, one in academia and one at the DOE national labs. During this group conversation, which was recorded online in May, we discuss their careers, what drives them forward and where computation fits into their work. We also talked about broader challenges such as finding the highest-impact problems to work on and the urgent need to align society and science to reshape our energy infrastructure.

Sarah Webb 01:13
I want to welcome Leslie Dewan, Brandon Wood and Asegun Henry here today to Science in Parallel. Thank you for coming.

Brandon Wood 01:22
Thank you.

Leslie Dewan 01:23
Thank you so much,

Sarah Webb 01:24
Leslie Dewan is a nuclear engineer and is currently CEO of RadiantNano, a startup focused on radiation detection, identification and imaging. At the time of our conversation, she headed a venture

capital firm for energy projects, Criticality Capital. From 2010 to 2018. Leslie was the co-founder and CEO of Transatomic Power, a startup company focused on advanced nuclear reactor design.

Leslie Dewan 01:52
So one of the main prior things that I had been working on was advanced reactor design and development. So I was the founder and CEO of one of the first advanced reactor design startups Transatomic Power, where we were working on making smaller, safer nuclear reactors that would leave behind less nuclear waste than other types of designs. So I ran the company for just about eight years, and it was, was truly a phenomenal experience just pulling together a team working on interesting technology. And what I'm working on right now is also in nuclear but approaching it from a slightly different perspective. So I'm putting together a venture capital fund called Criticality Capital, that's going to be investing in clean energy technologies, including nuclear, as well as other types of enabling technologies up and down the nuclear supply chain. So one of the things that I was very, very aware of when I was running Transatomic is that you don't just need the advanced reactor designs. In order to succeed you need to make sure that you have the high temperature steels the high-temperature, easily mass-manufacturable ceramics to make these reactors possible, you need better types of instrumentation, you need better equipment for materials management and security and nonproliferation. And so those are the types of companies that I'm particularly interested in right now at this fund.

Sarah Webb 03:09
Asegun Henry is currently an associate professor of mechanical engineering at MIT and was on the faculty at Georgia Tech from 2012 to 2018. He has won numerous research awards, including an NSF CAREER Award, and the 2018 World Technology Award for Energy.

Asegun Henry 03:27
So I work on two rather distinct, but somewhat interrelated things. I work on my expertise is in heat transfer and energy systems. And you know what, coming out of grad school, my bread and butter, so to speak, was to work on studying the physics of heat transfer at the atomic level. So that's how I ended up with the DOE CSGF fellowship. And we were using parallel computing to run simulations of atoms and study the vibrations of atoms and going on to develop new methodologies for extracting more information from those simulations. You generally end up with this ginormous data set, and so trying to use that dataset to extract information about how materials behave, why they behave the way they do, and to get some insight and theoretical guidance. As I was graduating, I got a job at Georgia Tech as a professor. And before I started, I ended up doing three different postdoctoral experiences.

Asegun Henry 04:27
I ended up postponing deferring my position for about three years. First I went to Oak Ridge National Labs, started studying materials using first principles calculations and then started to transition into the energy space specifically working at Northwestern as a postdoc in materials science, looking at solar fuels, high-temperature thermochemical cycles. And then I spent almost a year at the Department of Energy in ARPA-E. And now my second area that I'm heavily, heavily involved in very broadly, we work on anything that we think will move the needle on climate change. Generally speaking, we look for applications that involve some heat transfer so that we can, you know, leverage our expertise.

Asegun Henry 05:11
We have more ideas than we have bandwidth to pursue. But the major ones are an energy storage technology. So there's a very high temperature, extremely high temperature energy storage approach that we're looking at that is, at least on paper, slated to be at least the lowest cost option I'm aware of. It's down to about $10 a kilowatt hour. And that's about a factor of five to 10 cheaper than batteries. And then there's a methane pyrolysis technology that we've started working on. So making hydrogen, not necessarily just for the hydrogen economy, but just for food. We rely on hydrogen to make ammonia; you need ammonia to make fertilizer so you can feed seven and a half billion people. And so even just from that standpoint, we are trying to make hydrogen in a way that doesn't release CO_2. And so we have a new method that, again, involves high temperatures and heat transfer. And so our main contribution, big, I guess, step forward is that we have developed the ability to use ceramics and graphite at extreme temperatures, with liquid metal as a heat transfer fluid. And so we've made seals that work up beyond 2000° Celsius, and things like that. So we make glowing, white-hot, moving machinery.

Sarah Webb 06:26
Brandon Wood works at Lawrence Livermore National Laboratory, where he is Deputy Director for the Laboratory for Energy Applications for the Future, known as LEAF. As a computational material scientist, Brandon is also the associate program lead for Hydrogen and Computational Energy Materials at the lab.

Brandon Wood 06:44
So a big part of what I do is hydrogen actually did that back in graduate school. So part of my fellowship research was in that. So we look at technologies for producing hydrogen renewably, both low temperature technologies and the high temperature technologies like the one that Ase was referring to. And I lead the modeling and simulation for the Department of Energy across three different multinational lab consortia focused on hydrogen, one that's focused on production and one that’s focused on storage, the storage problem, which is a big issue in hydrogen technology, and one that's focused on durability of electrolyzers is sort of more applied. So in addition to the hydrogen work, I do a lot of work in in batteries, particularly solid state batteries-- so sort of next generation batteries, trying to understand transport processes trying to understand failure of those systems. And then I have portfolio in catalysis, looking at CO_2 reduction, production of liquid-organic hydrogen carriers, different molecules, basically, that can be produced, either chemically, or electrochemically.

Brandon Wood 07:52
A big new focus area for me that it's actually crosscutting through all those technologies is degradation science. So we do kind of a lot of modeling simulation work that's tightly integrated with experimental characterization, on trying to understand initial mechanisms of failure. So that's electrochemical failure, thermal chemical failure, there's mechanical failure, lots of different examples, but particularly, you know, for energy materials applications. So that large effort in degradation of solid-state batteries that I already mentioned. We're also looking at membrane breakdown, electrolyzer breakdown, radiation damage and materials, which is relevant for nuclear. That's kind of been for the last couple years been the big push, is kind of away from these, I would say, simpler calculation methodologies towards

looking at really, really complicated problems, which I think is probably going to be a theme that you hear from all three of us. But, you know, computation has really, I think, just evolved in the last 10 years, and is a lot more capable than it once was. Not just because of hardware, frankly, also because of algorithmic advances and, and mechanistic understanding. And, and so we can start to tackle a lot more interesting, I think, a lot more applied and industry-relevant problems than we used to. So that's a big, a big part of our focus is a laboratory. And, actually, I'd say DOE's focus more generally.

Sarah Webb 09:15
I do want to ask the more general question about how computation is figuring into these different spaces that you work in, and why it's important for solving the various problems that you're working on and thinking about.

Leslie Dewan 09:29
For me, one of the particularly interesting problems that I'm looking at is how you manage distributed sensor networks. One of the problems that I've always been trying to square is like, well, you know, I think that there should be more nuclear power, more advanced nuclear reactors that are deployed all over the world, especially in rapidly developing countries. But how do you square that with the need for proliferation resistance and nuclear security and better types of nuclear safeguards and materials management? And one of the best solutions for that is to make these new types of reactors exceptionally well-instrumented, have a very robust, wide range set of sensors both within the plant and around the plant to make sure that there isn't material being diverted and that there aren't accidental leaks at the same time. But it becomes a very tricky computational problem of figuring out how, you know, if you have 10, or 100 or 10,000 sensors around the site, how do you collect all of that data and bring it in, in a human-understandable-type manner? So that's one of the big computational related problems that I'm working on right now.

Brandon Wood 10:35
The role of data and data science, I think, is probably something that, you know, I didn't think a lot of when I was looking at these problems as a graduate student, but it's become increasingly important. I think there's a lot of opportunity right now for using computation to generate data in data-starved problems. And there's a lot of people working on this. So we do quite a bit of that. The things that are very difficult to measure, either because it's expensive, or in some cases impossible, we can come in with predictive simulation and, and play a role essentially, as a virtual experiment. People think of simulations only in terms of taking data and fitting it to a model. But I think this idea of actually being able to create data that is reliable, like an experiment is something that makes computation really, really important and has become more important in the last, say, 10 years or so. So we do quite a bit of that. And then that interfaces, obviously, with data science and analytical techniques and machine learning and artificial intelligence, and all of this stuff that's become very hot.

Asegun Henry 11:37
I guess I'll be maybe a little bit of a Debbie Downer in this. I was submerged in computation throughout my graduate studies. I love it; it's always been in my heart. And then when I spent some time with the Department of Energy, I just very quickly came to realize like most of the problems I was most interested in you couldn't approach computationally. Now, as I've gone, some interesting problems

have emerged. To me, the most interesting and important computational problems are exactly what Brandon was pointing out is where you can do predictive modeling.

Asegun Henry 12:13
Case in point, for the energy storage technology we're developing, we don't need any help simulating the system or any of that, like we can do most of that. But like, for example, we want to make, for lack of a better terms, solar cells, or photovoltaic cells that facilitate the conversion of heat back to electricity. And one of the most important parameters in the design of those cells is their effective reflectivity. So you have like a certain portion of the light, that's going to get converted, that's above the bandgap of the lowest bandgap material in the stack of materials that make up maybe a multijunction PV cell. But then all the longer wavelength lower frequency light, you do not want to absorb any of it, because then it becomes parasitic absorption, so you want to reflect it. But then if you try to optimize the structure, what you find is that we don't really actually know the properties of all these alloys that are in the stack. We don't have the data, and no one can really do very good predictive modeling. At the same time, the performance of the device is actually very sensitive to like the thicknesses, the doping, a variety of things in those structures.

Asegun Henry 13:17
And so it's an area where, to me where computation has its greatest role to play is where there are instances where doing the experiments is more expensive, moneywise and timewise, than actually doing a bunch of modeling. And I found that those instances are more rare than I thought they were when I was in grad school, but they do exist. I'm very big as an advocate that to try and get people who do work intensely on computation to really try to find the problems that are actually in the end going to make a difference in the in the way things are done in reality. Sometimes, finding the problems is equally if not harder than doing the problem. We have to effectively overhaul an entire energy infrastructure, right? Like, almost the entire thing has to be changed. And that's trillions of dollars of infrastructure. And it's going to take a lot of people thinking very creatively to come up with the best solutions as quickly as possible to get there.

Leslie Dewan 14:21
One particular area that I wanted to mention, and this ties into what you were saying, where you most want to run computational experiments in areas where running a physical experiment would be prohibitively expensive or time consuming. That is directly, directly applicable to a lot of the nuclear experiments. And I think a lot of what kicked off the new renaissance, let's say, in advanced nuclear reactor design over the past five, six years was the ability and the availability of better types of computational tools to run these simulations that were far, far better than what we had before. And bringing it back to DOE and ARPA-E specifically. There was a great ARPA-E program that's still ongoing that's for the development of digital twins for advanced reactors. And it's sort of showing a really interesting shift in focus from, how do we get the first of a kind plant built and designed and operational. And now with the digital twin program, there's a focus on how you make the ongoing operation of the plant to be as efficient as possible with the development of these twins.

Brandon Wood 15:23

Something that Ase mentioned triggered something in my head about this fundamental versus applied and the evolution, I think, of computation, at least in atomistic simulation that I think it's been really interesting is-- it was, to be honest, it was oversold. I completely agree with that. And I think it also wasn't always focused on the relevant problems. You know with all due respect to people who do materials discovery, computationally, it's of limited utility. We're very applied laboratory, and when we started actually interfacing with industry, the comment was, "Well, you know, it's great that you have a material that on paper looks phenomenal, but we can't integrate that into our existing infrastructure." Right? We have all of these belts of plant components that have to be considered. What about the compatibility factor? Part of the reason why I got interested in this degradation science problem is because compatibility factor is so important. And suddenly industry representatives would perk up and say, "Okay, there's something I actually care about."

Brandon Wood 16:19
Sometimes it's not about the next great material. Sometimes it's about tweaks, like how do we process our material in a different way? How do we implement coatings are basically engineering hacks, but do it rationally? And therefore, you make your entire system more efficient, and 1%, 2% efficiency gains to some of these industrial processes translates to huge cost and energy efficiency savings, right? And so that is, in my opinion, kind of the new frontier is maybe moving away from discovery, more towards deployment, optimization, compatibility-- more difficult, frankly, problems, but more relevant problems.

Asegun Henry 16:57
Part of the reason I went the direction I did, you know, I realized this isn't really going to get us where we need to get to. So our approach to corrosion, for example, was the typical way it's done right, as mechanical engineers comes up with this whole system to say, "Okay, I need a material that does X." And you go to a materials scientist, and they say, they look at the periodic table, and they think about the classes of materials and try to find you something that can do what you need, as best they can.

Asegun Henry 17:24
I looked at the problem, and I was like, there's no solution to this problem. There is no material that does this. So what we decided to do was instead flip it. And instead, we find materials that would work. And then we go figure out how to make a system out of those materials. That approach has been, I think, hopefully eye-opening to really think about using materials differently. Rather than treating the selection of materials as a second step, make it the first step. In our case, we talk about corrosion rate, our approach was we go to high temperature, corrosion is going to be the issue. And so we said, well, let's just solve the corrosion problem first. And then we'll figure out how to make a system out of materials that now may be an odd choice, and that's how we landed on ceramics and liquid metals. Because there are several cases of liquid metals that are thermodynamically stable with respect to the ceramics, meaning there's no corrosion at any timescale. Then it's like, Okay, how do you make a system out of ceramics, right? You can't weld them. Right? It's difficult to make threaded connections where you screw things together. And so that's what we took on as: let's try to solve that problem. Rather than try to invent new materials, that it's a losing battle, right? You go to higher and higher temperatures-- if you're trying to use metals, you got metal alloys, you got a bunch of elements, the entropy is going to kill you. The elements want to move around and go somewhere else than where they started. The strength of metals, fundamentally, will continue to get worse as they get hotter. And

then we found some ways to make it work. But I think getting people to think more along these lines of like, what just how do I solve the problem, and maybe be willing to divorce yourself from the traditional way of approaching it can maybe open up some new opportunities.

Leslie Dewan 19:03
How do you solve the ceramic manufacturing problem?

Asegun Henry 19:06
Our favorite material to use is graphite. So graphite is special because in the plane of the atoms, you get very stiff bonds. That's what gives you the refractory character. But then in the perpendicular plane, you now have very weak Van der Waals bonds, which now give it the ability to you can make graphite in very flexible formats. So you can make grafoil seals that are flexible; you can make ropes and different kinds of things with graphite. There's no other elements in there, but carbon, but you can actually make like a flexible rope out of graphite, because you're leveraging the flexibility in the sheets.

Asegun Henry 19:38
And lots of, I think, 2-D materials may behave this way and may have the same kind of character that they maybe you could, you know, if somebody spent the time you can figure out how to make it into a sheet, how to make ropes and how to make flexible things. Flexibility is what you need, and you need something squishy if you want to make a seal, right? And so that's what we use to make the seals is graphite. So you can take two pieces of ceramic. You could take two pieces of graphite; you can bolt them together. And you need something squishy in between to act as your seal as your seal phase to protect and prevent whatever's inside the two from getting out. I suspect you can do it with boron nitride. I don't know that anybody's made boron nitride seal, but I suspect it's possible. There may be all kinds of other 2-D materials that may behave this way. But graphite so when we can get that's industrially made, carbon's very corrosion resistant, depending on upon what you expose it to-- not oxygen, of course. And so it just depends on choosing the right materials and having that compatibility with whatever else is in your system.

Brandon Wood 20:39
I think that this idea of co-design at the system and materials scale, this is also something we're starting to do in the hydrogen program within DOE. You build the system around the material, but I think it's actually it goes both ways, right. And I think the other piece of the puzzle is also the operation conditions. And so a good example of that is there's a lot of interest right now in what they call hydrogen carriers, which is an umbrella term for ways of transporting hydrogen at high capacity. So hydrogen is very difficult to liquefy, you have to go down to cryogenic temperatures. And so it doesn't have all the advantage that, for instance, natural gas typically has. So if you can store it in a chemical that that is liquefiable, or is maybe liquid under any conditions, then you get a lot of gains. But the problem is when we talk about hydrogen carriers, it's so application specific. So where are we taking the hydrogen? Is that long distance? Is that short distance? Will it be trucked? Will it be piped? In the end are we going to use it for running a fuel cell and making electricity? Are we going to use it to make fertilizer? And then there's lots of different things that we could do.

Brandon Wood 21:47

And all of that affects the constraints, the design constraints of the system scale. And then at the same time, all of the materials properties also affect what needs to go into the system. And so there's this kind of three-way communication that I think has not been exploited to the extent that it should, between understanding use case basically, understanding system design parameters and understanding materials parameters. Another thing that computation can provide a lot of insight into is not just each of those individually, but the linkage between the three of them. And that's kind of where a playground that we're starting to play in for a lot of these renewable energy problems because there's so much regional, local and temporal variability in renewable energy, right? I mean, whether you're talking about production, whether you're talking about the utilization. It's just there's no rules that that lead to universal design constraints.

Asegun Henry 22:42
There's an interesting point you brought up: Somehow there is application-specific information and constraints that we have to figure out how to transport that information further upstream, because I find that the most creative academics and whatnot, they don't know a lot about what the final use case and issues are. And so there's a need to like patch the information back to complete the triangle, right? So that, from the very beginning, people are actually aware of what the real problems are. You know, I have a colleague. He's a guy at Georgia Tech, he was working on thermal interface materials, and he realized that the real problem they had to solve is the application of the materials, not so much about like the performance of the specific thing. All he did was take like carbon nanotubes and make it into like a two-sided tape. And by doing that, now everybody wants to use it, right? It's because it's like just that simple thing of the way it's applied, determined ended up becoming his main selling point. And instead of being an academic really driven just to like, Oh, I want to get higher and higher performance higher and higher performance, it's like, they just want to be able to use it easily and reliably. Because the real problem they have is that it's too expensive to have to take the whole thing apart. So I'm curious if you all have any thoughts on, is there any maybe more systematic, more broad way, in general, for a variety of applications to bring more of that application-specific data upstream, you know, to where ideas and creative things are being conceived?

Brandon Wood 24:07
It's a great question. I mean, it's something that a lot of fields struggle with. I don't know if there's really an easy answer to that. I think data availability and curation is starting to get some attention. And so I am encouraged by some of these repositories that have been started. I mean, even journals are kind of migrating towards this, right, scraping for data in the literature, getting industrial databases, getting them to release the data, basically, for public use. Baby steps are being taken in that direction. But I haven't seen it to the extent that I think it needs to happen.

Leslie Dewan 24:42
Yeah, I agree that the wider availability of more open-source datasets, even more open source journal access to distribute that information better among the different groups who otherwise would be very siloed off from one another. That's crucial to some degree. Also I think that just having more industry partnerships with academia can be exceptionally valuable in just driving things towards a use case because then you're you're thinking about basically the whole product lifecycle and having an industry partner means that you're focused on the actual use cases.

Brandon Wood 25:15
Yeah, I agree with that, too.

Leslie Dewan 25:16
But those are all very, very ad hoc. So I'm not sure how to, you know, systematize that,

Asegun Henry 25:21
I wonder if it makes sense, I don't know how this is in your respective fields, but I can speak from my own fields of study. One thing that's I think is on the decline is the attendance and viability of conferences. And so I'm wondering if maybe this is maybe an appropriate shift in focus for meetings, where conferences, maybe, maybe not the entire conference, but maybe some major portion of it is devoted to facilitating this dialogue. It'd be really cool, I know, I would be excited to go to a session on, you know, variety of different energy categories or, or sectors where you could just if you could just have companies willing to divulge, like, here's the problems we need your help solving, like, here's the real issue we have.

Leslie Dewan 26:09
Yeah, I really like that like a very informal way of requesting solutions to these problems. Because like I've talked to so many nascent deep tech startups where there are two or three Ph.D.s, completely brilliant, you know, whether they're nuclear engineers, or mechanical engineers, or material scientists or chemical engineers, and they're like, "We have this great technology. We have this new type of material. We think it'll be really useful. We have no idea who wants it." And bridging that gap between tech and possible customers is one of the main things that I've been working on.

Brandon Wood 26:38
This is something Department of Energy is deeply concerned about in general, too, right, is trying to facilitate those connections. A lot of workshops and such that are oriented towards that. But since it's an ongoing problem.

Sarah Webb 26:50
Well. as the communications person on this call, I mean that it sounds like it's a fundamental communication thing that we're talking about here, right-- at some level, having the right people asking the other right people the right questions.

Leslie Dewan 27:05
Exactly. And it ties into the fact that there isn't very much communication among different fields, there are probably dozens of people who are working in the oil and gas sector who would have information that would be very relevant to advanced reactor designs like high temperature materials under broadly punishing conditions. And there's just no cross-pollination between the two sectors. Similarly, with aerospace and automotive design, and I'm sure many, many other areas as well.

Brandon Wood 27:32

I mean, another divide that kind of mirrors that is this, going back to computation and fundamentals is this experiment theory divide, I think a lot of, you know, a lot of people who are trained in one or the other are sort of scared of the other camp. And it goes both ways. A lot of what I've tried to facilitate in my role at the lab is we have to find a common language. And sometimes it's just terminology, but also it's different ways of viewing the problem and having respect for the fact that each of those viewpoints brings something different to the table. And in the end, it's not about what is better than the other. It's about pieces of a puzzle that then you put together and try to solve.

Brandon Wood 28:08
And so if I have one piece of advice for the younger people, incoming fellows, do not be afraid of stuff you don't understand and be willing to talk to people. Because you will be the stupid person in the room the first time you bring it up but rest assured that the person on the other side of the table is also the stupid person in the room when it comes to the stuff that you know well. And if you can find that common ground and make it work, I mean, that's where the best science is really done.

Sarah Webb 28:32
I'd love to hear what other advice that you have for early career folks who are either interested in this space or computational science in general.

Leslie Dewan 28:41
Find ways to be as multidisciplinary as possible. Take classes, electives and other departments if you can. You know, I got my PhD in the nuclear engineering department, but also because of the fellowship, I was taking a lot of different algorithms classes within the computer science department. I took a lot of materials science classes, mechanical engineering classes. I even took a lot of archaeology classes when I was at MIT. Archaeology at MIT lives within the materials science department, and that, it's just very, very helpful to be able to think about problems from so many different angles. And to get back to Brandon's point-- to have different vocabularies for thinking about the same type of problem helps you be more broad in your thinking.

Asegun Henry 29:25
From the academic side, I would say I think we have to evolve the academy itself. We have created a system, that there's like two different kinds of impact. There's like real-world impact and there's academic impact. And we've created a system that biases towards the reward of academic impact, which may have no real-world impact. We can choose to change it if we want. And I think that that's a big shift that we should pursue.

Asegun Henry 29:54
And for young career scientists and engineers, I would say one of the biggest things is try to find impactful problems to work on. Instead of being so intensely focused on trying to solve the hard problem-- sometimes the problem doesn't have to be hard. There's like just some good problems where like a little bit of effort does a tremendous amount. And so I think putting a good amount of effort into like trying to really carefully figure out like, what problem are you going to solve. And not just inheriting the legacy of what problems maybe your advisor or the people that you've worked with have solved. If we can get a new generation of scientists and engineers who are willing to question that the inheritance

of all these applications that, yeah, they got talked about before, but maybe you can just do something different. I think that would be really, really powerful. And that would help young career engineers and scientists to distinguish themselves from the pack. Just go solve a different problem, one that actually matters.

Brandon Wood 30:53
One of the great thing about computation is the flexibility, right?

Asegun Henry 30:57
Yeah. And the other thing I think that goes along with it is the fearlessness. Be fearless. Because this is the if you're young, the advantage you have is the nimbleness. You can switch and do something different.

Sarah Webb 31:11
I want to take this back to this general topic of alternative energy. And, Leslie, I actually want to go back to something that we were talking about, I think, even before I turned on the recorder. I mean, you were talking about how exciting it is, to be in this area, I want to get a sense of maybe you can each briefly tell me the things that you're most excited by, the things that you're most challenged by, right now.

Leslie Dewan 31:38
So thinking about the future of the electric grid broadly is, and what makes it especially interesting to me is that it's so multifaceted. It's not just energy generation technology. It's grid-edge and monitoring and instrumentation technology. It's the economics of energy production and transport. It's what the transmission lines look like. It's the regulatory aspects of who maintains the transmission lines; it has geopolitics wrapped up into it. And just those types of problems that are not just engineering, but also social science and public policy and public outreach are things that I just absolutely love digging into. And for the aspects that I'm most excited about, I think, you know, more broadly integrating better types of telemetry in terms of, you know, not just how we monitor nuclear power plants, but how we monitor different types of energy generation facilities, how we monitor the high voltage transmission lines, and make sure those are both in a good state of repair and are acting as efficiently as they possibly can. Looking into those broader networks are the pieces that I'm most interested in.

Brandon Wood 32:50
I agree a lot with what Leslie said. So I think there's, we're at this, this point in history where the way we produce and store electricity, and not just for the grid, I would say also transportation fits in this category. It's a sea change that's coming. And it has to come, frankly, right, because we're going to be in trouble as a planet if it doesn't. But the technologies are, are beginning to emerge. Now we have a large penetration of renewables on the grid now. Sustainable transportation, electric vehicles are reality, and they're going to continue to grow. And so I'm really excited by what that means for fundamental problems. Right.

Brandon Wood 33:29
So intermittency is a big deal, so storage also becomes very important. You know, I alluded earlier to this idea of, of kind of regional and local needs, both spatially and temporally, long duration, storage,

the ability to have localized microgrid type technologies. These are ideas that have been tossed around for a long time. But we're at a point now where we're really starting to think about how to do it and how to do it practically. And so with that, you know, I'm a material scientist, ultimately. My interest is in materials. But I think there's a lot of materials challenges that come as a result of that. You have stresses that are put on materials, because of you know, for instance, wind power, right? You have periods of high generation and periods of dormancy, and that is a unique set of materials challenges that I think is really, really rich right now. So what am I most excited about the ability to connect, changes and understand reliability of you know, emerging grade and transportation challenges back to atoms and molecules, I mean, all the way down the chain. And I think one of the cool things about the energy problem is the context is all around us. We see it every single day, right? It's so obvious, and it's really inspiring, because you know, if you can actually do something meaningful, I mean this this is going to make a difference.

Asegun Henry 34:49
Yeah, for me, the most exciting thing I would say is having in hand what I believe to be, you know, a potential solution to storage problem. I think that I get to wake up every day, feeling like trying to save the world. Basically, when we make advances, it's a big deal. And it keeps the keeps the students heavily motivated, right? Because they're all committed, they work day and night, because they're like, we're trying to save the world. And so far as most challenging thing, I think the biggest challenges are really social in nature. I think that we could come up with the greatest energy storage technology and make it hit whatever metrics you want. But if we don't change the rules, nothing is really going to go very far.

Asegun Henry 35:40
I mean, at the end of the day, I think what is going to be necessary for us to change our infrastructure, and change our way of life, so to speak, is we have to build a social movement, you have to have people, average people, regular people, nonscientists and engineers, not just voting for things but demanding big changes, not tomorrow, not in 10 years, but 10 years ago. We are way behind, and the outlook is not good. People talk about getting on to the Paris Agreement to get to two degrees, right? And right now that’s kind of a joke, like, we're not going to get to two degrees, we're looking at four degrees with business as usual.

Asegun Henry 36:32
My biggest challenge is how do I figure out a way to inspire and motivate people who wouldn't normally want to do anything about any of this, and sit back, and maybe complain or comment, but not act. And to me, I feel like we need action we need; we need demands. And we have to know at the end of the day, our governments of the world are intended to represent the people and the interests and the desires of the people. And we have to get to a place where that is truly what's happening, and where the people are educated and know what to do and are demanding that this whole infrastructure we depend on be changed.

Sarah Webb 37:13
Well, with that, I think I'm going to wrap up. I want to thank you, Brandon, Leslie, and Asegun for joining us and this discussion about your work and how it all fits together.

Brandon Wood 37:27
My pleasure.

Leslie Dewan 37:27
Thank you so much.

Sarah Webb 37:31
To learn more about Leslie, Asegun and Brandon and their work, please check out our show notes at scienceinparallel.org. If you like this episode, please share it with a colleague and subscribe and rate us wherever you listen to podcasts. Science in Parallel is produced by the Krell Institute and highlights computational science with a particular focus on work by fellows and alumni of the Department of Energy Computational Science Graduate Fellowship Program, which is celebrating its 30th anniversary in 2021. Krell administers this program for the U.S. Department of Energy. Our music was written by Steve O'Reilly. This episode was produced and edited by me. Sarah Webb.

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