Transcript of the Volts Podcast: Grid-scale batteries do not currently reduce emissions. Here's how they could.

David Roberts: Alright, hello everyone. This is Volts for September 6, 2023: Grid-scale batteries do not currently reduce emissions. Here's how they could. I'm your host David Roberts. It is widely understood that decarbonizing the grid will require a large amount of energy storage. What is much less widely understood is that batteries on the grid today are generally not reducing carbon emissions. Indeed, their day-to-day operation often has the effect of increasing them. Yes, you heard me right. Most batteries on today's grid are responsible for net positive carbon emissions. I was quite disturbed when I first found out about this, mostly through the research of Eric Hittinger at the Rochester Institute of Technology. And I wrote a piece on it on Vox way back in 2018. Contemporary research suggests that nothing has changed in the ensuing five years. Most batteries still behave in a way that increases emissions. But a new startup called Tierra Climate is trying to change that. It wants to incentivize emission reducing behavior in batteries by making it an eligible carbon offset. Just as renewable energy producers can make extra money through the sale of renewable energy credits or RECs, battery operators could make extra money through the sale of carbon offsets on the voluntary market, but only if they change the way they operate. It is an intriguing idea and the only real solution I've seen proposed to a problem that no one else is even talking about. So I wanted to chat with founders Jacob Mansfield and Emma Konet about why batteries increase emissions today, what incentive they would need to change their behavior, and what's required to set up an offset product. And yes, I recall that Volts recently featured an episode extremely critical of carbon offsets. We will get into that, too. So then, with no further ado, Jacob Mansfield and Emma Konet. Welcome to Volts. Thank you so much for coming.

Emma Konet: Thanks for having us.

David: Emma, let's start with you. You worked at a battery company before jumping to the startup. Let's walk through a few basics here. Let's just start with this question. If I'm an investor, and I want to build a big battery and attach it to the grid, how would I make money? What are the routes through which I could make income with a battery?

Emma: So batteries typically have three ways in which they make money. The first one is I think what everyone traditionally thinks of a battery doing, and it's called energy arbitrage. And basically, that just means that a battery buys power when the price is low, and it sells power when the price is high. And the difference between those prices is what the battery is paid. Of course, some energy is lost through the process of storing it. And so batteries are not 100% efficient. So that's kind of the traditional idea of how batteries operate. But that's actually not really what a lot of batteries are doing on the grid today. Instead, they provide what are called ancillary services. And those are basically products that help to keep the grid frequency at 60 Hertz. And it's really important for reliability, just in everyday power grid operations, that that

happens and the grid operates more efficiently when it's in a tighter band around 60 Hertz. And batteries are really good at providing those products, because they can very quickly ramp up and down, and they can provide those products around the clock.

David: Yeah, this is a really cool thing about batteries - just to sort of insert an aside here - is those grid services used to only be able to be provided by giant fossil fuel power plants. So it's very cool that we have this digital source now of these grid services. It's much more precise.

Emma: Exactly. And just much more efficient. So that's the second revenue stream available to batteries. And then the third is what's called capacity revenue. And this is not available in every market. But it's basically available in every deregulated market outside of Texas. And it's like long-term grid planning. So the grid operator looks at the expected demand forecast on the time horizons of years rather than days or weeks, and determines how much power plant generation capacity it's going to need to satisfy that demand in the future. Then it creates a market to establish the price of what it costs to bring new generation online to meet that demand and also to satisfy powerplants that are retiring and going offline that we need to backfill. So that is another service that batteries can offer.

David: Paying them to be available, basically.

Emma: Exactly.

David: And you mentioned this, but maybe it's worth clarifying a little bit. Capacity payments are obviously only available in areas with capacity markets. So that is restructured areas other than Texas, because as Volts listeners may or may not know, Texas has this energy-only market with no capacity market. So what about in areas where there are still vertically integrated old school utilities? Can batteries make money in those areas? And is it the same way?

Emma: So that's actually a really good question. And there's a lot less transparency in vertically integrated markets. So it's not obvious to say exactly what batteries are doing. And basically, the utility decides the operating mode of the battery. And I think the biggest distinction between vertically integrated and deregulated markets are that in vertically integrated markets, utilities can rate-base the cost of bringing new generation online, whereby in deregulated markets that has to be supported by the fundamental economics of the power market. And that's why deregulated markets are so good at getting lowest cost dispatch. And that was why basically, they deregulated in the 90s. So it's basically that batteries functionally do the same thing. They're providing frequency services and probably doing some energy arbitrage and are online for capacity in vertically integrated markets. There's just much less transparency on how they're being paid and how much of that is essentially being subsidized by ratepayers.

David: And let's just say a little word about grid services. Because as we mentioned, it's very cool that batteries can provide these services - sort of voltage regulation - and stuff like this. But I think people should understand that this is not a large burgeoning market. Like the actual

demand for grid services is relatively limited and close to being saturated now? Or how much headroom is there in that particular slice of the market?

Emma: I think a lot of developers also would like to know the answer to that question. Because when ancillary markets saturate with storage, that's going to be a major revenue stream that has price pressure on it, so that revenue stream will decline. Basically, ancillary markets are - I'm just going to use Texas as an example because it's the market I'm most familiar with - we just are hitting around 85 gigawatts of load in the energy market. And in contrast, ancillary markets are between 3 and 5 gigawatts, so much, much smaller in scale. And we are not far from having 3 to 5 gigawatts of batteries in the ERCOT market operational. It's a little bit of a moving target, because the grid operator ERCOT can move around the quantity of those services that it procures. And that's actually changed a bit and they've released a new ancillary product in ERCOT this summer. So it's not exactly a certainty. But I think certainly in the next two to three years, we'll see some significant price pressure on these services. And one thing I just want to note here is that like, when we kind of talked about batteries getting compensated, it's not a clear cut "batteries can win" in these markets with respect to paying back their costs. A lot of batteries actually struggled to make enough revenue to meet their breakeven hurdle. And this is just one more pressure on the product that's been keeping them afloat in the past couple years. So I think this is really concerning to developers, and they're looking for new ways to compensate storage for the services that it provides.

David: Right, yeah, sort of getting around to that - the grid services market is relatively close to saturated, let's say, but if that's true, then it's definitely going to be saturated well before we get anywhere close to the amount of storage we think we're going to need to decarbonize. So this is not going to be a big driver of additional battery deployment. And as you say, just in general, and you made this point to me when we talked earlier Emma, it's just very difficult, even today for batteries to make money, period. For all the talk about batteries and how much batteries we need, and the gigantic quantities of storage we're talking about needing, it's very difficult for them to make money in today's market.

Emma: You're right, you're absolutely right. I think they are the sexy new thing that everyone's really excited about and gets a lot of buzz. But when you actually operate them and see the revenue they bring in versus the revenue you expect them to bring in, I think it's a little bit of a reality check for folks that are investing in storage, which is really problematic because we need to continue to invest in storage, continue to build storage in concert with renewable energy in order to get this power grid to net zero. So we can't lose momentum here. And if we start to see the economic stall out, that might be what happens.

David: Putting grid services aside, let's talk about arbitrage. So your basic "buying power when it's cheap, selling it when it's more expensive". One of the things that you've found - that Hittinger's research found, and that your research has found - is that today, at least, your typical arbitrage will have the effect of raising emissions. So just explain why that is so. How does how does that work exactly?

Emma: Yeah, just to put a little bit of a finer point on it - it's not necessarily a blanket statement that doing energy arbitrage will increase emissions. But it really highly depends on where the battery is located on the grid. In fact, some batteries are located in places where they can significantly reduce carbon emissions. But energy markets and power markets do not incentivize batteries to site in those places. They incentivize batteries to site in places where they aren't reducing emissions on the grid through energy arbitrage. And the reason why that happens is because - well, there's a few reasons - but the big reason is because of the roundtrip energy efficiency of batteries. So some energy is lost due to the resistance when storing the electrons.

David: What is the average efficiency of deployed lithium ion batteries on the grid today?

Emma: It's around about 85%. So it's actually quite efficient - basically the most efficient batteries we have - and every other technology that can do longer duration for cheaper is usually sacrificing efficiency.

David: Right. But it's still the case that for your arbitrage to make money, you need not just to sell power when it's more expensive, but it has to be more than 15% more expensive because you got to compensate for the lost power.

Emma: That's exactly right.

David: Yeah. So as we're saying, arbitrage does not intrinsically increase emissions, it entirely depends on where the battery is and what time it is, and a lot of other factors, but today, we think they are increasing emissions. So how do we know that? Tell us a little bit about the study you did.

Emma: So we are partnering with a company called REsurety, it's been around for about a decade, and they produce a dataset called a Locational Marginal Emissions rate, which basically measures the carbon intensity of power. So you can kind of think of it in terms of CO_2 tons per megawatt hour, at every point in time and space on the grid. And what it really is truly getting at is the incremental carbon impact of injecting a clean megawatt hour onto the grid. And so we can leverage that data to take a look at a battery's historical behavior, and actually measure what the carbon impact was of its charge and discharge cycles, including all of the things that may be doing to satisfy other markets like ancillary services. So I think what's really critical is that in some cases, it's better for a battery to cycle more and do more energy arbitrage. But it might be selling an ancillary service instead, because that's more profitable. And as a result, we're not getting the carbon impact that we want to see. And some reasons for that might be a battery might charge uneconomically in the real-time market to satisfy a state of charge requirement for carrying an ancillary obligation. Or a battery might charge and discharge very rapidly to respond to the frequency regulation signal that is completely divorced from the carbon signal. And so you start to see these behaviors that are incentivized for the battery to make money, but that don't actually correlate to emissions reductions.

David: This is a theme, the theme of this whole pod is there is no freestanding financial incentive for batteries to operate in a way that reduces emissions. They're just simply not incentivized to do that. And I just want to say about Locational Marginal Emissions, because this is an important concept for people to get and it sounds technical, Locational Marginal Emissions, LMEs. But basically, at a given point on the grid, at a given time, if you add a unit of demand for power, what power plant is going to come online to satisfy that next unit of demand? Right. So people will know in restructured markets, you generally buy power from the cheapest generators first, and sort of stack it up. As demand increases, you bring the more and more expensive generators on, and so the Locational Marginal Emissions in a given spot is just like that next unit of demand, what is the next power plant that comes online? If the next power plant that comes online is a fossil fuel power plant, then you have higher Locational Marginal Emissions in that one spot, basically. And this will change, as the name suggests, from place to place on the grid and from time to time, like it depends on time and place. And this ability to - people who listen to my pods on hourly matching and all that kind of stuff, trying to hourly match your power consumption to clean generation will sort of remember this concept - it's just a very granular, it's different from averaging the emissions in a particular place over a year or over a month or something like that. It's really real-time data. And so this is what you're looking at when you're studying how batteries behave is, what is their effect on Locational Marginal Emissions when they charge and discharge. And what you found is that generally, they're increasing, Locational Marginal Emissions, when they come on.

Emma: That's right. So we did a study in ERCOT, where we looked at 24 operating batteries in calendar year 2022. And we found that over the course of the year, 19 of them actually increased carbon emissions, only five of them reduced emissions, and only one of those batteries really did so meaningfully. And that battery was a paired solar plus storage facility. Kind of telling, definitely sort of tells us where we think the market needs to go to have big carbon impact from storage. But what I think is the most interesting thing we modeled out in this paper is what could have happened or what would have happened if we were actually compensating a battery for the carbon that it abates. And how does that change behavior. And we really found three things. And that's some batteries that are not in locations that allow for carbon reduction, and that are just that emissive, we can actually reduce their carbon footprint and make them less emissive. And then batteries that are in locations where they can reduce emissions, but they're not doing so because there are financial incentives for them to sell other services, we can actually flip those batteries from being emissive to being abating. And then a battery that is already abating, because it's in a really good spot on the grid, and it's paired with with solar, for example, we can actually double the impact and pull even more carbon off the grid. So it kind of runs the gamut of all the different places and operating modes that a battery might be located and operating in, and it can have a substantial impact on its behavior.

David: So before we leave the study behind, though, you just studied batteries in ERCOT, which is the Texas energy-only market. As you say other restructured markets are somewhat different in that they tend to have capacity markets as well, and then there are vertically integrated markets, how confident are you that you would find roughly the same thing if you

studied other power markets? In other words, is this a generalizable phenomenon that arbitrage tends to increase emissions?

Emma: It really depends on the stage of renewable penetration of the grid. So I think when we think of grids that are furthest along in the renewable energy transition, we think of California. Our company is not targeting markets like California, because they have a lot of state regulatory support in the form of mandated procurements for storage, so batteries are kind of just getting built off the back of that. And then Texas has a pretty significant renewable energy penetration, but it's also a market where there's not state support for storage or really green energy in general, from a regulatory perspective. The other markets that we think of are probably the biggest opportunity are probably MISO and SPP, because there's a wealth of renewable energy in that part of the country. And that renewable energy is getting built. It's in the interconnection queue right now. So we're going to see that penetration increase. And I think we can start to basically see the trends of these markets move as more and more renewable energy comes online. So to answer your question about do we think this is replicable? I think the answer is yes. Especially as more renewable energy comes online. But the critical difference being capacity markets, which is kind of the one little wrinkle - like Texas doesn't have those - so we have to think about how does this all play nice together with capacity markets.

David: You see the grid services market tends to lure operations away from what might otherwise reduce emissions. Does capacity market have the same effect?

Emma: Well, I think capacity market impacts a battery's decision making, actually with respect to siting more than anything else. Different capacity markets have different rules with respect to operations, maybe some less offer rules or just availability requirements. So in terms of operating mode, I don't expect it to have a big impact, but it's more in terms of where you put the battery. So when you have a capacity market that power has to be deliverable to load in order to get a capacity payment. And to be deliverable to load, It has to be studied under a System Impact Study, which is an AC power systems model that looks at power flow, and it can be not deliverable if there's not transmission capacity. And really unfortunately, where all the renewables are located is where the transmission capacity is bottlenecked, so it doesn't incentivize a battery to go site itself near renewable energy work and have the highest carbon impact because it's going to have to sacrifice potentially a capacity payment, or pay hundreds of millions of dollars in transmission upgrades, which would kill a project. So that kind of points to why this product is even more necessary in markets with capacity markets, because we need to incentivize storage to site in places that have high impact, but we need to pay them since they are not having this opportunity cost in the capacity market.

David: Right. Because right now, if they deliberately sited in places where they could have the most positive effect on emissions, they would be sacrificing capacity revenue, basically.

Emma: Yeah, they could be and I think 'would be' is probably the right word. Obviously, every location is different. And transmission infrastructure is getting built and things are changing. But generally speaking, yeah, where the power is bottlenecked is typically where the renewables

are producing. And so it's kind of a misalignment of incentives. And I think there are a lot of people working on transmission and interconnection reform. And I think that needs to happen as well. Given my experience, we're trying to work with stakeholders, and ISOs, and all the different people that make those processes go. This is a much faster path. It's just build the batteries where they need to be and pay them to be there. And then in that case, the battery acts as an aid to the transmission system as well. So it can be highly beneficial.
David: And so it's fair to say that in the fullness of time, this problem will go away, right? Like eventually, once we have enough renewables on the grid, and there's enough transmission built, then batteries will start just naturally behaving in a way that reduces emissions.

Emma: That's right.

David: But that's potentially quite far away.

Emma: Yeah, I think it's quite far away. And anyone who's worked in development and interconnection and trading - it's a sticky process.

David: I'm a bit of a wonk, so always my first instinct when I hear a problem like this, like we have batteries out there that could potentially be having positive impacts on the social good, but are not because of screwy financial incentives. I want to reach for public policy. So I just have to ask, if you were emperors for a day, and the U.S. political system was not grossly dysfunctional at almost every level, what type of public policy would solve this?

Emma: Yeah, I also like public policy. So I looked into this and did some modeling and basically we can use a production cost model, which basically simulates a power grid on a fundamental level. So it looks at bids and offers and structure and generators and all that stuff. And essentially, what we found, is that if you add a battery to a grid without a carbon price, based on how all the mechanisms of power markets work, you would see emissions increase today, right? If you add a carbon tax, and we just throw one in for $50, basically. So essentially what it's doing is it's causing generators to just bake that cost into their power offers. You see emissions go down - same grid, same model - all you're doing is changing, you're internalizing that externality, and it basically solves the problem. So carbon tax, I think, is probably the most effective way to go about that. And I think Jacob has some thoughts on this, too. So I know I've been talking a lot, I'd love to bring him in. But that's my take on it. And like you said, it's really hard to imagine a world in which that happens at a federal level in this country.

David: I'm painfully aware. So the carbon benefits are not being valued today, a straight up carbon tax would value them and would probably solve the problem at some reasonable level of carbon tax. Or some of that many ways we have of kind of simulating a carbon tax - like maybe something sector specific or something that goes through utilities - but anything that basically values carbon is going to get at this problem.

Emma: That's right.

David: Jacob, any policy thoughts before we sadly abandon public policy and move on?

Jacob Mansfield: Yeah, I think in an ideal world, I think having something close to like a Pigouvian tax, which is kind of a fancy economics term from my undergrad, would be a good way in which to - you could build something that's somewhat revenue neutral, where you're taxing the emitters, you're subsidizing the abaters, and that would create this clear transfer of value that's really meant to eventually decarbonize and transition the entire grid. I think the challenge is just that there's not the political wherewithal or the willpower to do so. And especially in an inflationary environment like we are right now, it probably seems somewhat unsavory to use a tax-based approach, which is why I think we lean more into leveraging voluntary carbon markets.

David: But you know, taxes are good, just going to plant that flag before we move on. Yay taxes. Okay, so given that politics, US politics is pretty dysfunctional, we're probably not going to see a carbon tax anytime soon. Tell me about this idea. So the idea basically, is that a battery that reduces emissions that changes its operations in such a way as to reduce rather than increase emissions, could sell those reduced emissions as carbon offsets. So just tell me a little bit about the idea and how it would work.

Jacob: To back up a little bit. I think the reason why we're talking about this is because of the fact that one, we've seen voluntary corporate activity be a huge driving force for adopting new technologies. My background was all in power origination, doing transactions between large-scale wind farms and solar farms, and corporate clients that were looking to procure renewable energy for their sustainability goals. And just to level set right now, where things stand, over half of all the renewables developed in the United States have offtake agreements in place with large commercial and industrial customers.

David: Yeah, that's really wild. I don't think people get that. I think maybe people in my world have a little bit of skepticism towards corporations. I don't think people get just what a huge force corporate procurement has been in driving renewable energy in this country. As you say, like half the renewable energy in development is for a corporate entity that wants to claim it's reducing its emissions. I mean, that's not small potatoes.

Jacob: Yeah, no, it's incredible. And I think that it's a really good thing in terms of free markets and companies themselves adopting these initiatives voluntarily. And I think if you take it one step further - so if you put that in context with batteries now, batteries have not had that to date. They don't have any sort of environmental attribute that they can sell, they don't have renewable energy credits as an alternative revenue stream. So the question is, what do they really sell or what do they package to receive more investment? And given the state of affairs where batteries may not be a great financial investment for some developers, the reality is that there's not a lot of investment going into batteries. And so Bloomberg put out a report earlier this year about how the green energy transition eclipsed a trillion dollars of investment, but when you actually look at the numbers, about half of that went to renewables. And when you compare battery investment to renewable investment, three cents for every dollar that goes towards

renewables is being invested in batteries. So there's gross underinvestment in batteries. I think it's in part because there isn't the financial revenue stream to really compensate batteries as net abating assets versus being generating assets.

David: Right, and as Emma said, there are some markets like California where the penetration of renewables is sufficient to cause problems unless you have energy storage in those markets. They are kind of getting off their butts and trying to explicitly support batteries and battery investment. But that's only in the places that have kind of been forced to it by the physics of the power system, right? Not these larger markets where penetration is lower.

Jacob: Right. And I would even say beyond California, there's other markets like Massachusetts has the Clean Peak Standard, New Jersey has been bouncing around the idea of adopting something similar to compensate batteries for reducing emissions. I think that there is some momentum towards supporting batteries in some mechanism. I think that the tension there is: what is the actual instrument used to encapsulate those environmental attributes?

David: Yeah. Is there no consensus? Is there no standard model?

Jacob: No, not really. And I think that's where it's really been derived in private markets, where you have companies that are also adopting an emissions first principles framework for thinking about this and where they allocate resources. And then at the same time, you have the burgeoning data space around LMEs with REsurety, Singularity, WattTime, Energy Maps - you have a whole host of folks that are dedicating themselves to building out these datasets that I think we're getting to the point where you can really use an emissions-based approach to estimating and quantifying what the abatement impact is of a battery.

David: If I can just pick up on one bit of that and spell it out a little bit. So this emissions focus by corporates is somewhat new. So to date, they've mostly just been stampeding to buy renewable energy, wherever and whenever and counting that against. But now that we have this more sophistication about the granular effect on emissions of a given investment - like a wind farm in one place might reduce net emissions much more than a wind farm in a in a different place, especially true for solar, I think - so now corporates are taking, as you said, a sort of emissions-focused look at this, which is "where can we invest in things that have the maximum emissions impact?" And that's what Locational Marginal Emissions, that's what all that data gathering is allowing them to do.

Jacob: Yeah, and if I could add just one more thing, I think there is some changes in the actual standards within corporate sustainability that are going to move in that direction, chiefly, the Greenhouse Gas Protocol, which I think like 97% of Fortune 500 companies have adopted, provides guidance on how to estimate your emissions and the Scope One, Two and Three.

David: Right. So they're being pushed to do this, not just voluntarily.

Jacob: Exactly. And so Scope Two guidance, which is how you essentially estimate your emissions from electricity, it's going through its biggest overhaul in the last decade. And so in 2014, they updated it to have a markets-based approach where you could take advantage of if you purchase RECs, are you enter into PPAs, to megawatt match and say, "I'm offsetting my total annual load of electricity." But now given that we have the data to more granularly estimate our emissions, we're starting to think about, "well, maybe if I'm in a dirty grid, where I'm consuming electricity, mostly from gas and coal, and I'm buying power from a wind farm in Texas, in the panhandle where it's already mostly green, maybe I'm not actually having the impact of being carbon neutral while I'm still claiming that I'm 100% renewable energy supplied."

David: Right. You can offset your electricity without offsetting your electricity emissions. And so they're going to need to do this. And so enter batteries then. So how do you slipstream batteries into that kind of system?

Jacob: It's worth noting that under that construct, where people are already supporting wind and solar, I think the next evolution is batteries, and from the corporates that we spoke to, some of them have told us that they think that buying more wind and solar is sort of 'table stakes'. And they see a lot of importance in supporting batteries as the next stage in decarbonization. And it's worth noting, too, as we add more renewables to the grid, and as penetration goes up, you're going to have more resiliency issues, potentially, and you're going to have to rely more on fossil fuels to solve for the intermittency problems. And the benefit is that potentially batteries if sited and operated appropriately, can really supplant thermal units like coal and gas, wean off the grid reliance on fossil fuels, and allow us to run the grid the way that we hope it to be, which is 100% renewable energy,

David: Right. So to do that, we have to incentivize that behavior. So the idea here is corporates going out on the Voluntary Carbon Offset market - corporates looking to offset their emissions, basically. You want to make batteries that reduce emissions eligible as an offset. So tell me a little bit about how that would work. Because I have no idea - is there a governing body running Voluntary Carbon Offset markets? Do you just go out and say, "hey, we've got some offsets." and people start buying them? Do you have to get certified by someone? How does all that work?

Jacob: Yeah, so it's interesting because it is a voluntary space, so there are a lot of different players and lots of folks trying to figure it out and chart new paths every single day. But I think generally speaking, the accepted pathway would be for us to work with a carbon registry. And so we've joined a consortium of players. It's called the Energy Storage Solutions Consortium, which is comprised of corporates and battery developers. And so we're charting a pathway to try to get a methodology in place with Verra. And so Verra is one of the key carbon registry bodies that exists, it's a nonprofit. Verra actually accounts for 70% of all the voluntary carbon offsets that are issued. It's gotten some bad press recently due to nature-based offsets, but the reality is that they've actually become much more stringent as a result of it, which hopefully is a boon for us in terms of getting something passed and getting something through that passes muster. And the goal for that is to have a check in place, such that if we're working with developers to certify

projects, issue offsets, get them minted through Verra, and have a validator that's a third party audit the entire process, you have all these checks and balances in place to ensure that whatever is being purchased by a corporate really is going to pass the test of time - it's really going to be something they can use towards their sustainability goals.

David: Right. Well, this seems like a good time to wrestle with the offset question then, because a few weeks ago I had Joe Romm on - very critical of the offset market generally. And I know at this point that offsets have kind of, even I think maybe among the general public, gotten a little bit of a bad reputation as sort of 'scammy'. So talk a little bit about how you see these kinds of offsets fitting into the market and how confident people should be in them relative to other kinds of offsets. How would you pitch this to someone who's skeptical of offsets, let's say.

Jacob: Right, and those are the folks that we talk to on a weekly basis. So it's nothing new from that end. I think the reality is that this is just a fundamentally different type of product than what exists on the market. To zoom out a little bit, there's sort of a bifurcation between avoidance and removal offsets. And then also between nature-based and things that are not nature-based. So avoidance typically means there is some sort of activity which might increase emissions, if we forego that activity, then we will avoid emissions.

David: Right, this is the classic counterfactual that is so problematic.

Jacob: Right. So it's been pretty challenging in terms of like deforestation - like someone threatening to chop down a forest or a parcel of land, and then claiming that that's an avoidance because they didn't do it because they got compensated. And that's pretty problematic. And the reality is that that requires you to make a guarantee of some sort of activity for hundreds of years, meanwhile still recognizing revenue upfront for something that hasn't yet fully come to fruition. I think the reason why this is pretty different is that we're getting to the point now where power markets are pretty instantaneous, the grid, what supplies electricity, is fairly instantaneous. And so the reality is that at the end of any given day, we can look back and calculate what was the empirical impact of a battery on the grid. And we're not making claims of 100 years into the future, what's going to happen, we can actually look back and say that this battery that was charged with renewables at this time, discharging at this point in time, reduced our reliance on this thermal unit. And that's the type of avoidance that I think is markedly different than a nature-based solution.

David: Right. So this would be then, maybe if we think of it in terms of - because I think as a rough and ready heuristic in the offset market, generally you get what you pay for. So these nature-based offsets are sort of legendarily notoriously cheap, which is why people buy so many of them. But they're cheap because they're mostly junk, I think. And then you have, as you said, the removal offsets, which are literally tons of carbon buried, right, tons of carbon sequestered, which is about as certain as you can get that you're offsetting a ton if you literally bury it. And those are incredibly expensive right now, I think, because the technology for capturing and burying carbon remains incredibly expensive. So where do you think battery offsets would come in between those two poles?

Jacob: Yeah, I think right now, nature-based offsets, the high end is probably like $20. And then you have CDR, DAC that are in the hundreds of dollars, even north to $1,000. And then you have some things in between, but for the most part I would use those as the key price points. Now going back to our study, what we saw was we did a sensitivity analysis on carbon price, because we wanted to know how much can you shift behavior, we found that there were diminishing returns, like batteries can infinitely abate carbon unfortunately. No matter what price of carbon you attach to them, there is a finite limit. And so what we found was, it comes down to the proverbial question of "is the juice worth the squeeze for a battery operator?". Like if we attached a price of $5 per ton of CO2, it might move the needle slightly. But if you're only increasing the total revenue to the operator by a couple percentage points, that's not meaningful enough to go through all these hoops and hurdles. So then it comes down to, "okay, what's the point at which this is meaningful money for batteries to move from being in the red to being in the black and changing their behavior?" And so based on our study, we found that it's between $50 to $100. And it put more mental benchmarks around that. If you think about RECs, and specifically high impact RECs, which are increasing in popularity right now, people are paying as much as $20 per REC or more, with maybe a carbon abatement of maybe 0.3 to 0.4 tons per megawatt hour. And then when you convert that to per tons that's already between $30 to $50 per ton of CO2. So we don't think we're totally off from that, but also with the co-benefits of improving grid resiliency, and building more batteries which will help us in enabling more renewables to be built as well.

David: So in the middle then, somewhere, cheaper than carbon removal, but probably more expensive than nature-based and RECs, in the $50 to $100 per ton range. And would that amount of money be different in different markets or is the idea to sort of standardize here across markets so that the market allocates efficiently across different regions.

Jacob: Yeah, I think the beauty to this is that you can actually have price differentiation across batteries, where the batteries that are the lowest hanging fruit, that are more easily enabled to change their behavior to reduce emissions, they may fetch a lower price than someone who's a little bit stickier or harder to abate. So I think that there is opportunity for price discovery, where based on the price point, maybe we need to hover closer to $50, in which case, we need batteries that are going to more easily shift their behavior to do so to justify creating these offsets. But as the price goes up through time, or there's higher demand for these types of offsets, maybe that's where you get to the higher hanging fruit of other batteries that are more difficult to change their behavior, starting to be economically incentivized to change their behavior. So I think in general it would be a market force where the product generally could be fungible, there's a claim that maybe it could be an inset or someone could want to source these from the ISO or the grid that they operate in. But the benefit of it being denominated in carbon is that it could be fungible across batteries, which is also beneficial in the event that you have an outage or you have an issue with any single asset, you now all of a sudden have a number of other assets that can offer a similarly qualified product,

David: Right. And you can imagine corporates wanting and preferring to pay batteries that are on the grids where they are operating, in the name of this hourly matching. People are talking about some sort of hybrid of hourly matching and emmisionality. That's probably too geeky to get into in this pod, but you can imagine a corporate paying a little bit more to change the behavior of batteries that are producing the power that they're using.

Jacob: Yeah, I think this also affects the siting as well. And I actually would probably hand it off to Emma to chat more about how that affects the siting.
David: Emma, let's talk a little bit about if, say $50 a ton carbon offset money were available to batteries - grid scale batteries - how would that change their behavior? And who builds what and where?

Emma: Well, batteries are always operating in the market to maximize the revenues. So one of the products that Tierra Climate is offering is optimization services to help batteries maximize their revenues across carbon markets and energy markets. It's kind of difficult to answer that question as a blanket statement, because every market has different prices for different things, and those prices are constantly changing as the grid is evolving. But generally speaking, as soon as you attach a price to carbon, even a smaller price to carbon - like once you basically jumped the hurdle of "okay, we're in the contract and I'm actually going to operate my battery in a different way", even a smaller price of carbon can start to change behavior. And so basically, batteries will stop selling perhaps responsive reserve service or spinning reserves in favor of cycling the battery more to capture an arbitrage opportunity that maybe it otherwise wouldn't have gone for. And a really critical example I think we see is that like on a typical grid, pretty much anywhere in the U.S., you're going to see maybe a $20 to $30 difference between the lowest price and the highest price of the day. But batteries degrade when you cycle them, right. And basically, the value that I think that the industry has landed on is about $25 to cycle the whole thing. And so if you are only making a couple bucks, or it's uncertain if you're going to be able to capture that, it's like, "why do I cycle my battery? I'll just sit there and sell something else and not take the degradation and just collect my money doing it." But as soon as you attach 50 bucks to that, and obviously carbon and megawatt hours are not one to one, but let's just assume roughly, you're displacing a unit that's one ton per megawatt hour, then all of a sudden your opportunity goes from 20-30 to 70-80. And that now can incentivize much more cycling. And I think as battery developers are looking to the future, they're going to start saying, "hey, this part is available to us. So let's go to the place in the grid where we get the max arb opportunity and let's maybe not so much worry about these small ancillary markets that aren't going to be relevant to us and then in the next five years." And so we might actually see battery operators and developers flocking to renewable energy rich areas that allow them to cycle the battery frequently and capture that arb. And then we had that whole discussion about capacity markets, which kind of throws a wrinkle into it, but I think generally speaking, the price of carbon should be discovered in a way - we'll have price discovery such that it incentivizes the behavior based on the demand for the tons.

David: Presumably, if there's a spot on the grid where there are considerable arbitrage opportunities that could reduce emissions. Those will saturate too, right? Like those are not infinite. So the idea by putting a price on these is to just start filling those in basically.

Emma: Yeah, and I think a lot of the big energy arbitrage opportunities that we see are driven by transmission constraints, where basically you have one part of the grid that's bottlenecked - the emissions factor gets really low, basically zero or perhaps negative, and so it's a charging opportunity. So that's going to change as we both build more batteries, and build more transmission. But I will make a comment just on what we've seen happen in markets where it's kind of like "if you build it, they will come", where you build the transmission, and you alleviate a constraint and now all the power can get out. And then a bunch more renewables build right behind that transmission, because that's where the renewable energy rich areas are. Those aren't moving, right? Like we know where wind is in Texas, it's in the panhandle. So we go build projects there, and then we fill up the transmission again. And we've just seen this, it's like history repeats itself. So I don't really have the concern that on the long time horizon for batteries, that they're somehow going to cannibalize the opportunity. I mean maybe for a few years, and we see a cycle where the opportunity is less, but we got to build a lot of transmission to solve this problem, and transmission is very hard to get done in this country. And we also need more renewables, and we need more batteries. And so these trends are going to continue, you're going to continue to see an arbitrage gap in both price and emissions in certain parts of the grid, basically in perpetuity.

David: Yeah. And this might be kind of a dumb question, but it occurs to me that if you establish a situation where batteries are making money because there is grid congestion, right - I mean, that's sort of what is making some of these arbitrage opportunities so big is that there's a lack of transmission - then, if somebody comes in and builds transmission in that area, they are going to be taking revenue opportunities from those batteries. And do you worry at all that this is going to set battery owners and operators against transmission, put their incentives against more transmission?

Emma: You know, this is something I've thought about a lot. And I think, not to get too technical here but there's two different flavors of transmission constraints. One of them is a thermal constraint, which is basically like an isolated singular, one line or a couple lines that's causing extreme price action. And typically, we see that price action on the upside, where we see really expensive units have to ramp up to satisfy demand. Then the other type of flavor is the voltage constraint, where basically you're trying to push a large amount of power across a wide region of very - we call it an interface. And those constraints are more persistent, harder to solve with a single transmission line, you can't just come in and say, "oh, I built a transmission line, problem solved." It's kind of this integrated whole process that you have to go through to solve that. And in the meantime, the interconnection queue is filled with generators that want to interconnect. So I don't really think that's going to happen. I think it could happen if you're trying to site a battery to just capitalize on like a small construct - we saw this in West Texas with the Permian demand with oil and gas load. As oil and gas started to electrify their process of extracting, we saw a bunch of electricity demand in West Texas and it caused prices to skyrocket. So batteries

sited there took advantage of that for a couple of years, they built like two transmission lines and the opportunity went away. But that's not really what we're talking about. We're talking about just these endemic, structural issues within the grid, where we're trying to get renewables from the middle of the country, to the coasts, to the load centers - that structure is not changing.

Jacob: And if I could just add something else, I would say that MISO did a study where they examined what would be the most cost effective way of decarbonizing and they evaluated if you used purely batteries, used purely transmission, or a combination of both, which would be the most cost effective way? And the answer really is: you need both. So it's sort of an all of the above approach where this isn't going to supplant the need for transmission, but it certainly is going to help alleviate it. And especially where we are so far behind and will be constantly behind as we electrify everything, I think it'll be really imperative that we are building more batteries in tandem with building more transmission.

David: Yeah, I think we can see in a couple of ways that in some sense, this opportunity that you're trying to monetize is temporary and going to go away at some point. But that point is far away, it's plenty far away, and there's plenty of money to be made in the interim. So maybe by way of wrapping up, I would just ask: this seems like a good idea. Right? We have this problem with batteries now. They're operating in a way that increases emissions. We have a relatively simple intervention, which is just monetizing carbon reductions in battery operation, by way of offsets, getting some of that corporate money flowing to batteries to incentivize them to operate in a smarter way or a way that is more emissions conscious. Where are you in this effort? And have you had - when you talk to corporates, are they open to this idea when you talk to sort of offset, the people analyzing and assessing offset quality, all these entities involved, who would be involved - is there interest? How far away are we from seeing this happen somewhere?

Jacob: I think it's a spectrum, depending on the corporate, their stance on sustainability, the tools that they're looking to use. What I have found generally, in our conversations, is that the shorter of your answer is, yes, there is interest from corporates. And in fact, there was a deal executed last September that was made public where Meta did a pilot transaction with a battery developer in Texas called Broad Reach. And I think that's really put it on the radar that this is potentially feasible.

David: Wait, what did Meta pay for?

Jacob: We don't know the exact contract terms. But in general, the idea was they were compensating these batteries in Texas to reduce emissions through this type of LME construct alongside REsurety. And I think that's a really core data point, to say there are pioneers in this space that are looking to do these types of transactions. And I think the corporates that are most closely aligned with doing this are ones that are, again, have done a litany of renewable transactions, they're looking to now move towards grid resiliency as the next phase of their sustainability agenda, maybe have an emissions-based approach. And their other alternatives aren't that great, whether it's doing a toll with a battery, financing batteries, a lot of things that would involve incurring significant risk to a project versus a very elegant instrument where

you're paying for performance for these projects to have an incremental revenue stream, and also reduce emissions in an empirically validated way.

David: What's between you and this is happening?

Jacob: I think it's just that it's so early days. So that transaction was done a little less than a year ago now - I guess we're entering September. But yeah, it's putting the wheels in motion in terms of corporates wanting it to be validated through a nonprofit like Verra and getting that set up. I think there's a lot in terms of getting batteries to the table and formalizing those partnerships. And that's where we hope to really play a role as an intermediary. Again, going back to my experience as an originator, looking at the PPA market, it's taken decades to get to the point where things are becoming standardized by intermediaries. And I think that there's a lot of value to doing that at the outset where this can be a standardized, fungible product that corporates can easily execute in and standing it up early relative to it being something far down the line later on when the market has already taken off.

David: If you had to put a time prediction, like what year will the first corporate buy the first official battery offset?

Jacob: So in some ways you can say it already happened with Meta.

David: Yeah, did Meta get an offset out of that? And if so, how? If that product hasn't been set up yet, or did Meta just get like a good feeling out of it?

Jacob: I can't speak for them. But I would say in general, I think the idea is that eventually, with a certified process in place through a carbon registry firm, like Verra or Gold Standard, they can use those offsets towards their sustainability goals. But there's a lot of other companies that have done transactions that have been off-registry. You could say a lot of CDR support has been for projects that don't have methodologies in place, but they're doing it to support novel technologies. But to go back to your original question of when, I mean, putting that aside, I would say next year is probably a really good bet in terms of maybe having something in place to get approved offsets. Everything in terms of the stars aligning and corporates being interested in supporting batteries - I think the more and more we talk to corporates, I'm pleasantly surprised as to how much they're already talking to developers, how much they're already thinking about this issue. And so I think we're just bringing it to the foreground and also providing a solution as opposed to pointing out all the problems. And I think that's really important for moving this area forward versus just setting it back and saying, "headline, there's all these issues, and there's no solutions to it."

David: Awesome. Well, hopefully, yeah, when I revisit this in five more years, there will be a different story to tell. All right, well, Jacob and Emma, thanks so much for coming on and walking through this. This is like a weird, obscure little side problem in the renewable energy world that I feel like hardly anyone's aware of and it's great to see someone actually attempting to solve it. So thanks again.

Jacob: Thanks again for having us on. Appreciate it.