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## Carbon Frontiers | Episode 3

Nat Bullard, Venture Partner, Voyager Ventures and Senior Contributor,  
BloombergNEF

For our third installment of Carbon Frontiers, we welcome Nat Bullard into the SmarterMarkets™ studio. Nat is Venture Partner at Voyager Ventures and Senior Contributor at BloombergNEF. He recently collected his thoughts on decarbonization in a 140-page [presentation deck](#), capturing the state of climate and covering how we got to now, where we are going, what's new, and how to approach what's next. SmarterMarkets™ host David Greely sits down with Nat to talk about the long view, trends, and transience in our pursuit of netzero.

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**Nat Bullard** (00s):

We need to understand what our ultimate goal is of decarbonization and realize in that process that we have to do quite a bit. We basically have, on a capacity basis, as much renewable power waiting in the wings to be built in the US's seven major independent service territories as we have in the grid right now, total. Like, we're never going to get even a fraction of that done if we don't get better at it, if we don't control costs, if we don't speed up timelines. And you need to make human decisions and make organizational priorities and societal priorities around them.

**Announcer** (42s):

Welcome to SmarterMarkets, a weekly podcast featuring the icons and entrepreneurs of technology, commodities, and finance ranting on the inadequacies of our systems and riffing on ideas for how to solve them. Together we examine the questions are we facing a crisis of information or a crisis of trust and will building Smarter Markets be the antidote?

**David Greely** (01m 07s):

Welcome back to Carbon Frontiers on Smarter Markets. I'm Dave Greely, Chief Economist at Abaxx Technologies. Our guest today is Nat Bullard, a senior contributor to BloombergNEF and venture partner at Voyager Ventures. He's recently collected his thoughts on decarbonization and a 140 page presentation deck and he'll be sharing some of those thoughts with us today. Hello Nat. Welcome back to Smarter Markets.

**Nat Bullard** (01m 31s):

Dave, it's great to be back and thanks for having me back.

**David Greely** (01m 34s):

Yeah, well I saw your recent presentation deck that you've put out on decarbonization and I had to talk to you about it. So first off, congratulations and thank you for putting it together. You've curated just a massive number of charts from a, a really wide variety of different sources and what's really inaccessible and thought-provoking way. I read that you spent about three months on it, which is probably about since the last time you and I talked. Why did you choose this project to devote that amount of time to?

**Nat Bullard** (02m 04s):

Thanks. It was something that, that that's always sort of eating at me as an analyst of some vintage now is sort of trying to capture a master narrative about really the biggest thing in the world, which is climate and our response to it. And the challenge there, as I think you well know and most of your listeners will know, is that we are almost always domain bound. All of us, you know, you can be, you are a world expert in one aspect of energy, which is in and of itself a multi-trillion dollar global economy, road transport fuel or oil itself or aviation, shipping, power generation, efficiency, whatever it is. But just outside of that domain you may be sort of less acquainted with everything that's happening. So my attempt here is to use factual information across as many of these different domains as I can to try to capture a sense of where we are, which in and of itself is challenging enough at the moment.

**Nat Bullard** (03m 02s):

But that's driven not just by I think the sort of universal numbers, which would be climate numbers themselves, but also the economic numbers, the trade numbers, the corporate strategic decision making, the capital flows and things like that across domains and ideally

across geographies wherein they're available to sort of give us a sense of where we are and in, in so capturing a sense of where we are, help us think about where we, we might be going. And I, and I thought this was in particularly important now because we've had an incredibly volatile, noisy, if you wanna say in last few years, we will be in the same fashion that we can look back and almost at the discount the global financial crisis in terms of the blips that it puts into every long-term curve. We have to do the same with COVID and we can now layer on top of that inflation and a great big war in Europe. So I was trying as much as possible to look into those things but also to look through them.

**David Greely** (03m 58s):

That's great and one of the sections that I really enjoyed in the presentation deck, you talk about searching for what is new and for what is normal. And after the past few years, as you said of COVID of the invasion in Ukraine, of everything else that's going on, it's a little hard for us to tell what's the new normal and what was just transient and where are we at. So I wanted to start maybe with that question for you. You know, what's new and what's normal?

**Nat Bullard** (04m 23s):

What's new I think is that we have a dedicated sense that everything needs to happen. I use later on in the deck a sense of everything everywhere, all at once. But that in order to tackle big climate challenges and their distinct intersections with trade, with war and with inflation, we need to do everything. Like there's no longer really a section of the economy that can kind of take a punt on thinking about decarbonization, if that's part of our goal as a society. So, and I think within that there's a new sense of like really muscular policy approach. That's the IRA, but it's also a great number of activities happening in Europe, not just the US inflation reduction Act that any listener in the United States is gonna be familiar with, but all sorts of things happening in Europe. All sorts of trade and policy implications in the rest of the world around what decarbonization might mean for industry, what it might mean for trade and for competitiveness.

**Nat Bullard** (05m 25s):

I think all of that is, is new. I think also new were some sort of super spikes in short term volatility that are a lot of the data that I have in the middle section and trying to sort of see whether or not we could ride through those. So that would be spikes in things like European gas and power prices largely driven by the war in Ukraine. Shipping largely driven by the pandemic, but then other things that have sort of input staples for energy transition in particular like lithium prices, silicon prices for solar, things like that. And then I think another normal is a re-engagement of very strong policy around everything. I mean I've mentioned that before, but I kind of wanna come back to it again because we've had an interesting 10 years in which we had low interest rates. We had generally an okay economy if not sort of performing to the level that it could have been globally.

**Nat Bullard** (06m 25s):

And out of that we had actually kind of a pass on doing a lot of big global policy that was driven by countries. We had plenty of international policy, we had the Paris agreement, we have things like that. But we didn't really have a lot happening at the activity of the nation state and that's coming back in a really big way as rates are going up and a final one, this is a sort of question about new versus normal is what our sort of terminal rate expectation is and what money is going to cost. I ran this calculations a couple of years ago, but we had for like about 12 years or so, we had an almost zero interest rate environment for all the places where most of the build and energy transition was happening and that meant that something like 75% of all of the assets that had been built for energy transition were taking place in a negative, in a nearly negative, negative or near zero interest rate environment and that's no longer true money is actually back to costing something and that's a new slash normal with a question mark on it, but a very, very big one for us.

**David Greely** (07m 28s):

Yeah. And when you look at things like the money flows and the investment dollars and how they're evolving, things like the inflation reduction act and some of the other policy moves promised to be putting a lot more money in, but when you look at where the money's come from on the policy side, on the, the private side in terms of investment, how has that been changing and what do you see happening there?

**Nat Bullard** (07m 50s):

Well we had, we had 1.1 trillion worth of investment in energy transition last year, which is up about 30% year on year, definitely a record. It was also incidentally about the same amount of investment in upstream oil and gas and also power generation that doesn't capture CO2 or doesn't have an emissions limitation on it. It's kinda a big milestone. I think that there's, there's still the sense that these are good and investment worthy investment grade opportunities to get involved in decarbonization. And a good example of that I think

is the fact that even in a rising interest rate and an inflationary environment like we are right now, the discount of wind and solar power to gas and coal fire power is at its best ever. So even though those prices have ticked up slightly comparatively compared to the alternative of just coal or gas fired power, they've never been more in the money.

**Nat Bullard** (08m 46s):

This is an interesting case where you have to look past the absolute decline in levelized cost and at the relative comparison to the alternative or competing option, you can see that as well in in energy storage. So the prices for batteries ticked up about 7%, but they were at the storage system level, like installed batteries in the grid were up more than 20%. This thing about that is, is that almost none of the participants in the market say that they're interested in pulling back. And again, that's because comparatively the value that they can drive into the market, even at an elevated price point is still such that they're in the money as an asset developer. And so that's, that's very important. That requires a bit of us looking relatively rather than absolutely, which I think for a very long time you've been able to do well. Absolutely costs are coming down. They're coming down on an inflation adjusted basis, they're coming down in an absolute sense in comparison to everything else, but now you have to look relatively to the benefit for the owner, the operator, the grid, the system.

**David Greely** (09m 48s):

And as you said, we've seen over a trillion dollars flow into energy transition investment. The prices are aligning to make these economically sensible projects to do and then when you look at where the rubber hits the road of the tangible results coming from this alignment of pricing and these investment dollars, where are we seeing the energy infrastructure build happening and to what extent is it happening?

**Nat Bullard** (10m 12s):

So we've got 1.1 trillion of which about 90% of it is money that's going into renewable energy. So power generation and then is going into transportation. Very interesting to see that in a very short period of time. The amount of money invested in electrified transport is very nearly 500 billion a year and it's actually always a close thing and it will be for the next couple of years as to which sector ends up being the marginal over 50% dollar of investment energy transition between cars, trucks, buses, e-bikes, everything else versus wind turbines, solar panels, geothermal and all of that. That's really the bulk of the money is going. But what's interesting is that the fastest growth rates are happening in areas that you hear about that frankly sort of still live marginally in the realm of potential and it's like hydrogen. We had only a billion dollars worth of investment in hydrogen last year.

**Nat Bullard** (11m 10s):

It's kinda hard to believe. Definitely the rhetorical investment in hydrogen I would say would give you an indication that there's a lot more activity happening, but that's also tripled in a year, right, so low base high growth rate and there's also this sort of renewed interest in all kinds of things that are downstream of power generation in particular. So anything in energy and materials in particular, but also in things like electrification of heat and heat pump sales have a chart in there of how many heat pumps are now sold in the Nordic countries that if you listen to the sort of debates that, that remind me in many ways of the debates around induction stoves versus gas cooktops is sort of similar that like there's a debate that goes on rhetorically, but the, the activity that's happening is definitely tilting strongly towards electrified options that will change the way we interact with our energy system.

**David Greely** (12m 00s):

And I know much of the discussion of the energy transition tends to center on what's happening in the US and Europe, but how much of the story do you think we're missing if we don't discuss what's happening in China, broader Asia and the developing world?

**Nat Bullard** (12m 14s):

Well we're missing a huge part of it. So like one example and this, this is a sort of an unfortunate and fairly quiet finding to my mind coming out of the pandemic is per the EIA for the first time in years the global population without reliable access to electricity rose it increased and that has not been on, that's not on trend, but let's say of the last decade, in the last decade or so, we've gone from what about 1.2 billion people without access to electricity to only about 700 million. But last year it ticked up again to 770 million. This is critical that obviously this gets addressed and it's something that hand ringing about the pandemic in the US and legitimate concerns about energy security in Europe right now and everywhere else in the world might obscure. So that's one thing. The other is that the scale of change, not just the rate of change but the scale of change in other places is extremely important to note.

**Nat Bullard** (13m 06s):

As a bit of an aside here, the biggest challenge for doing 140 page presentation is knowing when to basically put a cork in the funnel and stop putting new information into it. And so I published this on Sunday we're now recording on Thursday, on Monday morning, China comes out with its data on its electricity sector changes in 2022. But I can give you the numbers here. China added 210 terawatt hours of wind and solar generation. That's about as much as Vietnam generates in a year. Vietnam is a country of 90 million people or so. Total wind and solar generation in China is 1,190 terawatt hours, which is more than the total power generation of France and Germany combined. It's more than the total power generation of Japan or of Russia. And so if you were to chart this as a country in descending order, the largest electricity systems are China itself and then the United States and then India and then China, wind and solar, like I don't think this is something that is very well appreciated elsewhere.

**Nat Bullard** (14m 18s):

Another element to that is that the global addition of wind and solar last year was between 600 and 700 terawatt hours. That is much more than it's ever been added by natural gas in any one year. It is more than all but one year in coal which was 2021 and the rebound from the pandemic. I kind of think we should need that one out because that's sort of intensely affected by the margins in China. But it's also almost exactly double the fastest growth rate year on year for additions of power generation from nuclear in the middle of the 1980s. And I don't think people really apprehend this very well. The system is bigger every year so these absolute numbers are sort of hard to appreciate, but they're eating, you know, more than a percent a year into total power gen but also growing at a faster rate than anything has ever grown before.

**Nat Bullard** (15m 13s):

And I think that that's an extremely important thing to make a note of. The same applies in transportation. We have a hard time looking at peaks and we have a hard time if we're in this auto market or in Europe understanding the rest of the world. But a good example here in in the auto market is that new passenger vehicle sales peaked almost six years ago at about 85 million. They've since fallen during the pandemic they were below 70 million, but in the entire time EVs have been growing. So to put it another way, the only growth in global passenger vehicles is electric vehicles and it's been that way for more than half a decade. And again, you can sort of lose that in the rhetorical mix of saying, well yeah there's, you know, only 10.6 million EVs sold last year, but they're also the only growth in this sector globally. There's also 30 something million small EVs sold every year and this is like two wheelers mostly in Southeast Asia. This is a market that's almost 300 million total vehicles. It's an order of magnitude bigger than the total number of passenger EVs on the road. As you can tell I'm always looking to contextualize and I'm always looking to pull the sort of western North American European frame into global context into the comparison with other places.

**David Greely** (16m 28s):

And that context is so important. And I love the way you put in context the size of China's renewable grid. If it was a standalone grid relative to other countries, and I think I didn't quite count, but I think it would've been like the fourth or fifth largest in the world?

**Nat Bullard** (16:40):

It would be the fourth largest in it would be the fourth and largest in the world. Another comparison is that it's almost enough, there's almost enough electricity coming from renewables and it wind and somewhere alone in China to meet the demand of every household in China, which is about 1,340 terawatt hours. So put it another way though, forget one more layer of context here is that China's residential consumers are the fourth biggest power system in the world.

**David Greely** (17m 08s):

Here's some other areas where you were providing context that I wanted to talk with you about because I noticed in one section of your deck you talk about the three ages of decarbonization and I think you list them out as renewables energy transition and net zero. And I wanted to ask you, how do you think about those ages and why do you find grouping them that way important? Like how does it improve the way we think about decarbonization?

**Nat Bullard** (17m 35s):

I really appreciate this question because this is, these are sort of deceptively simple slides for those of you out there in podcast and I'm listening just picture three very unimpressive looking s-curves on top of each other. That's all that that the chart, that's all that the slide is. But it was because I was having, I was having trouble negotiating essentially an answer to questions that I had been getting at the, you know, from boardrooms from executives be like, how big a deal isn't net zero or what am I going to do about it and so I needed to sort of put it into a context and in as I phrase it, both evolution and revolution and so I thought that like we, we basically in the time

that I've been doing this, you know, which conveniently aligns with pretty much the beginnings of the renewable energy build out in Europe and the US is that we started with this very domain bounded good old world relatively speaking of renewable energy that was like wind, solar, it was biofuels in Europe, it was also CO2 markets and it was done by a specialty team in an investment bank like a special situations group.

**Nat Bullard** (18m 45s):

It was done by a small team of developers, it was done with bespoke contracts and it really was going to only have impacts on the margin. It was also mind you back in those days marginally out of the money we were talking about things that absolutely needed support. They needed subsidy, they needed feed in tariffs or portfolio standards or whatever it was in order to go and then that sort of starts to start to lose its primacy in the last decade, the past decade in which energy transition becomes a thing. And you'll still obviously hear about renewable energy and energy transition today. They haven't gone away, they're just sort of stacking on top of each other. And this is a little bit different because this is saying, well I need to do more than just electricity or biofuels. I need to start looking at other elements of energy consumption and production.

**Nat Bullard** (19m 34s):

And if I'm a big company I might be able to say, I'm gonna pick a group in my company and we're going to put together a strategy to get this group to net zero. Maybe we're gonna have net zero road transport emissions or we're gonna get all of our electricity from zero carbon sources within a bank. There's probably a team that does energy transition. Now it's not special situations group, it's been devoted for this purpose. It's green finance, it's energy Trent and something like that Within a big company you probably got a strategy group team could be run by an executive vice president, could be reported to the chief strategy officer. It's something you probably get a briefing on at the board level, you know, but it's not necessarily baked in at that level and it's also gone bigger than just power obviously to transport.

**Nat Bullard** (20m 13s):

And then the next one, which is our moment and looking forward for at least three decades isn't net zero. And as I said, it's an even go, it's the next thing to do, right, okay we've, we're gonna transition, we have to have an end game for that transition. This is the end game. But it's so much more, first of all, it's not like you can just pick one part of your company and say we're gonna get this part to net zero emissions and then everything else is will be fine. There's no out, you cannot talk your way out of it because it impacts every single aspect of the business. It must be baked in at the boardroom level. I can talk more about that later. You've seen I put a bunch of stuff about that in, but it's also an absolute imperative if you want to do it at a sort of an existential level for the entire executive leadership of a company.

**Nat Bullard** (21m 03s):

And it also means doing stuff that is very hard to do, I think I wouldn't call power generation and road transport solved from a decarbonization perspective, but they're solvable. Food chemicals, heavy duty shipping, aviation, these things are not solved yet. Getting grids that can really operate a hundred percent and a hundred percent zero carbon, you know, for decades at a time. This hasn't been solved yet. The capital that needs to flow into this hasn't been allocated yet. The regulatory compacts that need to govern all of this have not been built. The supply chains need to expand in some places and also they need to contract in other places for this to happen and everybody has to be on board with it and it has to be viewed as a sort of a must do. And also while you might have been able to sort of like cross fade from renewable to energy transition and energy transition to net zero, you can't get out of this one like you got to do it and you've got 30 years or so to get to that point, which means me to one sort of challenge within then, which is people related, which is we're gonna have a real challenge here is that I would, I would argue, and I think most of your listeners would agree that by the time you're the principal decision maker to enact a strategy like this, you are closer to retirement than you are to the beginning of your, your work life cycle.

**Nat Bullard** (22m 20s):

So in a sense it's sort of easy to make these decisions and then there are somebody else's they implement in the long run that could happen here. You can make this decision but it'll be in your company for quite some time for five more business cycles probably between now and the middle of the century and if you committed to it and somebody else has to do it, they still have to do it. It's not something that they can just sort of be like, well you know, that was the previous chief executives idea, we're gonna do net zero, we've now decided that we're not going to, we're going back to something else. So it's going to be a big challenge and I wanted to sort of really spend a lot of time thinking about that heuristically and from a sort of competition cooperation level from an organizational level for companies as they think about what the next 25, 27 years is gonna look like.

**David Greely** (23m 08s):

Yeah, and I'd love to dig into that a little bit more deeply with you. You know, this is a series on the Carbon Frontiers and you've certainly have laid out a lot of areas where we're, we're at the edge of what needs to be done and you know, with the discussion around how net zero requires new approaches to how we do things, it sounds like the very definition of innovation, you know, what new approaches and innovations are you see coming from net zero and maybe start with that boardroom, like how is it changing the way boards and the C-suite are engaging on these issues

**Nat Bullard** (23m 40s):

To that point I wish I could say that it is changing, but the evidence right now is so far, if it's changing at all, it is doing so very slowly. I quote some data from Tensie Whelan as a professor at NYU. She did a survey a couple of years back of the board of the Fortune one hundred, eleven hundred and eighty eight board members and she looked at all of their, across all of these board members, their capabilities. She is classifying them from an ESG perspective, but she does a nice job of atomizing the particular competencies and seeing what they're prepared for, which is that 29% of the board of the, the collective board of the Fortune 100 has some ESG qualification, but the biggest category, 5% have some exposure to or competency in workplace diversity, which is an a notable and important goal. 1.2% have any expertise in energy and about two tenths of a percent have any expertise in climate.

**Nat Bullard** (24m 33s):

It's just not there. Like there's really no other way to say that than that. It is not there, it has not been made a priority and I would say, you know, if you happen to be the person who was perceived as boardable as like somebody who you can pull in to be part of the Fortune 100 board and had that expertise, you should probably be sitting on 50 boards, not too, but you start to run into the kind of limits of time and space and there was an additional survey that I cite that also looked at how boards ranked themselves on their, their preparation for dealing with big challenges and climate change ranked very low, only about 56% of boards said that they felt confident in that and to be honest, I think that that's partly boards talking themselves up, if I'm honest. I doubt that any board is that prepared for this.

**Nat Bullard** (25m 16s):

This is a personnel challenge and I, and I end up in this discussion very, very often because it's, it's really of deep interest to me, which is how do you negotiate the fact that you need people with either scientific background or industry exposure in young industries, in places where the science is dynamic, in a domain where you don't often have scientists on boards and you don't necessarily have a lot of entrepreneurs on boards and you tend to have a, for very good reasons in many cases a sort of professional boardroom cohort that does this globally. How are we going to change hearts and minds and focuses and prime directives, so to speak without changing things at the board level and listen, I do briefings for boards all the time, but there's only so much that that I and my and my own cohort of people who brief and speak and engage can do. I will be happy to do as much of this as I possibly can, but there's also a, a change making element that needs to happen and that then needs to resonate throughout organizations at every level, not just in the special situations group, not just with a team that's set up to do something new.

**David Greely** (26m 29s):

So certainly a lot of work left to do there. Maybe outside the boardroom, what other new approaches and innovations are you seeing coming out of net zero?

**Nat Bullard** (26m 38s):

Well, I mean it's really exciting to see things like what the hybrid consortium is doing in the Nordics, which is to make steel in a zero carbon way. Like this is science fiction stuff, even like 10 years ago and when I started in, in the, in the mid two thousands doing this work, if you told me that somebody's doing this, I'd be like, that's absolutely outlandish. Like that's incredibly exciting to see things like that happen. Any efforts to do decarbonization of marine shipping are really exciting. There are some consortia that are doing that based in Singapore, like the Global Center for Maritime Decarbonization. I'm personally very excited by and observing very closely what's happening in aviation. I think we'll end up more electrified than most people expect today. But the, the sweet spots at least that the moment may not make a massive dent in total overall consumption of fuel.

**Nat Bullard** (27m 33s):

Like I have the feeling that we will be taking huddle jumper flights that are electric definitely within a decade and in fact we're already seeing trials of that. You can see those flights in trial fashion happening in Vancouver Harbor where Harbor Air has been flying in a

modified electric plane. There's a lot of startup activity on electric aviation and it's been interesting to watch how that has moved from largely a kind of personal air taxi sort of personal mobility framework into, you know, single aisle replacing turbo prop kind of aviation. And we'll see how far that can go. Are we gonna have the equivalent of an A three 80 that is flying on battery power, don't know. That definitely feels more like a place where, where some sort of zero carbon liquid fuel is probably going to be most welcome. But it also starts to highlight the, you know, the, the sort of pure energetic challenges around incumbency and why they exist to begin with, which is like, look, if we could, if we could invent a carbon neutral oil, we would be in a great spot.

**Nat Bullard** (28m 38s):

Like if it was possible to invent this energy dense, very useful goo in a way in a lab and produce it in a billion tons a year that we, that we need, that would be tremendous. The challenges that we, we can't really do that yet and so we're sort of coming up with solutions that are around them, but I think also what interests me is then is therefore when we come up with things that are not just alternative, that are also better in some other vector, you know, they're also an improvement from a local air quality perspective. They have less impact on, they have less impact on land, they have less noise in the city or things of that nature and in fact, it's something I wrote about from my piece that just published, you know, a big push for rural electrification in the early 20th century in the United States.

**Nat Bullard** (29m 27s):

It was not just about giving the grid to people but about giving people something that was better and I had to do a little bit of history, history work here for my readers to point out that there was plenty of energy on a farm in Mississippi, in Arkansas, in Georgia in the 1930s, but it was oats and hay and it was also kerosene and it was gasoline but, and it was gasoline that might be powering a single motor on your property or single engine rather than provided motive power to all kinds of things, including your washing machine. So we have to think too about frameworks of coming up with things that are better and I'm very curious to see how that plays in particular in, in hedonic contexts. So food would be a good example. You know, I think the, the bloom is off the rose at the moment, at least from a market perspective on alternative proteins. But the science is definitely there to, in a couple of years, have us in places where we may have better alternatives for any number of reasons than what we have in our incumbent system now.

**David Greely** (30m 25s):

Yeah, and you bring up such a great point that so much of energy that I think people who aren't close to it miss out on is how much of it's driven by logistics. It's about getting the energy in the right form at the right place and so yeah, if we could replace oil with something else and we've got the logistics, that's perfect.

**Nat Bullard** (30m 39s):

That's right and I'll give you one thing on that like to, to our, to our sort of circle back on our earlier bit about hydrogen is that, you know, like it, what fascinates me about hydrogen is you have a lot of people talking about it, but it's not, it's not great in some ways. So it has a very, very good gravimetric energy density that's by weight but by volume it has a very poor density, you just can't compress it that much. So a good example would be like if you wanted to film, if you wanted to have the equivalent energy of one of today's LNG tankers in a hydrogen tanker, it needs to be two and a half times bigger and there's no getting around that. Like there's there, there's like no way you can science your way out of that. Okay, like it just has to be that way.

**Nat Bullard** (31m 21s):

It's a reason that we fire rockets with hydrogen, right because hydrogen is light and you can put a big, very lightweight tank of hydrogen in rocket, great, but like you, you can't get your way around that in a tanker. You won't and so I think we're gonna, we're gonna be talking intensely in the next few years about where it is that hydrogen goes and for what purposes, right, it's also frankly not great for existing pipelines because it tends to in brittle them. It tends to cause them to break apart. But it's where, where you, you sort of have to come back to like what's the actual science here you know, what's the physics, what's the logistics is super, super important. We have a world that's optimized around what we've been doing, right. We optimize it for what we wanted and then we optimize the round what it is and changing those is challenging, it can be done, but it requires a very holistic approach

**David Greely** (32m 12s):

And you've touched on a number of the opportunities and challenges out there, but maybe as we try to start summing things up in a way, as you look out over the next, you know, however long a period of time, what are the opportunities and challenges you're gonna wanna keep your eye on you're gonna be most focused on.

**Nat Bullard** (32m 31s):

So one of, one of the things that I found myself sort of surprisingly drawn to towards the tail end of, of this project and wrapping it up was the sort of adaptive reuse of what we already have. You know, we tend to approach these things. It's like we are going to need to build X amount of new stuff, which, which we are there's no way around that but where and how are we going to build that I think is extremely important. We've decommissioned hundreds of energy sites in the United States in the last 20 years purely as a function of changing economics in power and the fact that a lot of these things were very old. Like we were decommissioning projects that were built before you and I were born for the most part and our sort of existing mentality around these for good reason is that they are on liability.

**Nat Bullard** (33m 21s):

I have an old power plant site, it has had heavy metals, pollution spills, it has had coal on site, it has tanks that need to be cleaned up and remediated and it has a very high negative net present value a very, very, very low negative whatever, a very significant negative present value but what if we were to view that instead as an asset for building something new, let's put a gigawatt hour battery into the site of an old coal plant where we already have all of the transmission infrastructure that we need to take that power. We don't need to plan and permit anything new. Let's put a modular nuclear reactor into that site. Let's turn it into something inbound instead of outbound. We've seen data centers built on Old Tennessee Valley authority coal plants in fact. So one of them is just a sort of like better adaptive reuse of all that we have that would apply as well, I think to techniques.

**Nat Bullard** (34m 18s):

I did a snide that was fun exercise in in data mining on all the drilling activity in Texas over the last couple of decades. Thank you Texas Railroad Commission for making it available. That's not just wells that you could reuse. You could you use them as a gravity Well for energy storage, I've actually seen designs to, to propose that you could do some geothermal possibly with it if you're, if you know what you're doing, but also think about all the expertise that's there, all the human capital that is in that capability and all the property plant equipment that does that and that is I think extremely exciting is talking about sort of not just adaptive reuse but sort of intelligent repurposing of what we have today to get us to the future. Like that's something I'm really excited about. And there's a related, which is we do have to get our act together and particularly in the United States around some sort of key unlocks.

**Nat Bullard** (35m 10s):

We do need to be faster about planning and permitting. We need to understand what our ultimate goal is of decarbonization and realize in that process that we have to do quite a bit. We basically have on a capacity basis as much renewable power waiting in the wings to be built in the US's seven major independent service territories as we have in the grid right now, total, like we, we we're never going to get even a fraction of that done if we don't get better at it, if we don't control costs, if we don't speed up timelines. And these are not technical things like this isn't science. You don't need to get like a consortium of physicists together to make this happen. You need to make human decisions and make organizational priorities and societal priorities around them.

**David Greely** (36:06):

Well I wanted to thank you Nat, for taking us along this carbon frontier journey and putting all the work in that you have to make it such a, a wonderful conversation. Before I let you go though, when I was flipping through your deck, I know you introduced me to a new word, that word is hyperobject, which when I read it made me think that this carbon frontier is a truly vast one. Can you describe what you mean by a hyperobject and how it should shape how we think about both climate change and the movement towards net zero?

**Nat Bullard** (36m 36s):

Absolutely. So first of all, full credit where it's due, this is from a fantastic book by the same name, by Timothy Morton. The book is called Hyperobjects, just to reiterate and he describes a hyperobject as massively distributed in time and space in relation to humans. So massively distributed in time and space in relation to humans is a perfect way to describe climate change because it's obviously very, very huge and it's also very, very distributed and it exists with both a spatial and a temporal element to it. It exists over time, over centuries, and it exists everywhere and I think that this is an extremely elegant way of thinking about the challenge. What I wanted to add to it is that the response is also going to be the same. It's certainly going to be massively distributed a lot of that is the nature of the distributed technologies that I think will be in play for them.

**Nat Bullard** (37m 31s):

It's also going to take a lot of time, it's going to take decades if we want to get to net zero and in relation to humans, it's very, very big. But I'm hoping that it's a helpful framing. The only, the only thing that can challenge one hyperobject is another and I hope that it's also a bit aspirational too for the people who are interested in making that change. Is that like anything you do can plug into that massive temporal and spatial distribution and only by doing these things at mass scale in time and space, are we going to affect any real change.

**David Greely** (38m 06s):

Thanks again to Nat Bullard, Senior Contributor to BloombergNEF and Venture Partner at Voyager Ventures. Join us next week with our guest, Svenja Telle Director of Project Organization and Technology at Base Carbon. We hope you'll join us.

**Announcer** (38m 21s):

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