Grow Everything Interview Transcript: Edward Shenderovich

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TEASER

EDWARD: We need a biomanufacturing cloud, in the same way that Amazon built this digital cloud and enabled the very successful companies of the last 15 years to flourish. In the same way, we need some sort of a biomanufacturing cloud that would allow companies to accelerate their path towards profitable production.

INTRO

ERUM: Hey Karl, how's it going?

KARL: What's up? I thought I would kick it off by saying happy birthday to Dom.

ERUM: Oh yeah, my little baby is now three years old.

KARL: That's amazing.

ERUM: Quite the young man. And so we've been busy celebrating, we had his party at Chuck E. Cheese. I mean, that was a big part of my childhood. So it was fun to take him for his birthday and be on the other side as a parent and it was a good time. It was a great time.

KARL: You know what? They've been around forever because when I was in college, we used to go there to play video games.

ERUM: Yeah. And the guy who started Atari or was one of the founding members created Chuck E. Cheese. Atari was in arcade game console space. They were also in that space. And then like, well, the guy was like, let's just make a family friendly arcade with the big mouse named Chuck E. Cheese and his friends. And they did animatronics, which was crazy, but yeah, it was a lot of fun. Your birthday is also coming up. So that's going to be a lot of fun. Any big plans?

KARL: No big plans. I will be in California for my birthday, but then I'm going to fly back to New York. So I'm going to be celebrating with my parents, and my sister. And hopefully 2 of my sons, because 2 of them will be out there. That's the big plan and celebrate with the family and then come back to celebrate with the family.

ERUM: Nice. Yeah. And you've been, having fun with your family already. You've been gallivanting around Manhattan, hittin' up the MoMA.

KARL: Yeah, Kristen had wanted me to see Life Cycles, which is an exhibit on the first floor of the Museum of Modern Art that explores the materials of contemporary design. So this is very topical to what we talk about here on Grow Everything. For example, there was a t-shirt made with cultivated collagen from Modern Meadow and previously we've had Suzanne Lee of BioFabricate on the pod, and she is the designer of that. She and Amy Cogman, who now lives in the UK, there were some pieces by Neary Oxman there I was more obsessing over the plastic being printed with a 3D printer, plastic waste. I ended up talking to our friend Aaron Nesser about the availability of plastic waste, and apparently, there's a lot of it out there, and you can buy it in some of these 3D printers you can throw the plastic waste in there, it'll turn it into a thread, and you can print directly. So that was fascinating.

And then right next to that gallery is a gallery where an artist chooses pieces from the entire Museum of Modern Art collection and curates a space. The person who curated it is a British designer, but there's a piece by an artist named Agnes Martin. The piece is called *Friendship* and it's a humongous grid that was created with gold leaf probably eight feet by eight feet or something like that and it was really interesting to stand in front of that and then completely on the opposite side of it were these giant horns that had been made from recycled horns, not horns that you would find on an animal made of keratin, but musical instrument horns. So if you can imagine a trombone that is, I don't know, 15 feet tall. That's what was on the other wall. So it's really interesting to see the contrast of those things. So, biology and new materials, and just pure abstract art on the other side, which I think is important for us to spark the imagination.

ERUM: Yeah. Did it spark your imagination? I'm glad that you're going out there to be inspired, not just from nature, which is very important in biology, but from art as well. Anything really pop out in terms of how it relates to our day to day work?

KARL: I think sometimes you just don't know what rabbit hole you're going to go down when you look at some of these things. Like I said, I was really surprised to hear how available plastic waste is. E-waste is the fastest growing waste stream in the world. so these are problems that we will solve with biology, among other things. one of the things that it made me really wonder about, and I did a bit of a dive. was just how is Symbio or synthetic biology being represented on TikTok? Have you done any deep dives on Symbio, on TikTok, Erum?

ERUM: Not on TikTok. I was on TikTok for two days. Two days during the pandemic, I went down the rabbit hole. I was scrolling two hours on by and like, what just happened? And I was like, I don't think I can have this in my life. So I am not on TikTok for that very reason, but what have you been seeing out there?

KARL: So I specifically went on TikTok because there is a creator that talks about synthetic biology, who I've seen on Twitter, but I could not find her on TikTok even though I was doing searches for syn bioo synthetic biology. I did see John Cumbers on there, who we just had on the pot a couple of weeks ago. But what I did find was, symbio-critical content. Someone who was referring as synthetic biology as the technologicalization of life itself, which is also kind of reactionary. I did found a guy named Dr. Craig, who is a bioengineering PhD in STEM content creator, who seems to deep dive into some pretty challenging subjects. So that was interesting.

We talk about it internally at Messaging Lab. There's a lot of room for using these platforms to get more educational content out there. And I don't know if I've mentioned it here, but on reels, I have seen ads from New England Biolabs selling DNA synthesis services, which I think was really interesting, so our audience is there.

ERUM: Let's go. Are you saying let's go, let's, let's take Grow Everything. We're gonna go on TikTok, let's do a dance. We should have a Grow everything dance. That's what they do on TikTok. Right? That's what I assume. Everyone just does a dance.

KARL: TikTok is all about people dancing, we're looking for the synbio dance. Jake Wintermute of Ginkgo Bioworks, where are you?

ERUM: Yeah, yeah, evangelize this. Doo doo doo doo doo.

KARL: Exactly.

ERUM: Yeah, I mean I've seen a lot of great content. I'm really into the Kurzgesagt. I can't say that german.

KARL: Kurzgesagt, so it means short saying or said shortly.

ERUM: Yeah, in a nutshell. I'm so into that. to the founder of Kurzgesagt. Philip Dettmer, He actually wrote a book called Immune, which is about the immune system and how it works, but in terms where you can understand, so there's a lot of analogies to battle because in your immune system fights, infections. It's opened up my eyes. It's been very illuminating. And today we had a call with the company and, we were talking about skin and I was able to really draw from this book because it's skin is the 1st line of defense. he talks about what the structure of skin is and. I think for us, it's like super helpful to hear other science communicators talk about biology, because it can help us when we continue that conversation with our clients. but also here on the pod. So, I would recommend that book. My friend Sharath gave me that book when I went to Bangalore. He knows I'm a big science nerd, listens to the pod and he's like, you have to read Immune. I'm reading it. It's great.

KARL: Sounds really good. the term that haven't heard applied to biology that much yet is hyperobject, which is a philosophical term used to describe something that is so complicated that it is something that is hard to comprehend. And biology is a

hyperobject, I think, if I'm wrong, please correct me and listeners in that, biology, there's so many moving parts, you're not just dealing with, DNA being synthesized and transcribed and RNA being translated into proteins and proteins moving around in a cell, but there's this temporal spatial component to biology that defies characterization it's just so incredibly complex. We know so little and yet we know so much, there's so much to learn. So that's something that I think we should dig into more.

ERUM: Because you can't really pin down biology, right? It's always moving, it's always evolving and reacting to its environment, even like ourselves as human beings, but it's a very hard thing to, have a moment in time and freeze it. It's never frozen.

A lot of us, when we go to get a health checkup, we get our blood work taken once or twice a year, maybe unless you're like Brian Johnson and get it done every day. I don't know what he does, but that's the type of information you need to really get a snapshot is how your biology is evolving and reacting to the food you eat, to the air you breathe, to the water you drink. That I think is a very important concept for us to discuss with our audience, but even everyone, as we talk about our health, it's not static. It's very, very dynamic thing. Genetics is just one part of a very complex picture. So I think it's something that we'll continue to talk about, as we not only talk about human health and biology, but just, leveraging biotechnology, it's a very hard thing to replicate, consistently, but depending on what we're talking about.

KARL: As we get into the interview, I think we've said it before. One of our themes for 2024 is biomanufacturing. That is the use of biology to manufacture things. Two years ago, I was at a conference in London where everybody's saying there's not enough capacity for biomanufacturing. Then that dialogue changed last year, and people were saying there's not enough products to fill capacity. There was a lot of capacity that was built during the pandemic to help make the mRNA vaccine, the COVID vaccine, that ended up saving millions of lives. Now, we're at a place where a lot of products could be made with biology, but maybe there's not enough products ready to scale for mass production, what do you think about biomanufacturing?

ERUM: As we've been digging into it, I'm learning that it's very complex it's not all created the same. there's different types of bio manufacturing. I think when it comes to the whole capacity versus. The demand for biomanufacturing is look at the chicken and egg situation. you build it, well, they come maybe, but, If you have a product that you need to scale, build it. So I don't know how much of an issue it is, and I think it's something that our guest today has very good insights into where biomanufacturing is, what types of instrumentation and setup is required to build these plants and really thinking of biomanufacturing, as an infrastructure similar to data centers so, I'm very excited to, have our audience here more from our guest, Edward Shenderovich, you know, very well, Karl, how did you meet him?

KARL: I can't say that I know Edward very well, we both met him at the same time Erum. We met him last year at C16 Biosciences at a networking event that we

co-sponsored with SynBioBeta and Edward was there. Pretty sure that was the 1st time we met him and we've had a few conversations with them. He was on stage at BioFabricate with someone from Boston Consulting Group and Boston Consulting Group just put out a report. Which we'll link to in the notes on biomanufacturing. So with that, let's let Edward introduce himself and tell us about his company Synonym.

BEGINNING

KARL: **All right. Well, Edward Shenderovich, I hope I said it the right way of synonym. We are so happy to have you today on the Grow Everything podcast. One of our themes for 2024 is biomanufacturing. You're at the center of biomanufacturing with your company, Synonym. I'm super excited to have this conversation with you.**

EDWARD: I'm super excited to be here.

KARL: **Thank you. why don't we get started? You have done a lot in your career. You're a serial entrepreneur. You've started several companies like Knotel and Kite. What got you interested in entrepreneurship in the first place?**

EDWARD: Well, I think what got me, interested in entrepreneurship is that, building companies gives you a lot of responsibility, but also gives you a lot of freedom. I think more entrepreneurship in the world, leads to more, ownership and ownership in the sense of, taking responsibility, leaning in, being cognizant of, what's happening, not just going with the flow. I don't think I'm a go with the flow kind of guy.

KARL: **Some people say that being an entrepreneur is a spiritual journey and it's as much about personal development as it is about the company that you're building. What do you think about that idea?**

EDWARD: Oh you definitely grow. Ands you grow much faster than if you're not an entrepreneur. And you must, because, I think ultimately what I learned, being an entrepreneur is that you are surrounding yourself with amazing people. The driver of success for you is really surrounding yourself with amazing people and you're responsible for them. That's not something that you generally feel when you're not the founder of a company. And I think that you become a really good founder when you actually understand that you're responsible for everyone in the company. The buck stops with you and the success of the company is dependent on your actions and your decisions. It's not only the people that work for you, it's their families. They could be your partners in a sense, but, generally they're dependent on your performance and your decisions. So, that, puts a lot of things in the perspective and, helps you develop much faster.

ERUM: **I love that. I am an entrepreneur myself. I totally resonate with that. I'm really curious because you've been a serial entrepreneur. You're also an investor. You've been an entrepreneur in different industries, but why did you move into the world of biomanufacturing?**

EDWARD: Well, biology is a science of life. And, it's incredibly complicated, and incredibly exciting and has, phenomenal potential. During the pandemic, I spent a lot of time in nature. I actually moved out to Hudson Valley from New York. I ended up observing nature I became really passionate about climate change. I've observed things that made me feel like climate change is real. And this is something you don't feel living in cities. You read about it. But, when you live in the country, you feel that things are different from one season to another. That made me very interested in how biology and, biotechnology can help us deal with the effects of climate change.

I started investing in companies in biomanufacturing specifically focused on the future of food. What I realized is that many of these companies don't have capacity to produce. And that's what the CEOs of the companies were telling me, that there is no capacity to produce. I read about this, fermentation capacity gap. And at the same time, what I realized is that, there's no production level thinking in the design process, many of the companies are designing something and they're not really thinking of how they will produce.

So, these two came together into the idea that, we need a biomanufacturing cloud. In the same way that, Amazon built this digital cloud and, enabled the very successful companies the last 15 years to flourish, in the same way, we need some sort of a biomanufacturing cloud that would allow companies to accelerate their path towards profitable production. That was a combination of factors that got me interested in the space. I probably didn't understand how complicated it is when we ventured, into it and, how complicated development is, and how complicated biological systems are. But, over time, you start learning how to deal with those complications.

Initially it seemed like, a wall of impenetrable information. And then that wall turned into a climbing wall of execution, you start seeing holes and you start understanding that you don't need to actually penetrate the wall. You can climb over it.

KARL: It's interesting that you were investing in food startups and that's where you noticed the gap because the way I understand it is it's a huge gap for food startups, especially if they want to drive prices down. But what was it specifically that you had seen among them that made you go, there's a need for more capacity?

EDWARD: It wasn't me seeing anything. It was me listening to, CEOs of, some of the leading Synbio food companies. They were basically saying, we need to produce at massive scale. We need, 4000 liter, 150,000 liter, 500,000 liter bioreactors will go as large as we can and that's the way you lower the price we need to lower the price of, our products in order for them to be competitive with, existing, alternatives made through animal agriculture. That was the key driver and I was seeing that on different levels, people saying, that they need capacity on the pilot scale, and they need more of it. But what I realized after is that it's not that that capacity doesn't exist. There's just a lot of friction in getting to it. And, same with demo scale and, same obviously with industrial scale. And with industrial scale we definitely don't have enough capacity, but we also don't have, enough, mature science. There is a capacity gap, but, at this point, it's a perceived fermentation capacity gap, there's a lot that needs to happen for that

gap to become real on the, science side, on the engineering side and also on the, offtake side.

So the markets need to be as ready as the science and, the capacity to produce, needs to reflect, the state of the market.

ERUM: If there are these companies that need more capacity, why would they, go to a company to look for that capacity versus fundraising for it and building it on their own? What's the pro and con of those two options, either capital or external?

EDWARD: I think it's a combination of factors. First of all, building, large scale facilities is very difficult. It's complicated from the engineering perspective, from logistics perspective, from the perspective of development, it requires coordination of hundreds of actors. That's not a skill that these companies have, building those skills internally is very difficult. They're generally science focused rather than engineering focused development focused. So that's one side.

Secondly, the capital requirements for building these facilities are massive. If you're wanting to build a large scale biomanufacturing facility, it is hundreds of millions of dollars. Maybe in '21, it was still possible to raise hundreds of millions of dollars and, actually, build something. In '22, it stopped being possible. That's led many companies to start thinking that maybe they can actually use third party capacity and can see if there's a way to build those facilities off balance sheet. That really resonates with, how more mature, how more developed markets are actually functioning. If you need an office—and, as you know, I've, built Knotell, so I know a little about offices—you generally don't think about building an office building. Unless you're companies like Google, you can buy an office building or a whole block as they've done in New York, or another very large company buying buildings and not leasing an office is a matter of just managing your treasury. That's not what most companies do. So if you're doing that in the office, which is a mature real estate asset class, let's see what you're doing another classes. Generally, you don't build your data center. There are a only a few companies that have built their own data centers. There's a huge multi trillion dollar, data center asset class, which has been developing over the last 30 years. Amazon and Facebook and Netflix and other companies that have large audiences, they're actually leveraging lots of third party data centers.

Similarly with warehouse logistics, you have companies like Prologis, which is a multi billion dollar business that, builds third party logistics infrastructure, that just shows you the maturity of an asset class over time, companies that, need fermentation capacity will all rely on some form of third party facilities, especially at large scale production, because you build one on the balance sheet and then what do you do?

You've locked several hundred million dollars, that you raised into your equity. Your equity investors expect completely different returns than the infrastructure investors. So you need to have match between the expectations of markets and the match between, timelines of, equity investment and business cycles and, timelines of real

estate cycles. I'm a big believer in renting, if we're renting offices or, warehouse logistics or data centers, why not rent large scale fermentation facilities?

ERUM: Can you help us understand the difference between, and if there's a difference between the fermentation capacity that breweries have versus the biomanufacturing capabilities needed for like the synthetic biology companies that are making milk or egg or other products? What's the difference in, manufacturing that you're talking about versus the breweries?

EDWARD: Yeah, you can't really upgrade breweries, although we're still talking about, large steel vats. The way they're structured is different, you have completely different utilities requirements. For both biomass and precision fermentation you need, very different, amounts of electricity, you need a lot of water to cool the bioreactors, you need wastewater treatment, you also need to be generally, within proximity to feedstock that you want to use, for it to be economically viable. These facilities will be, in different places than the breweries or in really even the ethanol facilities, although close, we're generally looking for a large scale fermentation facilities, for food and materials and ingredients that will change the way lots of industries operate.

> **We are going through this massive, massive materials transition in the same way that, many companies went through digital transformation or for the last, 20, 25 years. I think over the next 20-25 years, many companies that touch to the real world will go through a materials transition. Biology, and specifically fermentation will be one of the key pathways, through which they produce new materials and ingredients.**

And we just, want to be cloud, infrastructure company that enables that.

ERUM: I love that you, are using that analogy of AWS and data centers and bringing it to Synonym and biomanufacturing, I think it helps a lot of people understand the importance of biomanufacturing. Something that you can help us understand, too, is what scale are we talking about? How many liters capacity is actually one that's probably the best, right? I'm gonna, go back a little bit because I wanted to preface this because I had gone to SynBioBeta and there were a lot of alternative protein companies talking about what is the ideal size of a fermenter, because if it's too big and you have contamination, that's a huge loss. But if it's too small, it's not enough. So, what is that ideal size that we're talking about in terms of a biomanufacturing facility,

EDWARD: Well, there are biomanufacturing facilities now that produce vaccines, That produce insulin. Ultimately, Novo Nordisk, which is one of the largest pharma companies is also 1 of the largest biomanufacturing companies. They're using the same

process of precision fermentation, with that was pioneered by genetic in the 80s to make insulin before that insulin was made through animal agriculture.

So we're, trying to, build, facilities for production of other types of proteins. So let's say collagen, or keratin, or beta lactate globally. The size of the reactors really depends on the science and on the market. And how much of that product do you actually need? If you need, thousands of tons of product. Or millions of tons, ultimately, which, we will need millions of tons of milk proteins if we want to replace or really make a significant dent in the milk market. We will need very large scale bioreactors. With collagen, we may need smaller bioreactors and smaller facilities. With some specialty chemicals applications, we may need even smaller facilities.

It also depends on the potency of, those products and then the efficiency of the by process. If our yield from a certain bioprocesses, is large we need smaller bioreactors. And then there are companies that are looking at completely different approaches where if you have a continuous fermentation approach, maybe you need smaller bioreactors, than with batch fermentation. So, you're right, contamination is an issue, but it's an issue at all scales. It's an issue that, need to deal with, by tackling contamination, not reducing the size of the bioreactors.

ERUM: Right? I think the idea was that in this conversation that was happening at this event at SynBioBeta, rather than having few large tanks, you have more smaller tanks, you can isolate the contamination in one of the tanks versus a larger volume.

EDWARD: Yeah potentially. Ultimately these products need to be economically viable and they also need to be superior to the existing products, superior in many different ways. Economically viable is one way to be superior, maybe they should be cheaper. Maybe they shouldn't have different qualities. They definitely should be more sustainable. But, the only way these bioproducts will be adopted is if they are economically viable and superior to the existing alternatives. That's why companies are looking at larger scale facilities and, trying to improve science so that there are higher titers and there's higher yield. Ultimately, all an efficiency game and, it needs to be market driven.

We've been talking about this, at Synonym, the need for the market overall to start thinking about, economics of production, at the design phase, when you're actually in the labs and you're choosing the right chassis and the right microorganisms, thinking about what your downstream processing will look like. It’s not a post factum discussion.

KARL: And do you think that that limits where we are today when it comes to, biomanufacturing production capacity? Do you think not enough, companies are thinking about what things look like downstream?

EDWARD: We have talked to hundreds of, contract manufacturers. As Synonym, one of the first things we did, we launched this platform called Capacitor. When we

launched it, we were able to find about a hundred different, CMOs or CDMOs around the world. Then it grew over the next year, it grew to about 250 facilities. There aren't many others that are not active on Capacitor.

We have talked to most of them one of the key problems that they're dealing with is that they're looking for companies that have good science so their limiting factor is that they get approached by everyone, especially the top of top CMOs get approached by everyone want to be choosing. They want to make sure that that science is sound, that it works. They need to see good tech transfer documents. They're constantly talking companies out of producing now, they feel that they're not ready and you don't want to go to larger scale by reactors when you're not ready because you're just wasting time, both the CDMO's time, and your own time. And certainly your own money or your investors money.

ERUM: Capacitor as you mentioned, is a biomanufacturing facility database, where they're located. What types of other information is on there? Does what feedstocks are local? Does it have, the wastewater management capabilities? What type of information can someone find on Capacitor?

EDWARD: So there are dozens of, search and filtering parameters. You can filter by, size of the bioreactors or, obviously, where the facilities are, what type of downstream processing equipment they have, including waste water treatment. Not all of the information is perfect there. It's a very intransparent market. We're trying to make it more transparent, but it's, also a matter of time. It didn't happen overnight. It took months for us to gather the first set of information and then, we're constantly refining it. We're approaching those CMOs and CDMOs and, adding more information to Capacitor. They're approaching us and they want to modify their information as well. a drive towards transparency on both sides. It takes time.

KARL: A couple of years ago, I was at a meeting where people kept saying there's not enough capacity. And then last year people started saying, it's not that there's not enough capacity. It's that there's not enough products that need the capacity. So where are we actually? In that cycle of argument, I'm under the impression we don't have enough of either.

EDWARD: I think what we have is a lot of intransparency and a lot of friction and, a lot of distrust in the market. That's why the, capacity seekers, the synbio companies that won't access to capacity saying that there's not enough. And the CMOs and CDMOs, that are in many cases inundated with requests are saying that the science is not good enough. And, sort of pointing fingers at each other and they will continue doing that until, there is more transparency in the market. And that's actually what we're trying to build. We're trying to make this into a platform where we can help companies shepherd them from lab shelf help them with, automating, tech transfer and help them with, standardizing, contracting, standardizing, how you can actually compare different facilities. Because right now it's extremely difficult to even get quotes that you can compare from CMOs or CDMOs. Some people quote you on, runs. Some people quote

you on liters per year or liters per month. Some, include overhead, some don't, or feedstock, or labor. They're always comparing apples and oranges.

KARL: We had a conversation recently, you and I, Edward, where you talked about this idea of people charging per liter and where they have a certain price. So basically every time we run the biomanufacturing facility, we get charged per liter, but you guys had come up with another way that would save either the biomanufacturer or the facility, a lot of money.

EDWARD: I think that, the market needs, products that are charged per kilo. When you're making, let's say, egg proteins and you want to replace existing egg proteins, there's the existing kilo of egg proteins costs something, X. And you want to make sure that, when you're approaching your buyer at craft or union lever or, PNG, you're telling them that, you will be able to match that price, or it will be a little more expensive because it's a better product. you need to compare apples to apples. But from the production perspective. You're utilizing, capacity that's measured in liters the way you transfer these liters into kilos, it depends on your yield. So, when you're approaching a facility, and you you're saying that you need to get a certain number of kilos of product out, it depends not only on the capacity that they have, but really depends on your science and on the efficiency of the operations. There is a way to translate them, to translate the available leaders of capacity to kilos of product output, but, it depends on the science of the behind the product. And on the engineering, the efficiency of downstream processing.

ERUM: At Synonym, you also provide tools talking about scientists, they're figuring that out, but you make it easy for them to think about the economics, right? You have the techno economic analysis tool, you have your life cycle assessment tool, called Scalar. Can you talk a little bit more about that and how that's helpful in this commercialization part of the bioeconomy?

EDWARD: Absolutely. We're very proud of those tools. We have amazing team of engineers that started this process by talking to hundreds of companies in the space. And we went on deep dives with dozens of them and did manual technical economic analysis, on dozens of different products. And then we realized that we can actually automate that and create, a platform where you simply, enter few numbers and, it provides you with, rudimentary technical economic analysis in 30 seconds. And then if you play with the platform for another 15, 20 minutes, you actually get a pretty good document that's comparable to what you would get if you're had hired a consultant and paid them tens of thousands or hundreds of thousands of dollars. When we created that, it was like a ChatGPT moment where all of a sudden you get, wow, this is something that's, fully automated and it makes sense. Directionally, and even from the numbers perspective, it's very, very close to what I've already heard somewhere else. And it's a great second opinion. Let's see, we paid something for two consultants or we build something internally. Let's see what Scalar says. How close is it?

It's a set of tools that we developed to help companies understand, economics of production. Not only are we looking at, what the project returns would be, or a

bankability, we give companies, a certain sensitivity analysis to understand what are the sensitivities in their process and what variables can be tweaked. There are hundreds of parameters That can be tweaked within Scalar, we're exposing many of them, some are internal and we're figuring out how to best expose them to users. But, it's been overwhelmingly successful. Scalar has been used, for, doing TEAs on thousands of products.

Now we've been able to aggregate that data and we've published it in our trends reports, and we will publish more information that we're getting in aggregate from the market on what the returns could be from byproducts. What is economical to produce right now? And what is not economical? Because that's very important. As I said, we're dealing not just with science, but, with products that need to hit the market. If someone is in the lab and they're developing science, it's a university environment, great, that's fine. Maybe it solves, scientific or educational purposes.

As soon as you start thinking about distributing that product, to companies and ultimately, if you want it to be, within consumer products, those products need to hit certain price points. Otherwise they will not be competitive. What we've learned just historically is that everyone cares about sustainability.

There are, maybe 60 percent of consumers say that, they want to buy products that are more sustainable. But, when it comes to voting with, their wallets, 3 percent of consumers that buy sustainable products. So obviously we need to get the price right.

ERUM: Right. Yeah. we'll put that trends report in our show notes. That's one thing. And the question I have is can you share a user story like of when they did the TEA. They had a go or no go decision It's only going to tell you the data that you put in there and it's going to either be a good number or a bad number. So any story you can share from a user?

EDWARD: I know that, the TEAs from Scalar are being included in, fundraising data rooms. We have, venture investors running DDs, so they get the data from the companies and then, they come to Scalar and input those numbers and see what the TEA says.

But, my favorite story, and I won't name the company. But we were doing a presentation to one of the companies and showing them the technical analysis and showing sensitivities and numbers. And in the middle of the presentation, I get a text from the CEO of the company who is sitting in the zoom room on the other line. He's texting me says, wow, this is exactly what we're looking for. That was an amazing moment.

KARL: That is amazing.

EDWARD: That really showed me that we're on the right track.

KARL: Okay, so you've built these tools to basically track, and give companies access to these facilities that already exist, but you're also going to be involved in building new biomanufacturing facilities. Have you built any yet? Where's the first one going to be? What's it look like?

EDWARD: We haven't built any yet. It takes time. We founded Synonym two years ago. I actually got an email from LinkedIn today congratulating me for two years at Synonym.

KARL: Congratulations, by the way!

EDWARD: Thank you. Thank you. We've done a lot of engineering work. we, initially started, thinking about larger scale facilities. So 2.4 million liters, 4 million liters, because we listened to the CEOs of synbio food companies. And they were all saying that we need these huge facilities with very large bioreactors. So we started designing for the market. And then, looking into technical economic analysis, we really realized that, maybe these companies are not there yet.

Their ambition is to be there and maybe they want to be there in 2 years, but it could happen in 5 years. From the underwriting perspective, we need to make sure that there's a high level of certainty that they will be there because otherwise, project finance investors will not be able to invest. They will not be able to underwrite. We scaled that down and, started looking at, a smaller capacity and, we are, now, in late stage planning around the facility that, want to build in the Midwest. So, that is something that, we plan on doing in '24. So we'll, break ground in '24 and then we'll, build more facilities. it starts with one.

The goal for us is to make sure that, our engineering is sound and that we are standardizing that capacity. We want to make sure that whatever we build, it has as many standardized components as possible, so these facilities can be multipurpose not only multipurpose, only for food, but also multipurpose across different verticals. Because that way, we can unlock, project finance and speak with, infrastructure investors, about, taking these facilities off balance sheets of the companies that would actually use them.

ERUM: Yeah, it'll be very interesting to see the biomanufacturing facility you guys built because you've learned so much across all of these other existing biomanufacturing facilities. So you know what they have done wrong and you know what they have done right. So you can avoid a lot of those mistakes and pitfalls that they have today. So I think it's going to be very exciting for any company to be part of the Synonym Biomanufacturing Facility.

EDWARD: I certainly hope so. I think most of the facilities that have been built so far have been built on the balance sheets companies because companies were building it for themselves. They're all single use, single purpose facilities generally built for production a certain product. When a company is thinking about building a facility,

obviously, they're thinking that they will be successful. They want to aim for that success. So they're optimizing for that specific product and not thinking about reuse of that facility, not necessarily. And they're also not thinking about the optimizing the residual value of that facility. If you're doing this off balance sheet and thinking about multiple users and thinking about the interest of investors, you have complete different motivations and, your engineering approach is different as well. So it's not that anyone has done something wrong. They just did it for a different purpose. and I think over time that purpose changes. You can still build single purpose facilities, but if you're doing it using your own capital, are you as competitive as someone who will rely on standardized infrastructure? If you're still building your own data centers, are you still as competitive as someone who is relying on Amazon's cloud or Microsoft's or Google's or just in general on 3rd party standardized infrastructure? I think the question will be there over time. What makes you more competitive?

ERUM: So you mentioned that there are different types of biomanufacturing, There's the continuous flow. There's a precision fermentation. What are the top types of biomanufacturing do they require different builds? You would have like four types of biomanufacturing facilities, for those biomanufacturing processes to work?

EDWARD: Yeah, absolutely. There many different types of, biomanufacturing facilities. If we talk about biomanufacturing broadly. I mentioned there are facilities, that are pharma grade, and then you have, facilities that would be food grade are producing for human consumption. And then there will be, industrial grade fermentation facilities. And then, you have something that's, focused on precision fermentation or biomass fermentation or gas fermentation. Then you have, ethanol facilities, which are also a form of biomanufacturing, you will have facilities that are producing, sustainable aviation fuel, or SAF.

All of these are designed differently. Solugen is making, with their bioforges, also a new type of biomanufacturing facility. So, there will be different kinds. And different types and then they're not all reusable. Definitely not. But what we're tackling is what we believe is a large portion of the market, which is aerobic, aseptic fermentation, , specifically, focused on precision or biomass fermentation. And we believe that's the lowest hanging fruit. that's something that's, has a wide range of applicabilities, the upstream fermentation and the utilities around it, are quite costly. You can standardize around costs. So you, build the facility, which has the right, electricity, and water and all the wastewater treatment that you need. All the upstream fermentation can be standardized as well. On Scalar, you asked me to some of the data. I'm not sure whether that's in the trends report, but, across several hundred protein runs on scaler we've been able to standardize our facilities to be about 90 percent reusable from the cost perspective. We feel that's very powerful because we can talk to project finance investors and say that, there's a very high chance that, occupier of that facility fails for one reason or another, then there will be lots of others, hundreds of others. That's the way the data centers work. The reason data centers can be financed by third party investors is that because that infrastructure is reusable and reusability, that ability for the facilities to be multipurpose is very important for them to be this emerging asset class and to really unlock the capital and significantly lower the cost of production.

Because ultimately, it's not just the size that matters, it's also the cost of capital. You have really three drivers. It's CapEx, OpEx, and the cost of capital, that will determine what your cost of production is. And of course, the efficiency of your science.

KARL: It brings up a couple things because I'm curious, Edward, is it possible for you guys to buy existing infrastructure and repurpose it for anaerobic, aseptic fermentation? And I'm thinking are there chemical facilities that could be retrofitted into, doing that kind of thing?

EDWARD: Yeah, it's possible and we're looking at some of that. We're also looking and some of the studies that have been done on retrofitting these facilities. And we've visited, several that, we could retrofit. Ultimately in doing these retrofits, we would need to get them to the same standard as building new ones. We will buy facilities to retrofit them. I've no doubt about that, but there's just not enough in the market. So ultimately we will need to build more and we'll need to, hone our skills on building more facilities rather than, doing the retrofits.

ERUM: This could be more expensive. What's the TEA on retrofitting, you know?

EDWARD: Well, it should be technically, it would only make sense if it's cheaper.

ERUM: I mean, it reminds me, Karl, when you shared an abandoned facility in Canada. And we were like, let's buy that and do something. abandoned and it was for sale for like 500 thousand dollars.

KARL: Yeah, it was a protein production facility that was for dairy protein manufacturing. But the other part of it that is interesting, I mean, retrofitting is super interesting. I think about it because you've got, multiple trillion dollars of infrastructure that's been built by the oil and chemical industry that we don't want to tear it down. Is this a question of what can we turn it into? But secondly, my understanding, especially on the cultured food side, cultivated meat side, is that there's still a lot of innovation that needs to happen when it comes to manufacturing, because being able to manufacture tons of beef from beef cells is still something we've not done yet. So there is going to be a need for a lot of that innovation to happen on the biomanufacturing side in addition to you building these facilities. Is that correct?

EDWARD: You may have noticed, I haven't mentioned cultivation once. it's a completely different space. The requirements are very different. Tech and economics are very different. And from all the tech and economic analysis I've seen, we're not there yet. not even close. We may be 99%, there, from, where we were 10 years ago when the first cultivated burger was made, but that cultivated burger costs a quarter of a million dollars. Now, we're 99% cheaper, maybe 99.9% cheaper, and that would still be $250.

So, these projects are still a little more expensive and I think there's a lot of customer education that needs to be done in general on bioproducts and, cultivated food products are just one example. I think need massive education consumers and politicians and large companies on what these bioproducts are and why are they better and how they will change people's lives.

> **We've been working on AI for two decades. And, only the launch of GPT showed the world that's what the promise of AI is. everyone's eyes open and say, wow, this is, amazing. But AI has been used, in air traffic control and then autonomous vehicles and, in many, many other applications, even in the way our ads are being served or the way Zoom works, or zoom transcriptions work, it's been used for years, we've had some rudimentary AI for decades. We haven't had that ChatGPT moment in bioproducts yet. And we need that.**

We need consumers to say, oh wow, I put this cream with this bioproduced collagen in my hands and it's a completely different experience. Or this new fabric from which my, shirt is made is, both cooling and heating. I've never felt like that in a piece of clothing. We need those moments. We need the wow moments for consumers and before that we'll need a lot of other types of education.

KARL: Yeah, you didn't mention cultivation, but that's where I see a lot of pushback where people are, still saying, it's just going to be fake meat and they haven't had the education to understand that it could be better. The environmental impact is completely lessened. And the form factors could be different and more interesting than what we're used to these days. So I completely agree. There's a lot of education that we need to do. What about on the environmental impact side of biomanufacturing? What does Synonym see its impact on, the environment?

EDWARD: So Erum mentioned that Scalar has a TEA tool and it also has an LCA component, the life cycle assessment. We've done life cycle assessments for hundreds of products. People have run on hundreds of products, through Scalar we're seeing that, they are better, not only from the carbon perspective, but also from the water usage perspective other, sustainability metrics. Carbon is not the only driver of success.

It's a driver of success energy usage, but maybe our sustainability metrics should be a little different in materials, but LCA it's still very important. Bioproducts should be more sustainable. if you look at all the LCAs that have been done on, milk proteins or egg proteins, they're completely, completely different than what the existing animal agriculture alternatives are, from the water usage and, land usage they're much, much,

much better for the environment. There's no question that bioplastics are better than plastics, for the environment. They're biodegradable. There are no microplastics issues They can be water soluble within 60 days.

> **So once again, we need the markets to be educated about this. Otherwise, if they're not more sustainable, why do them? Why do it? No one wants to make things that are less sustainable and bad for the environment. Biology is too complicated to tackle it, to make things that are worse for the environment.**

ERUM: Our friend Aaron Nesser, who's fairly into the biomaterials space, he had posted on LinkedIn that bioplastic does not equal biodegradable does not equal compostable because there was this article that, there was a bunch of, bioplastic straws that didn't biodegrade and it was two years later after it was disposed of. So, I'm just pointing out that. I guess the other flip side of the argument of biology is that, okay, we've got to look at the full cycle, I don't think they used your tool to do LCA on their, bioplastic straws. So I think you'd be happy that I mentioned it on the pod, but it is, something to consider. Not everything's equal.

EDWARD: Yeah, absolutely. As I said, biology is complicated. I think everyone requires a lot more education. For most people, their biology education stopped with, high school biology could have been one course could have been like, I don't know, maybe two semesters of biology. Some people have taken biology in college, but not everyone. It's not required. Or ecology is not required. That is something that we really need to remedy as a society. It is the science of life and we can learn so much about us and about the way humans interact from biology, how to build organizations, even how to be an entrepreneur.

KARL: Yeah. So looking ahead, Edward, what trends or advancements do you see, in the field of biomanufacturing how does Synonym plan to stay ahead of those developments?

EDWARD: So, there's been a lot of talk about, new types of bioreactors. There are many different designs. One of the things that happens within a bioreactor is that microorganisms need to be agitated, to actually consume sugar. They are generally lazy in most of the bioreactors, there's a rotor that rotates at, I don't know, maybe 60 to 100 RPM. That requires a lot of electricity not everything can be made, when the rotor is rotating, at such speeds. So, there are companies looking at, doing agitation or contamination control with sound or light, or, making more efficient bubble column reactors. There's a lot that's happening on the continuous fermentation front. There's a company called Pow.Bio, which shows great promise and has, a different bioreactor

design or a completely different approach. And they're also tackling contamination issues. And I know a lot about them because I'm a small investor in the company. So, I think there's a lot that will be happening on the efficiency of feedstock. But ultimately we need to have the right expectations with respect to our science and, microorganisms that are being used. There must be the most efficient way of making milk proteins using synthetic biology. Right now we're using, approaches, with, algae and, bacteria and, yeast and, different types of, fungi. It can't be that they're all equally good. There must be one that will win, and we're not there yet. I think there will be some form of reckoning maybe. Or some discoveries. I think that AI holds a lot of promise in synbio, where we leverage these massive amounts of data to get to decisions faster.

ERUM: Are you leveraging AI right now and how?

EDWARD: We're leveraging AI, but only directly. There's not enough data that we can see. There's not enough data in Scalar or Capacitor. There's some bioreactor level data that could be leveraged, but, the improvements efficiencies you get are, still marginal. I think there's a lot of AI that's being leveraged on the discovery side and optimization, the optimization of bioprocesses. We will get to leveraging AI in production. I'm certainly thinking about this in the way facilities will be organized and operated. Ultimately, should be very efficient from the operations perspective; they're closed loops. There's no reason why AI will not, be able to roboticize a lot of these facilities.

ERUM: Now you're talking. I like that idea of not even having to go into the, I mean, obviously there would be some people there to maybe bring the feedstock to the robot and the robot does everything, but, if you can do any remote biomanufacturing. That's awesome. Okay, now we're towards the end of our interview, and you've already started talking a little bit more about the future trends and your predictions, but one thing Karl and I always like to talk about is distributed manufacturing and also the miniaturization of biomanufacturing so we can make things in our house!

EDWARD: I would love that. So when we started Synonym, we talked a lot about cultivation , and of course, imagine this, microwave-sized device that you can use to, cultivate something very quickly. Certainly I would be afraid of having something be cultivated in a matter of minutes, but maybe you can grow, dinner for like a Sunday roast in a matter of a week. So every Sunday you have, something like a cultivated roast in your little microwave sized device. I think we're very far from that, maybe decades. And I don't even know whether that's necessary.

ERUM: Yeah.

EDWARD: Listen, many of us have, miniature fermentation devices at home. You can make kombucha. There's so many people that are brewing their own beer at home, or making cider. We're already biomanufacturing. Our kitchens are little biomanufacturing factories.

ERUM: Yeah, or like medicines, small volume, biomanufacturing medicines, like cosmetics, things that you just need a little bit of, and you can just be like, okay, I need a little bit more of this cosmetic, or I'm not feeling well, This is all the data about my body and what's going on. Can you, you know, whip something up for me?

EDWARD: Yeah, I think these devices, will need to be super efficient and super safe. You don't want mistakes.

KARL: Yeah. I see a lot of it being more neighborhood sized, serving, I don't know, 10 or 20 thousand people versus, for some things that just doesn't make sense to do it, like you said, individually. I love the idea of a roast growing in my kitchen every week, but I like the idea better of going outside and knowing that I can go to this restaurant and eat beef from 1913 and I can go to that restaurant and it's, pork from, I don't know, Japan without having to import the pig from that far.

EDWARD: Yeah, I think over time, we will eat, meat in the same way that eat caviar. It will be a luxury product and, it will be an experience that we'll talk about with others. Maybe we'll have vintages of, like this has been aged for so many months, and it's cultivated and aged, or cultivated, it's a mix, of, pork and beef, different pork and beef cells, or these are beef proteins with, pork fat, and these products will be technically absolutely vegan.

KARL: Yeah. Exactly.

ERUM: It has to be. That's what we'll say on the, bioreactors. Vegan. And they have to have that label on there. and I'm sure you'll help us get there when you're getting all the data from all of the biomanufacturing plants. Wrap the AI around all that data and help us figure out how to miniaturize. I feel like, Synonym is positioned hopefully to help us get there faster. You'll be the ChatGPT moment of biomanufacturing.

EDWARD: I definitely hope so, and we'll try to get there, as fast as possible, and be as efficient as possible. it's not a straight road. As I said, biology is complicated, development is complicated, but, we're not afraid of doing the hard stuff.

ERUM: I love that. Spoken like a true entrepreneur!

EDWARD: I think you get great rewards from tackling hard problems.

OUTRO

ERUM: Wow. So impressive what Edward and sending them and the team over there. What they're doing. Karl, what do you think of this interview?

KARL: I'm fascinated by what Edward to say. I mean, we know we can use more capacity. I just saw a, tweet a few days ago. I haven't spent spending a lot of time on Twitter, but I did see a tweet that made the comparison of the carbon output of, I

don't know, a flock of cows versus a biomanufacturing center that was producing cultivated meat. There is no center yet producing cultivated meat because it's still quite expensive. It was very clear that a circular facility could produce meat at a much lower carbon cost than cows can. This isn't to say we should eliminate all cows. I don't agree with that at all. But I think that we really need every solution everywhere all at once and biomanufacturing is one of those solutions.

ERUM: Yeah, I'm very interested in the different types of biomanufacturing and how they are related to different types of products. You mentioned cultivated meat. What is the ideal biomanufacturing plant to lower the cost of production versus, optimizing, increasing the yield of what does that look like? And then, can that be a model for all cultivated meats or, how do we scale this up in a way that is easier for food designers? We're saying that for cultivated meat to just tap into an existing infrastructure and make the product versus having to invest so much in setting up manufacturing plant sounds like that's the idea behind Synonym is really making sure that, hey, with AWS we're the for you to get started building your software. Don't worry about it. I think smart move. And it sounds like it's a, requires quite an investment that Edward and his team making when it comes to creating that map and hopefully soon they'll start making some of these biomanufacturing plants.

KARL: Yeah, I mean, if we're going to grow everything, we need these facilities. So I'm very excited to see how they progress. But what do you think about this idea of biomanufacturing facilities as data centers? that's something that Edward says, I've always thought that that was a really interesting analogy.

ERUM: Yeah, the association of biotech to information tech is strong. We use it a lot. I think oftentimes, because of we have DNA, the ATCG. Similar to the binary codes of zeros and ones, and that being a foundation for programming life or programming computer programs.

So I think that this is another one of those. You mentioned data centers as an asset class, would love to hear your thoughts about that. I think data centers being an actual building? Yes, it makes sense. To what level is it an asset class? So are the actual servers and the equipment that's inside the data centers that are included in the value? Or is it just the space? I mean, would love to have dug in deeper with Edward, which we can talk to him offline. But what are your thoughts on this?

KARL: Yeah. So I did a little bit of research before we got on the pod with Edward, just to kind of understand that better. And investors do look at data centers as an asset class. And they actually started talking about this back in 2010. Today there are about 10,000 data centers globally.

I did even more digging and learned that, McKinsey issued a report, which we'll link to in the show notes that said that in 2021, there were over 200 data center deals those deals. Those deals are in the billions of dollars. So clearly this is an asset that is worth lots and lots of money. And so if you could imagine doing the same thing for

biomanufacturing and having facilities all over the world that are able to produce biomaterials, foods, anything that we produce, with chemicals, but using biology instead. I think it's a net positive for the planet. And also it's going to be necessary to help really drive costs down.

ERUM: I guess my question, and again, we need to talk to more people about this, or if you came across this in your research, does the value of data centers increase over time? Because for me, it's like, hard to imagine because I feel like technology just like cars, as soon as you take it off the lot, it decreases in value because technology is advancing. But, is it because of the materials that the computer chips are made out of and what's equivalent in bio manufacturing?

KARL: Yeah. It's a super good question because I would imagine that the data center as an asset is the building, the land and the computers that are in there. But if you think about it, those computers have to be swapped out on a regular basis. It's not static. Biology isn't static. You can't leave the same machinery in there all the time. You'd have to change them. So I would think that, the value is the entire infrastructure. It's not just the building, but we should dig into it more and we should come back and have Edward tell us more about it. And, you listeners, if you're listening to this and have some insights, please let us know.

ERUM: Yeah, yeah, definitely. It's something that we'll be keeping an eye on. We should ask this question since biomanufacturing and something we're focusing on here micro everything, we should talk to our guests about it. What do they think about it? We have a few guests coming up and they need to leverage biomanufacturing, to scale up their operations.

Are they going to be building it from scratch or were they, talk to Edward of Synonym and leverage existing infrastructure in the beginning? We know our friend Shara at C16, they're using existing infrastructure at the moment as they continue to do different biomanufacturing fermentation runs to make products to prove to their industries that they're selling to that you can make amazing products with the oil that they're manufacturing, which is a true oil, a replacement for palm oil, which is very problematic. So we should bring Shara or her co founder David to talk about their approach to using existing biomanufacturing versus raking capital to build out their own factories.

KARL: Yeah, I'd love that. should get them back on to talk about this. Well, I think that's a pod unless there's anything else, Erum?

ERUM: Yeah. The big thing is I'm so excited for send by beta that will be happening in just a couple of months. May 6th through 9th in San Jose, California. And we have a special code for all of our listeners. If you use the code, grow everything at the checkout for when you registered for SynBioBeta. You will receive $300 off very generous of John Cumbers and his team to provide that to us and to you. It's definitely worth going to as as you're growing more interested in biotech or you're in

the space and want to meet people that are making moves and are learning at a fast pace what's going on behind the scenes when it comes to biotech business. This is a must-go-to event.

KARL: We'll be there. so you can come and meet us in person.

ERUM: Yeah, absolutely. And I would say if there's one thing we wanted to ask it's please leave us a review. You go on Spotify, go on Apple. We would love 5 stars if there's 4 stars. Fine. If you want to do 3 stars, just don't or maybe do it. I don't know.

KARL: Alright, I think that's the pod! We'll talk to you guys next time.

ERUM: See you later. Bye.