Origin Materials, Inc. (Nasdaq: ORGN)

Investor Q&A Fireside Chat, July 25, 2024

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Participants

John Bissell, Co-CEO and Co-Founder

Ryan Smith, Chief Product Officer and Co-Founder

Ryan Smith: All right, welcome back! This is our second round of ask-me-anything interviews. Our first round was last April, and we received very positive feedback from those sessions. So, this is a follow-up.

The way it works is that we've solicited questions from our retail investor community. I have a little bit of follow-up with the investors to understand where the questions are coming from, what's motivating them, and just make sure I understand the questions myself. Then, with all that in hand, I and some of the folks here at Origin put together an interview structure to go through it all.

That's where we're at now, sitting down with John in a kind of fireside chat. The idea is to keep this pretty conversational and take a deep dive on several topics that tend to only get a surface-level treatment. Of course, there's still lots of things we can't talk about or can't go into too much detail on. But I'm going to try to take us down into the contours of the topics where we can. So, with all that talk about not being scripted, I do have to read our safe harbor statement, which we read all the time.

Please note that some of what you will hear during our discussion today will consist of forward-looking statements based on current expectations and assumptions, which are subject to risks and uncertainties. These statements reflect our views as of today, should not be relied upon as representative of our views at any subsequent date, and we undertake no obligation to revise or publicly release the results of any revision to these forward-looking statements in light of new information or future events. These statements are subject to a variety of risks and uncertainties that could cause actual results to differ materially from expectations.

All right. So with all that said, I want to jump into it. But probably first, John, you never want to see questions ahead of time, so we've shielded you from the questions or the questions from you. I think you had a brief glance, because, even though you're the interviewee, you're also the CEO and have to approve content that's going into this format. But that was less than a couple of minutes. So you really haven't seen this. This can be pretty off the cuff.

Where I'd like to start is on our caps and closures business. This is really just pulling from the questions that came in. There's always a heap of caps and closures questions, and we can't always answer all of them. But I think it's important to keep answering the ones that we can, so as the picture comes into focus, people can see how that business is shaping up.

I'm going to start with a manufacturing question. This is a question about timing. It's sort of two parts. It's asking about the lead time on getting cap-producing machines in place and then also asking, once they're in place, what is the time to ramp up to full production? You can feel that investors are trying to build a model of this new caps business.

John Bissell: So, I'll answer first by saying that we don't have the whole integrated system that we use to make caps, and it's several pieces of equipment that we've worked with vendors to design. We integrate them all together, and that's what really allows us to take in PET on one side and make caps on the other side. That system is one that we have the first line coming up here soon, and we're excited about it. But we don't have a standard "this is exactly how long it takes for a system," because this is the first one.

I'll use proxies for how long it typically takes for these kinds of polymer part-making equipment to come online and what's the lead time on these sorts of things. Generally speaking, I'll work from back to front. Usually, it's relatively short to bring these kinds of systems online. If you compare it to chemical plants, which could be months or even longer to get them up to nameplate, these polymer part-making systems are closer to weeks, maybe a couple of weeks. Sometimes a little longer, depending on the team and other factors, but it's on the order of a few weeks. It's pretty quick.

In terms of how long it takes to get the equipment, that ranges a little bit. Usually, the longest lead time piece of equipment for any of these, especially in PET parts making systems, is the extruder. The extruders will range anywhere from 12 to 18 months for a new extruder, with some additional error depending on what the market conditions look like and whether you want special considerations for that extruder or special specs. So, that's the range there. It could be as long as 24 months.

And then there’s the other pieces of equipment for it which are much quicker lead time, we usually think in terms of 6 to 12 months for the lead time for all the other parts. As a consequence, one of the things we think about quite a bit is, do you need extrusion capacity that you’re bringing online every time you bring online a system? There's lots of extrusion capacity for PET in the world, so you don't necessarily need to have a new extruder for every system. On balance, in the long term, yeah, probably, as we start to bring lots and lots of systems online, you'll need dedicated new extrusion capacity. But in the interim, we don't think that's necessarily true.

Ryan Smith: Got it. That's helpful. And of course, vendors and partners are an important piece of making all that happen. The next question touches on that. It references some of the recent press releases involving partnerships with Swiss companies. Origin has chosen for these companies for logistical or geographic reasons, or because they are best suited for our purpose? Do you expect near-term cap and closure production in specific geographic regions, such as Europe, based on these recent partnerships? Or do you expect to see production in North America also?

John Bissell: We do expect to see production in North America also. That's an easy question. In fact, I don't think there's any region that ultimately we wouldn't expect to see production in with these kinds of systems. Caps are low enough bulk density that you want to be producing them at least somewhat locally or domestically to the market you're serving. So, I don't think this is a situation where we want to have enormous capacity in one spot and then ship that globally.

Regarding the Swiss companies, we have very much gone to companies that we think are best in class for the piece of equipment they produce and develop. We've been pretty ruthless about that. There's nothing special about Switzerland specifically other than that they have a lot of precision manufacturing equipment manufacturers. That's true for a lot of roughly that part of Europe. Germany has really high-quality precision equipment manufacturing, and Northern Italy is known for that too. They're not the only places, of course; there are many other places around the world. But it's not surprising that we ended up with a few vendors out of Switzerland.

Another component is that there's a natural tendency to follow the networks of the initial equipment developers. If I analyze it from the outside, there's probably a higher propensity for partners in that region due to those networks, but it wasn't really intentional. It's just what happens.

Ryan Smith: Yeah, that makes sense. Okay. Also on PET caps, something we've touched on a little bit, this question kind of hits it head-on. Which is asking, you know, can these PET caps be made by Origin only? Does Origin have patents to protect the IP around this? You know, if a PET cap is such a big, good thing, why don't big companies who have more resources, why aren't they coming up with these solutions? And then sort of a follow on, once Origin starts producing these, can't those large companies just look at how we're doing it and reverse engineer what we've done?

John Bissell: Yeah. So we do see this very much as an intellectual property-rich sort of way of manufacturing. And so we've been diligent about making sure that we're protecting our process and our manufacturing and all that kind of stuff, and the design of the caps themselves with appropriate intellectual property. So I think that's one component. As with anything, it's very rare for intellectual property to be deterministic in providing a moat for a particular business, and so, consequently, we also believe that we just have to be good at it. We have to be good and continue to get better faster than anybody else could. And so that's an important component of it, right? So intellectual property plus execution. And then the last piece is, you know, you want to work with other parties. We don't see this as a business where we need to perform every single part of the value chain ourselves and box anybody else – everybody else, I should say – out of the business. There's a lot of work that needs to be done to deliver these caps at scale. There's lots of demand for it. And so our view is that we should be working with those parties instead of trying to lock them out of what we're doing. And so, you know, we think that between all of those different things, that'll give us a pretty meaningful moat and head start as well to protect the value, and let's say, protect our value capture.

Ryan Smith: Is it fair to say, then, that we can summarize some of that as saying it's using intellectual property and expertise to ensure that it's much easier to work with us than against us, if you're a large producer of these?

John Bissell: That's right. Yeah, exactly. I like that.

Ryan Smith: Great. All right, so. And again, you can kind of tell that folks are putting together their own models around this. But this next question is asking about the relative pricing between recycled PET, virgin PET, HDPE, polypropylene. How does the cost of those materials differ, particularly the grades that go into caps and closures?

John Bissell: Yeah, so it's kind of a tricky question. Because the answer to the question is different at different times. One. And so it's hard to answer that question in an evergreen sort of way, and it's always going to be pretty specific to, sort of, what I heard last week about polymer pricing and capacity, and all those kinds of things. But I think you could maybe say that rPET and the ability to switch between rPET and virgin PET is advantageous from a cost perspective, right? Because we can always pick off whichever one is less expensive. Also, you know, we think that recycled PET is a really attractive material to use for this because it enables renewable content mandates. We just think it's better to have application sinks for recycled PET as well. So, you know, we have an opinion, and we think rPET is a good material to use. But from a cost perspective, you can use either of them, and you just use whichever one is cheaper at any given time.

In terms of polypropylene and polyethylene that are used for caps currently, it depends a lot on exactly what grade you're using. What grade you use depends on which format you're going after for a cap. And even the dynamics of propylene versus ethylene pricing can change pretty dramatically. Maybe not usually on a month-to-month basis in terms of what the ordering of cost is. But there are interesting things that happen. For example, the fracking boom made propylene relatively much more expensive than it was before, relative to ethylene, because you were starting to do a lot more wet gas cracking, steam cracking, instead of cracking naphtha. And when you crack natural gas liquids instead of naphtha you're going to get way more ethylene and way less propylene. Usually you get both, plus maybe some butadiene or butane or something like that. And so consequently, that shift, which was really good for ethylene and really good for the crackers, was really not great for the propylene guys. And that stands in stark contrast to, you know, the 10 years before that happened when propylene was the byproduct. All of these naphtha crackers are making both ethylene and propylene, and everybody's trying to figure out what the hell are we going to do with all this propylene? So they start making polypropylene. Nobody knew what to do with polypropylene, right? So, you know, you could see this really stark inversion of the relative cost of polypropylene and polyethylene from the fracking boom.

And I think, as a consequence, it can be difficult to describe sort of what is some sort of long-term consistent argument on this. What you can say, I think, is that if you only have to be exposed to one material, PET, instead of two or three or many materials, in the case of if you have a PET bottle, and then you have a polypropylene or polyethylene cap, that drives a lot of efficiency, and it drives a lot less cost exposure. And most of these bottling companies are exposed to PET anyway. Right? There's no real plausible alternative to PET for most of the bottles. So they're stuck with that one. They've got to be exposed to PET. And so, if you can reduce your exposure to be just PET, that's good. It means that if polyethylene or polypropylene spike, you're not going to be hit by that. So that's a cost benefit.

Ryan Smith: Yeah, I imagine food and beverage companies don't want to be as exposed to all the intricacies of the ethylene-propylene dynamics that you're describing. That's not their business. They want to make, you know, beverages.

John Bissell: The less sort of exposure to catastrophic price increases in different materials, the better. Right? You probably can't get out of materials entirely. But if you can get all into just one material, that's good.

Ryan Smith: That makes sense. And I'm going to nudge you a little bit adjacent to this materials question around the fact that the amount of material that you use for a given cap design can vary quite a bit. I mean, we've seen this, like, even before Origin started doing this, you know, the polyethylene caps are getting lighter and lighter and lighter, and of course, material properties affect that. So even if you had sort of a good predictive model of the price differences there, there are other factors that, of course, multiply this one way or the other.

John Bissell: Yeah, I mean. I think one of the tricks to what we're doing is we didn't just take a polyethylene cap design and try to fill it with PET instead of polyethylene, right? We changed the design of the cap and the way that we manufacture it. And those changes bring benefits all on their own, right, that we think really take advantage of the PET, which has different material properties than polyethylene and polypropylene.

Ryan Smith: Yes, great. Alright, here's a question about sort of coming back to partners. And I'll just read it directly. It says, in July 2023, you announced a milestone in the development of PET packaging, incorporating FDCA in partnership and cooperation with Husky Technologies. Husky now appears to be developing their own PET caps and closures in direct competition to Origin Materials. Could you tell us a bit about the current relationship between Origin and Husky Technologies?

John Bissell: So we wouldn't, if we were going to have a relationship there and we were going to talk about it publicly, we would. You know, there'd be a press release around it. So I'm not going to give new information around that kind of stuff here, if we had any. But I think in terms of just educating yourself as an investor or consumer, or whatever else, you know, I think one of the first things to look at is the cap design. You know, we're just talking about cap designs. You can look at the way that, and Husky's not the only one that's tried to make a PET cap before. You can look back in history. You could see a couple of different programs around this at different companies. And I think the first thing to look at is the cap itself. You know, we were just talking about – you sort of teed this up nicely. You must have known this question was coming. You can look at the cap design, and that'll tell you a lot about how much material is getting used, how much material is getting used in the cap is going to drive a lot of the cost for the cap. And you know, there is, I'm obviously biased. I think there are aesthetic elements to this, too. You can look at that first. It can be, unless you're really sophisticated, it can be difficult to try to assess what's the processing characteristics? And whether or not that's going to be advantaged or disadvantaged, or something like that. And while that matters, it can be a little bit visible. But just looking at the design can tell you a lot, and that would be the first thing I point to, right?

Ryan Smith: That's great. Alright, and then maybe clearly can't, sort of, dislodge and unearth new relationship information where I don't want to do that here. But there is a question that's kind of just asking in broad strokes. If you can describe the general characteristics needed to secure an off-take agreement for the caps and closures products. What steps does Origin still need to complete to secure off-take agreements for PET caps?

John Bissell: Well, it's not the same steps for every customer or potential customer, you know. There's—we have a pipeline. We run people through that pipeline. We're checking boxes off all the way through. There's a negotiation of different terms at different points. So you know, I appreciate that people would want to know this. But I'm not going to talk about it, and shouldn't talk about sort of what we still need to do. And it's also not monolithic. There are different customers that need different things at different points in the negotiation process. That said, I can talk a little bit about sort of generally what are we? You know, what are the things that a customer looks for here?

You know, what they're going to look for is, does it meet their—and this one's sort of obvious—but does it meet their business criteria? Right? Does it meet their marketing and their brand criteria? You know, which is, sometimes we talk about. We think it looks good, but the marketing department needs to think that consumers will think that it looks good, too. Right? It's not just my opinion or the marketing guy's opinion. It has to meet their—and by business goals I mean everything from cost to performance to sustainability goals, too.

So you’ve got to sort of check all of those things off. And that's something that can be done largely, it's sort of a paper exercise, right, you're validating the data and all those kinds of things.

But then, you also need to actually use the caps on their systems and on their products. And so the thing has to work, right, and it has to work in two different places. It's got to work on the beverage or on the product and however you happen to get the cap on there, it's got to perform the way it's supposed to. But then you also need to demonstrate the way that it gets on there. We call these, you know, in the capping machines or the capping trials. Right? You've got to verify and qualify the performance of the cap in the capping machinery.

And so that's an important consideration as well. And then, of course, you've got to. You know, there's a variety of other terms around sort of supply agreements, all that kind of stuff that you've got to come to a conclusion on, which includes everything from price and volume and location and, you know, even the more nuanced terms like, you know, payment period and all that kind of stuff. But so that's generally what we're looking at. Right? You've got to—it's—it’s what you would think it is, I think, from the outside. If you didn't know anything about caps, what would you think that people need to check off? It's all those things.

Ryan Smith: That's great. Makes sense. Perfect. And also, as you said, kind of case by case. Alright. So this next question, it was interesting. It's a question about our view, or any work on, you know, we've got sort of now PET bottles, PET caps. There was a question about the labels, you know, moving those to PET. And I noticed there was, you know, there’s the ability for the investors when they're posing these questions to sort of upvote them. And this one had like a ton of upvotes.

I got in and was asking like, why are you guys so interested in this question? We don't talk about labels. That's not a thing that we're, you know, we haven't said anything about that.

John Bissell: Well, what did they say?

Ryan Smith: I dug into it, and it turns out, you know, I'll kind of paraphrase a bit here, but I think what investors and folks are trying to understand is, obviously PET caps are contributing in a big way to this idea of making a monomaterial package. And there's been some other work on caps and adhesives and inks and things too. So but I think the question is, you know, is Origin actually sort of cracking the code here? And is this part of a larger enablement for packaged food and beverages?

And I think there is an interest to understand our view on this. And I immediately sort of warn folks I'm like you're going to get a lecture. Something John and I have talked a lot about. So but I think it would be great to kind of walk out some of the views like how, you know, maybe zooming out: PET in packaging. How does that fit relative to other things? What does it mean to make something a true monomaterial? What does that enable? What's the advantage? Obviously our customers have views on that. But you know, from the investor side, can we translate why that's important?

John Bissell: Yeah, you're right. This is a long lecture. I mean, you and I've had a lot of hours of discussion on this kind of topic. I think there's the first thing would be that the driving adoption of monomaterials is something that's incredibly important, or as monomaterial as you can get, right. I mean, there are certain kinds of performance that we don't know how to get unless it's out of a new material, right? And the material properties drive application and a lot of spaces, but not entirely. You know, there's sort of an interplay between them. And you see this with steel versus aluminum. When aluminum auto body parts were being introduced, there was a question of like, well, can you do the same things? Do you want to do the same things, will they perform the same way in an application, all those kinds of things. There are questions around that. And people had to figure out new ways to do things and new ways to design things. And you know, I think in the end, the answer is that there you can do a lot of the same things with aluminum, and it can perform a lot of the same ways that we wanted steel. Whether or not you should, in every single application is a different question. But you can. And so that interaction of design, space, and material properties and performance is an interesting one.

And I think in our view—I'll speak for both of us for a moment—Our view is, you want to make everything you possibly can out of PET.[1] If you can make it out of PET, you probably should. There are very few materials out there right now that are going to perform better in all of the non-application specific ways than PET is going to. It recycles better. It's a monomaterial, or it's, I should say, it's a homopolymer. There's not a bunch of other garbage in the polymer itself to make the polymer perform, you know, and the counterexample of that is PVC. PVC, of course, is filled with a bunch of other plasticizers and other things which are... you know, it's not just PVC, it can be as much as 70% not PVC. And those things are mobile, so they end up in the air. They end up in the water, they end up in your water. It used to be that people made bottles, water bottles out of them, or soda bottles out of PVC. And the stuff in the PVC could get into, you know, conceptually, could get into the beverage. And so PET is notable because it is just PET, right? There's not that much stuff that's mobile in there.

Ryan Smith: Why not just glass? What's wrong with just making everything out of glass?

John Bissell: Right. Right. Right. So, okay, so you're getting to the extended argument. Of course, the extended argument is that there are probably a few different classes of materials that you want to have. You want to have... You would have glass or ceramics, let's call it. And you want to have a few different ceramics, and glass is interesting because it is recyclable, but it requires enormous amounts of energy to recycle. But still: recyclable and reusable. And that's pretty interesting. And it has great barrier properties. It's optically clear, right? Or optically transparent. And that's exciting because that's not a property that's universal. And it's a very useful property as we talk about when we're building chemical plants. Right? If you could see inside the pipes, man, would everything be easier! It's all inductive reasoning all the time with chemicals. But so, as a... so you want to have

[1] Here, PET is used as a shorthand for polyesters like PET, rPET, PEF, PETF. – Ryan

probably a class of like ceramics which might be a glass, concrete, right? Cement is another sort of probably canonical ceramic, and you might have a few others. With metals, it's probably, you know, your bulk ones would be aluminum and steel, right? It's hard to argue that it should be anything aside from those, although you usually want to have probably dissimilar properties if you're trying to sort of engineer this whole system from the top down. And then on the polymer side, it's probably a polyolefin and it's PET. And you try to do everything you possibly can out of those.

The name that we have for this is the Eigen materials argument, right? And the idea being that you want to have a relatively limited set of relatively dissimilar materials that form the bulk of applications in any given area. And PET, I think, is the dominant in polymers. Right? You want everything to be PET if you can, because it recycles so well, because it's a very clean polymer, because it's efficient to synthesize. It's sort of easily regenerable. Which I think is, that's the most interesting part of it. In fact, I think...

Ryan Smith: And in the case of, like, let's say, food and packaging, which we're talking about for cap and closures, there are a lot of properties that a polymer has that say, glass doesn't, you know, breakage and things like that. And the carbon efficiency of recycling it is much different than for other materials. It's much lower. Yes.

So I definitely, yeah, we could keep going on that a bit. Let me... let me sort of pull us a little bit closer to earth and say, if you are a food and beverage company, why does this matter to you? We talked already a little bit about how, you know, tracking natural gas pricing to figure out what the polyethylene is going to cost, you know, that's just an added headache for an analytics group for a food and beverage company that doesn't actually care about those things except for the fact they have to buy some of it. Are there other reasons outside of just the, you know, the spreadsheet of materials that go into their products, why these companies care about getting to monomaterial products?

John Bissell: Yeah, well, I think it drives recycling, right? And recycling is interesting for a whole bunch of other reasons. Right? The key with monomaterial products is that – or even if it's not monomaterial, it's easily mechanically separable products. So, you know, you could imagine like a... yeah, actually, I mean, to be fair to polyolefin caps, I think that polyolefin caps fit the definition I'm about to provide, which is that you want something that's easy to separate. You want the cap, the polyolefin cap floats, and the bottle sinks, and that's a pretty easy mechanical separation of the two. And so then you can recycle, you can separate that PET out and recycle it nicely.

The worst ones are the ones where they're so mechanically entwined or even chemically entwined that they're essentially inseparable, right? And that's a real problem. Those are basically all the non-recyclable things which, for example, would be multi-layer barrier films, right? So stuff that gets used like meat packaging or whatever else. You have an adhesion between multiple different materials, all of which would need to be recycled differently. You just throw it away. There's no other reason.

And the reason why recycling is important to a beverage company or a CPG company is because, of course, one, it means that they're actually being good stewards of the world, right, and of their product. But economically, it has impacts as well, which is that now, if you have a good solid recycling stream, then that gives you a totally alternate, in the case of PET that can – and aluminum too – an alternative supply to the same product. And it's inherent. It's baked into the system. And so, consequently, you are actually less subject to price shocks or supply shocks, I should say. On either of those sides, right? If your virgin PET production collapses for some reason, you know, for example, because you couldn't get a critical raw material due to geopolitical issues, well, having a large recycling stream is good. It may not completely resolve the issue, right? You're still probably going to be somewhat subject to that shock unless you have substantial overcapacity on both sides. But it's better. I mean, I would rather be able to get 80% or 70% of the PET that I wanted instead of 0% of the PET that I wanted in a supply shock situation. And so it bakes in a sort of appropriate redundancy economically to the materials that you're using. And so the better you can recycle this stuff, the more resilient your supply chain is going to be for your materials.

Ryan Smith: I'm going to throw open sort of one more door on this house here. We're going to zero in on polymers. I guess there's this follow-on question, which is why PET, right? I mean, in the case of caps, it looks like Origin was able to displace polyethylene. But if you have a polystyrene lid for a coffee cup, or if you have a PVC package that encloses something that I buy at the hardware store, can PET be used in those kinds of applications? Where does the innovation live? Is it in the materials or in the design?

John Bissell: So, you know the answer to this...

Ryan Smith: Totally teeing you up on that.

John Bissell: Yeah. So, the way that we've talked about that, which I think is a useful way, is that it's the performance of the macroscopic material, right? So the part that you're holding that's made out of something, it's a function of both the material properties and the mechanical design. And so, you know, I'd say 50 years ago, most of the part properties were going to be driven by the material properties. As we've gotten better at manufacturing, as we understand material science better, as we understand the applications better— and there's a lot of complexity in here— you can migrate the drivers of the part performance, the sort of macroscopic material performance, into the design, or the mechanical layer. And I think that is one of the key things that is enabling a migration into these basically better polymers like PET. You know, it used to be you needed something to have the right material properties. Now, I don't want to say that that's not true at all, but you can substantially adjust the part properties by changing the design of the part to make the material properties operate appropriately.

Ryan Smith: Yeah, that's great. And I know I'm playing, throwing you alley-oops, knowing where you're going to be. But this, actually, this kind of does lead to the next question, which is kind of pushing the other direction, I think. Which is asking, how does FDCA fit into this polyester world that we're painting? What role does it play in bringing innovation?

John Bissell: Well, I think FDCA is really privileged there. I think FDCA... and I don't know that this would be true about all the different sort of monomers that you could conceptually include in polyester, right? But it turns out that, as far as we know, FDCA will trans-esterify with PET pretty smoothly. And what I mean by that is, it doesn't change the solubility of that polymer in the rest of the polymer is something that happens a lot of times when you add in a different monomer. Suddenly, the polymer sort of doesn't recognize itself in some ways, and so it won't behave the way you think it does, even with relatively small proportions of additional monomer of a different monomer. FDCA doesn't seem to do that. In fact, FDCA seems to be advantaged in improving the properties of the PET in the bulk. So if you have a little bit of FDCA, looks like—and it's, you know, this is one of those things that you want to do a lot of testing on. And, frankly speaking, we haven't published a bunch of results around that, but there is data out there that indicates this—that FDCA looks like it actually makes PET recycle better if you have a little bit of FDCA in there.

Well, what does that mean? It means that, you know, one of the things that when you're recycling PET is, you've got to rebuild the molecular weight, and that's actually part of what makes PET special is that you can rebuild the molecular weight of PET relatively easily. You basically heat it up and pull a vacuum on it, and you're going to get, you're going to rebuild some of your molecular weight and make it act like or behave like it was new polymer again. And that's a pretty simple thing to do relative to what you would need to do to rebuild molecular weight, for example, with polyolefins. And so where you probably would need a large plant with a whole bunch of stuff going on and it would be, you know, maybe a billion-dollar capital project to rebuild molecular weight there. And so consequently, what happens is FDCA makes it so you—when you heat it up and you pull a vacuum right on that polymer – it rebuilds the molecular weight faster. And that's a pretty big deal. Speed is a big deal in this case, and so, as a consequence, you can sort of regenerate the quality of the PET more quickly when there's even just a little bit of FDCA in there. And so that, combined with the FDCA not seeming to negatively impact the properties of the PET, means that it's pretty special. We think that's a big deal.

Now, one thing you didn't mention earlier, Ryan, that I think is worth talking about, is, you know, in this world of monomaterials, is there room in that world for what we would often call like specialty materials? And I think the answer is, yes, absolutely. There's no question. In fact, in lots and lots of cases, you have to get some sort of really interesting property out of specialty material. But the goal is almost can you have this superstructure of the product be from one of the sort of limited number of bulk materials that you're using because they can drive monomaterial applications and then sort of have the smallest part of it be driven by special materials. Whether that's using surface chemistry or something else, right? That's—I think that's what gets exciting is when it's just a—a sort of a sometimes I'll call it a corona of a specialty material on top of a big superstructure of the monomaterial, right? The bulk material that can be recycled over and over again. That is where I think it gets interesting. And then FDCA and polymers like FDCA or, I should say monomers like FDCA, are exciting because that's a way to maybe influence your surface chemistry without negatively impacting the behavior of the bulk polymer. And I think that's really cool, and I think the more we can do that the better.

Ryan Smith: Yeah, that's exciting. That's exciting. It's a great—yeah, specialty and the sort of bulk commodity– finding something that can bridge between those different worlds is—that's huge. Okay, that's great. And I know I took us perhaps on a longer journey through that than the question might have implied, but I think it's worth touching some of those fundamental concepts there.

But I'm going to switch gears. I'm going to come back to—there's sort of another...A bunch of questions asked around, really, in response to something that we talked about last time. I think both you and Rich talked about multiple near-term business opportunities... Kind of comparing or saying they're similar to caps and closures in a kind of an unannounced pipeline of opportunities. And so there are a handful of questions here. So I'm going to ask around these and understood, I think, by everyone who is posing questions that we can't just sort of expose a bunch of information about them because they're unannounced. But there is an interest in understanding more about how to think about them.

And so...I'll just start with this first question, which is, as has been mentioned previously, you have a number of additional projects that are not reliant on our core bio-conversion platform. Without mentioning what they may be, or any potential level of revenue from them, and with the caveat that some of these projects may not come to fruition or may not be implemented successfully, how many of these projects exist, and what progress points? Very early, advanced, imminent? How would you describe that pipeline?

John Bissell: Yeah. So I think there's another part in there which is when we say that it's different than core technology, and similar to caps and closures. There's—there's sort of a question of what does that mean too? Like...

Ryan Smith: Yes, for sure.

John Bissell: You identified one as part of the question, which is that it's not necessarily dependent upon scaling of the core tech but that doesn't mean for us that it's totally separated from it, right? Divorced from the core technology. In fact, even, as we've talked about, even with caps and closures, we would not have gotten into caps and closures had it not been for the connection that we thought would be there for FDCA, right? And so, even though that didn't manifest that way, we didn't need the FDCA to make that technology work, we got into it because we thought it was going to be there. And so that's somewhat similar for some of these other things that are in our pipeline. Some of the other characteristics that I think make caps and closures different... And so I don't want to say that all of these apply to every single one of the pipeline technologies.

But it's sort of the way that make caps and closures different, and therefore maybe makes us put some of these in a similar category. You know, they're—they're faster to market. They require less capital, especially less capital on the ground. I mean, now, caps and closures is a little bit different here because caps and closures is a gigantic market also. But you know, some of these technologies we think about are not, you know, it's not drop into a gigantic market right off the bat. Right, it may—they may be a little bit more developmental in the market, right? Which can be actually very attractive because you can carve out a market niche that you can grow...and then you can command value that's a little different. You know one of the challenges when you're stepping into a giant existing market is that—whether you're selling at the commodity value or not, there's always the context of that commodity value, which is informing any of your discussions, and so being able to carve out your own market is interesting there.

So those are some of the characteristics associated with that. You know, in terms of how many there are, I mean, it's not—it's not a dozen and it's not one. So it's somewhere in between there. And again, just to reinforce the key thing about these is that we don't see them as fundamentally limited by the rate of scaling of the core technology. Those are sort of the key characteristics. I feel like there's another component of the question there.

Ryan Smith: Level of development, sort of, progress. Are they early? Are they sort of more advanced? Or are there some at some stages, and others at others?

John Bissell: Yeah, they're not all at the same stage. A lot of these we've been working on for years. They just didn't rise to the level of something that we would announce for whatever reason, either because we weren't sure if they had passed all the gates that were necessary for us to announce them publicly, or because we didn't want to, because we didn’t want to draw attention to it yet for competitive reasons, or because there's a partner that we're working closely with something like that. But so they're not homogeneous in their level of development.

I guess I'd say if they were going to generate revenue on their own merits really quickly, we probably would have announced them already. I guess I don't have a lot of comments on the level of development. I'm not sure how to slice that in a way that is the right kind of disclosure, I guess.

Ryan Smith: Understood. Yeah, no, that makes sense. And I'll just kind of call out some of the other perspectives that people are bringing to this question. You know, I think – and you're kind of already doing it— one is, can you characterize the scope of projects? Let me rephrase this. Can you characterize how the projects’ scope compares to caps and closures? You kind of already did that on sort of the market side. But maybe in terms of complexity or impacts to Origin, I think is part of what's motivating some of these questions.

John Bissell: Yeah, I think we’re not going to allocate resources to something that we don't think could be really strategic for Origin right now. In a resource-constrained environment, something's got to be able to have a pretty large impact. And in terms of complexity, I'd say... Complexity is a challenging thing to quantify, right? But I would say, more like caps and closures, and less like core technology.

Ryan Smith: Yep. And then, again, in the same vein someone's asking, do we think we will be characterizing these projects in general terms, like the stage that something's at, whether it's LOI or the estimated timeline, and they give references, like examples of number of months, 24 months, 36 months, or revenue potential, 10 million, 50 million, 500 million, confidence level, low, medium, high, you know...

John Bissell: Yeah, we'll talk about it.

Ryan Smith: Obviously there's internal ways of talking about it. But do we plan on building a language for external communication around these?

John Bissell: Yeah, absolutely. I think when we feel like it's appropriate to introduce some of these other projects, we want to do so. We don’t want to just keep them bubbling in the background all the time. If we wanted to do that, we probably wouldn't be working on them. I think caps and closures is probably a reasonable model for the way that we would introduce them. Whether it's at the same rate, or the same level of detail, or whatever, as caps and closures, I'm not so sure that that's necessarily a good guide, but conceptually what we've tried to do with the introduction of caps and closures is probably relatively similar to what we would do for these other programs.

Ryan Smith: Makes sense. And I think that lines out really well. This last question talks about how those get funded given competing resources. And so I'll just read it directly. “The existing cash flow can likely only fund caps and closures without an equity raise. New opportunities will likely require capital outlays and deplete Origin's cash even further, everything else held constant. Are there contract structures possible to have the partner or customer fund the initial outlays for these new business ventures so that Origin can avoid an equity raise at the current depressed share price level?”

John Bissell: Yeah. So we're pretty ruthless about allocating resources to these projects. And absolutely getting partners to have skin in the game is a big part of what you want to do with... That's actually, frankly, just sort of best practice, especially with the more application-focused technologies. Because it's so close to the customer, you really want them to be involved. We actually did the same thing with core technology, right, where we had customers that were really involved in both funding and development of it. And so I think that's a really good model. And I don't see any reason why we wouldn't be pursuing those kinds of models at the appropriate times, you know, at the appropriate sort of developmental stage for each of these.

Ryan Smith: Okay. So this next question set actually is focused on Origin 1, and then some follow-on questions around platform development. But on Origin 1, before we jump into these, one of the things I learned in my exchange with investors is a lot of the questions around Origin 1 are asking from a place of wanting to understand how that performance reflects on the ability to scale up to larger-scale plants. So that's where they're coming from. Some of the things asked about may or may not directly matter to that. But that's not obvious. And so I just want to call that out as a big motivator behind these questions. Maybe not the only one, but it certainly was the primary one. So I just want to keep that in mind as we walk through these.

The first question is about schedule and uptime. They asked, can you give us a general sense of the schedule being run at OM1? For example, how many days, weeks, or hours per day or week is the plant being run? And I think there was a little bit of rumor going around that there were—well, I won't repeat the rumors because they basically said those were not substantiated, but they still had the question anyway. They're like, okay, well, this was prompted by a rumor, but you know what? This is actually kind of a good question. What is the sort of runtime, or what does the schedule of OM1 look like?

John Bissell: It tends to be easier to run plants like this as campaigns. If you're not going to be running flat out, which we aren't, then it's a lot better to run it as a campaign. You run flat out for a little while, and then you sort of gather your thoughts, so to speak, on what you're going to do for the next campaign. What worked and what didn't work? What did we like and what didn't we like? Did we break anything? Whatever. And so that tends to be the way that it's run: in campaigns from a scheduling perspective. The frequency of those campaigns depends on what we're doing, what happened in between, and what happened in the last campaign, etc.

So I think that's probably the best we can do in terms of communicating, in part because it's pretty inconsistent. What we're doing in each campaign is different. When the goal of a campaign was to run wood, the goal was to get data out the other side. Yeah, we make product, too. But the data was the really important thing. For example, if the goal is to test some other piece of equipment, we may be operating it differently. Obviously, the broad structure is the same, but we're focused on something very different, and the campaign length might be really different depending on what we're looking at.

Ryan Smith: That is the perfect segue to the next part of that question. What's the longest campaign length? And I think just hearing you describe that these campaigns have different goals associated with them. I think that's actually very helpful to understand. So I just kind of want to make sure we address that.

John Bissell: I actually—you would think that I would know the longest campaign length off the top of my head, but I don't tend to think about it that way. But I don't think that's something we would probably disclose yet anyway – or we wouldn't disclose it here – it's something we would give as part of a broader statement about the performance of the plant, all those kinds of things. So I think maybe the best thing to do for that question is to say understood that people want to hear that—not surprising. We understand that people want to hear about the performance of the plant in general. But it's not something we would answer here.

Ryan Smith: Makes sense. Great. And then another question about the product that's coming out is about product quality. It asks, have you had any feedback from customers or potential customers on the quality of the output from OM1? And if so, what was the feedback in terms of quality and desire to purchase when available?

John Bissell: I think we've answered the quality question before. And so I'll probably just give the same answer that I think we gave again, which is quality seems good. The quality of the CMF that we're getting off is about what we expected. It's not particularly surprising. The HTC quality is always going to depend a little bit about what the reaction conditions are. But that's been pretty good too, we're pretty happy with it. For the customer question comment one, I am not sure what I am willing to say about customer willingness to buy aside from we have lots of interested parties, which is what we usually say, that wouldn't be new information. And that's obviously what we're trying to avoid in the Q&A.

Ryan Smith: I figured, and worth, I'll just chime in that, you know, CMF and HTC. We do have quality expectations. And as you said, we're seeing those being met. But it is different than having a well-established market specification. These are new materials, so it's not as though that exists, and that partners are coming in with a very set specification that they have in hand. It is a little bit more back and forth in that sense, just because of the newness. Okay, great.

And then the last question here is around learning, data, techno-economics. It asks, has OM1 provided enough data to conduct some techno-economic analysis for the biomass conversion products? If yes, how viable is the economic performance for oils and extractives, CMF, HTC, FDCA, and carbon black with multiple feedstocks? How have the results changed from prior to building Origin 1?

John Bissell: So yes, it definitely has given us information that's useful techno-economically. I don't think it's given us something that's all that different than what we were already expecting. I think most of the learning that we've had around OM1 has been around the techno-economics actually sort of ironically of OM1, which is maybe not so surprising. But, you know, a plant that's a subscale plant, the economics are going to be driven much more by non-chemical factors, let's say, like non-process factors, than a really large-scale plant which is going to be driven almost entirely by energy consumption and raw material consumption factors.

At a smaller scale plant, of course, your productivity is going to matter a lot, but also your labor costs and all that kind of stuff is going to drive it. So I think we've learned more about some of those things than we have about anything else. I think the technology elements, which is more about, you know, what do we think about this pump design? What about the spec of this valve? Right? What did we do right or wrong about the configuration of certain pieces of equipment? That we've learned a ton on, which is what you want to be learning on. I think, you know, from a techno-economic perspective, you're always learning something. I don't know that it's really substantially changed our view on anything.

Now that said, we continue with R&D on that kind of stuff, and that R&D is proceeding next to or informed by OM1. And we definitely make advances there that impact techno-economics, but either in uncertainty reduction or in just improvement in some fashion. But I think that's more indirectly informed by OM1 than directly informed by OM1.

Ryan Smith: Meanwhile, R&D is trying to advance and improve the economics always in the background.

John Bissell: Yeah, like, this is, I haven't fully thought through this analogy, so you know, take it with a grain of salt. But, you know, if I build a model airplane with the general configurations of a 747, and I fly that model airplane, it probably tells me a lot about the 747. But I don't know that it tells me a lot about the cost of operation and production at the 747. Do you know – if that makes sense.

Ryan Smith: Yeah.

John Bissell: I mean, it does if I find out that I need three times as many engines, or whatever, that might be a problem. Part of the problem with this analogy is that, of course, there's a bunch of nonlinearities in airplane design as you scale down and up. So, you know, suspend some disbelief on the analogy, maybe, right? But if I find out that I need way more power density or something like that in order to keep it airborne, or my drag coefficient is way different for my wing design than I thought it was, that may have some really large-scale impacts on what I think the economics of the full-scale airplane would be. I'm sort of moving out of my usual playing field, but I think it's somewhat similar in that sense. You know, we could learn big things about techno-economics from OM1. And we can learn lots and lots of little things about performance and operation from OM1. But I don't think we learn lots of little things about techno-economics on OM1, if that makes sense.

Ryan Smith: Yeah, yeah, that's helpful. I think that it's definitely worth walking that out. Just kind of reflecting on the questions in April, there was a little bit of confusion around the same concept. And so I think that continues to be sort of the role of OM1 in that broader push, and scale-up is important to understand how it plays there.

Alright, I'm going to take us now to platform development. And there's sort of a broad set of questions that fall into this category. They don't interweave as much as some of the other things we've talked about, but I do want to walk through them. One kind of interesting question asked about artificial intelligence. It says, how is Origin Materials utilizing advances in technology more generally, such as AI, in prototyping and testing new chemicals?

John Bissell: I think it's such an interesting topic. You know, we have a small group that is not solely dedicated but is sort of evaluating and thinking about AI pretty regularly. Or things like AI. You know what's been interesting recently, I think, is one: The world of chemicals and material science is pretty underserved on this kind of stuff. So, you know, as you think about AI, a chatbot turns out not to do that much, or a generalized chatbot is not that useful for, as far as we've seen, anyway, for chemicals and chemical engineering design, and that kind of stuff. Because it's not very trustworthy. So, you can really spend a lot of time going on a wild goose chase trying to verify whether or not the idea was correct, and the hit rate is pretty low. And so you get sort of an asymmetric effort issue that's similar to refuting bullshit, where it takes way more time and effort and resources to disprove the bullshit than it did to generate the bullshit. And so that turns out to be not useful right now.

But I think that there are some broader technology trends which are starting, you know, it's sort of surprising that it took this long in retrospect, but which are starting to have real impacts. So the availability of large-scale compute on demand – which has been the case for a while, right? Obviously, AWS has been around – but having people put the right kind of application on top of that for our purposes can be extremely valuable. So you know, just seeing some of the density functional modeling, right? And having effectively unrivaled compute to drive that is awesome. I think you and I both remember having to put together clusters not that long ago to be able to run some of these molecular orbital calculations to try to get, you know, a single molecule configuration right, and it would still take forever, and was probably wrong, right?

And so, having just oceans of compute available on demand, relatively inexpensively, is, I think, something that we find interesting and that we're starting to play with more and more. I think stuff like that, you know, getting the chemicals world better served by applications is going to be very interesting. The challenge, of course, is that there aren't a thousand customers for it, right? So that's why it's reserved right now. But I think that's going to be really cool. I don't know where it's going to go, but hopefully, it's the beginning.

Ryan Smith: No, yeah, I agree. It'll be interesting to see where it pops up, whether it's, you know, improving computational fluid dynamic models or catalyst design, as you're kind of alluding to, or even helping connect structure-activity relationships....

John Bissell: The one, but that's the thing.

Ryan Smith: ... things that are sort of nano scale, micro scale .... that's a sort of a weird influence that chemistry has on the physics at those scales.

John Bissell: Structure-function, man...

Ryan Smith: Yeah, it's so much of the game. But it's not there yet, is what's worth saying. You know we do look at this. You know, we've got our fingers on that pulse, but we're not seeing it pop up in a way that would transform things today.

John Bissell: Well, I think one of the problems, right, If I just... let me put my big idea, big think hat on, right? Part of the problem is that you just don't have the data sets, you know? You've got in the case of the large language models you've got whatever, 100,000 English words, let's say. I think it's a little over 200,000. But let's call it 100,000 English words. And you've got a few billion people that are writing about that all the time. And so there's a pretty good-size data set. You know, what's the data set for structure-function relationships? That's sort of nicely curated? I mean, it's really small, and it's totally broken up and disaggregated. And most of it's behind some sort of like, you know, multiple firewalls. And I don't know what you would have to do to get people to contribute that all into one big pool.

So it turns out to be almost all on you. It's it ends up being all on a single company to generate the entire data set that's required to train the model. And not only that, but syntax obviously constrains your word space or word sequencing space in the case of LLMs. And you don't have that for structure-function relationships in a way that's really all that meaningful. There are way more configurations that are available to generate different properties and different sets than there are in the case of language – or that are reasonable than in the case of language, intelligible, let's call it.

Ryan Smith: If you're designing a catalyst, the periodic table can be rearranged many, many – or used and leveraged in a bunch of ways that aren't constrained. So you just don't have those constraints that limit the search space. Yeah, that's a little tricky.

John Bissell: And I think the answer would be, can you – You need a sensor that is compiling enormous amounts of relevant data all the time. And the best option there is optical data, right? So if your cameras are in the visible spectrum, or something like that, or if you could extend the visible spectrum – And it's just collecting data about what's happening all the time, so that it could predict what happens to the next level. But the problem is – your comment on nano versus macro, or micro versus macro scale— Most cameras are obviously not interrogating very effectively at the micro or nano scale. Right? And that's where most of the interactions that we care about are taking place. So what the hell, man, what are you supposed to do? I don't see an easy answer to that yet.

Ryan Smith: Yeah, no, I think there's a massive, massive bottleneck there in order to be able to leverage some of that. Alright! Well, we could riff for a while on that. I'm going to move us to other elements of the platform.

Oh, so a question about oils and extractives...It says, if you use biomass in an OM2 phase one approach and are only accessing the oils, waxes, extractants, what happens to the rest of the biomass? Are there other products from the remainder of the biomass? Or is it likely going to be used as a thermal heating source in an oils and extractives process being used?

John Bissell: So, I'm guessing in an oils and extractives process here they're referring to like a phase one of OM2, where you would have just oils and extractives getting pulled off. And the answer is, yeah, you're basically running what almost looks like a pulping process. And on the flip side, one of your co-products would be cellulose and a certain fraction of the lignin. And so there are a variety of things that you can do, it turns out, with cellulose and lignin. You can use it for thermal heating, you can use it for subsequent additional processing. There's a lot of stuff you can do with that. Which one we would do would depend probably on the specific ecosystem that we engage with around that. But the idea is, of course, that you then take that and you feed that into the biomass conversion process. Right? That's how you want that to work. But yeah, there are a lot of different options around that.

Ryan Smith: Right. And you actually, in the course of your answer, answered the following question, asking about what is that byproduct. The last piece of that question here is, it asks, are methyl esters of these products a significant component of the marine fuel byproduct? Could these streams be further refined into feedstocks for downstream processes that use tall oil, fatty acids, and rosin acids?

John Bissell: Interesting questions that I will leave unanswered for now. But I think they're very interesting.

Ryan Smith: That works. Alright. Moving from oils and extractives to HTC, specifically about HTC processing and carbon intensity. The question is... How much additional processing is required to get from HTC out of OM1 to carbon black that you have been able to get to customers for evaluation? Is it minor or a significant contribution to the cost of production and carbon footprint?

John Bissell: So, I don't know exactly how much we've talked about that processing, but I'll try to answer that. It's a meaningful amount of processing. It's not trivial. It is, let's say, less complicated processing than you see in core tech, for example, right? The core biomass conversion process. It's much more similar to existing industries. And so, we have pretty high confidence in how that would behave at scale. And we actually think that we can use some existing equipment for it. Whether that equipment would be available at the scales that we needed in the places we needed is a different question. But in concept, you could even use existing plants to do some of that conversion. But it's sizable.

You know, one of the things that happens in the creation of carbon black is that you deoxygenate the HTC. And I think we actually talked about this quite a bit in some of our earlier presentations of the company a couple of years ago. And so when you're deoxygenating your HTC, you know, there's a lot of oxygen in HTC. You can sort of look at how much oxygen is in wood, you can look at how much is in CMF, and you can look at the volume of HTC that we're producing. And there's going to be a lot of oxygen in there. And so taking that oxygen out—or some of that oxygen out—means that you are losing some mass. Now...You're losing mass that was not going to be useful in the final product. But as a consequence, if you're losing some mass there, then obviously, that ends up being a very important step. Anytime you're going to lose mass in your conversion, you care a lot about what's happening there. And so that makes it non-trivial all on its own.

Ryan Smith: And then, a question you've answered some of already, and some I don't think we can answer directly, but I'll just read it out here. It's around unit economics. It says... "Last fall, John, you made a rough estimate that OM2 would be able to produce PET cost competitively with oil at no greater than $60 per barrel, up from a previous estimate of $30 in the early SPAC days. Can this increase be explained solely by inflation and the increased principal investment and interest required to build OM2? Or are there other factors that have contributed to the change in the estimate? Do the results at OM1 support the initial estimates regarding the underlying chemistry and yields? In addition to finding optimal uses for HTC oils and extractives, what other significant levers can you pull to bring down the cost of revenue at OM2?"

John Bissell: So, a couple of things. One, I think that the question—I can see why people are equating the two—but the way that I answered the question in both cases is a little different, and the question was a little different. So, I think that's important to keep track of, because there are lots of cost components that go into these plants, and there are lots of cost components that go into making para-xylene out of oil, too.

And as a consequence, it's... I know that it is very, let's say, convenient to make direct correlations between the two, but it's not quite real in a lot of ways. And so the way that I answer those questions is attempting to retain the nuance. I think, in many ways, you could look at the $30 answer from a few years ago and the $60 answer more recently as actually probably not reflecting that different of underlying economics.

Some of the considerations are, what is your capital payback period, and what's required to do that? And is that being considered as part of the break-even economic cost? Of course, expectations of return on capital are different at different times; in a more inflationary environment, the expectation of capital return is higher than it is when it wasn't. I tend to talk about cash costs of operation for those sorts of things, just to remove that uncertainty, which I think is an important thing to consider here.

Another one is co-product value is going to have a large impact on that. We make a lot of HTC; what we think the value of that HTC is going to be, or what it could be at any given plant or stage of technology advancement, or whatever else, is going to have a pretty sizable impact on that, too. Sometimes people will ask the question in a way that I am interpreting as assuming a particular set of conditions. Is it the long-term technology capability, is it OM2? People have asked that question more than just once. Understanding what those other conditions are is a part of answering that question. For better or for worse, I don't have a stock answer to that, and I think about it in the case that somebody's giving.

The broadest thing would be... Oh, and then there's also energy components, right? The way that energy inputs and the cost of energy has an impact on us. It frankly has less of an impact on the price of para-xylene coming from oil, right? So those kinds of things can make a difference there, too.

Ryan Smith: Yeah, it is a very... That is a question that's prone to lots of apples and oranges when you're comparing. And so it's a little dangerous to make those comparisons from something said two years ago versus last week versus five months ago, just because the... I mean, the assumption set on any kind of statement like that—there's a whole basis set of assumptions, like a very long list of assumptions that have a lot of impact around that. And even the particular metric that you're speaking to might even be slightly different, whether it's cash cost or includes return, like you say. So, that's somewhat fraught.

So, a little bit... Obviously, that's not... I'm sure the person asking that question doesn't find that the most satisfying of answers to learn that the question doesn't quite line up to be answered. But it's just how it is. You can't sort of force it to be answerable in that sense.

John Bissell: Someday we'll probably have a very consistent framework that we use for that kind of metric all the time. It'll be asset-specific and all those kinds of things, and then it'll... you know, it'll be, and we refresh it on a regular basis. It’s just not the case right now.

Ryan Smith: Okay. Moving forward, I think we are towards the end here. A couple more questions. On OM1—not even specifically OM1. This is more of a CMF and HTC question, asking what quantities of CMF and HTC do partners and customers generally ask for in order to do application testing? How long does application testing take? And, you know, they acknowledge this probably varies by application. But would you be able to provide some examples, or possibly some ranges, or how to think about that sample testing?

John Bissell: Yeah. So, it's a great question. It does vary by application. But there's certainly a general trend, and it tends to start with, you know, most application testing starts around 100 grams of material. And that is usually very quick. That's sort of more an application screen than it is testing. It's sort of the beginning of application development.

Pretty quickly after that, it moves to double-digit kilograms. So, you know, think 20-50 kilograms is usually what people want. Depending on how far we're going down the reactivity train, we may or may not try to push back on 50 kilograms of something that we aren't directly making. That can be challenging to supply if you're not set up for it. That specific species. But that's often what they want. And then pretty quickly from there, it moves to a ton, 2 tons, 10 tons. Especially in the world of polymers, it can get big fast.

Now, that's of the thing they're testing. So, you know, if we're having conversations earlier about recycling, you know, what's the impact of FDCA copolymerized into PET that's being recycled, you might have a lot less FDCA in that. What you need is tons and tons of PET with a little bit of FDCA in it. So, that can have an impact on how much of our material specifically is required for any given application or testing type.

But it goes to, let's say, caps out probably around 10 tons for sample testing there. And then from there, usually it goes relatively quickly to sort of commercial or semi-commercial scales. That's sort of the general trend. It's double to triple-digit grams, double-digit kilograms, you know, 4 to 5 digit kilograms, and then commercial. Whatever commercial ends up being for that application. Polymers trend towards needing more. So usually, if it's a polymer type, you need more of it. And things that are liquid applications, you need less, typically. So, stuff like surfactants tends to be on the lower end, right? Because it tends to stay as a liquid all the way through, which matches kind of the behavior that we've always talked about from a process perspective where solids are pain and liquids are great, and so – or, fluids are great. And so same thing's true for applications. Fluid anything—if it's a fluid application, then it's way easier. If it's a solid application, then it's more challenging.

Ryan Smith: Makes sense. All right. Okay, an ultimate question here. "Over the last 3 years, many potential end products have been discussed, but many of those have fallen out of the spotlight. Could you elaborate on whether some of these items have been eliminated from the field of expectations, and why, or if they are still something Origin is pursuing? Some of these things include PETF coatings, adhesives, HTC for carbon black tires, and also surfactants."

John Bissell: Yeah, so we talk about a lot of those things because they're interesting, and we think that there's value to them. And usually, we also have a partner that's interested in them. We often – or I'll say I talk about them as areas that we think the platform can grow into and reasons why the platform is exciting. But of course, there's—we were just talking about the testing and application development track between, hey, we think this looks interesting here to there's a commercial product of some sort on the other side.

And so most of these things we keep working on. And there's a relatively rigorous gate review process. As these things make it through the gates, we either say, "I think we've got to cut bait on that. It's not—it doesn't make sense for that particular application." It doesn't mean that we necessarily cut bait on that class of application, but that particular one, right? And some of them just keep going: bang, bang, bang, bang, bang. Some of those are things that, you know, we were talking earlier about what are the things that are sort of like caps in that sense. Well, some of that shows up here. I mean, caps was at one point an application there. And it started as an application for PETF. And, you know, we've told that story lots of times where we didn't end up needing the F, the FDCA. But those things keep showing up, and sometimes they emerge on the other side, and we stop talking about them as a PETF application, and instead it's a caps and closures technology, right?

But yeah, you know, we see the development of the platform as our job as much as anything else, maybe more than almost anything else. And the development of the platform is both the process technology development to make these things and also the application development for how to use them. So, we keep working on them. We'll tell you about them when we can.

Ryan Smith: Yeah, very exciting to think about the potential of the platform in its breadth. I'm going to end with this last question which asks, what are the biggest challenges facing the company in 2024?

John Bissell: 2024... We've just got to execute. We've got a lot of stuff we've got to do, and we've got do it. And it's fun, but you know, we've got to go do it. I don't think it's more than that.

Ryan Smith: I think you're right. I definitely...

John Bissell: We've got the capital we need. We've got the people we need. We've got the customers we need. We've got the technology we need. We've just got to go make it all happen together.

Ryan Smith: Yeah, it's a journey of a thousand steps that need to happen very quickly.

John Bissell: Exactly.

Ryan Smith: And are. But that's the challenge, right?

John Bissell: Sometimes it feels a little bit more like hopscotch. You've got to take multiple steps in different rows, all at the same time, but in the right order.

Ryan Smith: It totally does. It totally does. All right, that's perfect. That's everything. We hit all the questions that came through that were directed towards you. There are a few, couple lingering ones that are going to be introduced, I think, either into the earnings call or in later discussion. But we hit, you know, 90-95% of the questions that came in and made sense in this little fireside chat, so to speak, that we got. This is great.

Ryan Smith: Thanks, John.

John Bissell: Thank you.