MACRO Voices
with hosts Erik Townsend and Patrick Ceresna

Thomas Jam Pedersen: The Coming Thorium Energy Revolution

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Erik: Joining me now is Copenhagen Atomics founder Thomas Jam Pedersen. Thomas Jam prepared a slide deck to accompany this week's interview, you'll find the download link in your Research Roundup email. If you don't have a Research Roundup email, it means you haven't registered yet at macrovoices.com. Just go to our homepage macrovoices.com and click the red button above Thomas Jam's picture that says "looking for the downloads." Thomas Jam it's great to get you on. This is a little bit unusual because our listeners are not used to entrepreneur interviews, we usually talk to finance guys. But since Patrick's off this week, I wanted to dive into your company, which is very interesting to me, I think you're going to play an important part in energy transition. The cover page of your slide deck says your goal is mass producing or mass manufacturing thorium reactors. So why don't we start there with the obvious questions. What's a thorium reactor? How is it different or better than a uranium nuclear reactor that burns uranium, like almost all the other ones do? And why is it important, specifically that they be mass produced?

Thomas Jam: Hi, Erik, Thank you for having me. Yes, that's a good place to start. We have a lot of energy production in this world. And energy is a very essential part of everything, all products and everything we do, the economy. And, of course, we want to sort of eventually get away from our reliance on fossil fuels. Today, 80% of all energy production in the whole world is coming from fossil fuels. And I think everybody expects that to disappear at some point, or at least a smaller amount or a smaller percentage. And one of the ways to get away from fossil fuels is of course, nuclear energy. But the problem with nuclear energy, or the traditional type of nuclear energy is that it's very expensive, and it's slow to build. And so, we've come up with a new way of making nuclear energy, or what's called fission energy, a completely new way of making that and in order to make that sort of scale, we want to mass manufacture these reactors. And the picture on that first slide sort of shows that the reactors we have invented are roughly the same size as a 40-foot ISO shipping container. And it can be transported on a truck. And they can be mass manufactured in a factory or assembly line, similar to how we manufacture cars or airplanes or other things like that. And this means that we can easily make one nuclear reactor every day. And that's what's in our roadmap to do that. But of course, we currently are sort of developing the technology and make sure that it works before we can even start to run the first commercial reactor. And only after we have sort of proven that the first commercial reactors work, can we start to mass manufacture and so it's still some years away, maybe 10 years away before we can start mass manufacturing these reactors. But the reason for this goal is because this world needs a lot of energy, and just making 100 reactors would not make any difference at all, in the global energy system. We need 10s of 1000s, or maybe even a million of these reactors before it really makes a difference.

Erik: Let's talk about that in a little bit more detail. Because, if I think purely like a businessman without thinking about saving the world, something you and I are both passionate about, look, there's easier ways to get into the nuclear business. What everybody else is doing is, they're using the 70 year old, proven technology, although perhaps not the most optimal technology, of the light water reactor designs, either pressurized water reactors or boiling water reactors, these things have been around since the early 1950s. Seems like most of the industry hasn't really seen a need to change to a different technology. Why are you doing this, what some people might say is the hard way, you know, there are other entrepreneurs that have seen the benefits of thorium and seeing the benefits of molten salt coolants that you're working with and said that's better. But when I look at this as a business person, and I consider the just fighting city hall, what it's going to take to get past the regulators with new technologies, a new fuel cycle, a different coolant, and it's not worth fighting city hall. You're willing to fight city hall and do something that's different than almost anyone else's doing it. Why did you make that decision? And what are the benefits that you get from using more exotic technologies for lack of a better word?

Thomas Jam: Yeah, you're absolutely right. It is sort of a cutting edge, or some people call it the bleeding edge of technology development. So, if you look back at history, of course, we've seen this happen many times before, we had for hundreds of years or maybe even 1000s of years. We have horse carriages, and then somebody invented the car. And in the beginning, those people who invented the car, they will call crazy and but eventually it took over. It's a little bit same with the transistor before the transistor, we had radio tubes. And they worked pretty well. And then somebody invented the transistor. And it was clumsy and it was too expensive in the beginning, and people said, it's never going to catch on. But now, today, we have in our pocket, we have our mobile phone with the trillions of transition transistors. So it didn't really change the world. And we have the same view on this type of technology. Of course, it's difficult to break through this technology, as you say, it's quite different from the old technology. And there's some resistance in the market and from the regulators and everybody else. But we believe that it's time to change to this new technology. It was, actually it's not us who have invented all of it, the majority of this technology was invented back in the 1950s and 60s by a really smart guy called Alvin Weinberg. But unfortunately, at the time, they didn't have all the right resources to get it going. There's several reasons why it didn't happen back then. One of the reasons is that they didn't have computer simulation software, so they could accurately simulate how it should be built in order to make it work. There's also some of the material science we have today, or new types of materials that they didn't have back then. So there's a number of reasons why we believe this is possible today. And we think the world is ready for change to a new type of nuclear reactors. So that's the one thing that is a new technology. But it's also that this technology is much better capable of scaling to very large amounts of energy production. First of all, because you can mass manufacture the reactors on an assembly line because they are inherently smaller than the traditional classical nuclear reactors. So that's important. It's also important that it runs on thorium instead of uranium, there's a limited amount of uranium on this planet and all the reactors we have today, they run on a specific type of uranium on isotope called uranium 235. And that one is not very common, it's rare in nature to find it. And our reactors, they run on thorium, which is almost 1000 times more common in nature than this uranium 235. And even then, you get more energy out of it. So there's a number of technology advances that we're trying to make it win on those great properties of these Molten Salt Reactors running on thorium. So that's why we think the time is right for technology change. And of course, it's going to take 10 or 20 years before, before it's really ready for primetime. Not ready, but I'll say that in a different way. If you look at different technologies, in the past, like the airplane or the mobile phone or the car, like we talked about, or the transistor, all of those big technology changes took decades to transition. For example, there's an example that 20 years after the car had already been invented and was already driving on the streets, people still invested more money in the horse carriage industry, because they couldn't see that these new cars would take over. And it's the same with all the other technologies. I mean, the internet, I think all of us uses the internet every day. And it's a great technology. But it was invented in the 60s. But it was not until sort of the 1990s that most people got access to the internet. So it just shows that it takes decades to break through, this type of technology. We've already been working on this for 10 years. And like I said, there were people working on it in the past, even all the way back to the 60s. So we do not start from zero. And I would say we expect the breakthrough to happen in the early 2030s.

Erik: Thomas Jam, you said that you're using thorium as a fuel. I'll come back to that in a minute. But the other big difference between your reactor and almost all the others on the market is that you've gotten rid of water as the reactor core coolant, you're using molten salts instead? Why would you do that? What's wrong with using water as a core coolant and why is molten salt better?

Thomas Jam: Yeah, so now we get into a little bit more technical discussion. So the main reason we want to use molten salt for our reactors is that you can dissolve the fuel directly in the salt. And this means that you can remove fission products while the reactor is running. Fission products is sort of the exhaust and in all the reactors we have all over the world today, they are solid fuel reactors. This means that the fission products or the exhaust cannot be removed. And that means that there's a very limited amount of time that the reactor can run before the fuel is sort of unable to produce any more energy because it's been so polluted by the exhaust that it doesn't work. And actually, you only use is 1% of the fuel before you get to the situation where the exhaust make it impossible to continue, which is really, really bad efficiency of your machine. But I mean, that's what we had in the past and that it has worked sort of well since the 1950s. But in these new types of reactors with molten salt, you'll able to remove those fission products online while the reactor is running. And that means that you can get a much better burn up or much better fuel efficiency. So that's the main reason for using molten salt as a fuel.

But there are other benefits as well. One of them being that you can run at higher temperature. For example, in our reactor, you run at a temperature of 700 degrees, that's the output temperature. And at that temperature, high temperature, you can get much better efficiency of converting the heat to electricity. Whereas with classical nuclear reactors, they use water as a coolant, like you mentioned. And of course, we all know that water boils at 100 degrees Celsius. And this means that if you want to get to a high temperature and high efficiency, for the conversion from heat to electricity, then you need to keep that water under very high pressure. So typically, 150 atmospheres of pressure. And this makes the whole machine really big and very expensive and very complex. And this also leads to the problem that we can have meltdowns, like we've had with a few of the reactor accidents in the past. So there are some complications in using water. And, of course, that's part of the reason why we do not use water as the coolant. But we actually do have water in our reactor, we have heavy water, because we need that as a moderator. But the heavy water is not under pressure. And it's only at 20 degrees Celsius, so it's actually almost below room temperature. So we don't have this problem of the water boiling, or we don't need these very large pressure vessels. And that's also a big reason of why we can make the design smaller. It's not the only reason, but it's a big part of the reason. So there are many, many new things that we had to use in order to make these reactors smaller and much more efficient. And I have to be honest and say that we didn't develop all of it. We have developed some of those steps. But there were very smart people before us, who came up with some of these ideas all the way back in the 1950s and 60s. And of course, we are very happy that they were able to do that back then. Because otherwise, it would be an even bigger challenge for us today to get this working.

Erik: As I just mentioned, for our listeners' benefit, if anybody's looking for a summer reading book, boy, I really enjoyed Alvin Weinberg autobiography, which is titled ***The First Nuclear Era***. It tells the history of not just these technologies, but really the whole history of the Manhattan Project through the development of nuclear energy, what worked well, what didn't and so forth, fascinating book.

Anyway, let's come back to your reactor, Thomas Jam. So the combination of molten salt as the coolant and liquid fueled, in other words, not having solid fuel rods, allows you to completely eliminate meltdown risk, operate at higher temperatures and so forth. You've got a slide in your slide deck, number five, that gives some comparisons of your reactor versus the typical light water reactor, which uses solid fuel rods. Why don't we run through that chart?

Thomas Jam: If people are looking at the chart, it's just a table. And it talks about some of the key features of nuclear reactors. And we compare in the first column, the solid fuel reactors, which is all the reactors we have in the world today, they are all solid fuel reactors. And then in the next column, we have the thorium, the Copenhagen Atomics' thorium reactor. Sort of one of the first things we look at is the plant lifetime, like when you build a nuclear plant, how many years does it work? And you know, for classical reactors, the average is sort of 60 years. Some of them get extension, so maybe in the future, we will get higher value than 60 years. But for Copenhagen Atomics' reactors, we expect to start at 50 years, but we also expect to get extension. So it's sort of in the same ballgame. And the next thing we look at is the fuel prices. So what does it cost to buy one kilogram of enriched uranium, because that's what all the other reactors we have today, they run on enriched uranium. While that's not true, not all of them run on enriched uranium, the majority of the solid fuel reactors run on enriched uranium and you can get different enrichment percentages. But here in this table, I just show the price for 5% enriched uranium, which is $4,500 right now, the uranium price is going up and down all the time. It's a global market, commodity price and of course, right now, it's fairly high. It was less than half the price of just a year ago. But if I compare that to thorium, thorium is right now at $50 per kilogram, so, 90 times lower cost for one kilogram of thorium than one kilogram of uranium. And then if you look at those kilograms of the uranium fuel or the thorium fuel, how much energy can you get out of that in those type of reactors? So in solid fuel reactors with 5% enriched uranium, you can only get between 1 and 2 gigawatt hours of thermal energy out of one kilogram. Whereas, for thorium, you can get 22 gigawatt hours of thermal energy out of it. So, roughly 15 times more energy out of one kilogram of thorium compared to one kilogram of enriched uranium. And then finally, the next line we look at is the construction time, because these classical solid fuel reactors are really, really big buildings. And there are many requirements towards earthquake resistance and being able to handle these high pressures that I talked about before. So typically, the construction time are between 4 and 15 years, there has been situations in the past, especially in the past, where we have been able to build those reactors faster than 4 years. There's also been some examples recently, where those reactors took longer than 15 years to construct. So this is sort of just a ballpark estimate. For the Copenhagen Atomics' thorium reactors, we expect in the beginning, to be able to deploy a 1 gigawatt plant in 18 months, because none of it is constructed on site. It's all built in a factory, and it's holder on trucks. And then when you get to the site, there are some cranes that put up these big modules that come on trucks, so it's much easier and faster to construct. And eventually, we expect to get down below 6 months for constructing gigawatt power plants. So again, if you compare the left column and the right column, there's almost a factor of 10 difference between the construction time and of course, construction time is also equal to capital, I mean, the capital cost of your nuclear power plant becomes very high. If need 15 years in the beginning where you don't make any energy, you don't have any revenue, but you still have all the costs. So that's part of the reason why classical nuclear is expensive. And you also see the last line, is the comparison of electricity prices. You see that for solid fuel reactors, it's roughly three times higher electricity prices than what we expect from these thorium molten salt reactors. So I have a big, quick walkthrough, there are some links at the bottom where you can find references to more details about some of these numbers.

Erik: I want to focus on that last line in particular, because to me, this is the important one. You like nuclear, I like nuclear, but look, at the end of the day, what counts the most is the price. If you can make nuclear energy deliver electricity that costs less than electricity from fossil fuels, that's a game changer. If you can deliver better electricity, that's cleaner, that's safer, that cost twice as much, look, it still cost twice as much. If it costs half as much, that's a complete game changer. So, I want to talk about this $20 to $40 levelized cost of energy that you have at the bottom of the chart here for your reactors. It seems to me that if you can pull this off, that's where the real game changer is, do you agree? And I also know you to be a very honest guy, you know what can go wrong with this, what could happen that would throw that off to the point where maybe your electricity really does cost $60 to $80 per megawatt hour.

Thomas Jam: I mean, this is the reason why we started this company, because we really believe that this is possible to get the price down below the price of other energy technologies. Whether it's wind or solar, or coal and oil and gas or even fusion, we strongly believe that we can beat all of those technologies on price. And you're absolutely right, that energy is one of these things in society that is mainly judged on price. I mean, that's the key factor. If the price is not good, then it doesn't matter that it has the right color. And if we look in society, I mean, or the whole world, only a little bit less than 20% of global energy is converted into electricity. The other 80% of energy is used for all kinds of other things, transportation and heating and thermal energy and factories. And a lot of this thermal energy is actually for things like making commodities or different types of chemicals that are used to make all the products we need. So, I mean, industrial heat is a very large consumer of energy in the world. And of course, that's today, it's mostly fossil fuels, coal, oil and gas. And this is where the real hard competition is. And we hope, with these reactors, to be able to get the price down below coal and oil and gas so that we can compete for those 80% of the energy market. Because in the past, we have to be honest, and say that nuclear reactors were a little bit too expensive, and they were only able to compete in the electricity market for grid electricity. But I think this opens up a huge opportunity, where nuclear energy can be used at lower prices, and therefore compete for thermal energy for industrial processes and commodities. And you should also notice that classical reactors, the output temperature of most of the reactors we have in the world today are sort of 250 to 300 degrees Celsius. So it's difficult to use those for industrial heat, whereas our reactor can output energy or temperatures all the way up to 700 degrees. So there's many more industrial heat applications that we can be used for.

Erik: Thomas Jam, I'd like to share with you some of my own research on thorium, run it past you and get your reactions, and you can tell me if I'm crazy or not. As you know, and I want to share with our listeners now, my own passion for this subject is to really think about not just a company like yours, and how it can make money, but how could we, as a society, completely break our addiction to fossil fuels and replace it with something better. I've just become absolutely passionate with this subject of energy transition, despite the fact that my motivations for caring about it so much have absolutely nothing to do with climate change, which is the usual reason. But as I've really dug into thorium as a fuel source, you know, this chart of yours is compelling, but really, that 90x on the fuel price, you almost have to multiply that by the 15x on the difference in, in thermal energy output. I ran the numbers on this, and admittedly, the numbers I'm about to run past you are the raw fuel costs, it doesn't include the cost of building the reactors, the capital expenditure that goes into that. But if you just look at the cost of fueling planet earth today, with fossil fuels, fossil fuels provide about 85% of global energy supply, at a cost of 6.25 trillion US dollars per year. That's the total size of the global fossil fuels market. By my calculations, once you get past the CapEx and so forth, if you just look at the fuel cost for the thorium that you would need, if hypothetically, we were to transition off the age of oil into the age of nuclear and specifically thorium fueled nuclear, I get a grand total cost to run planet Earth of about 315 million with an M, not billion with a B, not trillion with a T, but $315 million, or less than 0.01% of the cost of fossil fuels today, so we could reduce the fuel costs around the planet by 99.99%. But more importantly, because it's not really about the cost, if we wanted to do a 10x on the amount of energy to make energy more abundant in order to restore the uptrend in our standard of living and human prosperity, okay, that would take you $315 million fuel cost, do a times 10 to get it to 3 billion, that's still less than 1% of the cost of fossil fuels today. It is just a staggering difference. And furthermore, that amount of thorium exists in either India or Australia alone, you don't even have to scour the whole world to find that much thorium. Am I right? Am I missing anything to think that it's that profound of a difference in terms of what the fuel would cost? Admittedly not including the CapEx for building the reactors and the transmission lines and everything else that goes into this?

Thomas Jam: Yeah, you're absolutely right. And this is also what got me started in this. I realize this isn't like a complete game changer. And you're right, when we look at that table, we have to multiply the difference in the fuel price by the difference in the amount of energy that you can get out of those fuels. And then you get to a factor of more than 1000 better than classical nuclear. And of course, I have to admit that the price is not 1000 times lower than classical nuclear. That's not possible, at least not in the beginning. But there is sort of very, very huge advantages of using thorium over using uranium. And for many people that hear about this the first time, they think it's too good to be true, it cannot be true. And I had to admit that it was the same for me. I had to spend more than two years researching this topic before I got convinced that it was correct. In the beginning, I thought there must be something that I didn't understand or that you know, the numbers were wrong, or I was doing wrong calculations. So it's a little bit sad to say that it took me almost two years to convince myself that this is true, and that it's going to change the world and we have to start a company developing this technology. But you're absolutely right, that this is a huge opportunity for humankind, to get away from fossil fuels.

Some of the problems related to fossil fuels are pollution. And people have wars over who have access to fossil fuels. The great thing about thorium is that there's thorium in every country of the world, where we are already mining for other materials. And when we mine for copper, or iron ore, rare earth materials, we get enough thorium out of the ground from, already today, from the existing mining industry, that we could power the entire world, with the thorium that we already mined today. But because there's no market for thorium or very, very, very small market for thorium today, most of that thorium, 99.99% of the thorium that is mined today just go back into mine as mine tailings, and they are not used. So that's unfortunate.

You also mentioned India and Australia, that's because those two are the countries where there's the most thorium reserves, and also where there are mines that get huge amount of thorium out of the ground already today. And it is, of course, when you look at economic opportunities in the future, I think this is one of the really, really big economic opportunities, I would even say that it's bigger than when oil or coal or gas got started. I mean, when we discovered oil, of course, you know, in the beginning, we couldn't really figure out what to use it for. So we used it for petroleum lamps and a little bit later, we were able to use it for engines in automobiles. And in the beginning, those engines and automobiles and tractors were very inefficient. But still, we were able to use it, it was still better than a horse carriage. And now, today, the whole world is running on those fuels. And we're transporting goods from one corner of the planet to another corner of the planet. That was unthinkable before, when we only had horse carriages. But now with airplanes and large container ships, it's possible. And I think this technology, thorium molten salt reactors is a technology that will also transform the world. It's difficult right now to predict how it will transform the world, because who knows what's going to happen? But, of course, we know that things like AI and cryptocurrencies and robotics needs a lot of energy. And those are some of the things that might make it easier, and easier life for us humans here and on planet Earth, it could take away some of the really tough jobs for some people in the world. And who knows, maybe one day we will all get flying cars or jetpacks, I don't know. But I think this is a kind of technology that has the potential to really transform the world, because there’s lots of this energy source. And like I said, when we get it scaled up, we can get a much lower energy price. But there is this issue that it's very difficult to get started. And there's a huge upfront cost to building and developing this technology in the beginning and getting the mass manufacturing production line up and running. I mean, the cost for setting up these production lines are in the 10s of billions of dollars. And there is a risk that it won't work perfectly in the first, when we try to get it up and running first time. So, it's like all other new technologies, that there has to be some people that step up and take the risk. And of course, then they also get the benefit of the return on investment when it works.

Erik: But look at what their return on investment is, Thomas Jam. On the day that we're recording this interview, the US Senate passed an aid package of $95 billion to go to Ukraine, Israel and Taiwan. That $95 billion would build all of the technology that you need to engineer and develop. It would build all of your assembly lines, and it would buy enough thorium to supply the entire planet for the next 100 years. Am I right?

Thomas Jam: Yeah, I agree with you. Sometimes the world is not rational in that sense. I agree with you that some of those amounts that we spend on war, if we didn't do that, we could actually provide every human on this planet with all the energy they need, basically for free.

Erik: And we wouldn't be inclined to have wars or to feel a need to go and fight with other people if we had that kind of energy abundance. That I think is the real point.

Thomas Jam: Yeah, so I'm not sure that human would not fight each other, even if we had lots of energy. But you're absolutely right, that some of the times, the wars we have are over energy, over resources. And I mean, there's cheaper and better ways to solve that problem than having a war. But unfortunately, that's, you know, you and I don’t run the world, we just invent or I invent new technologies that hopefully, in 10 or 20 or 30 years from now, will make the world a better place. And that's what drives me every day to go into the workshop and get things to work. But yeah, the world is not always rational. And I think it's great that we can have this podcast where we can talk about it, and hopefully inspire a few more people to see that there's a huge opportunity here for making something that can provide cheaper products and greener products, and more prosperity to many, many more people on this planet.

Erik: I want to move on to another topic, because the things that have suddenly become big and popular as marketing buzzwords in the nuclear industry lately, have been smaller reactors, but particularly this idea of modularity. Now, suddenly, small modular reactor is the in buzzword, except that it's a marketing term that has no precise technical definition. And if you talk to one person, you get a completely different definition of what it means. Some people, when they talk about SMRs, are talking about these micro reactors, which are very, very small nuclear reactors, let's say, five megawatts of electrical output or less, they're designed to compete with the market that's currently dominated by diesel electric generator sets. Something like a remote mining operation where you're too far away, you're off the connected electric grid. So you've got to have an independent source of energy. Right now, they use diesel generators, maybe in the future, they use micro reactors. That's what some people mean, when they talk about SMRs. Most of the people talking about small modular reactors, are talking about things like the Westinghouse AP300, or the GE, Hitachi SMR, which I think is called the BWRX 300, which is a boiling water reactor. The idea there is, they're basically just building conventional old school, light-water reactor nuclear plants. The difference is, supposedly, at least, they're building more of the components ahead of time in a factory and just assembling them on site, as opposed to custom building things on site. But really, what they're doing is they're building an old school nuclear reactor, which in terms of its design, and functionality is pretty much the same as the ones we were building in the 1970s. I think your company might be unique in the sense that, although you don't call it SMRs, you've got some ideas around modularity and how to build nuclear power plants efficiently, which is really different than the way anybody else is talking about doing it. So, starting at page 7 in the slide deck, talk us through how you think about what should be built in a factory, why it should be built in a factory, what gets put together on site, how it comes together, and how that evolves over time,

Thomas Jam: I want to broaden it out a little bit. And I want people to notice that back in the day, when we had horse carriages, there were many different type of horse carriage wagons or whatever and they had different names. And you can look that up on the internet. And there was, back then, if you're an adult male, and you didn't know what these different type of wagons meant, they thought you were stupid, because that was really important knowledge back then to know the names of those different types of carriages. And we had a little bit the same with the transistor, before the transistor came along, we had radio tubes, and the people who were skilled in radio tubes, they knew all the different circuits that those radio tubes fitted into. And that was really important knowledge because that was sort of that told you if it was a high power radio tube or fast switching radio tube or whatever, but then something else came along and just completely erased radio tubes. I mean, it's not completely erased, there's still some amplifiers and stuff using it today, just for the fun of it. But of course, the majority of the market has embraced that. And it's the same with nuclear technology today. I mean, nuclear technology, of course, the thought of the old technology is still evolving a little bit and there's different companies trying to market their reactor under new terms. Like you said, there are some companies marketing their reactors, there are classical nuclear reactors under the term called small modular reactors. Some are marketing them under a term called micro reactors. There are other companies marketing their reactors under something called advanced modular reactors or advanced reactors. I mean, there are all these different terms and there are more of them. There's Generation IV, and you could go on like that, but it's sort of, it's a little bit irrelevant when you compare it to thorium reactors, because what we looked at, the table before, we talked about the fuel price is 1000 times lower than the fuel price when you use solid fuel uranium reactors. And when you have something that is 1000 times better than all the other players, it doesn't matter whether they call it SMR, or advanced reactors or micro reactors. I mean, they are sort of all in the same ballgame. And thorium molten salt reactors are in a completely different ballgame. And, of course, I believe that that's going to be the future, but it's probably still 10 years away before it's starting to be mass deployed.

And now I want to look at this picture on slide number 7. This is a 3D rendering of how we expect our one gigawatt power plant to look like, it's basically a regular storage facility, or a storage building similar to distribution center that Amazon would build or some other company. Those buildings are in every city of the world and sort of typically a little bit on the outskirts of those cities. That's how we distribute all the products we need today, they go through these distribution centers. So those buildings, we know really well how to build, you know, we humans, and then inside that building, we are going to put a long array of reactors. And depending on how much power or how much energy you need at that site, we can put more reactors or have fewer reactors, but in this particular case, it's a one gigawatt electrical power plant. And then we need 25 of those reactors in the building, so an array of 25. But as you can see on the picture, there's 30 of these boxes. And the reason why there's 30 is because we need to have some extra boxes to replace things and swap things in and out. Everything inside the building can be remotely operated with a remote controlled cranes and remote controlled forklifts and so on. So we don't actually need any humans to operate this plant. And what happens in those, every five years, we have to replace some components. So it's not like something is going on in there every day. And most days, on the 50 years of this plant’s lifetime, the reactors will just sit in there, and they will just be humming along and producing energy. And in this building, what comes out of the building is just heat. So the heat is what we sell to the customers, you can see in the background, there's four round tanks, and those four round tanks is how we send the energy to the customer. In the beginning, it's hot salt, a very hot salt that comes out of the building. And then that hot salt can be converted to, for example, to steam. And then the steam can run a steam turbine to create electricity, or the steam can sometimes be used directly in an industrial process for creating some other products. But you can see that the nuclear power plant is the building in the foreground, that looks like a distribution center. So again, it doesn't even look like a nuclear power plant with these cooling towers, and so on. So you might have one in your neighborhood and you might drive by it every day. But you might not even know that it's a nuclear power plant because it looks just like all the other distribution centers in your city.

And you also asked, how does all of this get built? So the building itself is just built like any other distribution center, there's already a lot of companies around the world that are very good at building these buildings, at low cost and efficiently. So of course, we will just call one of those companies and say we need a building built and it should have this length and height and width. And then they will build that. And Amazon has actually put online, some videos with a CEO, they can build these buildings in 60 days. So it doesn't take that long to build one of those buildings. Of course, we need a little bit extra, we need some cranes and stuff inside. So maybe you could say that maybe for our building, it would take 90 days, I don't know. But then all the reactors inside you see, they're sort of in some boxes, we call them cocoons. It's a box that is

30 metres long. And it's roughly five metres by five metres and it's made out of steel. So it's a very, very heavy and strong box of steel, that it has a wall thickness of almost half a metre thick steel and that means that if an airplane crash into this reactor building, then the airplane will of course get destroyed, but the reactors will not get punctured or release any radioactivity. So, these cocoons are made so that they can withstand an airplane strike. And also, if there was some sort of accident inside the reactor, it will not explode, or the gases, anything will not get out. So that's sort of the protective shell around the reactor. And then inside that cocoon, we have the reactor that produces the energy, I hope that explains sort of a little bit how it's made. The whole cocoon and the reactor and everything is produced in a factory. And it just arrives at the site on trucks, and then it's craned in place.

Erik: I just want to add a point, because when I first started learning about this, a point you just made, which is this building is really just a Sam's Club. Basically, it's another distribution center type of big box building. The significance of that was lost on me, because I didn't know very much about the nuclear industry. So, what we're comparing it to, is a nuclear power plant that's built out of nuclear concrete, when those things get built, the decommissioning fund has to be set up before they're even allowed to turn the reactor on. And the idea is, it's not just a usual demolition job to tear down those great big concrete cooling towers that you see at a nuclear power plant. Because every single ounce of that concrete becomes low level nuclear waste that has to be disposed of, according to nuclear waste disposal rules, it's very, very expensive. And it contributes an enormous amount to the cost of electricity that comes out of that power plant, because they have to amortize that decommissioning cost over the life of the plant, and charge it to customers in the form of higher electricity prices. Jam, if I understand this correctly, your building doesn't have any nuclear concrete in it, all of the nuclear is contained in those cocoon tubes. So, the tubes probably do have to be taken out of there someday. And maybe those get disposed of as low-level nuclear waste, but the entire building is just a building, you could sell it to somebody and they could put a Sam's Club there. Is that right?

Thomas Jam: Yes, that's the idea. There are still, in the nuclear industry, there’s still a lot of rules and regulations. And this is, of course, a new idea in the nuclear industry. And we have to sort of convince the regulators that the outside building, the distribution center building, can be what is called, free released after end of life, that means that we have to convince them that the building will not be radioactive, and it doesn't have to have any nuclear approval. That's another way to explain this, when you build nuclear infrastructure, you want to have several barriers between the radioactive materials and the outside nature. And in our design, this cocoon that I talked about before is the third barrier, we actually have two barriers inside the reactor that also would have to be compromised in order for anything to be released. But you talked about the classical nuclear reactors, that concrete building, it's a really, really big building, that is actually part of that barrier itself. So, it's part of the safety structure. In our case, the distribution center building is not part of the safety structure, it's only there to keep the birds and rain out of the building. It doesn't have any safety function or protection against radioactivity or anything like that. So, you're right, the building doesn't have to be demolished afterwards, it can be used for something else if somebody wants to build a distribution center there afterwards. And the cocoon thing inside, they can be disassembled and driven away on trucks, they are not that radioactive that you cannot drive them away on a truck. I mean, this steel, and we humans are really, really good at recycling metals, especially steel and stainless steel. So most of our reactors are built out of stainless steel so they can be reused. And also, the salts and heavy water that we use inside the reactor can actually be reused. So, like 95% of all the materials we use, they can be recycled and used again. We do create some radioactive waste, like I talked about a little bit earlier, that the exhaust or the fission products of the process. I mean, those fission products are still radioactive, and they need to be stored for 300 years. And that cannot be directly recycled. There are some, actually some companies we're looking at, can also recycle some of that because some of those fission products can be used for medical isotopes and for treating patients in hospitals and so on. So, it might be in the future, that there will be companies who can use the fission products. But right now, we look at it as a waste stream. But yeah, that's a small waste stream.

Erik: That waste has a storage period that has been reduced. If you look at the conventional reactors nuclear waste, it stays radioactive for about 100,000 years, you're reducing that storage period by more than 99% from 100,000 years down to 300 years. So it's a pretty profound difference. And then you've maybe got a plan at some point that you'll be able to sell the medical isotopes contained in that waste and reduce its volume even more. So it's a completely different equation, I think in terms of waste compared to conventional technology.

Thomas Jam: Correct. That's also because of the thorium. I mean, when you run reactors on 5% enriched uranium, classical nuclear reactors and 5% enriched uranium, that you cannot avoid that they will produce some plutonium. And plutonium is toxic, and like you said, it has a very long half-life of 10,000 years. So it needs to be stored for maybe 100,000 years before it's safe to put it back in nature. So, the waste from classical nuclear reactors are much more difficult to handle than the waste from thorium reactors, because thorium only creates these fission products that needs to be stored for 300 years. And therefore, because it's only 300 years, it doesn't have to go in deep geological storage, which is very expensive. We can store them in some building above ground. And that's much more reasonable and lower costs. So that's another way to save on these type of reactors, compared to the classical nuclear reactors.

Erik: So, your vision is to eventually have a factory assembly line that manufactures nuclear reactors, thorium burning, molten salt cooled, high technology generation for nuclear reactors in the form factor of shipping containers that would get delivered to a plant like this one put into these tubes. And this is the way you make a gigawatt power plant, you would build these all around the world. Let's talk about what it's going to take to get from here to there. Because right now, what you're doing is, you're building a first prototype of that reactor, but it's not even a functioning nuclear reactor. So why don't we go ahead to skip ahead to page 11, where you talk about what it's going to take to get from here, where we are today, in 2024, to actually realizing this vision that you see on page 7.

Thomas Jam: So we have developed this technology already for 10 years, like I spoke about before. And we've created sort of the foundation for all the different things we need to do. We've created salt purification and special pumps that run at these high temperatures, and a special reactor core that works in order to make this reactor small enough to fit inside a shipping container and some other things. And we've taken a lot of patents. So, the first 10 years is sort of the first step of these six milestones in our company development roadmap. The second milestone is where we started testing actual full-scale reactors. Unfortunately, at the company site where we are today, we are not allowed to start a real reactor. So here, we can only heat up the test reactors, we heat them up with electricity, and pump the salt around and test all the different things we need to test. There's a lot of testing that needs to happen before we can be allowed to start a real reactor. Those are tests like thermal expansion, thermal recycling, a lot of different tests of flow rates and pressures and so on. So that's what we're doing today. Here at the facility, we have two full-scale reactors. And we're building the third one now, where we're doing all these tests on them. And then the third milestone for our company is to build a first one megawatt test reactor, one megawatt is what you, a little bit earlier, referred to as a micro reactor, it's a small amount of energy. And it's something that where we can run a test reactor at low risk, we will not be able to run it at this particular site. But we are in dialogue with a number of different places in Europe where we can run this. And we believe that in 2026, we will be able to start the first one of these test reactors to actually prove that all the things work, including the chain reaction, and making energy from thorium. And then of course, after that, the fourth step in the milestone plan is to make the first commercial reactors. And we will start building those in 2025, and probably have them online by 2029. That's what it says here in the slideshow. And then as soon as we have proven that the commercial reactors are competitive on price, we will start to ramp up and do mass manufacturing. And I think the way I look at it today is that we will go directly to large scale manufacturing and when I say large scale, it's sort of these giga factoris, a little bit similar to the Tesla giga factory, we will make one of those factories and we will try to ramp up to one reactor every day as fast as we can. Because once the price point has been proven, we believe that there's a myriad of customers out there who want to buy green energy at low cost, and especially the business model that we have in Copenhagen Atomics is one where we will finance the reactor. So as a customer of energy, you actually don't have to buy a nuclear power plant, you just have to sign an agreement with us, you know, an offtake agreement where you agreed to buy the entity over the next 20 or 30 years. And then we will finance and set up the reactor and we will run it at the site of the, whatever factory needs that energy. So it's sort of a low cost decision to say, okay, we want one of these plants at our site, and then Copenhagen Atomics would come along and set it up. And then we will make energy for that aluminum factory or ammonium factory or whatever for the next 20, 30, 40, 50 years.

And then finally, the step number six, or milestone number six on this slide we are looking at right now, So that was slide 11. Milestone number six is a really really important milestone for us as a company and especially for me, personally, that is called a breeder reactor or a waste burner. So these thorium reactors have the potential to become a breeder reactor. And what that means is that it actually produces more fissile fuel than it consumes. And it's a little bit of a technical term. But basically, what it means is that you need to take less nuclear fuel out of the ground in order to make it work. And this means that it has even better fuel economy than some of the first commercial reactors that we will deploy in 2030. And we believe that we can reach this point of a breeder reactor in 2035. And this will be a huge step forward for mankind, to be able to have breeder reactors, and those breeder reactors can also burn waste, that means that they can take spent fuel from all the classical nuclear reactors, and use it one more time and get much more energy out of it. Typically, in the order of 10 times more energy out of the fuel than what came out of it in the classical reactor. I mean, the spent nuclear fuel from classical reactors today, we look at it, the society and politicians look at it as a liability, they look at it as something that is really expensive to get rid of, we have to put it in deep geological storage. But I think after 2035, it will be evident to everyone that this spent fuel actually has a lot of value, because you can put it into our type of reactors, and then you can get even more energy out of it than you got the first time around. So this will become a valuable waste product.

Erik: I want to pick up on something you said a minute ago, you mentioned making a reactor every single day was your goal. It's something I just want to share with our listeners, folks, the first time that I met Thomas Jam almost two years ago, he hit me with this line about building a new nuclear reactor every single day on an assembly line. And my first thought was, this guy is off his rocker, we've only got 412 nuclear reactors in production now, after 70 years of this industry existing, and this guy wants to build one every single day. Well, then I sat down and actually did the arithmetic, and I realized one a day isn't enough to make a meaningful dent in energy transition, you need to build one an hour and produce them at a rate of one an hour for about 20 years straight, in order to build enough reactors to replace the energy that we get from fossil fuels. So, what needs to be done here is absolutely extraordinary in terms of its scale. So I want to come back and ask you about your plans. You said before you're going to go straight to mass production. It sounds like around 2029, you're going to ship your first commercial reactor. What if I said to you in 2029, Thomas Jam, I'm not really interested in buying one of your commercial reactors, or I guess you're not selling them and not interested in leasing or having you operate one of them. I want 10 gigawatt power plants, which is going to require 300 of those reactors, since you've got 30 tubes in each one. And I want you to build those plants right away. How long do you think it's going to take, if you have that conversation with a customer January 1 of 2029? What's the delivery date, where all 10 gigawatt power plants have been built and are turned on and operating? Is it 2031? Is it 2039? What how long does it take to do that?

Thomas Jam: We already have those conversations today because there's already some…

Erik: Oh they're not waiting for 2029 to place those orders.

Thomas Jam: No. So, there's already some companies around the world today that says, oh, this is a big opportunity for us, because if you are in the commodities industry, many commodities that we use in this world to build all the products we need, those commodities are, typically 40% or 60% of those commodities are the energy cost. So if you have a aluminum for example, some commodity, then a very, very large piece of the price of aluminum is actually the energy cost. And they realize, of course, that if they're competing against 10 other aluminum companies, then if they can get the price of their energy down, then it's easier for them to compete with their competitors around the world. And therefore, some of these very, very big plants we have in the world today, they're already looking at this technology as a solution to being more competitive than the other players in their industry. And it's not just aluminum, I mean, there are 20, 30, 40 different types of commodities, that needs lots of energy in order to make their product. And all those commodities, of course, is what is used to build all the other products that we buy, like shoes, and clothes and cars. And so we're sort of at the bottom of the food chain, you could say, for providing the energy that makes it possible to make all the commodities. And those big factories, they're already looking at today, you know, if I could get access to a lower or cheaper form of energy, and also a form of energy with more stable prices, because today, they usually use fossil fuels, and the fossil fuel prices going up and down. And I think we all remember a couple years ago, after COVID, when the gas prices went through the roof, that is really, really dangerous for a company that rely on buying these commodities all the time. So of course, they like something like thorium energy, where you have a stable price for 20 years. And also, where you have, you're not going to run out of it, when you buy coal or oil or gas, you have to get it delivered almost every day, or at least once a month, you need to get a delivery. But with thorium, it's different. I mean, you can take delivery every five years or every 10 years. So you have a lot of energy security, because you don't need to rely on the global transportation systems to deliver stuff to you every day or every week. So, some of those really, really big plants around the world, and there's hundreds of those that make different commodities, they are already looking at, can they actually install some of these reactors at their site for making energy. And it's not difficult to install a lot of reactors at a site. And it's not difficult to make them in an assembly line.

The difficult thing right now is to get all the approvals from the authorities, because when you build nuclear technology, you need a lot of approvals. And those approval processes are very slow. So this is one of the things we need to work on. How can we make this type of technology as, you know, type approval, because when we buy airplanes today, I mean, of course, we all know that if there's an error or bad construction method for an airplane, and it crashes out of the sky, then a lot of people die. But today, we actually, you know, airplanes in my country, I'm from Denmark, they are not approved in Denmark. Airplanes, we just assume that if they are built in France, or United States of America, whatever, we assume that they are of high quality, and we can trust the quality of that product. And we allow them straightaway to fly with passengers here in our country, there is no approval process. There is, of course, an international standards and collaboration around the safety requirements. And also, you know, aircrafts have to be inspected and all that. So it's not like there's no security and no safety. But it's sort of a type approval, and we need the same for the nuclear industry, we need something where these reactors can be manufactured in one country, and then they can be installed in another country without having to go through the same approval process over and over again, because those approval processes today, usually take 3, 4, or 5 years, in some cases, they have actually taken 10 years. And that is devastating if you make one reactor every day, and then it takes 4 or 5 or worst case, 10 years to get it approved, then I mean, it doesn't really scale from an economics point of view. So that's one of the next big hurdles that we need to solve. We need to figure out in some countries, how we can get a type approval for these type of reactors. And then we can install many of them, hundreds or thousands of them at these type of factories that, like you said, need 10 gigawatt of energy or heat or electricity. And that is one of the next big steps that we have to solve, but let's get the first reactor up and running in 2026. So that the world can see that this is actually working. And then after 2026, I think we have to invest a large amount of resources in getting this type, new type of technology type approved, at least in some countries, so that we can install hundreds of 1000s of them without too much delay from the approval process.

Erik: If January 1 of 2029, you get a type approval from at least one country and several other countries make the agreement you're describing, you know, they say, look, if you've got that type of approval that's good enough for us. You can run it on our soil as well. If you start January 1 of 2029 and you just go as fast as you can, from a technology limitation standpoint, how much is it going to take, how hard of an engineering problem is it to design these assembly lines, let's say, to get to your first 1000 reactors in production or in operation someplace,

Thomas Jam: I actually have some experience from my past about scaling things up for mass manufacturing. And it's any type of product you want to scale up for mass manufacturing, whether it's a car factory, or an airplane factory, or a microprocessor factory or whatever. It takes a lot of capital to scale up these things for mass manufacturing. But then, after you've scaled it up, and it's working, then you reap the benefits of having mass manufacturing, because there's an economic scale of economy in doing that. And we've also seen, for example, with Tesla, how it was difficult for them to scale up car manufacturing. But now they've done that, and it took, you know, I don't know, 3, 4, maybe 5 years to get those giga factories up and running and scaling it up. And it also took a large amount of capital to do that, investment to do that. And of course, the same will be true for us, it will take a lot of resources to scale up those mass manufacturing. And of course, in order for the investors to put that finance on the line, they need to make sure that we don't run into a problem where we cannot deploy the reactors afterwards, they need to trust that we can actually find countries that will allow us to deploy lots of these reactors, like you said, 1000s of reactors. So it's sort of a hen and the egg problem that we have to solve both, we have to raise enough capital to set up mass manufacturing. But at the same time, we also have to solve the problem of some countries that say, yes, in our country, you are allowed to install 1000s of these reactors. And to be honest, we don't know yet, which are going to be some of those first countries. But it's also clear that it's a little bit similar to other technologies, the first countries to take advantage of this new technology will also have some benefits from that in their society, it will create jobs, it will create a lot of export, because then suddenly, they're able to make products and goods and commodities at low prices than other countries that they compete against. So there will be a lot more growth in those countries. But yes, to be honest, I don't know which country will be the first one, I have a sort of a stomach feeling that it will be a smaller country, it will not be one of the biggest countries in the world. And then I think once one of the smaller countries have succeeded, then some of the bigger countries will wake up and say ,shit, this is a huge opportunity for us. And then they will start doing it as well. And I don't expect that we will be the only company in the world supplying this technology, I think there will be 10 or 20 companies developing this technology. But right now, we are sort of the spearhead company of this technology.

Erik: I'll share a prediction with you and with our listeners. I think, where you're headed with this, Thomas Jam, is you're going to get your type approval in some, let's call it, second or third rate country first, you know, a Venezuela, El Salvador, Mexico kind of place. And the people in the first world countries are going to look down their noses at you and say, oh, you know, let them deploy in little third world places, because they're not good enough to operate on our soil. Because we're the United States, NRC, and we're in charge of the world. Then, I think what happens is, all of a sudden, Mexico and Venezuela and El Salvador and wherever else, suddenly have a massive economic advantage over first world countries because their cost of energy is so much lower in manufacturing. And all of the sudden, there's a complete change of attitude where it's, you're posing a risk, we have to get this technology, you have to promise to bring it to our country next or else. And, you know, if it goes that way, remember I said at first.

Thomas Jam: I totally agree with you. And it's also, a lot of these commodities that we are using today, you know, where is copper made? Where is aluminum made? Where is ammonia made? It's a lot of times, a lot of the mining, also the mining industry and the processing of that raw material, a lot of times those things happen in low income countries, some of them you already mentioned. So yeah, I think it's also those countries who have the most direct benefit of installing this early on. Whereas I think a little bit later on, you also mentioned the USA, I mean, they will probably use this technology more for things like AI or cryptocurrency or whatever. And I think they will come sort of a little bit later in the maybe 5 years after all these other countries start using it.

Erik: When first met you, Thomas Jam, a really big problem that you faced was, frankly, you were working with a lot of cutting edge technology that the regulators didn't know how to regulate, and more importantly, showed no interest in learning how to regulate. It seems to me that there's been a sea change. Just recently, I actually heard Jennifer Granholm, the US Secretary of Energy, make three intelligent statements in a row the other day, I think that's a record for her. She's talking about the importance of fast tracking advanced nuclear reactor technology and getting Generation IV reactors online. And I mean, she's saying all of the right things suddenly, when she couldn't spell advanced nuclear a year ago, it seems like they're coming around. How do you feel as a founder of this company? I know a major risk that you had to look at when I first met you a couple years ago is, you know, what if the regulators are just never smart enough to wise up and recognize the importance, the strategic value of these advanced technologies that you're working with? Is that still a concern? Or is that concern coming out of the system now?

Thomas Jam: It's still a concern, I would say, but it’s definitely…when we started this company 10 years ago, I talked about something called the ketchup moment. This is where suddenly people realize that they have to have this. And then the whole process changes around it. Everybody wants to learn about it, everybody wants to see if they can install it in their country, and so on. We're not yet at that ketchup moment, where everything just completely changed around and there's less resistance. I believe that the, what I call the ketchup moment, will be in the sort of around early 2030, 2031, or something. That's my prediction right now. But you're absolutely right. I was just at a conference in Texas last week, and everybody I met there also say, yeah, this is the thing of the future, this is what's going to happen. When I met those same people five years ago, they said, I mean, you know, it could take 30, 40 years before it happens. They were more skeptical five years ago. Now, a lot of those people in the nuclear industry that are developing these technologies, they have realized that yeah, this is going to happen and it's going to come a lot faster than they had originally expected. So I absolutely see that we're getting closer to that ketchup moment. And I also see, like you said, some of the people in policy in Washington, also waking up because they hear this from their friends in the industry. They hear that this is the new thing and the new kid on the block. And now they want to learn about it. So, where two years ago, you're absolutely right, when we spoke to two nuclear regulators, they were, again, skeptical, and they didn't want to spend their own time learning about it. Where now, they actually want to learn about it. And we've had a number of people from different countries travelled here to Denmark to visit us and see how we operate these reactors. Even though they're not fully functional with chain reaction yet, they're still running at temperatures at 700 degrees, and we're still pumping the salts around and everything. And we've solved some of the problems that people mentioned, like corrosion and other things. So the regulators from around the world now come and visit us here to learn about how we've solved those issues and when we expect this technology to be ready for commercial deployment.

Erik: Now, the other thing that you mentioned is the big challenge that you're going to face in order to be able to get to that 2029 expansion where you have to build these assembly lines, which require raising a huge amount of capital. I know you've told me that when you first launched this company, your investors were almost exclusively passionate, wealthy individuals and family offices, people who shared your vision for energy transition, and they were investing because they emotionally wanted to, not because they had done any kind of rigorous institutional kind of analysis on your company. So, a few years ago, it was probably almost impossible to even attract institutional capital to a company like yours because you're just too far ahead of the technology curve. You're working with a brand new, well, it's not really brand new, they first proved that thorium worked as a reactor fuel before I was born. But in terms of commercialization of thorium as a fuel, it's considered to be brand new. You're working on the cutting edge of molten salt coolants thorium fuel waste burning breeder reactor, I mean, you're doing everything that's right on the cutting edge. And that was making it initially very difficult to attract institutional capital because they didn't want to take the risk on unproven technologies. How's that going? I know you've got an open capital raise going on right now. It sounds like you're starting to get a lot more institutional investors that are at least kicking the tires and asking questions and considering making investments in this company, how has that evolved since when you first launched the company? And where do you see it heading?

Thomas Jam: You absolutely right that we are getting noticed. And we get a lot of attention now from much larger institutional investors than what was possible even just two years ago. And if you look at different technology companies, when they start to develop that technology is always difficult to get big investors in the beginning. I'm sure you remember some stories of Google or Microsoft or some other company that it was impossible for them to raise capital in the beginning. And it was the same for us. For the first 3 or 4 years, we had to sort of bring our own. The four founders that started the company, invested our own money, and we asked friends and family to invest together with us. And then later on, like you said, it was a high net-worth individuals and family offices. And we've done that now for a number of years. And lately, sort of within the last year, I would say, we've started to get significant traction with institutional investors. And we’re actually, right now, we're negotiating with one of the biggest institutional investors in Europe to invest in Copenhagen Atomics. And I also think that when all the contracts have been signed, and the news comes out, then this will raise eyebrows for some of the institutional investors that may have not started looking at this yet, and they will also start looking at it. So, I expect to have many more of them come and visit us, and try to understand this technology. And of course, not all of them are going to invest, I mean, they will look at it and maybe 5%or 10% of them will be interested in investing at this point in time. But of course, we need a lot of capital, you mentioned yourself also, to set up the giga factory or the mass manufacturing, we probably need something like 10 billion euros. And we're not even ready to take in that amount of funding at this point in time. So there will be many later investment rounds as well. Right now, like I said, we are running an investment round, it's sort of divided into two steps. The first step is 50 million euros. And the second step is 150 million euros. And I expect to complete the first step this year, and the next step next year. So those are the investment rounds that are open right now. And they're a little bit connected, also in terms of the price and terms and so on.

Erik: I'll come back to that at the end of the interview. Because for our institutional and qualified accredited investor audience, I want to put them in touch with Mike Christiansen, your CFO, if they have any interest in participating in that. But first, I want to move on to page 13. Almost every one, and I don't know if it's quite every single other company, but almost every one certainly the big ones like Westinghouse with their AP 300, NuScale with their reactor, these guys have never actually built anything other than CAD programs that have really beautiful renderings of what some idyllic nuclear reactor in the countryside is going to look like someday. You guys actually build stuff, physical things in shipping container form factor in your shop in Copenhagen. Why are you taking this approach where other people, apparently the regulators are satisfied with allowing some of these companies just to develop a nuclear reactor in a CAD program, it's all, you know, simulated. You're building real stuff. Why are you doing it that way? And what are you building? What are these pictures? What are we looking at on pages 13 and 14 here?

Thomas Jam: So page 13 and 14, are pictures of one of the test reactors that are currently running here, in the workshop that we have built. Like I said, it's a full-scale reactor prototype. It's made out of real steel, and it's running at temperature, 600 and 700 degrees. So yeah, you're absolutely right that the majority of nuclear companies, especially nuclear startup companies, they do what is called Paper design. That means that you try to design the complete reactor system on paper and in CAD programs on your computer, and then you try to go to the regulator and get that approved before you start building anything. One of the reasons for that is the sort of the driver behind classical nuclear technology, the building has to be really really big, and therefore the building is just really really expensive. Also, the pressure vessel has to be made out of really thick steel. So, I mean, you cannot build anything for less than $10 billion. But in our case, because our reactors are made with ambient pressure, I mean basically no pressure, and it's built in fairly small form factor, the 40 foot shipping container. And over the last 10 years in order just to make the technology work, things like pumps and heat exchangers and make everything work with thermal cycling at these high temperatures, there's a lot of thermal expansion of all the different materials, and different materials expand at a different rates, there's a lot of things that we had to basically build to understand how it would work. It was not possible to simulate that on a computer. And the great thing is that it was possible to build, I mean, it didn't cost billions of dollars, or even, didn't even cost millions of dollars, it was things we could buy. In the beginning, when we invested our own money, we invested a few million US dollars. And for that we were able to buy many prototypes of pumps and heat exchangers and so on. And we were able to build small test systems in our workshop. And that's how we got started. And that's how we got a lot of traction. And we're able to take out a number of patterns and figure out how these technologies could be put together. So you could say the last 10 years, we've been at the point where we were building the first transistor, or the first car. And that's sort of still where we are because we haven't started the first reactor yet. And the great thing about this technology is that you don't need billions of dollars to build the first prototypes, and that's why we started building things. Whereas, if you want to build a Hinkley Point C reactor, I mean, it's just humongous-ly expensive. I think Hinkley Point C is like, I don't know $20 billion, or something like that. It's really, really expensive. And of course, when those are your sort of budgets, you don't have the option of trying to build any of it. You basically have to design everything on paper. And therefore, you also have to, there's things, you have to put in extra safety margins, simply because you're not able to test it before you build the real thing. And this is also part of the reason why it becomes more expensive and more slow. And that's why our reactors are, it is a complete different technology.

Erik: And finally, Thomas Jam, on pages 15 and 16, I don't want to go super deep on the technical details, because we're mostly a financial audience on this podcast. But just give us a quick overview in terms of the technology, how is your nuclear reactor designed, the way the thing actually works? How does it differ? And how is it better than the conventional kind of reactors, say, that melted down in Fukushima.

Thomas Jam: One of the big differences is that when you have a conventional reactor that is water cooled, which is almost all the reactors in the world today, if that water evaporates, it's in a pressure vessel, so if you just have a little bit of a crack, then the steam will escape and the pressure will go away and all the water you have for cooling your reactor will evaporate into steam and disappear. And then suddenly, you have these nuclear fuel rods in there that is starting to melt. And this is what's called a meltdown. And this is a situation where it doesn't necessarily kill anyone, but it's just really expensive to clean up afterwards. And we don't have that in our reactor, we don't have fuel rods, or the fuel is dissolved in the salt. So, you know that when you have water and you can dissolve a lot of salt, table salt into the water, it kind of disappears. But when you taste the water, you can taste that the water tastes salty, it's a little bit the same here. It's not the same salt as table salt, it's a different type of salt. But it's the same process, we can dissolve uranium and thorium into the salts. And it looks like it disappears, the liquid is still transparent, you can see right through it. But that liquid has a huge potential of producing energy. And what you need to do to make the energy or make the machine produce the energy is you only need to pump it around. And that's why in this picture on page number 15, you can see at the bottom, there's a number of tanks, and there's a number of pumps. And that's basically the only thing you need inside the reactor, you need a reactor core, which is this “onion core” in the middle. And it has to have the exact dimensions. If it doesn't have the right dimensions, it does not work at all. And then once you have the right dimensions and you have the right density of different materials in there, then you just need to pump it around. That's the only thing you need to do in order to start producing energy or heat. And this is so fascinating about this type of technology is that it seems really, really simple. You just need a pump and then it starts producing energy. But of course, there's a lot of simulations that go before that, and you have to be able to control the thermal expansions and the corrosion, all these other things. So there are a lot of technology challenges. But in this kind of schematic that I show here, it looks to be really simple. And the simple thing about it is that you don't need a lot of components You need a few pumps in our reactor, we need seven pumps. So you need seven pumps and a number of heat exchangers and you need this onion core. And then you need some tanks at the bottom. And of course, you need some sensors and measurement technology. But it is a technology where you actually need less components than in a modern car to make it work. So I don't know if that's sort of a quick introduction, I don't want to deep dive into how all the different components work.

Erik: Now I'm sure that our financial audience is going to prefer that you don't, but for those few who are techno geeks that want all the details, you do have quite a number of videos that go into much more detail on how all this stuff works. And that's at copenhagenatomics.com. So I'm going to refer anyone who wants to go deeper on how the technology works to those video resources and other materials on the website. Last thing I wanted to cover before we close, because you did say that you have an open capital raise round, I'm assuming that that is available to accredited investors as well as institutional investors. In the interest of full disclosure, I should mention that I did invest myself personally in the prior round before this one. For people who are interested in contacting, I'm assuming Mike Christiansen, your CFO, is the guy to talk to? Is he the right person? And how can they reach him?

Thomas Jam: Yeah, he's the right person, the best way to reach us is to write an email to invest@copenhagenatomics.com Or just go to our website and there's two sort of a forms where you can fill in, and this will also send an email to invest@copenhagenatomics.com And then Mike is one of the guys are reading those emails and he will respond to that.

Erik: Fantastic. Well, Thomas Jam, I can't thank you enough for a terrific extended length interview. We'll be back to our regular show format next week, folks, after Patrick's big shindig down in Mexico has wrapped up and look forward to seeing you for our regular format then. And with that, we're going to call it a wrap on this episode.