MARTY ROSENBERG
August 1, 2024
GridTalk #420

CHRIS LEVESQUE INTERVIEW

Hi, and welcome to GridTalk. Today we have with us Chris Levesque, the president and CEO of TerraPower. It’s all about bringing back nuclear power to our energy mix.

Q: Good morning, Chris. How are you?

A: Good morning, Marty. Doing well, thanks for having me.

Q: Yes, I’m very excited to jump right in and want to talk about the technology you’ve developed at TerraPower. TerraPower’s been around for quite a while. I remember talking with some of your predecessors at the company. Tell me if it’s talking longer than you anticipated to get ready for primetime or are you right on target?

A: I’ve spent my whole career in nuclear energy beginning in the Navy and working in the light water industry so I have pretty good insight that nuclear takes a while. I think that some of the entrants to nuclear, some of the innovation companies had thoughts that nuclear would go much faster but it’s so regulated; it’s so dependent on a heavy industry supply chain and things do take time, so we’re happy with our progress;

counterpart is 18 years old now and you know, if you think the journey from going from a startup to leading a new nuclear project in a heavily-regulated industry, the energy of a thousand person design team, interfacing with utilities, that's not a job for a small startup. We've had to really, in addition to building our technology, we've had to build our processes to be up to that task.

Q: So, this is the right time to jump in because you had a major milestone in March where you submitted a Construction Permit Application to the Nuclear Regulatory Commission. You hope to have an operating license in 2027 and possibly crank up your nuclear plant in southwest Wyoming in this decade or by 2030, is that correct?

A: That's right, that's right so we submitted our Construction Permit Application to the NRC in March and they accepted it and their acceptance indicates that it was a very complete application and we feel really good about that application and in fact, it's the only construction permit for a commercial reactor in front of the NRC today so by that objective measure, it means we're next. It means the next American reactor is our Natrium Reactor in Wyoming; yes, so we plan to receive that construction license in 2026. The NRC already wrote to us with their schedule and that's what we were hoping for. We can begin construction of non-nuclear parts of the plant before then including our sodium test loop and which is beginning now and our energy island, which is the turbine and the molten salt storage system. That can all begin this year and next year, and then we'll start the nuclear part of the powerplant which is a fairly small part of the footprint; we'll start that in 2026. That has us lined up to low fuel in 2030 and be making commercial electricity in 2031.

Q: So, early estimates or early articles put the cost of this project at four billion dollars with two billion to come from the Department of Energy, is that still your estimate?

A: The estimate is really kind of a sum-up of; when you do these things, it's a sum-up of your concrete, your steel, your labor. There's been some inflation on it but on balance, we've been happy with our updated cost estimate even after adding in inflation. The other thing we get out of the cost estimate is those commodities; how many tons of concrete, how many tons of steel per megawatt, how much labor, and what we saw from that update was that by moving to a low-pressure advance reactor like Natrium our cost in commodity measurement should be about half of what light-water reactors are and that's really because we moved away from the high-pressure plants that we have today. We don't have the need for the heavily reinforced civil containment. We don’t have the need for the super heavy forgings for the reactor vessel. Our vessel’s made of plate so yeah, we did have some inflation but again, the high part of the updated cost estimate is the refinement of those quantities so a lot of work went into that with Bechtel and you can’t do that more accurate estimate without really investing the time in the design. We say there’s a lot of PowerPoint reactors out there. TerraPower’s working on a power plant, not a PowerPoint.

Q: So, this four billion dollars, Chris, is that after Bill Gates gave you a billion, or before?

A: Oh, so, Bill Gates has been; he’s our lead investor and chairman. He began his investment in TerraPower going 18 years ago now so…

Q: He helped create it, right?

A: Oh, absolutely, he’s the founder. He was at our groundbreaking in June. He’s into this about a billion dollars and much of that even began before the ARDP cost share program began.

Q: So, the billion is really for the company, the four billion is on top of that for the project, is that fair?

A: Ah, I mean…

Q: A billion here, a billion there; what are we talking about?

A: I don’t want to overgeneralize numbers. We also have some great investors like SK, a 3M company; and HD Hyundai and ArcelorMittal who participated in our last round which was a total of eight hundred and thirty million, which is the largest investment in new nuclear that I’m aware of.

Q: So, I can ask you a lot about the financing. I’m interested in the technology, too. This is going to be a 345-megawatt plant comparable to other SMRs. You hail originally from French Canada. You know, in Ontario we had the energy minister on this podcast earlier. They’re all in on SMRs. Would you tell them to hold off and consider what you’re bringing down the pike? How are you similar to what they’re doing? How are you different?

A: Yes, so you have a definition of SMR; it’s broadened a lot and it’s changes region by region. In some regions, they’ll consider it an advanced reactor like Natrium an SMR. Others like in the U.K, they’ll call us an AMR, an advanced modular reactor, so I think there’s going to be a place for multiple new technologies, right? I was a COP28 in Dubai last year where with Emirates nuclear energy, we announced a tripling of nuclear energy around the world with many heads of state there so I think there’s going to be room for multiple technologies. I wouldn’t try and talk anyone out of a project they’re pursuing. I think the climate and energy security needs are so great that we're going to need multiple technologies but we do believe that nuclear energy was so ready for innovation. I've only worked in nuclear my whole career. I've worked on submarines; I've worked in the light-water reactor industry and what I've learned when I joined TerraPower was that up to about 10 years ago, again when I joined Bill, I didn't really know what innovation was because the nuclear industry has been a hugely risk-averse industry for good reason, right? It's heavily regulated; we care about safety so much, but if you have that risk-averse behavior for 30, 40, 50 years to the point where look at our control rooms on light-water reactors, many of them still have analog controls. When you have that behavior of hey, let's just keep repeating past successful performance, improve on it by one or two percent; if you do that for decades you find you're pretty behind on innovation and I have worked internationally; I know the competition in China and Russia. They're moving forward with these Gen IV reactors and the U.S. was falling behind unfortunately and again, light-water reactors are super safe and they'll going to continue to be supplying 20% of our electricity in the U.S. under a lot of big new demands but we have to move to these advanced designs. There's benefits we're leaving on the table in terms of economics…

Q: So, let's get into that and the fact that you worked at Westinghouse and Areva in France, I think lends even more credibility to the move you're making to new technology because you know the old way intimately so I'm really interested in hearing you explain for example the benefit of replacing light water with liquid sodium. What does that achieve for you?

A: Yes, sure and you need to talk to those specific nuclear companies about their own merits. I know they're pursuing some new innovations as well, but for me, who's spent most of his career in light water, huge eyeopener when I joined TerraPower, and some of it goes…if you just look at the boiling point of water versus the boiling point of sodium, water boils at 100 °C, right, so light water reactors are super safe. Again, they've been so important to our energy security but when you use water as a coolant, a reactor quickly gets over 100 °C, right, which means you have to pressurize it; you have to confine that water and to keep it as a liquid, to keep it as an efficient coolant and confining that water in a pressurized system requires super heavy forgings, requires very heavy ASME-certified piping and it also requires a heavy containment in the case of a leak and very heavy civil structures to support that piping, and so that means in today's light water reactors, you just keep layering on this cost all about the pressure and so when you move sodium as the coolant, sodium, instead of boiling at 100 °C like water, sodium boils at around 900 °C, alright, and our Natrium reactor operates at 500 °C so that means we can operate the planet atmospheric pressure 400 °C from boiling so not only does that have great cost benefits but now you can a low pressure system but it's a great safety margin. Your operators are working the reactor which is still a fission reactor; we're still fissioning uranium but where in light water reactors is you kind of always this close to boiling if you have a depressurization demand or if you have a loss of quell. In a silicone-cooled reactor, you have 400 °C to boil it, and with Natrium fuel, we're using a metallic uranium fuel so we have a metal fuel with a metallic coolant and so the heat transfer away from the fission is so efficient. The centerline temperature of our fuel is below the boiling temperature of the coolant which is very different than light water reactors so, this is what innovation does for you.

Q: So, Chris, this is fairly sophisticated physics and chemistry. Do you think you'll be able to convince the public; forget about the regulators, it's the public who's been shy about embracing nuclear, that this is inherently a different, game-changing, safe technology?

A: Oh, definitely and we have a lot of experience with the public so one of the reasons we love working in Wyoming is, it's a very energy-literate state. They've been making electricity for the rich West Coast, on top of their own region, they've been making electricity for the West for 60, 70, 80 years…

Q: In the form of coal extraction, right?

A: Yeah, coal and now wind and now significant solar as well and they have significant fossil resources. But we've done multiple town hall meetings all around Wyoming explaining the really strong safety record of today's nuclear and then explaining how Natrium's safety case is even better on top of the already safe record of today's grid.

Q: So, talk a little bit early on when I talked a decade ago to some of your company's research executives like John Gilleland there was an element of taking nuclear waste and using it as a fuel source. Is that still a relevant exercise for this project?

A: Yeah, I want to be clear though we're not reprocessing there, so John Gilleland by the way, he's the founding CEO, he's still with us. He's is my CPO and so what you're referring to with utilizing waste was not utilizing spent nuclear fuel. It involved using waste products from the tailings from the enrichment project or the enrichment process to make fuel, so that was when we were working on…

Q: Just to be clear, that's something that's not being done by conventional nuclear technology today, correct?

A: Yeah, that's correct, that's correct, so you know when enrich uranium today for light-water reactors, we enrich up to about 5% and then the tailings or waste products go off and get really stored as waste so when you spoke to John probably over 10 years ago, that's when we were working towards a larger traveling wave reactor, okay, which is really still our aspiration but with the larger sodium-cooled reactor, the leakage, the neutron-leakage of those larger reactors is lower so it enables you to use lower enrichments even to the point of using natural uranium or depleted uranium, so that similar aspiration at TerraPower if you imagine when today's 92-older LWRs are retiring in 20 years, we'd hoped to be able to replace those with larger gigawatt-size Natrium reactors that can be fueled with depleted or natural uranium due to those physics.

Q: Already on the site of those plants?

A: What's that?

Q: Already housed on the site of those plants?

A: Yes, totally, totally, but our near-term efforts since then are most focused on the smaller 345-megawatt nameplate design with built-in storage that can ramp to 500 megawatts and so that shift was driven by a couple of things: one is, even when light-water started, it started with smaller plants and then they scaled larger; you can see that, but the other reason we went from gigawatt scale down to 345 was available sites. We have all these retiring coal sites. The amount of places in the grid in the U.S. and internationally where you can plug in a gigawatt-plus is very limited and as we're adding all these renewables, transmission is becoming even more limited so we're focusing on the first Natrium deployment at 345 megawatts that maximizes the number of sites where can connect. It maximizes the available cooling water and it's a great call to the nuclear transition opportunities.

Q: Chris, is this would be a good time to talk about how this plan has the capability of backing-up renewables unlike a more conventional nuclear plant. Why is that?

A: Sure, so this was our latest innovation really with Natrium. It happened about five years ago. Remember, when I joined coming from the light-water industry, I didn't know what innovation was but this is something I really learned from people like John Gilleland and Bill Gates, and from our super smart team, so we were pretty happy with our 345-megawatt size Natrium about five years ago but what we were hearing from utilities was, can't you load follow; can't you load follow? And the reason for that was that all around the world we've been adding wind and solar which are great carbon-free sources of energy but they're intermittent, right? and so the challenge in so many regions is with the aging of the coal plants, some of them reaching 70, 80 years old, aging of the coal plants and the massive addition of these intermittent resources, wind and solar, the grid is needing more storage. We need storage; the more renewables we add, the more storage we need, so they asked us, hey, can't you make Natrium load-follow and today's reactors have been more about baseload, right. They provide the kind of cheap electrons at the bottom of the dispatch curve and during the day, it's the peekers like natural gas peekers that come online and ramp quickly; that's how we've accommodated demand changes throughout the day. So now, not only do we have demand changes throughout the day when people start cooking or put their air conditioning on, we have significant changes in generation that happens throughout the day as the wind and the solar…

Q: To cut to the chase, Chris, you use liquid salt as a battery, right? Tell me how that works.

A: That's right so I'm telling you that's a problem statement and our solution was we saws that molten salt storage was being successfully being applied in concentrated solar and our engineers realized that load salt system operates at 500 °C, the same as our operating temperature for Natrium and we said, hey, let’s stop boiling water with our reactor; let’s first heat salt with our reactor and use it as a thermal battery so our energy transfer is fission to sodium to salt, and then we boil water and this has several benefits for Natrium and again allows us to ramp the Natrium reactor really quickly when renewables output changes. We keep the reactor powered the same all the time, okay, so we’re just flexing up and down using our molten salt storage tanks as a large thermal battery. The other thing it does for us is, which is a huge benefit, is it creates this big pool of thermal inertia between the reactor and the turbine and that helps us a lot with our safety case and it helps us justify to the NRC that the whole permanent island and the energy island is a completely non-nuclear facility because it’s totally insulated from the reactor by this large tank of molten salt.

Q: So, this molten salt that’s inherent to the process is also a battery, is that what you’re saying?

A: Yeah, it’s a thermal battery instead of an electrochemical battery and it’s much simpler and less expensive than an electrochemical battery.

Q: How does than mean you can extract power on peak and not put power on the grid when it’s not needed?

A: Yes, so again, the reactor's running at the same fission rate all the time and again if you think of the molten salt storage tank as a thermal battery, you have a hot tank and a cold tank. When you need to change power, what we will do is we will pump more hot salt to the steam generator and that will allow the electrical output to increase and so when we're pumping more salt, we're kind of discharging the thermal battery. When that higher period of demand passes, which it will because these are all cycled throughout the day, we will then reduce the electric output of the plant and we'll charge up the thermal battery again, so it really does behave like a battery and it makes the Natrium reactor and energy storage system very competitive with solar plus batteries in terms of cost.

Q: So, Chris, I want to kick the tires on the numbers just a little bit more where this unit is supposedly around four billion. Do you see that coming down and the reason I ask that is if you back an envelope, everybody talks about the two plants that were built in Georgia, the two Vogtle units coming in at thirty to thirty-five billion dollars, double their initial estimate. Those two units represent about seven times the power of one of your 345-megawatt reactors. Well, if you're four billion and you multiply that by seven, you're getting pretty close to the cost of two Vogtle units to the equivalent amount of power. Tell me why you think with time, you'll become a more economic option?

A: Sure, so our ARDP project is far more than just building the plant in Wyoming; it also involves the first-time design. I mentioned we have a thousand engineers working on the design right now. That will need to be repeated for every reactor.

Q: For instance, do you think this will come down to a billion a unit in the near future, or what's your goal?

A: Okay, it's going to come down dramatically and I think the DoE's Liftoff Report gives you an idea of what percent reduction that we can expect but if you hear some hesitation on me talking dollars is because we just finished five years of historic inflation so for me to tell you how much steel and concrete and labor will cost in 2030 is very difficult. But what I can tell you and this is kind of the source code of a cost estimate, is quantities. If you want to compare us to a light-water reactor or to wind you need to, as Bill does in his book, *How To Avoid A Climate Disaster,* think of how many tons of steel, how many tons of concrete, how many hours of labor per megawatt generated and those numbers don't lie. There's no inflation on tons of concrete, miles of pipe, and we're seeing it and this is validated with a Bechtel kind of pedigree that we're quite advanced in our design. We’re like half of what a light-water reactor is per megawatt and that’s the source code on cost.

Q: That’s one paradigm. The other is your literature says, you’re four times as efficient as a nuclear plant.

A: Yeah, I think depending on which figure of merit you’re using on efficiency, our fuel utilization is much, much higher because of our advanced physics and because we’re using HALEU. We’re still doing fission but we have what you call a deep burnup core so again, because we start with HALEU and we have super advanced physics that were really enabled by computer modeling that wasn’t available even 10 years ago, we will burn the fuel much more completely and at the end of the day, we’ll still have a used fuel form that is very much like today’s light-water reactors but it will be one-third the volume of the waste of today’s reactors.

Q: So, you know there’s an enormous need for electricity, clean electricity to get us to where we need to be to tackle climate change. From where you sit, Chris, the last question I’d like to ask you is when you bring on this nuclear solution as you say, in complement to other new technologies that are emerging around the world, as the ultimate backup to wind and solar and hydroelectric and other non-carbon generating sources, how confident are you that we're going to make an appreciable dent in the challenge that we face bringing down climate change?

A: Yeah, reshoring nuclear has to be a part of it so my confidence is much increased if we can make sure nuclear is part of this energy transition. All the models show that the optimum mix on an emission-free grid is going to be 20% to 30% nuclear. I wish we could move faster, though. TerraPower is the leader. We're trying to deliver as fast as we can on the first one and scale as fast as we can but we're going to need multiple technologies so that's why I don't want to downplay any other technology. Nuclear; we really do need to triple nuclear and we're excited about being first but even when we deliver hundreds of reactors to triple nuclear, it's going to require a really massive deployment . China and Russia are super committed to this and the U.S. and Europe are really playing catch-up.

Q: Thanks, Chris.

A: Thank you, Marty. Take care.

We've been talking to Chris Levesque, who's the president and CEO of TerraPower.

Thanks for listening to GridTalk a production of the U.S. Department of Energy's Office of Electricity. We regularly convene conversations with thought leaders in the fast-changing electric sector in America and around the world.

Please send us feedback or questions at GridTalk@NREL.gov and we encourage you to give the podcast a rating or a review on your favorite podcast platform. For more information about the series, now in its fourth year, or to subscribe, please visit www.SmartGrid.gov.

###