Rep. Keith Ammon (00:00:01):

All right, so this is, we're calling the meeting to order at 9:05. This is the commission to study Advanced Nuclear Energy in New Hampshire. Much longer official title. I guess we'll get right into it because we'll respect the time of our guests. Ryan Duncan is the director of government relations for a company called Last Energy. They're a small modular developer and they have some interesting things about their business model that Ryan will tell us about. So without further ado, Ryan, I don't know if you have any slides you'd like to share?

Ryan Duncan - Last Energy (00:00:48):

Yeah, lemme share my screen

Rep. Keith Ammon (00:00:51):

And if you can't share it, let me, there we go. You should be able to do it now.

Ryan Duncan - Last Energy (00:00:56):

All right, perfect.

Rep. Keith Ammon (00:00:59):

And just a quick intro. We have about half the commission members in the room. There's at least two I see online and there's one joining us at about eight, or sorry, 9:30. So we'll have Cathy join us later. Alright,

Ryan Duncan - Last Energy (00:01:19):

That sounds good. Can everyone see my screen and hear me?

Rep. Keith Ammon (00:01:28):

I can hear you. And we see "still loading"? Yeah,

Ryan Duncan - Last Energy (00:01:31):

Still loading you said?

Rep. Keith Ammon (00:01:33):

Yeah.

Ryan Duncan - Last Energy (00:01:34):

Okay.

Rep. Keith Ammon (00:01:35):

I can hear you online. So commission members online, just Bart Fromuth and Matt Levander are the two that I see online. (Chris McLarnon was also online.)

Ryan Duncan - Last Energy (00:01:51):

Just give me one moment.

Rep. Keith Ammon (00:02:04):

That's perfect.

Ryan Duncan - Last Energy (00:02:05):

We can all see you now?

Rep. Keith Ammon (00:02:07):

You can all see, and this is being recorded just to let everyone know. Thank you.

Ryan Duncan - Last Energy (00:02:10):

Okay, that sounds good. Well, thank you everyone. I really appreciate you having me this morning. I look forward to giving you this presentation, but also answering any questions and having a little bit of a dialogue around this as well. So as mentioned, my name is Ryan Duncan. I'm the director of government relations for Last Energy. Last energy, as you'll learn through this, is a micro modular nuclear power plant developer. Basically what happened was back in 2017, we started our organization as a think tank called the Energy Impact Center. We decided we wanted to tackle climate change in the best, most effective way possible, and that led us to look down the energy route. There was a lot of different ways to approach this from an energy perspective, from the renewables to nuclear to others. But really when dissecting what the best way to go forward with, we decided that nuclear was the right path.

(00:03:11):

But we took quite a few years in talking to experts throughout the industry, both here in the United States and abroad, to determine what really was the problem with the nuclear industry and how could we approach it to potentially fix that or come up with solutions for the future. And so we determined three root causes. One, these projects take way too long. They go well over the timeframes in which we've set, and with that they go way over budget. We are seeing that today with some of the projects that are coming online, coming at billions over their projected budget. And when you take these two factors into consideration, really all that's left is for large utilities and governments to be able to fund and to put these projects on the grid. And we determined there's got to be a better way to do this. And so what we did was we took a lot of lessons learned from multiple industries, oil and gas, from renewables, from other business models, and we applied that to nuclear in a way that really has not been done before.

(00:04:19):

And so our solution was this, and we're going to dive deeply into each of these, but one is from a technology standpoint, really not reinventing the wheel, sticking with time tested technology that's been around for decades, but instead innovating on the way that we construct these power plants in a modular factory setting. Second is private financing. We have decided and have held true to this day, not to take any government funding. We are fully backed by venture capital, private equity investors. This allows for us to really cut down on a lot of timelines and to be able to get these power plants manufactured and on the grid as quickly as possible. And then lastly, we are not a vendor, but we take full responsibility for the entire lifecycle. So we build own and operate our power plants and we sell energy direct to our customers.

(00:05:17):

So we have this energy as a service model, very similar to what you would see in the renewables industry. So that kind of highlights this here. We felt that this model really took the onus off of the customer. We want the customer to be able to focus on what they do best, whether that's a government with their services, whether that's a steel or other heavy manufacturer or maybe a data center. There's a lot of worries that they have on their end and they just want to have good clean energy. So we've taken it upon ourselves to finance each of the projects to build, to own, to operate, to have the insurance and all the other things that go into a single project all the way through to decommissioning of the plant. And we've found that that model has been very attractive to our customers and has gotten us to where we are today with a lot of the PPAs that you'll see later on in the presentation that have been signed to date.

(00:06:19):

So this kind of touches on a few of those, what I've already mentioned in a different way. So that full circular build to own operate. I kind of mentioned energy as a service. We do that through power purchase agreements. And our power purchase agreements could be anywhere from 15, 18 years upwards to 25 years of selling that energy directly to those customers. I already mentioned private financing, but as you'll see as we get a little bit closer into the technology portion of this, we have built and designed our power plants to have flexible siting and scalability. This has been really attractive for customers as well. There's a lot of developers out there that are producing plants at one megawatt level that might be too big for a lot of customers or some that are building at a certain level that's too small. We are able to scale in a fleet-wide approach, which is great for many different customers.

(00:07:18):

And then for siting, traditionally in the nuclear sphere, you've had to be near a big body of water to allow that large amount to water to cool your plant. As you'll see, we have designed our plant in a different way so that they're air cooled to allow for that flexible siting just about anywhere. And because of all of this, because we're sticking to time-tested technology because we're sticking to off the shelf components, we're using supply chains that exist right now and therefore we could stick to a 24 month delivery. So from the time that the actual final term sheet assigned, once the regulatory process is good to go, it's 24 months to get those modules built in the factory, delivered on site and reassembled. And I'll show you an animation that kind of looks at what that building on site looks like. So now I kind of want to get into a little bit of the technology.

(00:08:20):

I'm going to keep this pretty high level. I am not a nuclear engineer by trade, so we're going to just hit the wave tops here. But like I said before, we're not trying to reinvent the wheel. We're using that time-tested technology and that is a pressurized water reactor. That is what is used in over 300 plants around the world. And we feel that not only is it a successful use of nuclear technology, but the supply chains already exist for 'em. We're using those standard components and equipment. We are using vendors all over the world, a lot of which are here in the United States that already had this equipment on the shelf ready to go so that we could stick to those timelines that we agreed to. As for our size, we are 20 megawatts electric, about 80 megawatts thermal. But again, we can scale to a customer's needs. So when we talk about some of the current deals we have, I can talk about how we're scaling in a fleet-wide approach upwards to 200 megawatts for some of these projects.

(00:09:22):

For the construction, this is actually what we're innovating on. We're not really doing anything new with the technology, but instead how we built them, this is that factory built and factory module kind of component. So we look at it like a Lego kit. What you're seeing over to the right is a design, a depiction of what one power plant would look like. It is built of about 40 different modules in the construction animation. You'll see in a moment you'll see how those are put together, but that allows for rapid assembly on site. Each of those modules is about the size of the trailer of an 18 wheeler or the standard size shipping container. So very easy for transportation anywhere in the world. And then for digital controls, we get a lot of questions about how many people do you need to operate one of these plants.

(00:10:14):

If you look at energy and power plants around the world today, especially some of the new ones, a lot of them are run pretty much on their own. I know that can be scary in the nuclear sector. And yes, there will be people on site operating the plant, but there are a lot of digital controls that can be put into power plants these days. A lot of safety mechanisms, and we're trying to harness as much as that as we can and learn from the oil and gas industry of how they operate their plants today and put that into our design. So it gets a little more into the weeds of the technologies, a cross section of the plant. I just want to highlight a couple of things here. One is all the nuclear components are subterranean. So you're seeing here where the number one is, is what we call the atomic battery.

(00:11:04):

So the plant has a 42 year lifecycle. It has refueled every six years. So the seven times it has refueled over its lifecycle. Each time that it's refueled, one of these atomic batteries has dropped into the ground, the one prior to it. So for instance, what you're seeing right now would be the first one behind that atomic battery would be an empty slot for a second one. So six years later, an additional one gets dropped in That one previously though stays in the slot that it was in. The way that this is designed is that the plant acts as its own dry cast storage. We want to minimize the exposure to humans and we want to keep the spent fuel on site for the entirety of the lifecycle of the plant. So every six years, a new one gets dropped in at the end of the 42 year life cycle.

(00:11:57):

We then will cover up the dry cast storage where those fuel supplies are. We will decommission the plant itself. And then once those fuel rods or fuel cycle fuel assemblies actually are ready for transport, whatever country that we're operating in where this plant is, we'll have an agreement with the regulator to then move it to a long-term storage facility. So number two kind of gets at how are we able to keep it in the ground for an extended period of time. So we have built this iron cask that again acts as that dry storage. We do not use concrete in our plant at all. That was a decision that was made to really minimize on the construction time. Instead, we use a lot of cast iron and other materials that are allowing us to still have the same level of safety, but again, allowing us to be a little bit more flexible on those timelines.

(00:12:52):

And then what you're seeing up at the top, the balance of plant, again, this is those 40 module units that are all air cooled. So you could see at the very top the fin fans, those allow for the plant to be cooled without water again for flexible siting. So if you have a customer that's not near a big body of water but could really utilize nuclear energy, we could still site this plant next to them. So this is going to get into a construction animation of pretty much everything I've discussed so far. This is going to show you exactly how the plant is built on site. So what is happening here is they're going to be preparing the land. This is about a half an acre, so pretty small footprint. Now again, there is a safety barrier all around that. That's about a hundred meters, but the plant itself is only about half an acre.

(00:13:42):

So here they're digging the subterranean components and then they're going to start building the iron cask where the fuel assemblies will go. So this is going to be dug, it's about 48 feet, and then they're going to start putting the foundation for the balance of plant itself. So here are the modules that'll be coming in. Again, standard size on a back of an 18 wheeler. This is going to be the surrounding for each fuel assembly. They're going to be dropping in eight of these. I had mentioned before that we have seven fuel assemblies for the lifecycle of the plant, but we always have an extra just in case something were to happen, we can have that extra slot available for one of those fuel assemblies. So next you'll see all the rest of the modules for the balance plant coming in. They're going to lay 'em out. Once they're all laid out, they'll be then installed on the site itself. Again, this happens fairly quickly. We're using a lot from the oil and gas industry on how they quickly build their plants. Especially when you think of the rigs out at sea, they have to be able to put those together pretty quickly. So a lot's done in factory. This is utilizing a lot from the oil and gas industry for quick assembly so we don't have to use concrete and other components.

(00:15:03):

Once this is done, you'll see that we will continue to build other parts of the plant. This is only a few months. We're really talking about 90 days. There's an extra about month or so built in for any issues that would happen. But because of the modularity of this, we can do it fairly quickly. But now you're about to see the fin fans at the top. This is what's cooling the whole plant itself. We've get questions about safety and what if the fin fans fail. They're all in separate systems, so for them all to go down at the same time would be a pretty dramatic event. But we've factored in a lot of safety elements as well that we could talk about. But this is one of the fuel assemblies going in. So this will be the first, it'll go for six years. We do not reshuffle the fuel either, so it's not being pulled out in 18 months or so. Like other power plants, it's going to run that full six year cycle until another one is added. And this kind of goes through some of the specifics of what's in the balance of plant, but again, very generic to what you would see in any power plant around the world, including nuclear power plants.

(00:16:13):

And so this is just one you'll see when they zoom out. There is several other in the background. So this would be a customer that might need say 80. So there's four here. So 80 megawatts electric, we can build in that fleet wide approach to get to any customer's needs. Move to the next one. Alright, so we have done a lot of prototyping. We're doing all of that in Texas, just outside of Houston, in a town called Brookshire. So this is a prototype of our nuclear steam supply, the one that you saw being dropped in the fuel cycle. We're doing a lot of different type of prototyping here and we have been and continue to. So this is a great place for us to test to see how all of our design is working. So this is kind of where I want to spend a few more minutes and talk about exactly where we are today.

(00:17:07):

So we are manufacturing in Houston. Our headquarters is in Washington DC. But all of our commercial activity right now is in Europe, specifically in the United Kingdom, the Netherlands, Poland, and Romania. When I mentioned earlier that last energy started as a think tank, the Energy Impact Center, when we determined that nuclear energy was the route we wanted to go down, we basically looked at every country that the United States had a 1 2 3 agreement with. And we looked here in the United States as well to determine what was the best commercial sense for us to get started. Where was the most demand? Where were energy prices the highest and several other factors. The United States for us at the moment did not make sense for a couple of those reasons, but Europe did. The energy prices are very high, the demand is exorbitant. The regulatory process is fairly simple, particularly in how long it takes to get through.

(00:18:12):

And so this is where we decided to focus our energy for the first deployment of our power plants. So right now we have 25 billion worth of power purchase agreements signed with off-takers in the United

Kingdom, Poland and Romania. And that is for 51 units. We are in pre-licensing right now in United Kingdom, Poland and Romania. That means we have met with the regulators, we have done technical workshops, we have provided white papers on our safety case and design, and we are about to enter the licensing process in both the United Kingdom and Poland in those countries. It requires an actual site that we plan to develop on. So we've been working with the customers that we've signed PPAs with for siting, and once we have that finalized here, soon we'll actually enter the formal licensing process. The Netherlands. That is a country that we have been engaged in, but not as much as the other three.

(00:19:15):

We are still looking at what the customer demand looks like in that country, still having some conversations with the government, but that's the fourth country that we look to get into. And I'm talking here to a US audience. So I'll say, look, we continue to have an open eye to the US market. We have not seen the demand signal that we have seen in Europe. We also, I'm not going to say something that's shocking. I think to many people, if you stay on the news of the NRC and how the nuclear environment looks here in the United States, some of these advanced modular reactor companies, SMR companies like us want to see some changes from the NRC to make the process a little less arduous. It can cost a lot of money. It could take a lot of time to go through the NRC process and without a clear demand signal from customers here we have seen in Europe, we are wanting to kind of step back and wait and see what the NRC is going to do.

(00:20:20):

We've had lots of meetings with stakeholders here in DC, especially on Capitol Hill that oversee the NRC. We think a lot of great work is being done. We pat them on the back and say, keep going. We will keep watching. But when it comes to first of its kind technology like this and commercial viability, we think Europe is the place for first deployment and that's where we're going to put a lot of our energy now. So this is kind of just an overview of our team, our CEO, our engineering team. We have a very robust engineering team. We have people that come from our national labs here at the United States. We have folks from big nuclear technology companies, GE and others. So a very robust nuclear engineering team. Also those from other energy sectors, oil and gas, and other manufacturers as well.

(00:21:18):

We have a lot of key investors. So our company's been around for three years. We've been primarily funded by those at First Round Capital by Giga Fund who funded SpaceX and by a former chairman of the board of Microsoft as well as a lot of other investors. And we keep a lot of key advisors, former NRC commissioners. We have former presidents of the regulatory bodies in the countries that we are engaged in Europe as well as a number of other folks as well. So I'm going to go ahead and pause there and open it up for any questions you all have for me.

Rep. Keith Ammon (00:21:59):

Thank you, Ryan. That was very informative presentation. It's amazing what you can do with computer graphics nowadays. You can build the entire plant. Very interesting.

Ryan Duncan - Last Energy (00:22:11):

Yes.

Rep. Keith Ammon (00:22:12):

So I'll throw it out to the room. Any questions to start off? Anybody?

Daniel Goldner - PUC (00:22:20):

Did I miss how much it cost?

Ryan Duncan - Last Energy (00:22:23):

No. Yes, I did not mention that. So one plant is around a hundred million dollars.

Rep. Keith Ammon (00:22:31):

Alright, and then I was jotting down a couple of technical questions. How do you control the reactor? Is it all just done with physics or is, I mean is it preset with your fuel mixture or is there some control mechanism to control how hot the core is?

Ryan Duncan - Last Energy (00:22:51):

Yeah, as I mentioned before, I'm not a nuclear engineer so I can answer this 30,000 foot level and I can get you more details as well from our team. But there is some proprietary passive cooling that's being done, some physics that's built into it as well as some actual physical construction, the way the actual core is constructed itself. But we've put together some answers to questions like this before, so I can happily send this to you afterwards.

Rep. Keith Ammon (00:23:22):

Okay, great. I guess my other question might be on that list, you said six years and then you'll add a new fuel unit. Does that mean that that previous unit was completely spent or is there some way to utilize any leftover energy in the previous unit?

Ryan Duncan - Last Energy (00:23:44):

Yeah, it's not going to be completely spent, but we are in talks with some companies about reprocessing that fuel as well. We definitely want to see that we can get as much out of it as possible. I think what I wanted to really hit on there was there's a lot of, especially in the past, a lot of talk of reshuffling of fuel. So every 18 months or so those fuel rods would be reshuffled. We are not doing that. We are putting it in the ground for six years, letting it stay, letting it run. Its full course now at the end with decommissioning when we're actually moving that somewhere. If there's opportunities to reprocess that, we would definitely take that under consideration. But that's something we're still in talks with our engineers and other companies.

Rep. Keith Ammon (00:24:32):

Great. If anybody has a question online, just use the raise your hand feature of Zoom and we have one from Paul Guntner here in a second. I did want to mention Chris on Zoom is Chris McLarnen, he's a professor at UNH. He teaches physics, so he's also a commission member. I just wanted to point that out. All right. And we have a question from Paul Guntner from Beyond Nuclear, I believe. Paul, do you want to unmute?

Paul Gunter - Beyond Nuclear (00:25:03):

Sure. It's Paul Gunter and I'm with Beyond Nuclear. Yes, we're in Maryland. So given you've got Jeff Merrifield on there from former NRC Commissioner, it is curious, but as I understand, you're not approaching the US Nuclear Regulatory Commission, is that correct? I mean is it correct to say that you're avoiding them or

Ryan Duncan - Last Energy (00:25:38):

No? No, not at all. No, we're definitely not avoiding them. We're just not putting forward a license for the NRC here in the United States right now.

Paul Gunter - Beyond Nuclear (00:25:46):

Well, globally, the US NRC is sort of considered the gold standard. And I'm just curious, so Poland doesn't have really an established regulatory body. I mean they're just in the process of doing that. I understand that they are relying a lot on consultation from the US Nuclear Regulatory Commission, but so you're expecting more of a unobstructed or smooth sailing going through a regulatory process that doesn't really have a lot of history. Is that correct?

Ryan Duncan - Last Energy (00:26:36):

Yes and no. We very much recognize that a country like Poland who does have a fairly new regulatory process, there's going to be hurdles and speed bumps. I will say yes, you're correct. They do work with the NRC quite often. We have a lot of engagements with stakeholders across the US government, not just NRC but Department of Energy. We want to make sure that they are as much up to speed on what we're doing as what we're providing to the regulators in these European countries because we do recognize that there is a lot of interaction between the two. Our kind of philosophy on that was even with some hurdles within Poland, just for example, but you could apply the same thing to any of the other countries that we're operating in, it would still cost significantly less and potentially be less amount of time than what an NRC license today if I were to submit a license today would take. And from a business perspective, that's just the decision we decided to make at the time and are still holding to 'em.

Paul Gunter - Beyond Nuclear (00:27:51):

So in your modular approach for these units, and this will be my last question question, I noted that I didn't see anything for common mode failure for grid failure. So I mean your fan system I assume, I mean it figures that it's going to be powered by the electrical grid, but a common mode failure that you'd have to incorporate into your design would be what happens if the grid goes down either by earthquake or security issues, but what are you using for backup power and safe shutdown?

Ryan Duncan - Last Energy (00:28:37):

Yeah, let me get you an answer offline for that. I do know our engineers have put thought into that and do have an answer. I just don't have that readily available right now.

Paul Gunter - Beyond Nuclear (00:28:47):

Thank you, that's all.

Ryan Duncan - Last Energy (00:28:50):

Thanks

Rep. Keith Ammon (00:28:50):

Thank you, Paul. And just throwing it out there for continued questions in your slide, I think the country with the lowest number of units, it was five units and I guess that would be a hundred megawatts. Would it be feasible to entertain a customer with just a single need? Single?

Ryan Duncan - Last Energy (00:29:18):

Absolutely. And some of those customers are just a single need and we're currently having conversations as well with others that are single need as well. There's also conversations that maybe a customer only needs 10 megawatts, so what within the general vicinity might also need and could utilize that additional 10. So there's a lot of different options that we can look at with a customer, but basically we start with them and their needs and build out from there.

Rep. Keith Ammon (00:29:48):

And I have two more and anyone else is invited to ask questions. The NRC process for advanced nuclear that's sort of being built out currently, does your design fall into that? If they do make progress in licensing advanced nuclear, does your design fit that within those parameters?

Ryan Duncan - Last Energy (00:30:12):

Yes, that's where we would target our licensing is through that new advanced reactor licensing process.

Rep. Keith Ammon (00:30:21):

Okay. And assuming it's the last question for me is the type of fuel you use is HALEU, is that correct?

Ryan Duncan - Last Energy (00:30:28):

No, actually, sorry, I forgot to mention that. Another reason, or it kind of falls under this philosophy of using time-tested technology, we're using standard sub 5% enriched uranium fuel. So we're not using HALEU or any of the other fuels that are going to be under development. Now, I will say this sticks to our business model of trying to get nuclear energy on the grid as quickly as possible and stick to these lower construction timelines. But technology maturation years down the road, if HALEU becomes readily available or another fuel supply and this is where everyone's going and it's safer and makes more sense for us to use, that's 100% something we would be considering for our plan. But right now and the way the supply chains look, standard of 5% enriched uranium fuel is where we decided to stick.

Rep. Keith Ammon (00:31:25):

And that's maybe an advantage over some competitors, is that correct?

Ryan Duncan - Last Energy (00:31:31):

It can. I mean everyone's got different business models and different customers, but we felt it was the quickest way to be able to cut through supply chains and to be able to get these power plants built before 2030.

Rep. Keith Ammon (00:31:45):

Interesting. So you have a nuclear battery that's run on conventional fuel.

Ryan Duncan - Last Energy (00:31:51):

Alright,

Rep. Keith Ammon (00:31:52):

Very interesting. And your energy as a service model is also interesting. The fact that you're completely privately funded could make you more nimble?

Ryan Duncan - Last Energy (00:32:04):

Definitely. And again, that goes back to us wanting to take as much off of the customer's plate as possible. We want to be able to push through these ambitious timelines and so that's kind of why we decided to go with that model.

Rep. Keith Ammon (00:32:18):

Okay. Can I ask one last question and then my stream of consciousness here will be over the types of customers that you are arranging purchase power agreements with? Are they municipalities or are they private industry for manufacturing and so forth? What do they look like?

Ryan Duncan - Last Energy (00:32:38):

Yep, mostly industries. Some quasi government, special economic zones that have a lot of manufacturing companies within it, but think heavy manufacturing, steel, cement, big data centers. We also have some customers that are getting into the green hydrogen production and so they're going to be building out their facilities and then from the special economic zones, so this is a lot of what Eastern Europe does. Some of their special economic zones are run by coal fire power plants, so transitioning those. So that's our main customer, not so much municipalities or residential, at least for now.

Rep. Keith Ammon (00:33:20):

Okay, great. We have a question in the room from Dan Goldner. He's the chair of our PUC in the state. The mic's right there I think.

Daniel Goldner - PUC (00:33:30):

Yeah, I was just curious about the motivation of the folks in Poland and the Netherlands to put in one of your plants. Is cost a part of it or is it just converting from coal? Can you talk more about the motivation?

Ryan Duncan - Last Energy (00:33:44):

Yeah, of course. No, I think it's across the board. I mean they have very high energy prices even before the war in Ukraine. They really want to get to decommissioning, or I'm sorry, decarbonization, they have very heavy carbon footprints in those countries. And then with the war in Ukraine still going on, they want to be completely resilient with their energy internal to their countries. So not being able to rely on anyone else. So when you factor 'em all together, you're seeing a lot of push in countries like Poland and Romania and our model's attractive to 'em, but we're not the only ones. There's plenty of US companies and other international companies operating in those eastern European countries. So together we're all trying to meet their needs.

Daniel Goldner - PUC (00:34:35):

What kind of a cost point are you at today? You talked about the plant costing a hundred million dollars, but in terms of a per kilowatt hour cost, can you give us sort of a general idea of where you're at on that right now?

Ryan Duncan - Last Energy (00:34:47):

Yeah, look, each country is a little bit different and each deal is a little bit different. What I can say is the operating costs, I think we landed on around $70 and so it'll fluctuate from there depending on the customer and the country, but operating cost around 70.

Daniel Goldner - PUC (00:35:06):

Okay, thank you. And the last question is how close can you put these modular reactors together? Do they have to be a mile apart, a half mile apart, 10 miles apart?

Ryan Duncan - Last Energy (00:35:15):

Yeah, so together they can be pretty close. It's about a half an acre and then it's a hundred meter security perimeter. There is another boundary that's going to go around all of them, but if they're sited together in a fleet approach, give or take about 200 meters.

Daniel Goldner - PUC (00:35:32):

Thank you. That's all I have, Keith.

Rep. Keith Ammon (00:35:34):

Okay, great. Thank you very much Ryan. We will reach out to you with further questions, I'm sure.

Ryan Duncan - Last Energy (00:35:42):

Yes, definitely do stay in touch. I'm happy to provide more answers in written form.

Rep. Keith Ammon (00:35:47):

Great. And maybe you could share your contact info and if you're comfortable sharing those slides, we'll put those up on our website.

Ryan Duncan - Last Energy (00:35:54):

Absolutely.

Rep. Keith Ammon (00:35:56):

Alright, great. Alright, thank you. And you're welcome to stick around or drop off it's your preference. Next up we have Ryan Umstattd and correct me if I'm saying your last name wrong.

Ryan Umstattd - Zap Energy (00:36:11):

You've got it.

Rep. Keith Ammon (00:36:11):

Okay. Easy enough from Zap Energy and I just want to make this clear from the start, this is something completely different. We're talking about fusion energy, they both have nuclear in the name, but fusion is drastically different type of technology. We have not had a fusion developer present to us, but I think it's good that we have at least some idea of what the future might hold for fusion energy. So with that in mind, I know Ryan, you'll underscore that point. We'll turn it over to you and if you need to present, feel free to share your screen.

Ryan Umstattd - Zap Energy (00:36:49):

Great, thanks much. Hopefully this is showing up on your side now. Do you see a full screen there?

Rep. Keith Ammon (00:36:56):

Yeah, you're good to go.

Ryan Umstattd - Zap Energy (00:36:58):

Great. Well thanks again to everybody for sharing some of your time with me today and for the opportunity. So again, this was already hinted at Fusion is something quite different. I understand this commission is looking at various forms of nuclear. I think that the main thing that Fusion shares with its fision cousin is the fact that when you break apart or put together atoms, these nuclei can give off lots of energy. And so because in fusion we're bringing small nuclei together and making larger ones, we are indeed a nuclear process. But beyond that, there's a lot, pretty much everything else is different between fission and fusion. So much so that the NRC has already decided that fusion is going to be regulated under a vastly different framework. Our regulatory structure is going to look a lot more like what they would use for particle accelerators, for example, that might be used at medical facilities or for research and development simply because it's already recognized that the risks and hazard profile and the safety profile of fusion is quite different than with fission.

(00:38:03):

But with that as an intro, lemme go ahead and step through a little bit of material. We'll cover a little bit about fusion, how it's different Zap Energy and where we are in our research and development and commercializing our technology. But I also should at the very beginning, note that again compared to the Fission cousins, there is no commercial fusion energy yet available. Fusion is still in research and development, but there's been some extremely promising results around the world. And again, even within Zap Energy within just the last couple of years.

(00:38:37):

We're about 150 people located just north of Seattle. We spun out from the University of Washington a handful of years ago with a co-founder. Our president is an entrepreneur and the two other co-founders are scientists and professors from the University of Washington.

(00:39:03):

The idea here is that we spun out with the purpose of commercializing fusion energy based upon our specific approach. And so we're not here just to prove the science or prove the engineering, but to actually deliver a product.

(00:39:18):

We have cultivated a healthy set of investors, everyone from climate focused energy, strategics, oil and gas. And so we've got the backers who not only can help us financially, but also interfacing with the industry to which we're trying to bring a brand new technology. Fusion is indeed the ultimate universal energy source. Everything that we get here on earth basically comes from the sun, which is driven by fusion reactions, but the process of fussing small atoms together doesn't produce harmful exhaust or large quantities of waste. In fact, we don't have spent fuel. Our spent fuel is basically helium because we're taking two small isotopes of hydrogen, fusing them together.

(00:40:13):

We get an energetic neutron as well as a helium atom comes out of it. So our exhaust could literally be filling party balloons, but again, it's relatively small quantities. So I think we'll focus on electricity as opposed to helium for party balloons for our revenue stream.

(00:40:29):

Now we can design the plant through proper material selection to avoid the generation of long-lived waste. There are energetic neutrons flying around, so you do want to be careful about what materials are used to moderate and slow down and capture those neutrons. And so we have to do smart material selection to make sure we're not making anything that has an extremely long lifetime in terms of its radioactivity.

(00:40:53):

The other key thing here is that with fusion energy, it's a powered or a driven process, you have to actually heat compress and confine this fuel to make fusion happen. And so that basically eliminates the possibility for a runaway reaction or a meltdown if you stop trying to heat compress and confine this plasma, it simply relaxes back into its hydrogen isotopes in a safe manner.

(00:41:21):

Looking a little bit about how does diffusion fit into the energy mix and why we think there's an opportunity here for fusion, even with the increased penetration of cheap renewables and adding, we know that the world needs a source of on demand, clean, safe, scalable energy. And the models I've seen indicate that as renewables penetration gets much above 80%, maybe 90%, there's significant challenges to actually closing it out decarbonizing entirely with costs starting to go through the roof as you try to close that last 10 to 20% to decarbonize it. And so that actually creates an interesting opportunity for something like fusion to come in and be able to serve that.

(00:42:15):

To describe a little bit about what's going on at the micro level here inside of fusion again, as opposed to taking a large atom that wants to break apart and breaking it apart and getting excess energy out that way. We come at it from the other side of the periodic table. We're taking two isotopes of hydrogen deuterium and tritium fussing them together and in the process generating significant amounts of energy. Some of that energy, most of it's actually carried by the neutron, but also plenty of energy going into the helium nucleus that comes out as well when we talk about sustainability and people talking about, hey, the fusion fuel is limitless. What we really mean there is that the deuterium, which is actually it's commonly found, it's a naturally occurring isotope and so it can actually be extracted from seawater. And so we have basically a limitless supply and anybody who has access to water can extract out the deuterium and use that as a fusion fuel.

(00:43:15):

The tritium actually is not naturally occurring in the quantities that would be needed, but it can be readily produced inside of the fusion energy machine by letting high energy neutrons interact with lithium. And so our other fuel besides deuterium is actually lithium, but again, because of the energy density of this whole process, we're talking about kilograms of lithium per year to run a module that would be designed in our case for about 50 megawatt electric output. And so small quantities of fuel being the deuterium and the lithium that are brought in to the plant each year to generate all this excess energy as well as some helium gas as the output.

(00:44:02):

So how has fusion been done to date? Many decades of primarily government funded research have led to two of the largest approaches in terms of gathering funds, but also in terms of physical footprint and cost as well. So what we see here on the left is one can heat and compress and confined this deuterium and tritium fuel mix with holding it with big magnets. It's at such a high temperature that you can't touch it with anything physical, but you can confine this charged gas, this plasma by using magnetic fields. And so what's shown there on the left is a cartoon of the eater device being built in France to the tune of 25 billion and rising. And it's been ongoing now for a couple of decades. So while it may actually lead to some really fantastic fusion science, it is not on a commercial pathway and I don't think anybody expects to be able to build something like this and make it commercially viable at this scale and cost.

(00:45:07):

The other way to heat and compress and confine this plasma to get the fusion reactions to occur is with inertial confinement, which typically uses very large lasers. Over on the right we see National Ignition facility, which has 192 laser beams powered using an infrastructure that takes up the area of about three football fields to heat and compress a tiny pellet of fuel. Fantastic scientific results from just late last year that they actually got more fusion energy out of that fuel pellet than the laser energy that entered into the target region. Now the energy they used to power those lasers was still more than a hundred times greater, so they're nowhere close to an engineering break even. But again, it was important for the scientific community to demonstrate that there is no fundamental barrier preventing us from getting more energy out of the plasma than what we've put into it. So great science, but again also not on a path that we believe leads to a commercially relevant power plant.

(00:46:13):

So that's sort of the idea behind most of the massive government funded approaches to fusion. I'm going to show you now about talk to a little bit about how Zap Energy does it. And so we're using sort of something old with something new, a Z-pinch. So if you've ever had to struggle through an engineering or math class or electronics class like I did the right hand pool, which is basically anything that's carrying a current, if you point your thumb in the direction of that current, there's a self-generated magnetic field that curls around the direction of that current flow. If you are a charged particle moving in that magnetic field, you're going to feel a compression force, a squeezing force that wants to make you move towards the axis of this cylinder in this case. And so actually back in the 1950s, researchers thought that, hey, maybe we can just run a bunch of current through a plasma, it'll compress itself and we'll get fusion reactions.

(00:47:09):

And so that was one of the first approaches at trying to make a commercially relevant fusion. But they found that these Z-pinches have some natural inherent instabilities they would quickly turn into it would kink or it would turn into a bunch of sausages which would break up the heating and compressing such that they couldn't get enough useful fusion reactions out before the whole thing would fly apart within nanoseconds. So the innovation that one of our co-founders came up with in the mid nineties is to now think of the plasma instead of it just being a static column of gas, it's a flowing river. And if you make different parts of that river flow at different velocities, you have what's called sheared flow and that can be used to actually help mitigate these instabilities. Let me show you a little animation that sort of describes what we mean by sheared flow.

(00:48:04):

So in this case, there's artist's conception here of a stream of plasma where the outer parts of it are moving at a different speed. So now as plasma in the center wants to develop a kink or break apart, it's actually prevented from doing that by being bumped back into its lane on this freeway that is carrying all of this plasma. And so we've shown now both in the theory as well as in simulations and models as well as now in several experiments over the course of many years, that we can stabilize these Z-pinches. So instead of them flying apart within nanoseconds, we're holding them stable for many, many microseconds, so thousands of times longer than they should based upon the inherent instabilities. So the true question that remains for us now is as we're keeping it stable, can we maintain this stability as we continue to heat it and compress it even more? Because again, the fusion reactions that we get out are very tightly coupled to the heating and compressing of this plasma fuel.

(00:49:11):

A little bit about our results. So we've been making fusion in our labs ever since 2018. The company was founded, we brought the FuZE device there shown in the upper left. We brought that up from the University of Washington, put it in our facilities just north of Seattle and started making fusion reactions. And so what we see here, the middle graph is basically showing how the performance of the device is predicted to scale with the current flowing in the pinch itself. On the right we see some of the data of the early neutron counts from this FuZE device. As we start to increase its current, it was really only designed to handle and be able to push about 400 kilo amps of current into the Z-pinch. And so we got it to that level, we got it to 500 kilo amps, but we also knew that we needed to design and build the next system, which is FuZE-Q, so named because the Q again is the common term for the gain out of a fusion energy device.

(00:50:17):

And so this device is purpose-built with a power supply and all the ancillary systems that should be capable of achieving a Q of 1, basically a scientific energy breakeven. Something akin to what we saw out of the Lawrence Livermore National Lab National Ignition Facility. So this device was commissioned last year. We are in the process of operating it, but you can see that as we've started to increase the trends that we're getting are very promising in terms of the fusion reaction rate that we're achieving. This looks like it's skyrocketing, like it's off the charts and it is very promising, but I got to tell you, this is exactly what we need to see. We're still many orders of magnitude away from the kinds of neutron counts, the fusion reaction rates that one would need for a commercially viable fusion energy machine, but this is exactly going in the right direction as we see from operating the device day in and day out.

(00:51:17):

We're making fusion reactions every day, but there are a lot of adjustments that we can make with this new device in terms of the electrical pulse that's being applied and the timing of that, the injection of the fuel gas, the way that it's puffed in and the timing of that. And so as we're exploring this space and trying to get the best heating and compressing that we can, we're finding that there's still going to have to be more development needed to get us to the scale that we need for a commercial power plant, but extremely promising results as we've started to exercise the muscles from FuZE-Q.

(00:51:55):

I want to share now what this starts to look like as you go towards a more practical fusion energy machine. In this case, we take something like the FuZE-Q and we turn it vertical. And the reason we do that is because one of our electrodes for this Z-pinch discharge is a flowing liquid metal wall That flowing liquid metal wall does a lot of workforce.

(00:52:23):

It's catching the neutrons, it's turning that into usable heat. It becomes our heat transfer fluid. And again, part of this liquid metal is composed of lithium, and so it's actually breeding the tritium that we need and can then extract to help fuel the machine. But as we look at how it works, we are a pulse device. It's not that drastically different from sort of what goes on inside of a cylinder, an internal combustion engine, right? You're injecting some fuel gas, you then heat and compress it. In our case we're doing that with an electrical pulse that's driving this plasma down the axis and then you get it to the conditions that you need for the reaction to occur. You catch all that energy, do something useful with it, and then you exhaust the system and do it all over again in a commercial application. For us, this would happen at about several times a second in terms of the gas injection and then evacuating it out in between pulses.

(00:53:23):

We can take this module now and enclose it in the appropriate exterior shielding. And I think that what we find is that this Z-pinch is one of the simplest and perhaps most cost-effective approaches to fusion energy. We've got a person down there for scale, but again, our natural size for this technology is about a 50 megawatt electric module. And again, plants can be built off of several modules and because of the size of this, we can also then similar to the previous speaker, our model would be to put these pieces in shipping containers and then ship to site for an install rather than actually trying to build a power plant. It's not a construction project as much as it is an installation project. Over the course of just a few months, as we're still in parallel developing this technology in our lab and proving out the performance of that device, we've started a systems engineering team developing all of the ancillary technologies like the electrical pulse power that must be applied repetitively, the liquid metal walls and everything else that it's going to take to build out a pilot plant.

(00:54:43):

A lot of my role at the company is in looking at that path to our first commercial product. And so we have been assessing a site in Centralia, Washington. It's in the southern part of the state of Washington, the last coal-fired power plant in the state, and we're looking, it's retiring in 2025. We're looking at a piece of their facility as a prospective spot to put our fusion pilot plant looking at things like how much of the existing infrastructure could be reused, everything from cooling towers to the electrical grid interconnect and the switchyard as well as some of the facilities that are there. But it's also been extremely helpful working with an actual power provider there in the region. TransAlta has been putting power on the grid in the region for decades now, and so getting to leverage some of their expertise working with the various markets has been extremely helpful and speeds up our progress in terms of our plans for commercialization.

(00:55:44):

So we're about to enter our second phase of this site feasibility assessment. We're going to, over the course of the next three years, be looking at things like the talent pool and making sure that we're ready to go when it comes to the labor that's going to be needed, looking at the condition of some of that infrastructure and understanding if it's going to need refurbishment and also trying to estimate what are the savings associated with that versus what are the actual costs of trying to reuse and meet our pilot plant to what's already there on the ground. As well as continuing the stakeholder outreach and engagement. I show there are a few handful of letters of support from folks that we've been talking to about this project over this first year. Eeveryone from the local utilities to city mayor as well as the Lewis County Commissioner's office.

(00:56:31):

And already today in our laboratories we're licensed by the state of Washington, their department of health for the fusion reactions that we're making. And so we understand the path to being able to license something like a pilot plant, but we're also still directly plugged in with the NRC as they're creating the framework that's going to be needed for the commercial fusion industry when it's actually at scale and putting plants all over the us. So that's sort of the intro to fusion and Zap Energy. Again, for us, the most rapid progress to commercial fusion energy is only going to be made by efforts that are smaller, cheaper, and faster than the national programs that have advanced the underlying science. That's kind of our reason of existence. With that, I'll open it up for any sort of questions you folks may have. Thanks for your time.

Rep. Keith Ammon (00:57:29):

Thanks, Ryan. That was impressive and completely different than we've heard before. I have some questions as usual, but I'll open it up to anyone in the room or online. Feel free to go first. My question is about the Q, which is really the crux of everything to be commercially viable. Could you go back to that slide with those graphs on it?

Ryan Umstattd - Zap Energy (00:58:00):

You bet.

Rep. Keith Ammon (00:58:02):

That one there. So the purple portion of both of those graphs, that is present day?

Ryan Umstattd - Zap Energy (00:58:12):

Yes. Now the lower right is experimental data. The middle graph is basically the modeling and sim based upon the theory. And so we're in the regime for where we should start to be able to get to a scientific Q of 1 where we're going to be able to generate enough fusion reactions that with our right now we're using just deuterium fuel, but we can make a DT equivalent calculation. And so that's the purpose that is driving the work that the team is doing day in and day out is learning how to drive the FuZE-Q to get the best possible performance and get above that yellow Q equals 1 line.

Rep. Keith Ammon (00:58:59):

So we're looking at that white arc and where it crosses the yellow line, this breakeven.

Ryan Umstattd - Zap Energy (00:59:06):

Yes. Yes. And so we should be able to get breakeven conditions within this range of 500 to 1000 kilo amps of current in the pinch. And again, the Q of 1, again, isn't nothing special or fancy about it in terms of the physics. And so we do expect that getting to Q of 1 is going to be really hard, but it's not that much harder or it's not going to be that much harder to get to Q equals five or 10, which again is where you start to become commercially relevant.

Rep. Keith Ammon (00:59:39):

And so the graph is in logarithmic format on the Y axis there. So you're quickly getting to much higher Qs and maybe I don't understand that exact metric exactly, but it seems to be pretty rapid progression on the right above that breakeven point. And so you're getting more energy out of the system than you're putting in, and you have hypothetical models that can predict what you'll get in your physical system, but then actually doing it in the real world would be like a breakthrough in energy production.

Ryan Umstattd - Zap Energy (01:00:20):

That's right. It'll be massive when in experiment we confirm that we are getting more energy out than what we put in. So I do want to say that we've taken some artistic license with these graphs here. And you're right, the middle one is a logarithmic scale on the vertical axis. The one on the right is a linear scale. And so again, it's because we wanted to be able to show the amazing progress so it's not on a logarithmic scale. And those purple data points that are from our FuZE-Q device on the right hand graph extremely promising. But again, it still needs to go much, much higher before we're approaching that Q of 1. So there's important science to de-risk as we figure out the best ways to operate this thing. So yeah, we're not at that Q equals 1 break even. And I can't predict exactly when if things go extremely well, this may happen much sooner rather than later, but right now it's still about learning how to best operate this device. It's got a lot more flexibility in terms of how we operate it compared to previous generations.

Rep. Keith Ammon (01:01:23):

The breakthrough that was heralded recently by the Department of Energy, where were they on that graph?

Ryan Umstattd - Zap Energy (01:01:30):

Right, so what they hit was basically this yellow line. So they were doing a different approach. They weren't trying to push a bunch of current through a Z-pinch. They used a bunch of laser beams to heat and compress the fuel, but they got this yellow line, a scientific break even where they had about two megajoules of laser energy hitting this target and they got about three megajoules of total energy released after all was said and done. But again, it's not on a commercial path because they needed 400 megajoules of energy to feed into those lasers that then drove the fuel capsule.

Rep. Keith Ammon (01:02:09):

Interesting. Could you go to the next slide? This is a really simple question.

Ryan Umstattd - Zap Energy (01:02:17):

Sure. It was

Rep. Keith Ammon (01:02:18):

The animation. So you mentioned there's liquid metal that's used. Is that what that shimmering effect in the background is? Is that

Ryan Umstattd - Zap Energy (01:02:25):

That's right. Okay. Yeah, it's flowing over a weir wall and then creating sort of a cavity that the plasma can operate inside of. The rest of the interior of this is filled. Essentially it's vacuumed. We evacuated out such that the only particles that are in there are the fuel gas.

Rep. Keith Ammon (01:02:44):

Where does the energy come to liquefy the metal? Is that part of the process?

Ryan Umstattd - Zap Energy (01:02:49):

Right. Yeah, so during the plant startup supply that energy through consuming electricity, we will have similar to many other power plants, we'll draw from the grid if it's from a cold start or a black start, but as we start to drive the fusion reactions, the fusion reactions themselves are enough to more than keep the liquid metal at temperature such that it stays liquid.

Rep. Keith Ammon (01:03:15):

And then my last question, and anyone else feel free to jump in then, so there's fuel connections at the top of that and they go out to some kind of tanks. You mentioned that the tritium is generated by the reaction potentially or by the process somehow. Could you just describe what those tanks look like and what the fuel supply chain looks like to feed the plant?

Ryan Umstattd - Zap Energy (01:03:43):

Sure, sure. Yeah. The tanks themselves are not going to be very large, and in fact, when we're puffing in gas, we're puffing in tiny quantities on the order of milligrams of fuel are being injected each time. And so the tanks themselves are much, much smaller for the gas. The compressed gas are much smaller than this fusion energy module that we show here, which is just again, about 10 feet by 10 feet. The largest component that goes into these fusion energy modules besides this module is actually the electrical pulse power system. So we have to take energy that we're generating on site, store it in capacitors, which can then discharge that energy very, very quickly into one of these pulses. These electrical pulses last on the order of a hundred microseconds. And again, we do it a few times a second, so we have time in between to clear the system out and prepare the pulse power to fire again. But the energy storage for that pulse power actually is a significant footprint. But again, the scale of our plants are such that these modules similar to the prior speaker, can fit on small numbers of acres of land. It's more about having the right security boundary than it is needing to have a large footprint of land for the energy system itself.

Rep. Keith Ammon (01:05:11):

Very neat. I can keep going. I won't go too long, long. How is the electricity, you mentioned that you don't use magnets, use coils, but not magnets. So could you explain how are the neutrons converted into electricity? Just so we have the basics.

Ryan Umstattd - Zap Energy (01:05:30):

Right. This is something that we also share with our nuclear cousins, and that is, so the neutrons here are caught in this liquid metal blanket. That hot liquid metal then flows through a heat exchanger and is used to then turn a steam turbine. And so yeah, a fairly common approach where again, this fusion energy module could, when we look at brownfield applications where we're going in and repurposing an old plant, whatever the heat source was for that old plant, this could sort of be a drop in replacement. Although realistically, we're probably going to need our own bespoke steam turbine because you really want to get a steam turbine optimized to the heat that you've got to feed it with.

Rep. Keith Ammon (01:06:12):

Okay. Interesting.

Daniel Goldner - PUC (01:06:17):

What's your trigger point before going to production? You're trying to get Q to five or 10 or a hundred, what's your trigger point?

Ryan Umstattd - Zap Energy (01:06:24):

Right? Yes. So a Q of five I think gets us at a commercial plant that can pencil out Q of 10 would be fantastic. Again, it just makes it a little bit easier on us to get things to pencil out. So while the R and D team is really focused on achieving the best possible plasma performance in parallel we're developing, I mentioned earlier the liquid metal blanket and the pulse power. And so really we've got a development path that marries those two together in an integrated demo. And the integrated demo is the last device we build that is for research and development purposes. After that, we've got our pilot plant that is now customer facing and intended to be an example of what the commercial product looks like. I mentioned, we can't right now accurately predict exactly how long it's going to take us to get to Q equals 1, but with the development that we're doing right now, we are building a schedule that if everything stays on track, we can make commercial fusion energy available in the early 2030s. And so again, turning on the pilot plant and getting some output from it as early as 2030. But again, I want to emphasize that this is not a developed technology like nuclear fission where there's decades of operational experience already being leveraged.

Daniel Goldner - PUC (01:07:44):

And if you had taken all the factors that you've learned so far and you look at the total sort of cost picture, have you guys penciled out what that cost would look like in the early 2030s?

Ryan Umstattd - Zap Energy (01:07:56):

Right,

Daniel Goldner - PUC (01:07:57):

In production? Yeah,

Ryan Umstattd - Zap Energy (01:07:58):

Sure, sure. Yeah. And I'll caveat and say that these are again, early estimates, and again, we haven't solved fusion energy yet, but we do have a good feel of the materials involved and the quantities of materials. And so when we look at our estimated capital cost, again, these have error bars in them, but it's around 3 to $4,000 per kilowatt in the capital cost and then the cost of electricity, the error bars get even larger because we're baking in other additional assumptions about the financing and the operations and maintenance. But I do believe we can come up with good upper and lower bounds for that. Does that drive us towards a levelized cost of electricity of between 30 to $60 per megawatt hour?

Daniel Goldner - PUC (01:08:41):

Thank you.

Rep. Keith Ammon (01:08:43):

Interesting.

Ryan Umstattd - Zap Energy (01:08:44):

So it's promising it's not dirt cheap, but it's going to be challenging to bring new tech into a commodities market when it's a first of a kind. It's really tough to break into cents per kilowatt hour and dollars a gallon, but finding the right beachhead markets and the right initial customer base allows us to scale up, get the experience, and start to drive down our costs.

Daniel Goldner - PUC (01:09:08):

Thank you.

Rep. Keith Ammon (01:09:10):

You mentioned regulatory processes are different for this technology. How far along the path is the NRC in building out a regulatory regime?

Ryan Umstattd - Zap Energy (01:09:23):

So it was just this April that all five commissioners signed out the decision that fusion will be regulated differently from fission and that they're going to try to do it under the part 30 byproduct materials. And so they've told their staff to get cracking and start working on it. And so we are now in the process of some limited rulemaking and the NRC estimate is that they intend to have that conclude by 2027, right? Again, I'm not a regulatory expert. It's mind numbing to me to think that it takes that long to figure out how we're going to create a framework, but it is what it is. And so we're going to keep working with them on making sure they understand that the differences in the different fusion approaches, but that also that we understand our hazards and our risks and how to mitigate them.

(01:10:13):

And that timeline, frankly, of a regulatory framework by 2027 is compatible with us being able to put commercial fusion on the grid in the early 2030s. So I'm encouraged by that. And again, in the interim, in the meantime, the fusion companies across the US are working with their state level Department of Health to do things like get licenses for the radiation we produce when we're making fusion. The small, tiny amounts of tritium that are produced today because these are still at an experimental scale and any sort of other radioactive materials that we might have on site that help us do things like characterize the diagnostics that we're using to count the fusion reactions and such. So we have something that works for us today. And the NRC is working on what's going to be necessary when you're at commercial scale.

Rep. Keith Ammon (01:11:05):

We have another question in the room. This is the Honorable Dick Barry, former Chair of the House Science Technology and Energy Committee.

Hon. Richard "Dick" Barry (01:11:14):

Obviously you know that we're trying to look at what nuclear is going to be doing, how we can get into nuclear in New Hampshire. I would expect that there's a cost to everything involved and trying to find out how much it would be cost for us to try to be like, you've got up in Oregon, could we have a sample reactor, if you will, here?

Ryan Umstattd - Zap Energy (01:11:41):

Right. Yeah. So again, we're looking at our pilot plant site. We haven't made a final determination yet, but I do think that there are things that the various states can do to be attractive for these sites, finding perhaps a joint development agreement where a pilot plant might transition into a commercial unit that could be attractive for a fusion energy provider. Because again, we don't want to get into a situation where a pilot plant at this scale, if you're making megawatts of electricity, it's going to take mega bucks of financial investment. And so we know that this is going to be a high value asset. It'll be great for getting the customer base going, but it also would be nice to know that wherever it goes, it might actually serve additional useful purposes. And so a state that was willing to find a commercial partner to work with the fusion company for it to be a joint development agreement or a fusion company that wants to build on operate like Ryan from Last Energy, again, that's an interesting business model that should be considered as well.

(01:12:49):

But I think that states that are staying well connected with the NRC through the agreement states will be in a good position to be hosts for pilot plants and first of a kinds. There aren't a lot of municipal scale utilities that are signing up and saying, we would love to host the first fusion power plant. Most of them want to say, look, when you're up to plant number five or 10, give us a call. But they're not that interested in being the first. I think that the utilities with an appetite for having the first of a kind might be in the vertically integrated, large regulated markets. Folks like Southern, TVA, Duke, they seem to have a stronger appetite for potentially being customers for a first of a kind unit. But we certainly wouldn't count it out if a smaller state or a smaller municipal utility was interested.

Hon. Richard "Dick" Barry (01:13:45):

Thank you.

Rep. Keith Ammon (01:13:46):

We have another question in the room.

Sen. Howard Pearl (01:13:50):

Thank you. And this is kind of new to me since this isn't really an area of expertise, but are there limitations for you siting say on the same site as either a former nuclear plant or perhaps being on their operating side by side? You talked about the need for security, the perimeters, those kind of all exist in the plants. New Hampshire, we have one nuclear plant, they have a second pad site that they never developed. Is that something that would be an attractive site for you to put a location like this?

Ryan Umstattd - Zap Energy (01:14:24):

Right. Great question. And frankly, those were some of the things that we're going through our heads when we were looking at where do we want to look for our feasibility study for our pilot plant? And we settled on the coal plant to help us answer some of these questions of what does it make sense? Can we fit fusion inside the existing footprint? And we're finding that with a coal-fired plant that there's more than enough space and usually even more than enough outside security perimeter that would be needed. We steered away from looking at siting at a former nuclear plant or something that had been intended for nuclear, partly because of what that might do for public perception. It was important for us to continue to distinguish ourselves and talk about nuclear fission. Well talk about fusion energy as an energy source that is being developed and it's best for us at this stage to make sure that as we start to educate the public and other stakeholders that they think of it as fusion energy.

(01:15:24):

And in fact, we dropped "nuclear" from the term just like you don't get an "NMRI" anymore, you get an "MRI" precisely for those reasons of just making sure that we can be clear and open and honest about what fusion is, but not have to carry any of the baggage that might be associated with other approaches. But no, I think that if fusion is accepted and comes by the public and has its regulatory structure and framework in place at that point, there's a lot less of a downside to siting alongside traditional fission energy. And so it would be reasonable and feasible, I believe for fusion to go nearby. We just need to be careful about the public perception of that. Fusion needs to stand on its own first before we get too close to people associating it with fission, if that makes sense.

Rep. Keith Ammon (01:16:23):

Great. Could you just talk a minute about the waste processes? You mentioned that the process is like a big combustion engine, so there's a spent fuel gets exhausted, and just could you explain what happens with that spent fuel and what that looks like?

Ryan Umstattd - Zap Energy (01:16:42):

Yeah, great question. So for the reactions that happen that gets turned into helium gas, that's going to be pumped out, the gas that doesn't get reacted, the fuel gas, the deuterium and the tritium that get in there, but they don't actually fuse, they are still useful deuterium and tritium. So we actually recirculate them. So some of our fuel is coming from unspent fuel from the previous cycle, whereas the of the fuel is coming from tritium that was either bred in that blanket or it's deuterium that we again are sitting in those side tanks. So we have basically, it's like a chemical processing facility in terms of the gas plant that is being used to separate out the isotopes of hydrogen, separate out impurities or things like the helium atoms that we don't want to inject into our fuel cycle. And so yes, we're running a closed loop gas system to help with the fueling.

(01:17:37):

And again, I do think that's one of our strong advantages is that we don't have a spent fuel when it comes to what is our radioactive waste. Our radioactive waste is now confined to the solid parts that are exposed to the neutrons. And again, I mentioned that we have to choose the appropriate materials such that those are considered low level waste and they decay in timeframes of years or a decade or two as opposed to millennia. But again, it's a small volume of solid material that can either be stored on site until it's safe for recycling or shipped to one of the four US centers for storage of low level waste.

Rep. Keith Ammon (01:18:19):

Great. I think I've exhausted all my questions. One last one, last appeal. Anybody have a question online? If not, we'll wrap it up there. Thank you, Ryan. We really appreciate it. I know you may have a colleague or two on Zoom if they'd like to say anything or if you'd like to introduce them. We have Andy Freeberg also from Zap. So thank you Andy for coming.

Ryan Umstattd - Zap Energy (01:18:46):

Yeah, Andy's our head of comms and helps me prepare for each and every single one of these. But I appreciate your guys' time and as you can tell once you get started, me talk about fusion, it's hard to get me to shut up.

Rep. Keith Ammon (01:18:56):

Yeah.

Andy Freeburg - Zap Energy (01:18:56):

Yep. Sorry, I'm here. Thank you. Thanks for the shout out. Appreciate that.

Rep. Keith Ammon (01:19:01):

Great. Alright. And I may request those slides from you if you're willing to have us put those up. That would be helpful to the public.

Ryan Umstattd - Zap Energy (01:19:11):

Yeah, I'll circle back with Andy and we'll let you know. Thanks.

Rep. Keith Ammon (01:19:14):

Yeah, let me know. You're welcome to stick around. We have a few minutes of commission business. It's probably not interesting for you, but you're welcome to stick around and if you drop off, we really appreciate you taking the time to present.

Ryan Umstattd - Zap Energy (01:19:28):

Yeah, thanks for your time today. I appreciate it. Take care.

Rep. Keith Ammon (01:19:32):

Take care. Alright. That was super interesting. So the next item on the agenda is an opportunity for any more public input. Anybody online would like to say anything about anything, now's your opportunity.

(01:19:54):

Alright, well that's my mouse. Okay. We issued a draft report and I know maybe some of you got an opportunity to read it. I'm going to use that sort of as the baseline for the final report filling in things that we cover since I think that's up until June was in that report. I know I didn't catch everything. So I'm going to go back through the old material plus the new material, but I'm hoping that we can put out a fairly polished final report with a nice glossy cover just to make it look official in December and then be able to circulate that. So if you have any feedback, feedback now or you'd like to talk to me later about anything that I missed or got wrong or left out.

Hon. Richard "Dick" Barry (01:20:47):

I don't remember seeing it.

Rep. Keith Ammon (01:20:49):

Okay. It's on the website.

Hon. Richard "Dick" Barry (01:20:51):

Oh, it's on.

Rep. Keith Ammon (01:20:52):

Yeah, there's a link that says reports on the website. If you click that, you can download it. And it's also on the official state website.

Hon. Richard "Dick" Barry (01:21:00):

Thank you.

Rep. Keith Ammon (01:21:03):

And far, are you still with us? I know Matt had to drop and I see Chris is still there.

Hon. Bart Fromuth (01:21:11):

I'm still here.

Rep. Keith Ammon (01:21:12):

Okay. Any thoughts on the Seabrook tour? I thought it was super interesting. I had to duck out a little early. I had something after that, but that's my second time taking it and I forgot a lot of the things that I learned the first time. So it was great to be able to fill in some of those gaps.

Sen. Howard Pearl (01:21:37):

I was very disappointed I had to mess it, unfortunately.

Rep. Keith Ammon (01:21:40):

Yeah, sorry. It's hard to coordinate everybody's schedule. Yeah,

Sen. Howard Pearl (01:21:43):

I had a obligation and I couldn't get out of it.

Rep. Keith Ammon (01:21:47):

No sweat. I'm sure there'll be more opportunities.

Hon. Richard "Dick" Barry (01:21:52):

One of the interesting things about Seabrook is that since it was built for two reactors, only one is there, it has the infrastructure for the transmission of it. For the second one, which is something we haven't talked about for this in terms of where do you locate the reactor, do you locate it closer to where the users are going to be, the cost of will, the hysteresis losses that happens. And that's why birds could sit up on there and keep their feet warm because they're only getting one part of it. They're getting the heat off it. But by reducing the amount of poles and things going through the mountains, maybe there's another way to look at how to use that as an advantage as we move forward to selling this process.

Rep. Keith Ammon (01:22:42):

So looking at closer to where it's being consumed?

Hon. Richard "Dick" Barry (01:22:45):

Yeah.

Rep. Keith Ammon (01:22:46):

Then minimize transmission.

Hon. Richard "Dick" Barry (01:22:48):

We have now we've got utilities, I happen to live where the utilities are underground. Think of it as a device you could put at a large shopping complex, a large manufacturing complex. You don't have to bring in electricity from outside and you're saving all of that. Well, the maintenance, the destruction, earthquakes and things.

Rep. Keith Ammon (01:23:17):

Yeah,

Hon. Richard "Dick" Barry (01:23:18):

I don't know how to put it a dollar figure. That's something

Daniel Goldner - PUC (01:23:23):

I know Matt (Levander) had to drop off, but what I heard their manager say was that they weren't interested, NextEra wasn't, in any further engagement with the second pad and that they, that's what I don't know, (it sounds right) there, but that's what I kind of heard them say, which I didn't really understand the why part of it, but it was interesting to hear that they weren't interested. At least might think we was further engagement.

Hon. Richard "Dick" Barry (01:23:46):

I think it was for another nuclear facility. Right. A normal one I guess,

Rep. Keith Ammon (01:23:53):

Right? Yeah. I guess the trick would be you have that security perimeter and if you're trying to construct something there, you have to kind penetrate that perimeter for years to get something built out. But that's just my thought, Cathy? Mic, that helps us out later with a minute trying to figure out what people are saying.

Cathrine Beahm - NHDES (01:24:13):

Yeah, so when we were on the tour, we asked whether there'd be an interest in putting one of these small modular reactors at the site, which would still be fission, right? I'm confused. But anyway, and the response seemed to be that they weren't interested. I found it interesting, the last speaker when he talked about the fact that he didn't want to put fusion with a fission site so that the perception and all that sort of thing. I hadn't thought about that particular aspect of it, but I also see your point about having them closer to where you're going to be using it. You're not losing all of the electricity through the transmission lines and all that, but as a trade off, I think that probably the industry will pick the choice of the location. We need to figure out how to get it feasible.

Rep. Keith Ammon (01:24:55):

So a piece of that is where you can put an interconnect, right? Like an interconnection. And we're going to have ISO New England come in October. It's October 2nd, sorry, the next meeting's in two weeks. But they're going to talk about that interconnection process. So we could probably ask them about a little bit about siting. It's not going to cover everything, but

Hon. Richard "Dick" Barry (01:25:16):

That's also an interesting tour if you've ever been out there.

Rep. Keith Ammon (01:25:19):

To ISO? Yeah, their main control room? I think I did it with you. I remember their manager said, "as soon as I retire, I'm moving up to New Hampshire."

(01:25:32):

That was pretty funny.

Cathrine Beahm - NHDES (01:25:34):

Did you want to go to policy aspects in the draft report, to see if you missed anything or what your point was?

Rep. Keith Ammon (01:25:40):

Yeah, if you'd like. That's the final. That's really the main output. So, part of what I'm considering, including the final report is this, the n e I has a whole list of state policy options. Some of them are for political climates and jurisdictions that are different than ours that it might not fit. So there's a resources page on the website. This document is linked to on that page if you want to review it yourself. But I've been talking to Christine Csizmadia from NEI, and I'm saying her last name wrong, about policy and options. One of the things that she suggested was we should get and was, I had two conversations on Friday or Thursday. One was with NEI and the other was with the GAIN people. I remember the GAIN program. But one of the things they suggested was we need to get a definition of advanced nuclear into our statutes because that creates a linchpin for any other policy changes.

(01:26:52):

And she pointed me to the federal statute, which defines advanced nuclear, they don't call it small modular. They use I think just advanced nuclear reactor technology. And there's a definition in federal statutes. So I put in a bill last week to update our atomic energy statute, which is really ancient. It still refers to the Atomic Energy Commission, which doesn't exist anymore. So I put in a few updates to that. I was trying to tread lightly and the bill's still in development and when I get my first draft, I'll circulate it for input. But one of the things I did have them do was put the definition of advanced nuclear linking it to the federal statute. That'll give us a starting point. Is there anything specifically you wanted to go over?

Cathrine Beahm - NHDES (01:27:41):

No, I just figured it would be good to be on the same page.

Rep. Keith Ammon (01:27:46):

So I put that draft report out and Michael Harrington, who's not here today, Rep. Harrington, he was uncomfortable with that list. So I put some caveats in there based on his feedback. And I also went back and put in the testimony from the Consumer Aadvocate because he talked a lot about our market and what might fit and what might not fit. So that's in there because of Michael Harrington's feedback. So just so that people have the full scope when they read it.

Sen. Howard Pearl (01:28:16):

You may have something to share.

Rep. Keith Ammon (01:28:24):

So Chris had to drop off now. Alright, so I think that may be the only nuclear bill that's in, but I have a retained bill that you're aware of. We're going to talk about it tomorrow, which is the original draft of the bill was kind of like half baked. That's my assessment. And the idea for that bill actually came out of the Governor's Crypto Commission. There' was talk about energy use. So that bill's focus on microgrids. The idea of a microgrid, which is kind of what you were mentioning earlier, Dick, if you build out one of these industrial parks, like Last Energy was talking about some of their customers are industrial customers. Well, you'd want that microgrid to be able to operate as an island, but also connect it to the larger grid and then have rules around how they contribute to the resiliency of the larger grid when everyone else needs energy. Those are

Hon. Richard "Dick" Barry (01:29:33):

Timing too. A mall is shut down at night, generate electricity

Rep. Keith Ammon (01:29:42):

Or use it for a purpose inside the microgrid. Right. It could be industrial heat or could be

Sen. Howard Pearl (01:29:48):

Something complimentary to it. Yeah.

Rep. Keith Ammon (01:29:52):

And that gets into the area of these large flexible loads. I've been trying to line somebody up to talk to us about that. I haven't been successful, but I did talk to, I think his name is Gary Morris. He is one of the top executives in the Q Hydrogen project, which is in, they're building a facility in Northern New Hampshire. And I asked him about that idea of a large flexible load because traditional hydrogen production would fall into that category. At night, you don't need the energy, so you divert it to hydrogen production. That's energy storage that you can use to run an engine even if you needed to. But they have some kind of proprietary technology that wouldn't be a good fit for that scenario. He said they're going to go public in a couple of months and he couldn't really talk about it, but their process doesn't need a lot of electricity, which I thought is kind of fascinating. But he did say my biggest pain in the you-know-what is the interconnection rules and he's saying, so he mentioned that to me and I said, well coincidentally we're talking about that. So not nuclear related, but there's complimentary crossover.

Hon. Richard "Dick" Barry (01:31:07):

This whole thing also ties in with solar. You can't use solar at night so you'd need a battery backup or some other storage.

Rep. Keith Ammon (01:31:15):

Right. So yeah, I mean it's such a huge topic, right? We're never going to solve all the issues here.

Hon. Richard "Dick" Barry (01:31:25):

I thought you were going to fix that.

Rep. Keith Ammon (01:31:27):

No, not today.

Sen. Howard Pearl (01:31:30):

That's was sort of the genesis of my question earlier. You look at these, the way we set up energy production, now we create a center like Seabrook. We make energy and we ship it to the grid. They're set up for two sites. Could you do something with that other site? Because they've built out basically everything they need there to handle considerably large capacity to produce. I just thought maybe that's a prime target for doing something like this. It could be a relatively low cost from an infrastructure standpoint to put something else. But I don't know.

Rep. Keith Ammon (01:32:05):

Yeah, I think

Sen. Howard Pearl (01:32:07):

I know they're putting a solar farm in on site, right?

Rep. Keith Ammon (01:32:11):

I think two, right? They call 'em reactors 3 and 4, but they're really solar farms. They call it sites 3 and 4.

Hon. Richard "Dick" Barry (01:32:21):

We're looking at offshore wind and then that could be where we bring that in. Right.

Sen. Howard Pearl (01:32:28):

Use that as the connection.

Rep. Keith Ammon (01:32:31):

Oh, interesting.

Hon. Richard "Dick" Barry (01:32:33):

Then we're also looking at another Northern Pass whole concept. Where else do we bring it down Canada hydro power? How long be before they expanded their use of their other energy sources would say we need that ourselves. Right?

Rep. Keith Ammon (01:33:00):

Yeah. Right. They have control over our energy then, right? Yeah, true point. Alright, any other input from online? I think we covered just about everything in the agenda. As I said, the next meeting is October the second. It's a Monday. 9:00 AM like today.

Sen. Howard Pearl (01:33:21):

Keith, did you do the minutes yet?

Rep. Keith Ammon (01:33:23):

Oh we did do that. Let's see. I need... So Mikael Prytel, he's no longer with the Department of Businesses and Economic Affairs. So our commission goes down to 10 members. So I need to have quorum of six, which is no different than four. And we have five in the room and bar is online. If he's available, I'll throw in your quote bar. Otherwise we'll push this to the next meeting. Approval. The number of votes.

Hon. Bart Fromuth (01:33:59):

Keith, what'd you say? I'm sorry, you were kind of quiet there.

Rep. Keith Ammon (01:34:02):

Oh, I'm sorry. How's that?

Hon. Bart Fromuth (01:34:05):

Better.

Rep. Keith Ammon (01:34:06):

So we need six votes to pass the minutes from the August 7th meeting and just was seeing if you're available to make a vote.

Hon. Bart Fromuth (01:34:18):

Yes. So moved.

Rep. Keith Ammon (01:34:21):

Alright, so seconded, moved and seconded by Dan Goldner. Any discussion? There's a lot of interesting information in those minutes because we had representatives from federal departments and programs came and presented to us. And you may have noticed we had Senator Shaheen's office present and Senator Hassan's office was present, was present in the meeting. So I think some of that information went back to our federal delegation.

(01:35:01):

Alright, ready to make a vote on the August 7th meeting minutes. All in favor of accepting the minutes, say aye. Aye. Aye. Any opposed? And that was unanimous just for the minutes. That was Cathy, David, Dan, Senator Pearl, myself and Bart Fromuth were present for that vote and then it was unanimous.

(01:35:25):

Alright, any other comments? Further business with that, we'll call the meeting adjourned at 10:41 AM. Thank you everyone for being online and we'll see you October the second, which is in two weeks. And I think I did not mention this, I'm sorry. Our confirmed speakers, ISO New England, I did mention. We'll also have Moltex Energy. They have a molten salt reactor design and so they've both confirmed for that meeting. I have some other invitations out. I might try to squeeze a third presentation into that meeting. Okay, that's it. We'll end the stream here. Thank you.