Rep Keith Ammon (00:00:04):

All right. We'll call the meeting of the New Hampshire commission to study nuclear technology to order. And we'll, we'll be recording this meeting. We have a quorum in the room. Actually, we have more than a quorum in the room now. And many of us are off camera. So I, I'll I'll wave from over here. All right. And so just we have about five minutes worth of business, and then we'll get into our first presentation. Alright. And we wanna welcome Senator Pearl. Thank you. The newest member of our commission.

Sen Howard Pearl (00:00:46):

Sorry, I'm late. 30, ran a little

Rep Keith Ammon (00:00:48):

Long. We just started. So,

Sen Howard Pearl (00:00:55):

Syrup fudge, show up late.

Rep Keith Ammon (00:00:59):

Fudge Howard does his own maple syruping. Right? Alright, Howard, you wanna say a few words just to introduce yourself?

Sen Howard Pearl (00:01:09):

Hi thank you for welcoming your committees, or very interested to learn. Is this a microphone? Alright, very interested to learn about what you all do here. And quick background of my first term as a senator. I serve three terms as a state rep. I own a farm in Loudon. I do make maple syrup, so I'm thinking maybe I can put a nuclear reactor in for my evaporator, but I don't know. There may be problems with that, but we can think about that <laugh>. But no, I appreciate being here and I look forward to getting to know all of you. And I did bring some couple of different types of maple fudge and peanut butter, maple fudge that you can enjoy either now or later, I'll, however you want. So, thank you. And I appreciate being on the on the board here with you.

Rep Keith Ammon (00:02:04):

Yeah. So everyone online, can you hear okay with these microphones? Good. Okay. We're trying to get Yes, zoom friendly here. All right. So we just have a little bit of business to open up with. We have two rounds of minutes that we have not approved yet. And this is just for commission members only. We have enough in the room to vote to approve. So could I have a motion to approve the December 12th minutes? So, all right. Moved by. Oh, who's our secretary? We'll, we'll do the, we'll do the transcript later. Okay. So, so we moved by Representative Harrington. Second.

Sen Howard Pearl (00:02:42):

One

Rep Keith Ammon (00:02:42):

Second.

Sen Howard Pearl (00:02:43):

Second chair. Question. Do you have a quorum if I state since I wasn't here?

Rep Keith Ammon (00:02:48):

Yes. Yeah, we do. All right. All right. Seconded by I, Mr. Goldberg Gold. Goldner. I'm sorry. That's OK, <laugh>.

(00:02:57):

All right. That's the last time. I'll do it. Alright, any discussion? Any changes to the minutes? Alright. All in favor of improving the minutes from December 12th, say aye. Aye. Any, any opposed? Aye. And one abstention Senator Pearl abstains. All right. Now we'll move to the minutes of January 23rd and motion to approve the minutes from January 23rd. So moved. Representative Harrington, Mr. Gardner? Goldner. seconded. All right. Any changes, any discussion on the app? Approve the minutes from the 23rd. All right. All in favor say aye. Aye. Any opposed? And one abstention one, one abstention Keith. And those will be posted on the website tomorrow most likely website is nuclearnh.energy, nuclearnh.energy. Alright, so we'll go into our first presentation. And this is by Jeff Navin. Am I saying that? Correct?

Jeff Navin, TerraPower (00:04:11):

You got it.

Rep Keith Ammon (00:04:13):

From TerraPower. And we have Jeff a link to Jeff's bio on, on the commission website. And Jeff's gonna tell us about TerraPower. And I know they have an interesting project going on in Wyoming, and I'm, I'm curious to hear about that. And also that you have you have a feature of your project that has to do with industrial heat, right? Do you have a way of like, storing energy as heat? And I'm curious to hear about that.

Jeff Navin, TerraPower (00:04:46):

Great. Well

Rep Keith Ammon (00:04:47):

Well, thank you. One, one chat before we get started. I think I saw that was, was that Bart Fromuth it's phone? I'm guessing that's Bart, I'm trying find the chat that just popped. Can you, can you hear me? Bart is a commission member, so I need to pay attention to him. "Don't forget to put me down as abstention for January." We'll do that. Alright. And we have some new people that just joined the room, so welcome. So without further further ado, we'll get into the presentation by Mr. Navin from TerraPower, and I will make you a presenter. I think I'll spotlight you. Great. Yeah, thank you. And if you, if you need to present, just let me know. Thank you.

Jeff Navin, TerraPower (00:05:34):

Okay. You can hear me now. Great. Well, thanks. Thank you for the opportunity to appear before you. I will say that I was not told that there would be fudge available if I had appeared in person which, you know, may have changed changed where I was doing this from. So my name is Jeff Navin. I'm the director of External Affairs TerraPower. TerraPower is an advanced nuclear that's based in Bellevue,

Washington. And and as was mentioned, we are building a reactor that we call the Natrium reactor at the site of a coal plant that's slated to be retired. Just outside of Kemmerer, Wyoming. I can tell you a little bit of a background about the company, which I think gives some insight as to how we've approached some of these issues. Like I said, we've been around for a little over 15 years.

(00:06:21):

We came out of a conversation that our chairman and founder Bill Gates had with a set of energy experts around that time. And he asked this question, is there a technology that we're gonna need to solve the dual challenges of climate change and global energy poverty that is unlikely to come to the market unless somebody like him made some, some long-term strategic investments. And they very quickly realized that we're not gonna be able to meet the growing demand for energy around the world and do it in a way that allowed us to meet our, our climate goals, unless nuclear power played a pretty significant role. And Bill being an innovator said if we're gonna do that, we need to look at ways to improve over the current technologies. And so we started inquiry. We looked at all kinds of different reactor types, different technologies.

(00:07:14):

We looked at the very long history that the United States government had funded through the, for the fifties and sixties and seventies into different kinds of reactor technologies. And out of that conversation, out of that research and out of all of that work we developed the product, this product that we call that we call Natrium. Now, I'll give you guys probably know this, but I know you've got a, a at least one new member. So just give a very brief background on how, how conventional nuclear power plants work. And then a little bit about how our reactor is different. You know in most power plants nuclear power on the enough of particularly particular types of uranium together, they start splitting their, those atoms releasing energy. That energy is is, is released as heat.

(00:08:22):

And then the heat's used to generate steam and spin a turbine. So all of the power plants that you've seen across the, across the country and the world really operate on that, that basic principle. In fact the fission process is really, really good at creating heat. And, and it creates so much heat that the primary thing you're trying to do when you're running a nuclear power plant is to remove some of that heat from the core, because if you don't, that it will get so hot within those fuel rods that they'll actually melt together and melt down through the reactor vessel. And that's where the term meltdown comes from. So the reactors in the United States that are currently operating all use water as they're coolant. Water does a lot of things really, really well. It's plentiful.

(00:09:07):

It's easy to find, it's easy to handle. The problem with water is that it has a relatively low boiling point, and so you know, a hundred degrees Celsius water will boil off. And some of the accidents and incidents that we've seen, like, for example, with Fukushima, those were caused by failure of the cooling system to circulate cool water over, over the core. That water boiled off became a gas, and pretty soon there was no water left to cool the core itself. And, and tho those fuel rods melted together. There are three main differences of our Natrium reactor to a traditional convention reactor. And the first one, and the biggest one is that we don't use water as a coolant. Instead we use sodium. Sodium is an element, it's a metal. It is a solid at room temperature, but if you heat it up a little bit, it turns into a liquid.

(00:10:01):

And the boiling point of sodium is 883 degrees Celsius. So that means that our reactor will never get so hot that the coolant boils off and turns into a gas. So while a traditional reactor is required to have lots

of backup safety systems, because the thing you're really trying to make sure happens is you can always pump cool water over the core or remove that heat. And you have a lot of belts and suspenders in that systems because if those pumps stop or there's a problem moving that cooling over, that's when you have the event. You know, to have an, an accident. Sodium doesn't require us to do that. And so it our reactor fuel rods will literally sit in a pool of liquid sodium, and that sodium gets hot, it will rise when it cools, it will drop back down into the pool of the core.

(00:10:51):

And we use natural convection and, and air cooling to just remove that heat from the vessel itself. So not only does that give us an increased safety case, because we don't have to worry about those redundant safety systems failing it actually makes it a lot easier for us to design the reactor as well. It's a pretty boring design when you look at a cutaway of our reactor versus some of the, some of the reactors that you know, were built in the seventies because we don't have all those pumps, all those, all that piping. We also operated op at atmospheric pressure, so there's a lot less tension on some of those wells and the like that very simple basic design, which is enabled by the inherent safety properties of our coolant, allow us to build a reactor that's actually much cheaper and much more economical as well.

(00:11:40):

So by making the safety inherent, you can actually bring down the cost, which has been a challenge for, for nuclear power. The second way in which we differ from conventional reactors is our size. So most of the conventional reactors, like the two that are being constructed in Georgia are over a thousand megawatts or over a gigawatt in size. Ours is 345 megawatts, so a third or a fourth of the size of the, of the big conventional reactors that are being built. Our reactor can, can, can be scaled to be bigger. But we just think that what the market is looking for right now are the kinds of tools and technologies that can replace coal-fire generation and, and other thermal generation that's coming offline. And we believe our enth of a kind cost for our reactor's gonna be somewhere in the realm of a billion dollars.

(00:12:29):

Now, that's a lot of money, but if you're a utility and you're looking at long-term planning that's not a number that's gonna make you bulk too much. So and also that size allows us to build many of the components of our reactor offsite in factories and then assemble it onsite at the at the location where, where the reactor will be built. And so you know, the overall price tag for a utility customer or from an industrial user is gonna be much smaller than you'd see for those big large gigawatt scale reactors. And then the final thing that differentiates our reactor, and this was mentioned in the, in the very kind introduction as well, is instead of using the heat from our reactor to directly make steam and spin a turbine, we use the heat from our reactor to power a very large molten salt energy storage system.

(00:13:23):

Now, molten salt energy storage is a technology that's been around for a while, and it's usually used in concentrated solar. So you may have seen images of those towers in the desert with thousands of mirrors around them. And they concentrate the sun's rays into a, into a collection point. and they get, they get to be quite hot, and they use that heat to heat up a molten salt, which is very good at storing thermal energy. We use the same kind of off the shelf products that they use for, for our thermal energy storage. But what the thermal energy storage allows us to do is to store up to 500 megawatts of electricity equivalent for up to five and a half hours. That's gigawatt scale energy storage, which is currently not available on the market for utilities.

(00:14:11):

So why is that important? Well, in in Wyoming, for example, where we're building our reactor Wyoming has seen a massive influx in wind power over the last number of years. And as more and more wind power has come on it's put strain on some of their generation capac cap capacity because, you know, you need that, that ability to ramp up when the wind stops blowing and to store energy when the wind is blowing strongly. And so what makes this a nice fit is in a 21st century grid or grids that are gonna become increasingly reliant on variable renewable technologies, it allows our nuclear power plant to help fill that gap. So natrium will be something that can run 24/7 at 345 megawatts regardless as to what the weather is.

(00:15:05):

And we have the ability to ramp up and down if that's what's called for and needed on the grid. And we would do all of that without emitting any, any carbon carbon dioxide. So we are building this project, as I noted in Kemmerer, Wyoming. It's part of the Department of Energy's Advanced Reactor Demonstration Program, which is a program that we applied for a couple of years ago. And and that that allows us to have a 50 50 cost share for our first of a kind plant. When the plant is completed, we expect our to be, to come online in, in a right around 2030. We will turn the plant over to our utility partner, Rocky Mountain Power PacifiCorp, who will then own and operate the plant through the, through the lifetime of the plant.

(00:15:51):

The plant will be licensed for 60 years, with an opportunity to extend that license for another 20 years. When we won the award and we started looking at, we were where we were gonna site the project we began talking with Rocky Mountain Power. They noted that they had four communities that were hosting coal plants that were slated to be retired in the coming years. We actually went to all four of those communities and let them know that we were looking at the potential of citing our reactor in those communities. And one of the things that we wanted was those input from those communities to ensure that this was actually something they wanted in their, in their backyard. All four of the communities were enthusiastically supportive of the idea. You know did small lobbying campaigns to convince us to try to come to their communities.

(00:16:40):

And we chose Kemmerer and we're very happy with that selection. It's been a really big boon for that, for, for that community. So, Kemmerer is a small town in southwestern Wyoming. It has about 2,700 people in its total population. There is a large coal plant there. And next to that coal plant is a coal mine. And the vast majority of that mined coal is sold directly to the plant next door. So when it was announced that that coal plant was gonna shut down, it had a pretty profound it sparked some pretty profound fear in that community. They were gonna lose two of their biggest employers in the, in the county. You know that was a community that, that existed and was put on the map because of the coal that was in that area, and they were very concerned about, about their future.

(00:17:28):

There are 109 IBEW members that work at that coal plant. Right now, when we're fully operational, we'll have between 200 and 250 full-time employees at the Natrium plant. Nuclear is, is by far and away the most the highest paying sub-sector of the energy sector in terms wages and Rocky Mountain Power has promised that every single one of those IBEW members of their employees at that site that want a job, will have the ability to walk across the road and, and come to work at that plant. In fact, it'll more than double, most likely the number of full-time employees operate, you know, working for, for Rocky Mountain Power. In that community, at peak construction, we expect to have around 1500 jobs.

(00:18:22):

You know, and so the community's really gone from worrying about how they were gonna keep their their, you know, their clinic and their schools and, and their, their downtown viable to now worrying about what they're gonna do with all this influx of people that are coming. I mean some of those officials have told us it's a, that's a much better problem to have up to there's coal plan, is that, you know, obviously the biggest advantage to us is that we have access to a very high quality workforce. We also will have access to the transmission lines from the coal plant. And transmission is becoming a really big issue in terms of limiting the ability to, of energy projects to be, to be sited. We'll also be able to use the water from the project, which is a very big deal out west, and we'll use less water than the coal plant used, but we still do need access to those, to those water rights as well.

(00:19:25):

So we are very excited about the project. We're very proud to be partners with the Department of Energy to build it, and we, we have very much enjoyed becoming a part of the community in Kemmerer as well. This is, there's nothing unique about Wyoming or Kemmerer or that you know, for us in terms of our ability to build these reactors. Our sites are pretty small, 44 acres total for that much generation, you know which is a fraction of what you might need for other forms of clean energy generation. And we're very excited to see the interest of folks in New Hampshire and, and happy to answer any questions you might have.

Rep Keith Ammon (00:20:07):

Alright, that was a great presentation. Thank you, Jeff. So we have microphones in the room to make sure that we have decent audio for the Zoom. So there's one on the other side of the room. There's one here, the green light means it's on. And there's a little button on the side to turn that green light on.

Rep Michael Harrington (00:20:25):

Is that on?

Rep Keith Ammon (00:20:26):

This one is on. So I'm gonna pass this to representative Harrington. He has a question for you.

Rep Michael Harrington (00:20:32):

Can you, I just make sure you can hear me.

Jeff Navin, TerraPower (00:20:34):

Yep, I can hear you.

Rep Michael Harrington (00:20:35):

I've got a couple of questions. First one, I'm assuming Wyoming is a non restructured state in that the this plant would be approved by the PUC out there, and then the rate would be on the hook to fund it. Is that correct?

Jeff Navin, TerraPower (00:20:51):

Yeah, so it is a regulated state, and but the deal that we have with them is we're still working out the final details, but we will set a fixed price for the for the sale of the plant, and the rate payers will not be on the hook to pay for that until we can deliver the plant at that set price. So some of the challenges

you've seen in some other states where you have these massive escalations of costs and those risks are fully born by the rate payers we're, we're structuring the deal in a different way here to protect against that.

Rep Michael Harrington (00:21:26):

And the second one I mean, the obvious, I guess maybe not so obvious question to some people, but where are you gonna get the HALEU?

Jeff Navin, TerraPower (00:21:34):

So I think Dan Leistikow hopefully will be able to answer that as our next, our next witness.

Rep Michael Harrington (00:21:42):

Just so everyone knows, HALEU is High Assay, Low Enrichment Uranium and it's typically in the, somewhere around 15% enriched, where the lightwater reactors in the United States all used somewhere in the five to 6% enriched rain. So once you get over the 10% enrichment, it's a whole extra set of, it's not weapons grade by any stretch of the imagination, but there's a whole extra level of security that's required. Right now, there's nobody in the United States making it.

Jeff Navin, TerraPower (00:22:10):

Sorry. Yeah, that's, that's right. So well send, I'm sure Dan will talk about this, but Centrus is, is, is producing small amounts of HALEU and Piketon, Ohio as part of a project with the Department of Energy. You know they, the same Energy Act of 2020 that authorized the Advanced Reactor Demonstration Program also authorized a HALEU fuel program that would help get over this kind of chicken and egg problem. Nobody wants to invest in HALEU enrichment until you have enough customers to purchase it, but you can't get customers to purchase it until you have the fuel available. So that program had been lacking in funding. And there was a com one commercial supplier. There is one commercial supplier of HALEU globally but they happened to be in Russia.

(00:22:59):

(Gotcha.) So, last year when the invasion of Ukraine happened, we made clear that we would not be purchasing any HALEU or any materials from, from Russia. And we worked with the Congress to expedite the funding of that high assay low-enriched uranium program. There's about $600 million that's sitting in there. We think that as soon as this week that the D OE might release their draft RFP we're hoping that companies like Centrus will apply. and basically what it will mean is that money will be used to purchase HALEU from Enrichers like Centrus, and then developers like TerraPower will buy the HALEU back from the US government. But it's designed to provide enough demand to try to expedite and, and investment decisions. Right. So, so we're waiting to see what that RFP says.

(00:23:50):

You know, we had planned on initially having our reactor come online in 2028 because of the challenge with HALEU. We pushed that now back to 2030. But we are very much looking forward to having domestic forms of HALEU made available to us. There's also some small amount of HALEU that, that I, we think will be available from the Department of Energy's weapons program. They're down, they, they have the capabilities to down blend some of the highly enriched uranium that they're taking out of nuclear warheads and down blend that into HALEU that we could use potentially for our first core load.

Rep Michael Harrington (00:24:28):

Just one more follow up on the operation of the plant itself. I mean, having, obviously it fits well with the intermittent resources, wind or solar, but I'm just trying to get how this works. So, in normal operations, you would be putting the 345 megawatts out on the grid, and then when there was a lot of solar or a lot of wind, and they didn't need that, you're not gonna load follow, you continue to produce 345, but you'll be dumping that into the thermal storage, or do you actually intend to load follow?

Jeff Navin, TerraPower (00:25:00):

We intend to load follow. So the, so you know, the heat from the reactor will go through an intermediate loop heat exchanger and will be used to power to heat up the salt in the molten salt energy storage system. All of the electricity generation will come from a steam turbine on that attached to that molten salt energy storage system. So we won't produce any electricity on the nuclear island. It'll all go through that system. we could run that system continuously at 345 megawatts indefinitely or we can ramp up and down from about 40 to 50 megawatts up to 500 megawatts.

Rep Michael Harrington (00:25:37):

Okay. So you would, I'm just trying to picture when you would, when you would ramp down, that's your output. So it, it, you would, would you mean maximize your storage capability at the, when you have five megawatt hours? So you Yep. Once that was hit, then you go ramp down if the load, if the demand wasn't there.

Jeff Navin, TerraPower (00:25:56):

Correct.

Rep Michael Harrington (00:25:56):

Okay. And then when would you discharge the storage? is that attended to discharge or is it just sort of like a dumping ground? So you always have something there?

Jeff Navin, TerraPower (00:26:06):

Well, we, we, you wanna keep, you do, we do have to keep the system moving. So there is some small amount of heat that would've to move through the system.

Rep Michael Harrington (00:26:13):

Okay. Alright. Thank you.

Rep Keith Ammon (00:26:16):

All right, great. Any other questions in the room? You wanna pass this over to you and then Sure. Introduce yourself from the room.

John Schneller (00:26:25):

John Schneller from Bedford. I'm a, a late add to the to the invite list. Thank you for having, so you had suggested the production site the current production site is 44 acres. Is there a minimum baseline number? I would assume that's sort of optimal land availability, maybe not an issue so much in Wyoming. So is, is there, say a, a baseline minimum number of acres where a production facility could be built, and then what level of stability would be required for that site? Yeah, one follow up question on the finance site.

Jeff Navin, TerraPower (00:27:12):

Sure. So the current layout and site that we have is 44 acres. We try to keep that as compact as possible. But there are different, you know, there are multiple buildings on the site and there are different ways to configure it. I'm not sure how much smaller we could go, but, you know, there, there would be an allotment for some flexibility. You're, you're right, that the available land in southwest Wyoming is pretty massive. So it's, that's not really a huge constraint there. And I know that it's, it's a different situation in, in New Hampshire. In terms of the feasibility of the site. our licensing process through the Nuclear Regulatory Commission requires us to get both a, a construction permit and an operating permit. And the construction permit has a very robust site assessment that we have to show that we are designing our reactor to operate in a manner that's consistent with, with you know the geology, proximity to fault lines and the, like, we have to build a meteorological tower that, that collects two years worth of data so we can look at things like weather patterns and and such.

(00:28:27):

We did very robust deep borehole drilling to get you know, sort of a, a a good sense of what was under the ground and how stable that land was as well. And, and that's something that every nuclear proposed nuclear plant would have to do too, you know, there are some places where probably just doesn't make a lot of sense to build a nuclear reactor. But that nuclear regulatory commission process is extraordinarily robust and requires a significant amount of of work as you might, as, as you might imagine. So you know, I guess, you know, if you had a 42 acre site, would that be a deal breaker? I think we could probably work to try to figure, you know, some, some of that out. But the ultimate question from as to whether or not we could build somewhere is something that, that we would have to also get input and answers and an okay from the Nuclear Regulatory Commission.

John Schneller (00:29:22):

Thank you. And then one other question in a different vein. So the useful life, I believe would exceed 60 years, but you suggested the original licensing was a 60 year period, and then maybe subsequent multi-decade follow on licensing. How would that be financed? Because sort of conventional bonds 30 years, maybe out to 50, 60 is sort of an odd number. It's how is this site being financed? And then how would someone like me consider talking in, in various circles about, you know, is this a hundred year bond type of thing, or what are your thoughts on that?

Jeff Navin, TerraPower (00:30:05):

Yeah, the financing of new construction of nuclear power plants is actually a pretty pretty act under a lot of active discussion at the moment. You know, the bulk of the plants that we built in the United States were built in the built in the seventies and in the sixties and seventies and a little bit into the eighties. And at that time, almost every market in the United States was a regulated market. And so you could rate base those assets over a 60 year period. You know, so it would add a little bit of cost to somebody's bill, but you'd be basically taking the cost of the reactor construction and spreading it out over, over 60 over, you know, over, over those 60 years. It's obviously much harder to finance an asset with that long of a life in an unregulated market or kind of in some of the, some of the just, just just the way the project finance generally works, right?

(00:30:59):

The useful life of when, you know, a solar project has assumed to be 20 years. Natural gas and coal plants can, you know, last much longer. But you know, that's the idea that you're gonna be selling electricity from them for 60 years is something that's been kind of hard for people to get, get their

heads around. And, you know, while there are some types of investors, pension funds, insurance companies, you know, and the like, that, that might be interested in something that could return investment over that long period of time, we're kind of entering a little bit of a new era in, in that space. And we're working, trying to work through that with, with our utility partner as well. This particular project, because it's a federal cost cost share with the federal government, you know, for every dollar we put in, the federal government will, will put in up to, up to a limit.

(00:31:46):

And that is really designed to just help us solve this financing piece in the near term so we can get the thing built, first and foremost. If you take the conventional financing challenges given just where markets are right now, and you put on top of that first of a kind nuclear technology, it really could, you know, it's gonna be virtually impossible to build anything. So the government stepped forward with this advanced reactor demonstration program to help us build the first one. Now, I will say that we have a memorandum of understanding with Rocky Mountain Power to look at building five additional plants in Wyoming and Utah in their service territory. They have five more coal plants that are slated to be retired. They're interested in learning how, if we could build multiple units in the same region, where we're taking those learnings that we get from the construction process and just driving down the road, you know, pouring concrete at site one, driving down the road, pouring concrete at site two, repeating that over multiple times can drive down the overall cost. You know, once we can get a few of these in the ground, we show that they can work, we show the value that they can provide to the utility. You know, I think, I think the financing mechanisms will help, will develop a little bit. But you're absolutely right that, you know the way that we, that we, that we financed all of these in the past was through rate basing and that just isn't as prevalent as it used to be.

Rep Michael Harrington (00:33:04):

Mike Harrington again, then the question, you know, we can go back to the 1960s and it was, you know, molten salt reactors were being made on a, you know, develop experimental basis. And one of the big issues back then was material science. How, how do you withstand in a molten salt, which is very corrosive, high radiation environment? And to the best of my knowledge, that's why those reactions didn't go forward very much in the sixties. And what is it you're doing different today to get around that problem? I dunno if he heard anything I said.

Rep Keith Ammon (00:33:46):

Let's give it a second here. Wonders of modern technology. <laugh> dropped off.

Rep Michael Harrington (00:34:03):

Oh, he's gone completely.

Rep Keith Ammon (00:34:09):

So Mr. Navin dropped off. Is everyone else, can someone chat me to say that you're still there? Just so we know, we're still live. So we, we lost Jeff, he just dropped off.

Rep Michael Harrington (00:34:32):

Hope my questions didn't drive him away.

Rep Keith Ammon (00:34:33):

Did, did did everyone hear Representative Harrington's question just a second ago? Alright,

Rep Michael Harrington (00:34:46):

Anybody can hear us?

Rep Keith Ammon (00:34:47):

Yes. Still? They're still there. Yeah, I can hear you all right online. Okay. Hi, Mr. Leistikow. that may have been the end of his presentation. <laugh> an abrupt ending. Maybe if he jumps back on at the very end, which would be around three 15 or so we could have a few more questions for Mr. Navin, but let's

Rep Michael Harrington (00:35:15):

It's just, it's kind of an important issue. I'm sure they've addressed it. I just dunno,

Rep Keith Ammon (00:35:18):

Do you wanna repeat the question?

Rep Michael Harrington (00:35:20):

Sure. I can repeat it now. But in the 1960s there was you know, were experimental reactions of all sorts of different types. Mm-hmm. <affirmative> one of them was molten salt reactor. And the problems they had with that is because of the corrosiveness of the Bolt and solved, combined with the high radiation fields, they had a real problem with materials being able to stand up to that. And I'm wondering what they've done to get around that issue, obviously. Yeah, they've gotten this far, they've figured out a way to get around.

Rep Keith Ammon (00:35:47):

It sounded to me like they have an off the shelf solution that also is used for those solar arrays that he had mentioned. So we, we could, well, we'll find out the answer offline. All right. So let's move on to our next presentation. And correct me if I'm saying your last name incorrectly. It's Dan Leistikow, vice President of Corporate Communications for Centrus Energy. And Dan's bio is also linked on the commission meeting webpage if you'd like to read that. And Centrus was recommended to us. We had Mr. Durham from Westinghouse present at our last meeting at the end of January. And he mentioned that Centrus was an, an expert in the fuel supply chain. So that was where the recommendation came and we're happy that Centrus is here. And Dan, I'm gonna make you spotlight and I believe you sent me slides. Is that right? Yeah,

Dan Leistikow, Centrus (00:36:47):

I'll, I can share them from here if you can. Yeah. It says right now it's disabled.

Rep Keith Ammon (00:36:52):

Whatever is better for you. Would you like to do the slides? Yeah. Okay. Let me I think we had an issue with this before. Where, here we go. I don't wanna disrupt our recording, is the issue. Are you able to

Dan Leistikow, Centrus (00:37:10):

Yeah, it's, it seems to be going. It seems to

Rep Keith Ammon (00:37:14):
There you go. Perfect.

Dan Leistikow, Centrus (00:37:17):
Okay.

Rep Keith Ammon (00:37:18):
Alright.

Dan Leistikow, Centrus (00:37:20):
Copy here.

Rep Keith Ammon (00:37:23):
And you sent me a copy of your slides and would it be okay if we posted those to our, our web portal? Yes. Okay.

Dan Leistikow, Centrus (00:37:31):
Yeah, absolutely.

Rep Keith Ammon (00:37:32):
Alright. We can see in the room here.

Dan Leistikow, Centrus (00:37:35):
Okay, great. So well yeah, thank you for having me happy to talk to you today. And like Jeff, I'm, I'm sad to miss out on the, on the fudge. So just to give you a kind of an overview of Centrus, who we are. so we are, as we say, America's uranium enrichment company. We're the only publicly traded enrichment company in, in the world. All of the others are, are state owned corporations. So the so, so we are have been for many years a supplier of enrichment to utilities in the United States and around the world. We, we ran the US governments enrichment plants for, for decades the last one of those shut down in, in 2013 and so since that period of time we've been purchasing enrichment from other suppliers in the world and, and selling that to our utility customers and then using that revenue to reinvest in our own technology so that we can actually deploy a us uranium enrichment technology.

(00:38:51):
And we are now pioneering as, as Jeff alluded to production of high assay, low enriched uranium, and actually building the, a first of a kind HALEU production facility in Ohio, which I'll talk to you about. And then in addition, we also have a important role to play for national security because we have the only enrichment technology that is fully domestic technology which means that it, that it could be used to meet US national security requirements as well over the long term. So this just sort of gives a little bit more of our, our history. We actually grew out of the Manhattan Project. In the 1990s, the US government decided to privatize its its entire enrichment complex. And so, so that's how our company was, was born. We continued to operate those gov, those, those enrichment plants that were built during the Cold War.

(00:39:52):

So we continued to operate those and produce enriched uranium for utilities. We also became the US government's executive agents for what was called megatons to megawatts. You may remember when the Soviet Union broke up, there was a lot of concern about loose nukes and, you know, what was gonna happen to all of that nuclear material. And so what happened was under this, this agreement between the two governments we actually went and, and, and bought a lot of that highly enriched, you know, weapons grade material to sort of take it off the market and then had it turned into civilian nuclear fuel that powered half of the US civilian nuclear energy fleet for 20 years. So we like to say from, from 1993, roughly to 2013 you know, one out of every 10 light bulbs in America was, was, was powered by former Soviet weapons grade material that, that used to be pointed at the United States.

(00:40:53):

So it's, it is that, that effort removed 20,000 warheads worth of highly enriched uranium, and it's the most successful disarmament program in, in history. So we're really proud of that history and, and more broadly, our partnership with the US government on non-proliferation and national security issues. And we are right now working to deploy our technology in Piketon, Ohio to demonstrate HALEU production and, you know, with the, with the longer term goal of actually scaling up to meet the full range of both government and commercial requirements for enriched uranium, that would include both, you know, LEU for the existing fleet of reactors and HALEU for advanced reactors. So just to give a picture of kinda how, where, where nuclear fuel comes from. So uranium, when it is well, so I'll get into enrichment levels in a second, but, so e essentially the process is you, you're gonna start with, with uranium that comes out of the ground, it has to be then converted into uranium hexa fluoride or UF6 in, in that, that's a gas use form.

(00:42:12):

And then it gets sent to an enrichment plant in which the gas, then it goes into centrifuges that use, that take advantage of the slight difference in, in weight between uranium 235 and uranium 238 to enrich it so that the, so you're basically separating out some of the U238 to raise the U235 content level to a, to a point where you can use it in a reactor. And then that, that u f six gas is then put into a cylinder and sent to a fuel, excuse me, a fuel fabrication facility where they deconverted and turn it into, into an oxide, and then they turn that into fuel rods that then get sent to the nuclear power plant.

(00:42:59):

So there's been discussion about LEU and HALEU one of the members there gave a pretty good explanation earlier, but so uranium, when it comes outta the ground is less than 1%. It's, it's 0.0711%, U235, and U235 is, is the good stuff. That's, that's what makes the reaction go. And it's 99 plus percent uranium 238. So for today's fleet of commercial reactors, you've gotta enrich it to be just under 5%. That would be low enriched uranium. and that's what all of the commercial reactors in the United States operate on today. When you go up over 90%, that's really, you know, weapons grade material. This is also what what powers naval reactors. So that's HEU. HEU technically anything above 20%, but it's really, you know, when you get to 90 and up that, that, that's kind of like the weapons grade range.

(00:44:00):

And then so high assay, low enriched uranium is in the middle between five and 20%. A lot of these reactors will run like the Natrium reactor that we just heard about, will run at 19.75%. And so that higher percentage of U235 gives the fuel a much higher energy density. And it has a lot of other benefits that we can go to, that we can get to in a minute. You know, one easy way to think of this is the existing fleet of reactors runs on Miller Light. Weapons grade stuff is, you know, essentially ever clear. Whereas HALEU that we're producing would be like a nice Belgian beer or a nice vintage port.

(00:44:44):

Okay? So advantages of of HALEU, you have this, this higher U235 concentration, which means that the reactor core can be physically smaller, which means the reactor itself can be smaller. That allows for there's a number of companies working on like portable micro reactors, for example. It means you have the possibility of having you know, a reduced stream of waste because you have this more highly concentrated fuel. You know, I mean, ultimately the amount of waste produced whether it's LEU or HALEU in terms of volume is, is very, very small. But yeah, the, the, you know, I think the key point here is that it would take about three tablespoons worth of HALEU if you got, if you got all of your energy needs for life from the time you're zero to the time you're a hundred years old if you got it all from, from nuclear energy powered by HALEU it would take about three tablespoons of fuel to meet your entire lifetime need. So that, that gives you a sense of kind of how, how powerful this, this fuel is. And that, you know, just a very small amount can go a long way.

(00:45:58):

Okay, so here you see a picture of the American Centerfuge plant in Piketon, Ohio and some of the centerfuges that, that we've recently finished constructing there. We are under a contract with department of Energy for the last few years we've been building this demonstration cascade. And Cascade is just a group of centrifuges working together to enrich uranium. So we have the, these it's a 16 machine cascade, 16 centrifuges that's going to begin operations by the end of this year. We've already finished the construction of the cascade itself and most of the support systems. There's some additional support systems that need to be finished, and then we've then, then there's an NRC operational readiness review and some other sort of final steps that have to happen.

(00:46:55):

So by the end of this year, we will begin producing, you know, modest quantities a little bit less than one metric ton per year at this facility in, in Ohio. But the, but the facility itself is licensed for much larger scale of production and has plenty of room for that as we'll get into it in a minute. So our goal is really to be able to, you know, once, once we've demonstrated production to be able to then scale it up you know, to very large levels of commercial scale production of both HALEU as well as as LEU, because the plant is also licensed for, for LEU production as well. But ultimately, you know, it's just a matter of having the access to the, to the funding and, and offtake commitments that we would need to be able to finance that, expand that, that expansion, because Uranium enrichment is a, a capital intensive business to be in.

(00:48:00):

So just to give you some sense of scale here in terms of our, our plant in Piketon, Ohio, this is actually has a footprint that's roughly the size of the Pentagon. So even though we have 16 centrifuges now it's built for, you know, potentially thousands of centrifuges, more, more than 10000 centerfugees that we could have there. And our centrifuges are much bigger and, and more powerful than the, than any other centrifuge in, in, in the world. As I mentioned, this is, this is, we are, we have as part of this program with the Department of Energy, we have secured an NRC license for HALEU production. It is the only facility in the country that is licensed for HALEU production. So we can move, you know, more quickly than any other producer.

(00:48:56):

And our, our license also covers production of LEU and what we call in the industry "LEU plus," which is essentially you know, a little bit higher than that 5% level but you know, less than than 10% say. So there's a number of companies that are looking at, you know, opportunities to refuel existing reactors with, you know, slightly higher levels of enrichment to capture some of those same benefits that you'll see with, with HALEU. In particular, it would allow them to have fewer refueling outages so that you can

you know, get, get more power production from, from the reactor, because you just don't, you don't have to sh to shut it down to refuel it as, as often.

(00:49:45):

Okay. So part of the context behind all of this is that in addition to the, to the commercial requirements for uranium enrichment, the US government also needs to have en enriched uranium for, you know, a variety of of missions. And so you see in the, in the graphic here, there's a category of defense missions and then there are other missions. And so you know, ultimately the government will need additional HEU for naval reactor fuel. You know, our entire fleet of aircraft carriers and submarines that are a critical part of our, you know, national security and, and force projection they're, they're all sailing the world on a fuel that the United States has not produced since 1992. And so eventually we will need additional naval reactor fuel. DOD is also looking at the possibility of micro reactors for a number of national security missions.

(00:50:46):

And then we also need LEU for tridium production, which is sort of necessary to maintain the readiness of our, of our existing nuclear deterrent. And then there's a number of non-proliferation space exploration as well as reactor development missions that, that the US government has. And the distinction between defense and, and other mission and the sort of non-defense is important because there are long-standing treaty requirements, non-proliferation agreements that actually prohibit the use of any foreign enrichment technology for a national security mission. Which means that the other enrichers in the world that are supplying, you know, US commercial reactors we actually can't use any of that material for our, for our own national security needs. So the last of, as I mentioned, the last of the US government's enrichment plants shut down in 2013.

(00:51:48):

And so the, all of these national security requirements that we have have been met on a, on a short term basis since 2013 by, by down blending the government's finite and presently irreplaceable stockpile of highly enriched uranium leftover from the Cold War. So eventually the US government is going to need this capability anyway. And so we think there's an opportunity here to actually, you know, accelerate some of those investments that the US government is gonna have to make someday anyway. Let's do it now, get this capability up and running so that it, we'll have it for, for, for their national security needs. It'll be cheaper for the government that way. But then it also can meet the very important commercial requirements that that, that we have you know, in particular for, for HALEU and, and really, you know, reclaiming America's leadership in, in nuclear fuel, which has a whole bunch of you know, sort of public benefits in terms of particularly non-proliferation influence for the United States.

(00:52:57):

So we think there's really, you know, a, a good opportunity here to kind of leverage these requirements to help to reestablish US leadership in, in nuclear fuel production. Which leads, leads into this discussion of a public-private partnership. You know, it is true that every enrichment plant that's ever been built anywhere in the world has been built by governments and state-owned corporations with significant government financing and, and, and so forth. And so, you know, we don't, we don't have that kind of model in the United States. We're not proposing to, you know, return to this all being government owned. You know, I think that that ship has, has sailed, but it is important to have some kind of public partner, public-private partnership. I think there's pretty broad bipartisan recognition of that. You know, you do need to achieve a certain level of scale to sort of make this you know, self-sustaining as a, as a commercial venture.

(00:53:58):

The market for HALEU is, you know, I think it has enormous promise and potential, but it's still filled with uncertainty. As Jeff mentioned, there's sort of a chicken in the egg problem right now where you know, it's difficult to get you know, private capital to invest in enrichment in, in HALEU production when there's not, you know, customers for it yet, but it's very difficult to like actually sell the reactors that that need HALEU until you actually have a fuel supply. And so that's where government role can be really valuable here. What was you know, started in 2019 or 2020 with the Advanced Reactor Demonstration program at, at Department of Energy is helping to bring some of the demand for HALEU online. And then we have the separate effort that was authorized in 2020 under legislation signed by President Trump, and then funded in the Inflation Reaction Act to have a HALEU availability program at the Department of Energy.

(00:55:08):

That will actually help to create the supply for HALEU through sort of helping on, on both, on both sides to kind of get it get past this chicken in the egg problem so that we can, you know, accelerate commercialize commercialization of advanced reactors to meet our, our energy and, and climate needs. And you know, as I mentioned, this is all, you know, this whole industry is composed of state-owned enterprises, and, you know, there's nothing particularly nefarious about that. I think, you know, governments around the world recognize that there is you know, great national value in having uranium enrichment capabilities that it adds to their you know, it could be sort of an extension of foreign policy. You know, for, for, for decades the United States dominated the global enrichment market, and we provided all of the enrichment needs for our allies around the world.

(00:56:07):

And that meant that everybody had to live up to our standards of non-proliferation and safety. They had to agree to, you know, IAEA inspections and, and various other requirements that we put in place. So, you know, much of our ability to sort of establish a global non-proliferation regime came from our indispensable role as a nuclear fuel supplier. And you know, when, when we as a country kind of, you know, gave that up and, and seeded the field to other, to other countries, that that gladly stepped into that role, we lost a lot of influence. And so as, as we see, you know perhaps a, a transition to a lot of HALEU based fuels, we really see a big opportunity to get the US back in the game in, in a big way. And you know, as I, as I alluded to it a moment ago, one of the best ways to do this is to kind of, you know, leverage the investments that the government is gonna have to make anyway in enrichment and, and use that to create the capabilities that we also need for commercial requirements as well.

(00:57:14):

And the US Department of Energy to its credit is, is you know, looking very closely at this model and is, and is proposed much the same thing to have a kind of a long-term effort to actually start to purchase some of the enriched uranium fuel that the department is gonna need for its own purposes to create the demand that will allow this, this investment to happen.

(00:57:41):

So just to kind of sum up where we are with our technology, we are ready, ready to deploy. We've, we have demonstrated these machines through three and a half million machine oper hours of successful operation. We had a previous demonstration program in 2012 to 2016 where we were actually demonstrating for LEU production at our, at our site. So we feel very confident in, in, in these machines and their ability to perform with sufficient you know, funding and offtake commitments to kind of, you know, clear signal to go. We could scale this up within think pretty quickly and have within three years we would have initial production of LEU and within 42 months, you know, three and a half years of starting, we could, we could scale up with additional HALEU production.

(00:58:41):

Just, just to put a little bit, I mean, I don't know how in the weeds you want to go on this, but, so the demonstration cascade will produce about 900 kilograms per year. Our full scale cascade, which has 120 machines, would produce about six metric tons of HALEU at 19.75% per year. And then we could continue adding, so it would take us about three and a half years to get the first cascade online, but then every six months after that, we could have a new cascade producing HALEU so we could get up to very large scale production. So once we get to that, to that stage, we'll be able to build the enrichment much faster than anybody, anybody can build the reactors. So there's no concern about falling behind at that stage. The concern is how soon can we get started now so that we can have the HALEU available so that the first reactors will have, will have HALEU.

(00:59:35):

And that's, that's why, you know, it's important for you know, the Department of Energy to move, to move quickly on this so we can get get this program going and, and, and get hay production up and running as soon as possible. We also think that we, we can provide another crucial benefit to the global market and to the US market in particular, which is greater supply diversity. This is not like the oil market where there's, you know, dozens and dozens of different suppliers. There's really only four commercial enrichers in the world, and they're all state-owned corporations. And so there is concern about supply diversity. The United States, as I said, was historically the leader in this area and, and has, you know, allowed, allowed that, that leadership to erode. So we think that there's a, you know, big need, frankly for to get an American producer supplying the market as well, not only to provide additional supply, but to provide additional suppliers.

(01:00:37):

And as I said, this, this has the benefit of being kind of an all in one solution. We're, we're uniquely positioned in that we are able to meet not only the commercial requirements but also the US government requirements for enrichment and the national security requirements in particular that will require a US technology. So that's it. This, this is a final look at our demonstration cascade in, in Piketon, which we will be be beginning production with by the end of this year. And with that, I'm happy to take questions.

Rep Keith Ammon (01:01:15):

Alright, thank you for that. That was a really enlightening presentation. I know representative, representative Harrington's gonna have some questions. Does anybody have any questions particularly you wanna, is there a mic, can you pass that mic over? Sure.

John Schneller (01:01:37):

Thank you. What is the total capital investment that you need to start the 36 month LEU production? When I say capital did, I'm sure there's a debt component to that, but sort of, are you looking for an equity infusion now or that's remains to be seen based on HALEU demand.

Dan Leistikow, Centrus (01:02:10):

So, you know, we can you know, we, we haven't, we haven't talked about like, you know, specific dollar figures. And you know, as a publicly traded company, we have to be careful to sort of never get a ahead of, you know, what we've disclosed about our, you know, financials and, and so forth. But you know, broadly speaking, it, you know, it, it's, it's, it's hard to give a, a precise number because it, it, you know, it, it varies a lot depending on what you're assuming in terms of what we are deploying. If, you know, if

we're just going to expand our HALEU production with additional cascades of HALEU then that's a you know, that that's, that's a much smaller deployment than if we're gonna go further than that and actually produce LEU. You know, if, if you're, if we're producing for the HALEU market in the near term, we're talking about hundreds of machines, whereas if we're producing for LEU, we're talking about thousands of machines. But there are, there are, you know, effects here in terms of economies of scale of the more you build kind of the better your, your unit costs get. But you know, I mean, broadly, broadly speaking, you know, large enrichment plants of, you know, the, the, you know, the very large commercial enrichment plants producing, you know, large amounts of LEU, these are like multi-billion dollar projects.

Rep Keith Ammon (01:03:50):

Representative Harrington.

Rep Michael Harrington (01:03:52):

Yeah. I did have a couple of questions. First your question, okay, you're starting with almost 20% enriched. What's the end of cycle enrichment left with the fuel? So when, when it's decided no longer useful? Is it 10%? Is it 5% or?

Dan Leistikow, Centrus (01:04:09):

Oh, you know, I mean that's, I think that varies a lot based on the reactor design. I wouldn't I don't know that I can answer that. You know, there is, there is some amount of enrichment that's left in the, in the fuel when, when it's done and, you know, certain reactor designs have, can achieve, you know, better burns than others. And, and so they'd be able to capture more of that. And then there's, you know, fast reactors that are able to, to, you know, burn it down even further or, or use you know, previously used fuel. So I, it's, I guess I don't have a good answer for that.

Rep Michael Harrington (01:04:54):

Is there anything very,

Dan Leistikow, Centrus (01:04:55):

It's based on the reactor design.

Rep Michael Harrington (01:04:57):

Okay, is there any talk of the processing or would this fuel be just handled the same way that the lower level enrichment fuels handle that?

Dan Leistikow, Centrus (01:05:05):

Well, some of the reactors some of the advanced reactors have the ability to burn off u used fuel. And, and you know, actually going back to the, to the like fuel let's leftover from lightwater reactors from, you know, decades of operation you know, there is discussion now in terms of, you know, how do we get the initial HALEU quantities to kind of get the industry up and running and, you know, maybe we could do, you know, re reprocessing. I mean, I will say, you know, at Centrus, you know, we don't <laugh> we don't see a big need for that and don't see that as a as as much of a, a viable solution. There may be some role for down blending to get some initial core material. But there, you know, re reprocessing has you know, a lot of non-proliferation implications.

(01:06:08):

And it's probably not really necessary in terms of getting the fuel that we need. And I think, you know, more broadly the issue is that we face this chicken in the egg problem and to say, well, we've got this, like, we've got this pile of old fuel. Maybe we could clean up some of this old fuel and create, you know, a reserve of of HALEU that way. You know, it's pretty expensive to do that. And it doesn't solve the chicken in the egg problem, right? It's you're, you're, you're creating some frozen omelets, but you haven't solved the chicken and the egg problem. And if you're not careful, you make the chicken and the egg problem worse because you end up displacing, you know, you could spend billions of dollars reprocessing a bunch of of old you know, stuff that's in the government's inventory.

(01:06:54):

And all you've done now is actually, you know, burn through billions of dollars and, and make it harder for anyone to ever actually deploy new HALEU production, sort of delay that whole process. So you know, we, we think that the priority now has to be on making the investments to produce fresh HALEU through enrichment. The other problem with the sort of reprocessing solutions is that I think mo a, a very large number of the advanced reactor designs that are being developed right now, they can't, they, they, they, they can't take that, that reprocessed fuel in their reactors or through their fabrication. it just creates a lot of complexity. You really want to have the sort of fresh fresh fuel that comes through enrichment.

Rep Michael Harrington (01:07:42):

And one last question then given the NRC is, is as agile and fast as a beached whale, is the HALEU coming in to them? I can see them going, oh my God, this is a whole new different type of fuel we get research this, review it for 20 years. Is that an issue or is it something we think that the industry can push on and the NRC can get around because they're fairly lethargic when it comes to anything that's new.

Dan Leistikow, Centrus (01:08:06):

So we've had a pretty good experience with, with, I mean, there certainly are those, those concerns. We've had a pretty good experience with the NRC in our project. We've already received our license for HALEU.

Rep Michael Harrington (01:08:17):

I was referring more to the license for the, for the actual reactor using that fuel.

Dan Leistikow, Centrus (01:08:21):

Yeah, yeah, the reactors. I mean you know, I think I mean, I don't, I don't know. I don't want to, I don't wanna speak about stuff that I'm not not well worked on. But, but you know, I mean, I think the NRC's gotta look at those, at those reactor designs themselves. The fact that they're running on, on HALEU. I, you know, I would hope that that's not as big of an issue given that they've already licensed the HALEU production itself. It's just a matter of getting the reactors licensed and, you know, doing that in a, in a timely way. And, and I think, you know, part of the promise of these, you know, small modular designs is, you know, the goal is to get the design licensed so that we could build a lot of them.

(01:09:11):

I mean, the, you know, the problem with the way that plants were built before is you're probably well aware, perhaps painfully aware, is like each plant, each of the, like 99 reactors was kind of like its own

unique unicorn and so they all got licensed independently and each one of 'em built a little bit differently. And you know, I think the aspiration of terror power and a lot of these other sm r companies is if you need a big, big enough pipeline, you get the design licensed. And you still gotta do your, you know, your site licensing, but it's not like you're building a different reactor every time you want to, you wanna mass produce these.

Rep Michael Harrington (01:09:50):

Thank you.

Rep Keith Ammon (01:09:51):

This is Keith Ammon. Question for you, the demonstration reactors that are being planned. Where, where will they get the fuel? What's the plan for assuming that they use HALEU? What's the plan for their fueling?

Dan Leistikow, Centrus (01:10:06):

Well you know, their, I mean, it's up to them to determine their own fuel sourcing. I mean, we would like to be, their, their source of supply is the short answer. I mean, we have if, if we can get you know, the funding quickly enough and get, get started with production, we think we'll be able to intersect, you know, most of the timelines that have been put out there, but I mean, the clock is ticking. I mean, the longer we wait to get started with HALEU, the longer it's gonna take, the more, you know, programs get, get delayed. I mean, TerraPower already had to do this sort of two year delay related to HALEU. We don't wanna have to them delay any further. We think we could, you know, intersect their, their requirements timetable today. But, but we gotta get, we gotta get started. So we're really hoping that you know, the, that the Department of Energy will, will move, you know, quickly on this. And, and, you know, we think that they understand the need to move, to move quickly, but it's but it does need to get started soon.

Rep Keith Ammon (01:11:17):

Is there any coordination inside the industry to solve the chicken and the egg problem on other companies like TerraPower or OKLO or Westinghouse that we've heard from you know, sort of get together, pull resources and and solve the problem as a, as a group?

Dan Leistikow, Centrus (01:11:35):

Well, we've been talking to all of those that you've mentioned and a lot more you know, I mean ultimately, I mean, this is sort of the core of the chicken and the egg problem, right? Is, is that you know, they, they're, they're, they, they're working to build reactors and they're investing their capital that way. And we're, we're, we're focusing on our capital, on, on, on building enrichment. We can't afford to build a reactors. They can't afford to build enrichment. So it is a challenge and, and to get so a number of years ago, this was long before I joined the company, but my company like 15 years ago, was working to build an LEU plant. And in the sort of 2007, 2008 timeframe. And what ULT ultimately happened to was the Fukushima sort of destroyed the market and the prices crashed.

(01:12:40):

And so the plan ended up never coming to fruition. But, but at the time, what we were doing, and sort of the way you would finance a major LEU plant is you go to these Fortune 500 companies that have reactors that already exist and you get, you know, long-term off take agreements from them of, you

know, 10 to 15 years. And these are, you know, like I said, blue chip Fortune 500 companies. So you can take that then to a bank and get a loan against it because, you know, you've got these huge companies that are promising to buy it. In the HALEU market. You have a lot of great companies with really innovative, promising designs. But, you know, they may have, they may have sold a reactor or two, or that they haven't development, but the reactors haven't come online yet, and they hope to be able to sell more, but they haven't sold more yet.

(01:13:28):

And that's, that's much harder to sort of finance against those types of off take commitments, which is where, you know, you really do need some kind of government role here. If you look back at like the first, you know, how do, how do we get the first generation of nuclear reactors online? You know, it was really the US government, you know, first of all, you had the reactor design from the government that was developed for the naval reactors that was adapted into the shipping port Pennsylvania reactor. But the US government had this huge enrichment capability that had developed for national security purposes. And the Eisenhower administration said, let's make this available for commercial purposes. President Eisenhower, in 1956, I think it was committed a billion dollars worth of enriched uranium fuel to utilities around the world provided that they signed up for our non-proliferation requirements.

(01:14:18):

So that took the chicken and the egg issue off the table. If the utilities were willing to take the risk of building the reactors, they knew that the fuel was gonna be there. And that same model could really work today where we have, you know, we still have these national security requirements, if we could leverage those to provide a source of fuel that, that would really help solve the problem. So I think industry does have a role and we are talking to them, and, you know, we do hope that as we scale up, that, that, you know, they'll, they'll help to invest in this. But it does need to be a public private partnership given, given the scale of it and the uncertainty that's involved, and the fact that there are these, you know, huge public interests at stake in terms of national security, non-proliferation, et cetera.

Rep Keith Ammon (01:15:01):

And I just have one last simple question. Your last slide had 36 months for LEU and then 42 months for HALEU. Were they consecutive timeframes, or were, was that <crosstalk>?

Dan Leistikow, Centrus (01:15:14):

No, no. You could, you

Rep Keith Ammon (01:15:16):

Could,

Dan Leistikow, Centrus (01:15:16):

That, that's their if, if we decided to deploy LEU, it'd take 36 months. If we decided to do HALEU, that's gonna take 42 months. There's just some additional steps with, with with HALEU to get that in mind. It's just, it's, you know, slightly more, more complicated. But we can do, we can do both at, we can do both at the same time. Just with, with LEU, you're gonna have a much larger deployment.

Rep Keith Ammon (01:15:44):

All right. Excellent. Any other questions in the room? Everybody's good here? Anybody online? Bart Fromuth, if you have a question, you can unmute and seeing no further questions.

Bart Fromuth (01:16:04):

Oh, nope. I'm, I'm good, Keith. Thanks.

Rep Keith Ammon (01:16:06):

Okay, thank you. Alright. Seeing no further questions Mr. Leistikow, we really appreciate your, your time and willingness to present to us, and I think we learned a lot about the fuel life cycle and it seems like it's just within reach and you know, and inevitable that's the, that's the impression that I got, so,

Dan Leistikow, Centrus (01:16:29):

Absolutely.

Rep Keith Ammon (01:16:30):

And what's the best way to reach out to you if we wanna ask you any further questions?

Dan Leistikow, Centrus (01:16:35):

I, I'm sorry, it cut out for a second. What,

Rep Keith Ammon (01:16:38):

What was the, what's the best way to contact you if we have further questions as we continue here?

Dan Leistikow, Centrus (01:16:43):

I think you have my email address. That's, that's probably the best.

Rep Keith Ammon (01:16:46):

The best. Okay. Yeah. Alright, I'll, I'll share that with the commission members. Great. Alright, very good. And I see I, Jeff, if you, if you're there, if you could unmute

Jeff Navin, TerraPower (01:17:14):

Yep. I'm here. Sorry, I think I you cut out there for a second. Sorry. Sorry about that. We, our internet went out in the building.

Rep Keith Ammon (01:17:21):

That's okay. We, we were worried it was us on, on our end, so we're glad it was you. <laugh> I'm gonna pass the mic. I think Representative Harrington has a question for Jeff.

Rep Michael Harrington (01:17:31):

Yeah. Overall question. I saw it, you know, that NuScale has got their design approved by the NRC, it cost a half a billion dollars. Do you expect to spend that much or in that vicinity for yours as well? And does the fact that it's using HALEU present any particular hard spots with the NRC?

Jeff Navin, TerraPower (01:17:53):

I think my understanding of that number, and I don't wanna speak for them, is that that includes the engineering costs that they have to do to kind of, you know, prove out their design. So it, it, you know

Rep Michael Harrington (01:18:03):

Yeah. I believe way nuts on that. Yeah,

Jeff Navin, TerraPower (01:18:06):

Yeah, yeah. So, you know, we, we do the NRC the way that it's structured is, is that the applicant actually has to pay for the staff time of the people reviewing your application. So if you do a meeting with three people I think it's somewhere in the neighborhood of $300 an hour that you have to pay in order for those NRC staff to sit through your your meeting. So it is a little s you know, it's a little different model than, than you know, most of your interactions with the, with the, with with the government. We do not anticipate y you know, that that our license is gonna cost, you know, the licensing fees are gonna cost anywhere, anywhere near that. We are in what's called the pre-application process with the NRC and where we're trying to identify the issues that, that they are gonna need to see us focus on as we go forward.

(01:18:54):

We don't think HALEU is gonna be a particular issue. You know, they, they've got experience with the fuel you know, they've licensed the Centrus facility you know but we are presenting the NRC with a lot of first of a kind issues for them. You know, they are used to licensing large light, light reactors cooled with, with water, and ours is a small reactor cooled with sodium, coupled with an energy storage system. So some of those things are gonna be kind of, kind of first of a kind issues for them. So far so good. Right. We haven't, we expect to submit our license you know, later this year for our construction license. And we're hoping that by the time we do that, all of the major issues are gonna be identified and, and, and we can move forward with them. So you talked to me in a couple years and I might have a different tune, but so far our interactions with the NRC have been have been quite favorable.

Rep Michael Harrington (01:19:49):

Well, good luck with that. You, one other question I had was, you know, in the sixties there were these molten salt reactors and the technology was being developed experimentally. And the big problem there was material science. The corrosion of the salt plus the high radiation levels made, made it really difficult to have materials that withstand that. So presumably you've got this fire, you must have a solution to that issue. So could you kind of give us a little bit of information on what it is?

Jeff Navin, TerraPower (01:20:18):

Yeah, so we, the United States has successfully operated sodium cooled test reactors at Idaho National Laboratory for, for many decades. The experimental breeder reactors, and there were, there were two of them operated successfully. They were sodium cooled. They, you know, because they were research reactors run by the, by the federal government, I mean, they did everything they could to try to test the limits of that technology. And that's part of the reason that we, we chose sodium is our coolant, is because while it is a truly advanced commercial reactor, there are decades of experience that we've had that, that the US government has had in operating and operating those rea reactors. Now there, there is corrosion anytime you use salt, but the sodium that we use, and I know it gets confusing when I talk about we have sodium and salt because the sodium's actually a metal and it's not particularly corrosive with, with the materials.

(01:21:10):

We have been running many, many loops of salt through different materials in our laboratory in Everett, Washington for many, many years to make sure that we're, that we understand exactly what's happening with the interactions with the interactions there. But, you know but you know, so sodium does have properties that you have to be, that you have to be careful of. You may remember when you were in high school chemistry of, you know, dropping dropping sodium and water and, and you know, watching it react. But but, but we, we really do feel like of all of the advanced designs, this is the one that has the most scientific basis. And then finally, as you know, the advances that have been made in material science since the sixties are pretty profound. And then that probably won't surprise anybody that a company founded by Bill Gates is using a lot of advanced computing to help us sort of look through different scenarios as we design our reactor as well.

Rep Michael Harrington (01:22:08):

Alright. Thank you. Good answer.

Rep Keith Ammon (01:22:11):

We have one question in the chat. John Tohill, I'm gonna invite you to unmute and just ask it directly. Cause I think you could probably ask it better than I can read your chat.

John Tuthill (01:22:24):

Yes, this is John Tuthill Acworth New Hampshire. I didn't quite understand, is the 500 million figure that Representative Harrington mentioned total cost for the NuScale project, or is that simply the licensing cost?

Rep Michael Harrington (01:22:41):

I believe it was the engineering and licensing costs all combined. So they have to do the, obviously the initial engineering and the design, then they have to submit all that to the NRC and work through the licensing process. So it wasn't just what they paid the NRC, a lot of that, like, I would imagine a good portion of it was what they paid engineers to develop their design and to do all their calculations and everything else that's required before they even talked to the NRC.

John Tuthill (01:23:05):

Okay. Thank you representative. That's great. Appreciate it.

Rep Keith Ammon (01:23:09):

All right. And just another question for TerraPower from me. Your focus is on retrofitting coal plants and you know, changing the thermal source over to small modular reactor. I guess could you, we've heard a little bit about this before about the advantages of that approach other than less carbon emitting there's infrastructure advantages, but then also do you have plans to build, can a Nutrium plant be built from scratch without requiring retrofitting an old coal plant? So two, two related questions.

Jeff Navin, TerraPower (01:23:45):

Yeah. So our plans are not to retrofit the plant. We're actually about two miles down the highway from where the plant is. We will use the, the workforce and we'll use the grid interconnect. We'll just run power lines those two miles to connect to the existing grid and we'll use the water resources that are

currently at the plant. I know that there are some that are talking about, you know, just replacing the nuclear heat source, you know, within the coal plant itself. We have not done an in-depth study on that, but we have found that there are some challenges with building the nuclear you know, a nuclear reactor on an existing coal site. Some of it has to do with just the you know, the age and industrial infrastructure around there and getting an NRC license when you're talking about building something, you know, that close to an older, you know place. Now in this particular instance, there's also a coal mine that's adjacent to the coal plant where active blasting could occur. And you know, that that was a pretty big red flag for us, for us as well. So so we will be using the, like I said, the workforce, the grid interconnect and the water from the plant, but we won't be using any of the other physical assets of the of the coal plant.

Rep Keith Ammon (01:25:05):

Yeah, thanks for for clarifying on that. That was my misconception. Representative Harrington.

Rep Michael Harrington (01:25:10):

Yeah, just one, I guess of the bottom line question on price. You probably wear NuScale, just has a contract with people out in Utah and a bunch of municipals utilities. They originally were coming in at $58 and just last I last week or something, they said their latest figure would be 89 and I think it was 26 out of the 27 municipal power authorities said they could live with that. When in your project that you're looking at in Wyoming, are you in that same ballpark range of about $89 a megawatt hour?

Jeff Navin, TerraPower (01:25:42):

we plan to be quite a bit lower than that. You know, like I said, we're working through our contract negotiations with Rocky Mountain Power for our Nth of a Kind design. After we've got a few of these built, we anticipate that we'll be in the $55 to $60 a megawatt hour with the integrated energy storage included in that cost.

Rep Michael Harrington (01:26:06):

Thank you.

Rep Keith Ammon (01:26:08):

Alright, I think we're outta questions if I'm reading the room correctly. So thank you to you both for your presentations and if you have any final thoughts that you'd like to add or I think Jeff, if you if there's the best way to contact you if we have further questions.

Jeff Navin, TerraPower (01:26:28):

Sure, yeah. The best way to contact me is you can email me at navin@boundarystone.com. I'm happy to share the contact information with you as well if you'd like to circulate it to the, to the members of commission.

Rep Keith Ammon (01:26:41):

All right. That's great. All right. Thank you to you both. We just have a few more minutes of agenda just to go through. So you're welcome to stay or drop off and we won't be insulted. <laugh>. Thank you.

Jeff Navin, TerraPower (01:26:56):

Thanks everyone.

Rep Keith Ammon (01:26:57):

Thank you. All right. Additional public input. Does, John, do you have any further thoughts you'd like to give us and anybody on the phone or on the Zoom call?

John Tuthill (01:27:15):

No, I'm set. That was a very good session. Thank you all.

Rep Keith Ammon (01:27:18):

Great. Thank you. And that was John Tuthill. Alright. and then commission member discussion and you know, do you, did you guys think this was useful to kind of expand out into the fuel area?

Rep Michael Harrington (01:27:33):

The fuel is the biggie because it's, it's a big one. It's like going into chicken in the egg is real, right? It's something's gonna give or nothing's gonna get built. So, and it sounds like they're at least working on a plan to make that happen.

Rep Keith Ammon (01:27:44):

I thought it was interesting tying it into national security needs was you know, it seems like that would be a big driver to solve that chicken and egg problem.

Rep Michael Harrington (01:27:54):

Right. And just a couple of quick updates. You've heard me mention it to him. The NuScale power one, they were originally at $59 and then they went back to the utilities that they were, it's all municipal small and the municipal utilities out in West Empire, mostly Utah, but other parts of the west as well. And they've come back and said, well, we can't do it for that price now, which is probably not unique necessarily to nuclear, but if everything's coming up on supply line, supply chain like that, for example, the wind project off the coast of Massachusetts, they've come back to the utilities and said, we can't build it for that price anymore. We can't, we kinda have to renegotiate. So they went with 89 and I think it was 26 out of the 27 organizations said they could live with the 89. On the downside there was a bill in Virginia, which went through, which was pushed by the governor and it was a whole idea of putting out this sort of I don't know, an area in southwest Virginia where gonna be a lot of activity and they would be really trying to heavily negotiate and recruit SMRs to come in. And the bill never made it outta committee in the in the legislature. So it's, that's dead until next year, I guess, at least.

Rep Keith Ammon (01:29:06):

Yeah. So the governor Youngkin, he wanted to make New New Hampshire, make Virginia Yes. The center of SMR production,

Rep Michael Harrington (01:29:15):

Right. All

Rep Keith Ammon (01:29:16):

The bill got stalled in committee.

Rep Michael Harrington (01:29:19):
Committee. That was the big package.

Rep Keith Ammon (01:29:26):
Yeah. That was, that was related.

Rep Michael Harrington (01:29:31):
Yeah, I send him so much stuff, I kind of lose track

Rep Keith Ammon (01:29:35):
Of it. Yeah. I get a lot of the yeah, the input from Mike and I think it's the American,

Rep Michael Harrington (01:29:43):
American Nuclear Society

Rep Keith Ammon (01:29:44):
Polices out a, they put a, a daily email

Rep Michael Harrington (01:29:48):
A monthly and a magazine and yeah,

Rep Keith Ammon (01:29:50):
You got it. You can sign up for a lot of good information. Old business. I have, I since bar's on the phone, Bart, you are now an admin of the web portal. So if I get hit by a bus, it's your job to take over.

Rep Michael Harrington (01:30:06):
Not again. Yeah,

Rep Keith Ammon (01:30:08):
You already, it, it almost happened once.

Rep Michael Harrington (01:30:09):
So <laugh>,

Rep Keith Ammon (01:30:11):
It's definitely a Alright ho

Rep Michael Harrington (01:30:16):
Hopefully a power I'll never have to utilize.

Rep Keith Ammon (01:30:18):

Yeah, that's right. There's one thing that I didn't make it on the printed agenda. I think it's on. So this is a new topic, but I think it's interesting. I'm gonna pull up, I'm gonna pull up the webpage here and I'll share it with the Zoom folks. So I was digging through the statutes on nuclear or atomic that are in current RSAs. And I came across something interesting. So I'm just gonna go down this, I'm gonna pull up the statute so I don't misquoted here, but there's a position in statute, it's called the Coordinator of Atomic Development Activities. And it's supposed to be appointed by the governor and the executive council, and they're supposed to give a biannual report to the executive council. And I don't think this is being done. I don't, I don't know, does anybody know of that position being filled? Yeah. So what I was thinking is, and I I'm willing to go, maybe I'll go to an executive council meeting and say, is there a person to fill this position? If you look at the statute, this is the main part here, the governor and counsel shall point the head of one of the state department's concerned as advisor to the governor with respect to atomic industrial development within the state as coordinator of the job

Rep Michael Harrington (01:31:53):

To the Department of Energy.

Rep Keith Ammon (01:31:55):

Yeah. So I mean, this whole statute talks all about it, but it's a position the "coordinator of atomic development activities" shall keep the governor and council and the several interested departments and agencies informed at least by Anna Lee as to the private and public activities affecting atomic industrial development and shall enlist their cooperation taking action to further such development as is consistent with the health safety general welfare of the state. So I mean that, that position seems like a good tie in for this commission. If we could, you know, bootstrap that. And

Rep Michael Harrington (01:32:29):

It was done in, it was upgraded in 2017, so it's not It was Yeah. In 19 you know, 72 or something.

Rep Keith Ammon (01:32:36):

Right. So I just came across that I didn't know if anybody had any inside information about, about that you connect with the administrator or, yeah, so according to this, it's up to the executive council to appoint whoever that is.

Rep Michael Harrington (01:32:54):

Would've to, I guess executive council would've to confirm probably, right?

Rep Keith Ammon (01:32:58):

Yeah. But I mean, it's required by statute to be filled. Right. So, so maybe we can, you know, breathe some new energy into that and that could be a good outlet for the reports that we generate for this commission.

Rep Michael Harrington (01:33:12):

Yeah, probably you know, the history of the bill, see what it was, what the <inaudible> it was. I mean, you had to get past, it's gonna be a blur of someplace that says why we need it. Because it was something was done to it in July. I

Rep Keith Ammon (01:33:31):
Mean '50 1955, '73,

Rep Michael Harrington (01:33:34):
But 2017 something done too. Yeah.

Rep Keith Ammon (01:33:37):
But as part of thinking for recommendations from this commission, maybe we could, we could adjust this, you know, make it more up to date. Thought I'd throw that out there. So this is not a, this is not, you know, this is something that's been thought about before by other people, right.

Rep Michael Harrington (01:33:58):
So, yeah. Yes. Keep it going. Probably from a long time ago. Atoms for Peace program advising he

Rep Keith Ammon (01:34:06):
Was talking about, that was back when nuclear was the great hope.

Rep Michael Harrington (01:34:09):
Yeah. Oh yeah. Yeah. It was two feet to meet. Yeah. <laugh>.

Rep Keith Ammon (01:34:14):
Alright. that's about it. I think we're gonna have Southern Company in our next meeting. They were aligned. Interesting. Yeah, so they actually built the projects that Westinghouse presented to us about. They were the, they actually I think owned the project right there.

Rep Michael Harrington (01:34:33):
Yeah. They own the, oh, I think not a hundred percent, but they own by far the majority.

Rep Keith Ammon (01:34:38):
Right. And so it'll be interesting to hear about the construction delays, delays and issues that they dealt with. And then have a list of a few other, if anybody has a suggestion for the next meeting. I have a list that I'm picking from on the list is X-Energy and, and a few others that, that

Rep Michael Harrington (01:34:57):
What was that last one you sent you? The guy was gonna make, you know, disposable reactors or something on those. What was it? Last Energy or something

Rep Keith Ammon (01:35:04):
Like that. Oh yeah, yeah. That was a new one. Me? Yeah. Alright, any final thoughts?

Rep Michael Harrington (01:35:13):
Fudge is delicious.

Rep Keith Ammon (01:35:14):

Oh yeah. Don't forget, get some maple syrup. Candy maple. Motion to adjourn shall move. All right. Rep representative? Senator Pearl <laugh> old habits. And second for adjourn. Representative Harrington, seconds. Okay. All in favor. Thank you very much everyone. Thank you. Thanks for sitting in on the Zoom, everyone. Appreciate it.