MINUTES

Submitted by Keith Ammon

Commission to Investigate the Implementation of Next Generation Nuclear Reactor Technology in New Hampshire

March 6, 2023

Attendance:

Commission Members: Rep Keith Ammon, Rep Michael Harrington, Sen Howard Pearl, Cathy Beahm, Dan Goldner, Matthew Lavender, David Shulock, Bart Fromuth (remote), Christopher McLarnon (remote)

Absent: Marc Brown, Alex Fries

Public In-Person: John Schneller

Public Remote: John Tuthill, Vikram Mansharamani, Christine Csizmadia - NEI, Andrew Richards, Karen Testerman, Connor Woodrich, Gary Woods

Meeting:

1. The New Hampshire Commission to Study Nuclear Technology meeting was called to order by Rep Keith Ammon at 1:40 pm. The commission had a quorum present.
2. Welcome New Member: Sen Howard Pearl was welcomed as the newest member of the commission. Sen Pearl introduced himself and shared maple fudge with the commission members.
3. Approval of Minutes: The commission approved the December 12th meeting minutes, with one abstention from Sen Pearl. The commission approved the January 23rd meeting minutes, with one abstention each from Sen Pearl and Bart Fromuth. The minutes will be posted on the commission's website: https://nuclearnh.energy/.
4. Presentation by Jeff Navin of TerraPower.

   Introduction:

   - Jeff Navin, Director of External Affairs at TerraPower
   - Discussing the Natrium reactor project in Kemmerer, Wyoming

   Background of TerraPower:

   - Founded by Bill Gates
   - Focused on advanced nuclear technology to address climate change and global energy poverty

   Natrium Reactor:

   - Differences from conventional nuclear reactors:

    - Uses sodium instead of water as a coolant
    - Smaller in size (345 MW compared to 1 GW)
    - Employs molten salt energy storage system
- Provides a safer, more economical, and flexible power generation solution

Project in Kemmerer, Wyoming:

- Part of the Department of Energy's Advanced Reactor Demonstration Program
- Expected to come online around 2030
- Will be licensed for 60 years with an opportunity to extend for another 20 years
- Partnership with Rocky Mountain Power PacifiCorp
- Selected site due to enthusiastic community support

Community impact:

- Kemmerer is a small town with a population of 2,700
- The Natrium project will help retain jobs from the retiring coal plant and coal mine
- 109 IBEW members currently working at the coal plant will be offered jobs at the Natrium plant
- Expected to have 200-250 full-time employees and around 1500 jobs

5. Q&A with Jeff Navin of TerraPower

Q: Rep Michael Harrington: Is Wyoming a non restructured state in that 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?

A: Jeff Navin: Yes, Wyoming is a regulated state, but the deal is structured to set a fixed price for the sale of the plant, and the rate payers will not be on the hook to pay for that until the plant can be delivered at that set price.

Q: Rep Michael Harrington: Where are you going to get the HALEU?

A: Jeff Navin: Currently, Centrus is producing small amounts of HALEU in Piketon, Ohio as part of a project with the Department of Energy. There is a HALEU fuel program authorized by the Energy Act of 2020 to help address the chicken and egg problem of HALEU production and customer demand. The funding for the program is around $600 million, and TerraPower is waiting for the DOE to release their draft RFP for companies like Centrus to apply. TerraPower's reactor was initially planned to come online in 2028 but has been pushed back to 2030 due to HALEU challenges. Some small amounts of HALEU might be available from the Department of Energy's weapons program through down-blending highly enriched uranium from nuclear warheads.

Q: Rep Michael Harrington: In normal operations, would you be putting the 345 megawatts out on the grid, and then when there was a lot of solar or a lot of wind, would you continue to produce 345 and dump that into thermal storage or load follow?

A: Jeff Navin: TerraPower intends to load follow. The heat from the reactor will go through an intermediate loop heat exchanger and be used to heat up the salt in the molten salt energy storage system. All electricity generation will come from a steam turbine attached to the molten salt energy storage system, and the system can ramp up and down from about 40 to 50 megawatts up to 500 megawatts.

Q: John Schneller: Is there a minimum baseline number of acres where a production facility could be built, and what level of stability would be required for that site?

A: Jeff Navin: The current layout for TerraPower's reactor is 44 acres. While they try to keep it as compact as possible, there might be some flexibility to accommodate a smaller site. The Nuclear Regulatory Commission process requires a robust site assessment, including geological and meteorological studies, to determine the feasibility and safety of the site.

Q: John Schneller: How would the construction and operation of a nuclear power plant with a useful life of over 60 years be financed?

A: Jeff Navin: The financing of new nuclear power plant construction is under active discussion. In the past, the costs of reactor construction were spread out over the plant's life through rate basing in regulated markets. The financing mechanisms for nuclear power plants are still being developed for the current market situation. The government's Advanced Reactor Demonstration Program has stepped in to help finance the first plant with a federal cost-share. TerraPower also has a memorandum of understanding with Rocky Mountain Power to build five additional plants, which could help drive down costs and develop financing mechanisms for future projects.

(Jeff Navin's connection dropped. More questions were asked of him later in the meeting.)

6. Presentation by Dan Leistikow of Centrus Energy.

Introduction:

- Dan Leistikow from Centrus presents an overview of the company and its history.
- Centrus is the only publicly traded uranium enrichment company in the world.
- They are working on high assay low enriched uranium (HALEU) production in Ohio.

Company history:

- Centrus grew out of the Manhattan Project.
- It operated the US government's enrichment plants until the last one shut down in 2013.
- Centrus played a significant role in the "Megatons to Megawatts" program to repurpose Soviet nuclear material for civilian use.

HALEU production:

- Centrus is working on deploying its HALEU technology in Piketon, Ohio.
- The goal is to scale up production to meet the needs of advanced reactors.

Nuclear fuel enrichment process:

- Uranium is mined, converted into uranium hexafluoride (UF6), and sent to enrichment plants.
- Centrifuges separate U-235 from U-238, increasing the U-235 content to usable levels.
- The enriched UF6 is sent to fuel fabrication facilities to be turned into fuel rods for nuclear power plants.

Enrichment levels:

- Natural uranium is less than 1% U-235.
- Low enriched uranium (LEU) is enriched to just under 5% U-235, which is used in

Benefits of LEU Plus

- Allows for fewer refueling outages
- Increases power production efficiency

US Government Requirements

- Need for additional HEU for naval reactors
- Need for LEU for tritium production
- Importance of non-proliferation and safety standards

Challenges

- Chicken and egg problem: Private capital hesitant to invest without customers, customers need fuel supply

Public-Private Partnership Proposal

- Accelerate investments in enrichment capabilities
- Reestablish US leadership in nuclear fuel production
- Leverage government investments for commercial requirements

Centrus Technology Readiness

- 3.5 million machine operation hours
- Full-scale cascade production capability
- 42-month timeline to HALEU production

Importance of Supply Diversity

- Greater global market resilience
- Reestablish American producer presence

Centrus Unique Position

- Able to meet both commercial and US government requirements
- Demonstration cascade in Piketon to begin production by year-end

7. Q&A with Dan Leistikow of Centrus Energy

Q: John Schneller: What is the total capital investment that you need to start the 36 month LEU production?

A: Dan Leistikow, Centrus: They haven't talked about specific dollar figures, and as a publicly traded company, they have to be careful about disclosing financials. It's hard to give a precise number because it varies depending on what they are deploying. Large enrichment plants producing large amounts of LEU are multi-billion dollar projects.

Q: Rep Michael Harrington: When the fuel is no longer useful, what's the end of cycle enrichment left with the fuel?

A: Dan Leistikow, Centrus: It varies a lot based on the reactor design, and there's no definitive answer provided.

Q: Rep Michael Harrington: 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?

A: Dan Leistikow, Centrus: Some advanced reactors have the ability to burn off used fuel. There is discussion about reprocessing, but Centrus doesn't see a big need for it and doesn't consider it a viable solution. They believe the priority should be on making investments to produce fresh HALEU through enrichment.

Q: Rep Michael Harrington: Is the NRC's licensing for reactors using HALEU an issue?

A: Dan Leistikow, Centrus: Centrus had a good experience with the NRC in their project and already received their license for HALEU. However, the NRC still needs to look at the reactor designs themselves.

Q: Rep Keith Ammon: Where will the demonstration reactors that are being planned get their fuel?

A: Dan Leistikow, Centrus: It's up to the reactor developers to determine their own fuel sourcing, but Centrus would like to be their source of supply. They need to get started quickly to meet the timelines for these developers.

Q: Rep Keith Ammon: Is there any coordination inside the industry to solve the chicken and the egg problem?

A: Dan Leistikow, Centrus: Centrus has been talking to many companies about this issue, but it's challenging because reactor developers invest their capital in building reactors while Centrus invests in building enrichment. A public-private partnership is needed to solve the problem, leveraging national security requirements to provide a source of fuel.

Q: Rep Keith Ammon: Were the 36 months for LEU and 42 months for HALEU consecutive timeframes?

A:Dan Leistikow, Centrus: No, they are not consecutive timeframes. It would take 36 months for LEU and 42 months for HALEU. They can do both at the same time, but with LEU, there would be a much larger deployment.

8. Q&A resumed with Jeff Navin of TerraPower.

Q: Rep Michael Harrington: Does TerraPower expect to spend as much as NuScale for their design approval by the NRC, and does the use of HALEU present any particular hard spots with the NRC?

A: Jeff Navin, TerraPower: TerraPower does not anticipate their licensing fees to cost anywhere near what NuScale spent. They don't think HALEU will be a particular issue. They are working with the NRC during the pre-application process to identify issues to focus on. TerraPower expects to submit their license for their construction later this year.

Q: Rep Michael Harrington: Has TerraPower solved the issue of material corrosion with their molten salt reactor design?

A: Jeff Navin, TerraPower: The US has successfully operated sodium-cooled test reactors at Idaho National Laboratory for many decades. Sodium is not particularly corrosive with the materials used. TerraPower has been running many loops of salt through different materials in

their laboratory to understand the interactions. Advances in material science since the sixties and advanced computing help TerraPower design their reactor.

Q: John Tuthill: Is the $500 million figure total cost for the NuScale project or just the licensing cost?

A: Rep Michael Harrington: The $500 million figure includes engineering and licensing costs combined. It is not just what NuScale paid the NRC, but also what they paid engineers to develop their design and do calculations before talking to the NRC.

Q: Rep Keith Ammon: Can a Natrium plant be built from scratch without requiring retrofitting an old coal plant?

A: Jeff Navin, TerraPower: TerraPower's plans are not to retrofit the plant, but they will use the workforce, grid interconnect, and water resources from the existing coal plant. Building a nuclear reactor on an existing coal site presents some challenges, and in some cases, older infrastructure or adjacent activities (like blasting in a coal mine) might pose problems.

Q: Rep Michael Harrington: Is TerraPower's project in Wyoming in the same ballpark range of about $89 a megawatt hour like NuScale's contract in Utah?

A: Jeff Navin, TerraPower: TerraPower plans to be quite a bit lower than that. They anticipate being in the $55 to $60 a megawatt hour range with integrated energy storage included in the cost, after they have built a few reactors.

9. The members discussed the importance of resolving the fuel issue for nuclear power and tie it to national security needs.
10. The members discussed updates on NuScale power and a failed bill in Virginia related to SMR production.
11. The Coordinator of Atomic Development Activities position in New Hampshire is brought up, and they discuss filling the position and making it a tie-in for the commission's reports.
12. Southern Company is a potential presenter for the next meeting, and there are suggestions for future meetings with X-Energy and a company that may make disposable reactors.
13. The meeting was adjourned at 3:15 pm.