

**ALASKA STATE LEGISLATURE
SENATE RESOURCES STANDING COMMITTEE**

January 25, 2023

3:31 p.m.

MEMBERS PRESENT

Senator Cathy Giessel, Co-Chair
Senator Bill Wielechowski, Vice Chair
Senator Scott Kawasaki
Senator James Kaufman
Senator Forrest Dunbar
Senator Matt Claman

MEMBERS ABSENT

Senator Click Bishop, Co-Chair

COMMITTEE CALENDAR

PRESENTATION: INTRODUCING THE FRONTIERS COLLABORATION

- HEARD

PREVIOUS COMMITTEE ACTION

No previous action to record

WITNESS REGISTER

DR. STEVEN AUMEIER, Senior Advisor
Strategic Programs
Idaho National Laboratory
Idaho Falls, Idaho

POSITION STATEMENT: Delivered the presentation "Introducing the Frontiers Collaboration."

PAUL KJELLANDER, Senior Advisor
Regulatory Policy
Idaho National Laboratory
Idaho Falls, Idaho

POSITION STATEMENT: Participated in the presentation "Introducing the Frontiers Collaboration."

MARCIO PAES BARRETO, Director
Industrial Relations

Wyoming Energy Authority
Laramie, Wyoming

POSITION STATEMENT: Participated in the presentation "Introducing the Frontiers Collaboration."

ACTION NARRATIVE

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CO-CHAIR CATHY GIESSEL called the Senate Resources Standing Committee meeting to order at 3:31 p.m. Present at the call to order were Senators Dunbar, Giessel, Kaufman, Kawasaki, Wielechowski, Claman, and Co-Chair Giessel.

PRESENTATION: INTRODUCING THE FRONTIERS COLLABORATION

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CO-CHAIR GIESSEL announced the committee would hear a presentation from the Idaho National Laboratory to introduce the Frontiers Collaboration.

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DR. STEVEN AUMEIER, Senior Advisor, Strategic Programs, Idaho National Laboratory (INL), Idaho Falls, Idaho, explained that the use of the term frontier is referring to the new frontier of economic opportunity in global markets. He relayed that he would talk about what is shaping this new frontier, how to capitalize on it, and how nuclear energy might be a key to a competitive edge for the state and nation. He said he would introduce the regional collaborations INL believes will be key to capturing this opportunity, what's been done thus far, and what might be done in the future. His colleagues would discuss how to prepare for the competition, the collaboration that has been done, and the partner states that can create the basis for the collaboration with Alaska.

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DR. AUMEIER displayed slide 3 and made the following points:

- INL is the nation's and Alaska's lead nuclear energy laboratory. It does not sell reactors or anything else; it works in the national interest. As one of the seven national labs in the US system, it has a unique role and approach to regional outreach and collaboration.

- Over the last 70 years INL has been at the forefront of many of the frontiers of nuclear energy. INL and its predecessors were first in the following frontiers of the past:
 - INL hosted of the country's first nuclear power plants.
 - The first electricity from nuclear power was generated at INL to power the first U.S city (Arco, Idaho) solely by nuclear energy.
 - The first submarine reactors were tested and demonstrated at INL, and over 40,000 reactor operators have received training over the years. This happened in the high desert of Idaho because of the surprisingly strong Navy presence in the area.
 - INL demonstrated the first mobile nuclear power plant for the US Army in the 1960s.
 - In addition to the many other firsts in nuclear energy, INL is now working on national security programs.

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DR. AUMEIER stated that the focus of nuclear energy technology has shifted in recent years to look at where it will be applied, in what context, and for what purpose. This is critically important today because global markets for industrial materials are being disrupted due to the CO2 emissions content of products. This is beginning to be monetized and this will play out in a number of ways. He noted that the captions on slide 4 reference several examples of policy decisions the European Union has made about monetizing carbon emissions. This will disrupt market competitors because companies with lower emission footprints on their products will be in a preferred position.

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DR. AUMEIER turned to slide 5 to discuss the penalties associated with carbon emissions and the incentives associated with carbon capture, utilization, and storage (CCUS). Embedded in the Inflation Reduction Act and the Infrastructure Act were the carrots seen in the US markets. He described the new tax provisions for low-emission industries and manufacturing as stunning. Capital markets and Wall Street are talking about lower emissions and financiers are incentivizing lower emissions. INL sees this as a growing trend that will fundamentally shape global competition in the future due to the economic and national security implications.

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DR. AUMEIER stated that to see where nuclear energy fits into the new frontier of global competition, INL believes it's important to look at the history of nuclear technology and how

differently some of the new technologies are being applied. He explained that the existing, large nuclear reactors are typically individual construction projects that generate gigawatt scale power and the typical customers for this size reactor are large utilities. He noted that the picture on slide 6, which was taken about five years ago, shows the two new reactors that are being built at the Vogtle nuclear plant in the state of Georgia. When the photo was taken, this was the largest construction project in the US. He relayed that reactors evolved to this size to attain efficiencies of scale. The cost to achieve this financial advantage includes the need for complex engineered safety systems, complex planning and operations, and a very large footprint that includes a safety exclusion area of about 10 miles.

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SENATOR CLAMAN asked where the 95 reactors that the slide mentions are located.

DR. AUMEIER said they're mostly located from the Midwest to the East. A large nuclear plant in California was slated to shut down early, but that decision was temporarily reversed in the last year due to concerns about energy reliability. There is also a large reactor operating in Washington state and several in Arizona. These large grid-scale reactors account for 20 percent of the nation's electricity, and whether they should continue to operate becomes a more significant question as the nation moves toward more electrical use. They are complicated and complex systems that are licensed for 40 years and some have been extended for several more decades. When the lifetime cost is considered, they are competitive. The 450 some commercial reactors that are operating successfully represent a multi-trillion-dollar business. Worldwide, there is still a market for large reactors and they're being built every day, which is very different from the US market.

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DR. AUMEIER discussed small modular reactors as outlined on slide 7. He explained that these 77 megawatt modular reactors are built in a factory and installed one at a time in a central infrastructure. Some of the advantages include passive safety, which means the safety of the system comes from the physics of the plant. In the event of temperature increases and loss of cooling, physics causes the plant to shut itself down.

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SENATOR WIELECHOWSKI pointed out that the concern with safety stems from accidents like Three Mile Island, Fukushima, and Chernobyl that devastated entire ecosystems. When those reactors were built they were said to be safe, but they weren't. He asked if these new designs were 100 percent fail proof such that there would be no chance that they would significantly impact an ecosystem and the people in nearby areas if a system failed.

DR. AUMEIER replied there is nothing that's engineered that can be said to be fail proof, so the question is about the consequences of the accident scenarios that cause the dispersal of radioactive material and the loss of coolant and heat sink. That is what happened in the most aggressive accidents, but these reactors shut themselves down. The physics won't let them run; they are passively safe. During the licensing process, the Nuclear Regulatory Commission (NRC) looks at failure probabilities (that are on the order of one in hundreds of millions) and the consequences of a failure. Passive safety reduces the consequences of a failure by relying on physics to shut the system down. Physics doesn't fail.

SENATOR WIELECHOWSKI asked what the worst case scenario would be to nearby communities if a small modular reactor in midtown Anchorage were to fail.

DR. AUMEIER replied that the failure radius is 50 acres, as opposed to 10 miles for the large reactors, because failures cannot have the same consequences as a gigawatt reactor.

SENATOR WIELECHOWSKI pointed out that the emergency extended far beyond 10 miles for Chernobyl and the entire Pacific Ocean was affected after the Fukushima nuclear disaster. He noted that some of the reactors at Fukushima were still leaking.

DR. AUMEIER said the emergency planning areas on the large reactors refer to the evacuation areas. But the real question with the different reactor types is how to make the maximum consequence smaller and smaller.

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SENATOR KAUFMAN asked him to talk about 1) the inherent safety features of pelletized and encapsulated fuel, and 2) the added safety that comes from building modules in a controlled factory environment.

DR. AUMEIER noted that he was talking about TRISO fuel which is a significant safety feature. It went through a 20-year

certification process at INL. Each TRISO particle is a fuel kernel that is encapsulated by three layers of carbon and ceramic-based materials. When these fuel kernels heat up in a gas reactor, the neutronic characteristics are that the reaction dies away. This passive safety characteristic is found in TRISO and the metallic fuel HALEU [high-assay, low-enriched uranium]. HALEU will be used in the reactors in Wyoming and Utah.

DR. AUMEIER highlighted that with a small modular reactor, there is a smaller emergency exclusion zone because the maximum consequence that can be postulated is smaller.

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SENATOR CLAMAN asked if the emergency zones he mentioned refer to the radius.

DR. AUMEIER answered yes.

SENATOR CLAMAN asked if he was saying that if there were an accident at a large reactor, the impact would be within that 10 mile radius and not beyond.

DR. AUMEIER clarified that there must be an emergency evacuation plan within that 10-mile radius but there could be impact beyond that zone.

SENATOR CLAMAN asked whether the evacuation plan for a small reactor has a .2 mile radius.

DR. AUMEIER said yes; it's the maximum postulated distance of the impact.

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DR. AUMEIER relayed that the first of these small modular reactors are planned to be built in Idaho by 2029. The first commercial project will be located on INL property and there are plans to deploy them in Europe as well.

SENATOR GIESSEL said she assumes that the reactor that is planned for Eielson Air Force Base will be a similar unit.

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DR. AUMEIER clarified that a microreactor is planned at Eielson Air Force Base. The first reactor of this type is expected by 2025 and the size will be 50 megawatts or less. Microreactors are a step smaller than small modular reactors. Their

application is barges for emergency power, industrial processes, and military installations.

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SENATOR DUNBAR asked about how many homes can be powered with one megawatt.

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PAUL KJELLANDER, Senior Advisor, Regulatory Policy, Idaho National Laboratory, Idaho Falls, Idaho, answered that one megawatt would electrify between 500 and 700 personal residences.

SENATOR DUNBAR asked if there were microreactors that produce one megawatt or less of power.

DR. AUMEIER answered yes; INL is building a 100 kilowatt microreactor and commercial units are under design for near term construction that will product between one and five megawatts. Microreactors produce up to 50 megawatts, but they could be any size within that range. He said he'd like to discuss what one might do with reactors of that size.

SENATOR KAUFMAN asked him to speak to the possibilities for co-generation.

DR. AUMEIER explained that microreactors have the potential to produce either heat or power or heat and power in combination, which is especially important for industrial applications. For example, a remote mine might need two megawatts of electricity and one megawatt of heat for processing. This changes the economic calculation for the reactors.

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SENATOR WIELECHOWSKI asked if microreactors were cold weather tested to -60 F and whether an operator was needed 24/7.

DR. AUMEIER said these reactors are not temperature sensitive, but they would probably be located in a building. The number of operators the reactor needs is dependent on the vendor and the application, but as a general rule they have semi-autonomous operation and remote control in some cases. However, it is likely that an operator would be onsite.

SENATOR WIELECHOWSKI asked whether a microreactor could be installed in a remote area and monitored from a community

several hundred miles away, and whether the operator would need to watch continuously and remain prepared for an emergency.

DR. AUMEIER answered that as technology advances they might be operated remotely, but right now it's likely that a microreactor in a remote location would have a couple of people at the station.

SENATOR GIESSEL asked whether it was accurate to describe microreactors as "plug and play."

DR. AUMEIER directed attention to the table on slide 9 that lists the microreactors the Department of Energy (DoE) is aware of, and the visuals on slide 10 of a microreactor in a "nuclear battery" framework. The bullet points read as follows:

- Plug-and-play system producing 1-50 MW of heat and/or electricity
- Carbon emissions free
- Dry cooling (no water needed)
- Standardized, factory fabricated
- Transportable in ISO containers
- Semi-autonomous operation
- Offsite refueling every 5-10 years
- No onsite storage of radioactive material
- Very small footprint
- US suppliers are in the lead (Westinghouse, BWXT, X-energy)

DR. AUMEIER said the question is which of these designs are plug and play and what opportunities do plug and play reactors open versus other microreactors. It's an important point for the economic development context. He explained that a microreactor can be put in a nuclear battery format which is plug and play. Importantly, not all microreactors are nuclear batteries, but all nuclear batteries are microreactors. He said he assumes that the companies talking about plug and play recognize the game changing attributes of systems like that. He noted that Westinghouse had been building reactors for decades and was one of the US suppliers taking the lead in this area. He pointed to the pictures of the 10 megawatt nuclear battery formats for a community solar plant and the Vestas wind plant and commented that this is sometimes the best choice and sometimes the best choice might be a microreactor. But the point is that the notion of nuclear batteries creates all kinds of opportunities, and INL was working to find the right industrial applications.

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SENATOR WIELECHOWSKI asked for the cost of energy per KWh, and for an explanation of the bullet that says no onsite storage of radioactive material.

DR. AUMEIER explained that a microreactor in the nuclear battery configuration is taken to the site of application where it is plugged in and used for 5-10 years. When a replacement is needed, the power module is unplugged and replaced with a fresh module. The old power module is then returned to the factory. The only fuel that's on site is the fuel that is actively being used.

He said he would discuss the question about cost in a subsequent slide.

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DR. AUMEIER advanced to slide 11, Nuclear Battery + Advanced Industrial Production = Major Disruptor. He stated that the important point is that when nuclear batteries are configured as a microreactor, for example in a mining application that needs electricity for power and heat for processing, it moves up the value chain and could be an economic game-changer. That is what INL has been working on with both the reactor vendors and, importantly, the end users of the technology.

DR. AUMEIER advanced to slide 12, This Approach Applies across Every Sector of the Economy, Including Marine Platforms. The slide depicts a number of applications including: military bases, microgrids in remote communities, mining sites, indoor farming, indoor aquaculture, data centers, desalination, and portable pharma. He said one can postulate how these nuclear batteries can be plugged into a range of industries, particularly mining applications in Alaska, but the point is that they're a game changer and a key that can unlock a door to other types of manufacturing and industrial production technology.

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DR. AUMEIER displayed slide 13, The March toward "Embedded," Localized Energy as a Competitive Advantage. The graphics illustrate the movement from the very large reactors to small modular reactors to embedded energy sources in the nuclear battery format. He acknowledged that nothing in the nuclear energy space is cheap, but the question is where can one extract

the competitive value from those types of systems and what does the market bear.

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DR. AUMEIER advanced to slide 14, Accelerating advanced reactor demonstration and deployment. He pointed out some of the nuclear projects on the timeline that are slated to be constructed and demonstrated in the near timeframe at INL and other locations. The first is the microreactor Marvel that INL is building for the Department of Energy (DoE) and will come on line late in 2024. It is being built so stakeholders can get comfortable with the technology and test how it can be integrated with different industry applications. One of the most important projects in the near term is the reactor called Project Pele Microreactor. It is being developed by the Department of Defense (DoD) and BWXT is under contract to build it to provide mobile transportable power to support US forces in action worldwide. It is being fabricated and will be demonstrated at INL in 2024.

Other reactors include the one at Eielson that is defined as a commercially offered NRC licensed reactor. The contract has not been issued. The two larger reactors being deployed are the Sodium reactor that's being deployed in Wyoming and the X-energy high temperature gas reactor that will be deployed in the state of Washington. He noted that X-energy signed an agreement with Dow Chemical to look at ways to reduce its emissions footprint. They found that the best way is through these small reactor technologies and Dow signed an agreement with X-Energy to embed those reactors in chemical processing plants in the Southeast.

DR. AUMEIER stated that this is more activity than he'd seen in his 33 year career as a nuclear engineer. It's similar to the activity when power reactors were first being developed. He described it as an exciting time.

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SENATOR WIELECHOWSKI asked whether any other countries were using microreactors.

DR. AUMEIER said China, Russia, and the US are the principal countries pursuing these reactors.

SENATOR WIELECHOWSKI expressed surprise that he didn't mention any European countries, and asked if any countries had prohibitions against microreactors.

DR. AUMEIER said there have been agreements and MOUs signed with several European countries for small modular reactors and he doubted there would be any prohibitions against microreactors.

SENATOR CLAMAN noted that one of the slides described 2025 as the likely timeline to deploy a microreactor and 2029 to deploy a small modular reactor. He asked if that was the timeline for availability in the US and if the timeline would be similar for other countries.

DR. AUMEIER clarified that these were demonstrations, not commercial offerings. Commercial deployment for specific commercial applications is anticipated in the next five years. This is heavily dependent on NRC licensing but that agency is actively planning on how it will address microreactors. The paperwork he'd seen indicates they will be licensed within existing authorities. He said NRC sees the very different nature of those small systems so the licensing has to be treated differently. If they're licensed in the US, offerings around the world provide vastly larger markets.

SENATOR CLAMAN asked whether the timeline were similar in countries that aren't subject to NRC regulations.

DR. AUMEIER replied it depends on the country, but many of the countries that INL deals with look to the NRC as a standard of service. Also, there are export requirements, including a signed 123 agreement, so one would expect exports to those companies that have already signed the agreement.

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SENATOR WIELECHOWSKI asked if there were security concerns about individuals or organizations that might gain access to these plants for nefarious purposes.

DR. AUMEIER replied that security is always planned for these systems and the consequences of failure or breach is always part of the calculation. NRC licensing also requires each licensee to show it has an adequate plan to ensure the system is both safe and secure.

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SENATOR KAUFMAN asked him to talk about the sodium-cooled reactor that will be deployed in Wyoming, specifically the concerns about the reactivity of sodium.

DR. AUMEIER explained that sodium burns when it contacts air, similar to gas that comes into contact with flame. Nevertheless, it is used throughout industry so there are procedures to handle it safely. He described the safety features of passive reactors as outstanding and pointed to the ABR 2 [anaerobic baffled reactor] experience as an example. He offered to give a follow-up talk with videos of the tests that have been done.

SENATOR GIESSEL highlighted safety and the cost per KWh as key questions for the committee.

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DR. AUMEIER advanced to slide 20, Microreactor Cost Assessments and Licensing. He directed attention to the green boxes in the table on the top left that show the preliminary estimates of the costs of electricity. The slide also had the following bullet points:

- Capital cost estimates for MRs range from about \$6K/kWe - \$30K/kWe.
- Costs are uncertain, and achievement of cost targets critical for competitiveness in markets.
- Key is VALUE - incremental provisioning, reliability, zero carbon, security, etc

MIT Study Findings:

- Adding CHP (Combined heat and power) is key for MRs competing against diesel and natural gas.
- Modest carbon emissions caps raise the capital cost ceiling and make MRs viable beyond isolated markets.
- Additional tax treatment, investment and credits (e.g. IRA, BIL, DPA) being determined

NRC Assessing Licensing Strategies

- High degree of design and ops standardization
- Generic EIS streamlines site env. review
- Factory manufactured - No spent fuel storage

DR. AUMEIER clarified that information about the cost of a specific vendor's offering for a hypothetical application would have to come from the vendor. However, first of a kind units are fairly expensive at 60 cents per KWh. The fairly dramatic drop in costs after that is because microreactors are a manufacturing project, not a construction project. This also has positive quality assurance implications. Vendors are saying the

preliminary cost estimates are acceptable. This conversation is ongoing in Wyoming where there is a very specific application

He also pointed out the cost analysis that was done by the MIT Sloan School of Management. It found surprisingly high ceilings for two different markets that are Alaska-based, one of which was remote application. They found that with a modest carbon (emission) tax and with combined heat and power applications the maximum price that can still be competitive is as high as \$30,000 per KWh. He offered to provide a copy of the published paper

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SENATOR CLAMAN asked if the cost to construct a microreactor was on the order of \$0.60/KWh.

DR. AUMEIER answered yes, and the capital cost of nuclear is generally about 70 percent of the total cost of power production.

SENATOR CLAMAN asked if that means that the cost of that power would be \$0.50 to \$0.70 cents/KWh.

DR. AUMEIER answered yes; \$0.60/KWh is the estimate for first of a kind and novel applications, which makes sense in unique applications. What that estimate doesn't include are the tax credits that may be available.

SENATOR CLAMAN commented that the smart investor would wait for somebody else to build the first 100 reactors so the price is in the range of \$0.20/KWh, but the timelines indicate that won't happen in the 20-year horizon that's been discussed. Rather, the investment starts looking attractive in the 40 to 50 year timeframe. He asked if he was missing something.

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DR. AUMEIER noted that he was pointing to the difference between first of a kind and 10,000 or more units. He said you're not missing any of the fundamentals but what's important is the price point where somebody is willing to bear the cost and the supply chain starts to build for the unique application. He said he believes that some industrial manufacturers would be willing to place orders if the cost came down to the second green box on the chart [$< \$0.50/\text{KWh}$]. He noted that the same question has come up with other game-changing technologies. Aircraft and spacecraft are examples of first movers that are filling in that

cost timeline. The market ultimately will go from small to comparatively large.

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SENATOR WIELECHOWSKI referenced the first green box on the chart that estimates \$0.60/KWh, and the statement that the capital cost of nuclear is generally about 70 percent of the total cost of power production. He calculated that it would add another \$0.18, which would bring the total cost for the 2020 to 2030 timeframe to about \$0.78/KWh.

DR. AUMEIER said he generally agreed with the calculation.

SENATOR WIELECHOWSKI observed that none of the cost estimates on the chart were economic for any Alaskan community on the road system until 2040.

DR. AUMEIER said it's a good point and it gets to the question of where the first mover market is located and what is applicable for microreactors.

He continued to say that when he thinks about a bulk grid application, he's not thinking about microreactors because the threshold costs are higher. But if one is looking at bulk grid applications, small modular reactors might make sense. Nevertheless, the question is where do these reactors fit and for what purposes. INL sees the niche markets leading into the industrial applications which will carry a different price threshold.

SENATOR WIELECHOWSKI asked where the largest holdup is that is preventing microreactors from being built on a larger scale.

DR. AUMEIER said it's about priming the supply chain to get the first 10-15 first-of-a-kind applications and joining that with a market poll, which is what he and his team really came to talk about. He noted that this was the way that the commercial energy market for nuclear started and now it's producing 10 percent of the world's electricity. It started with military applications followed by incentivizing a commercial market that drew the technology cost down. He called it a tried and true market growth approach for deployment.

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SENATOR DUNBAR stated support for a community partnering with DoD or somebody else to deploy a microreactor but wondered

whether any state laws would prevent deploying this technology, or if it was market forces that were the impediment.

DR. AUMEIER suggested Marcio Paes Barreto talk about what the Wyoming Energy Authority is learning about cost and what different markets are willing to bear at the different levels shown in the green boxes for the postulated applications.

SENATOR GIESSEL said that was one of the committee's predominant questions.

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MARCIO PAES BARRETO, Director, Industrial Relations, Wyoming Energy Authority (WEA), Laramie, Wyoming, stated that Pacificore recently announced plans to deploy a nuclear power plant in the state of Wyoming, and WEA is looking at the opportunities nuclear energy will bring to the state. Developing a supply chain in the state is the first such opportunity and another is to use the heat and power the reactor will produce to add value to existing industries. Mining and processing the mineral trona is an example. Trona is a sodium carbonate compound that is processed into soda ash or bicarbonate of soda and it represents 76 percent of Wyoming's international export trade. Leveraging the heat from the planned microreactor will help to keep Wyoming's trona competitive in the global marketplace. An added benefit is that trona mined in Wyoming has lower emissions than its largest competitor, which is China.

MR. PAES BARRETO concluded his comments stating that as the largest producer of uranium in the US, Wyoming is looking carefully at this fairly complex transition for nuclear and taking small steps in order to consider the potential end users, the developers, and the local ecosystem that can support the construction and fabrication of these reactors, which includes the fuel. He said it's one step at a time.

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CO-CHAIR GIESSEL observed that Wyoming has some remote communities, just like Alaska, but it was looking at industrial use, not residential.

MR. PAES BARRETO responded that Wyoming has rural communities according to Lower 48 standards, but they are not remote as in the Last Frontier. The current project is to provide grid-scale electricity, but there are other opportunities associated with microreactors and WEA is currently looking for inducer applications.

CO-CHAIR GIESSEL noted that Senator Bishop cited \$0.05/KWh power costs in Wyoming. She asked if that was realistic.

MR. PAES BARRETO confirmed that was the cost for many end users in Wyoming.

CO-CHAIR GIESSEL asked if that was now or once nuclear power is added.

MR. PAES BARRETO deferred the question to Mr. Kjellander.

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MR. KJELLANDER relayed that in the Intermountain West, which is typically Utah, Wyoming, and Idaho, the cost per kilowatt hour ranges from \$0.08 to \$0.10/KWh.

CO-CHAIR GIESSEL asked for clarification that the source for that electricity was not nuclear.

MR. KJELLANDER replied it varies by state and the utility. About 60 percent of the power for the Idaho Power utility comes from hydro, whereas Pacificore that serves parts of Wyoming, Utah, Idaho, as well as California, Oregon, and Washington is largely coal-based and many of its generators are located within the borders of Wyoming.

SENATOR KAUFMAN asked him to comment on the different decisions that France and Germany made about energy production and the outcomes of those choices.

DR. AUMEIER said energy security is once again a very real issue and the principal point becomes one of cost and price versus value and applicability. Grid-scale applications are one set of considerations and another in places that have \$0.10 to \$0.15/KWh costs for bulk electricity. The question of industrial heat, the price, and what the market will bear for a number of different security and economic competitive reasons is a different question and that's the realm of microreactors. Bulk generation from the larger reactors, wind, and solar can put electricity directly onto a bulk grid. Security choices are vitally important for the country, not just in choices on how to power the grid but how industry will be powered.

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SENATOR CLAMAN asked whether the reactor that will be deployed in Wyoming is a small reactor or a microreactor, and its expected output.

MR. PAES BARRETO said the reactor under construction is a grid-scale small reactor that will produce 345 megawatts with energy storage up to 500 megawatts for several hours. WEA is also working with industry to explore microreactors that could be deployed in a cogeneration framework.

SENATOR CLAMAN asked what specific industrial applications were under consideration.

MR. PAES BARRETO listed underground and surface mining, processing minerals, and value added to mining products. He said providing power for small communities has uncertain potential.

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SENATOR DUNBAR asked whether any of the presenters were aware of any industrial users that might have reached out to the fish processing and mining industries in Alaska to talk about the commercial use of microreactors.

DR. AUMEIER stated that INL has been asked to help mining companies engage with INL's network which includes the state of Wyoming. He highlighted the value of partnering with the first mover states in these advanced nuclear technologies to prepare for the needed workforce. He emphasized that outreach and networking is an important part of maintaining leadership in this area. It is putting industries together with the vendors, the operators, and the financiers. That is being done through the Frontiers Collaboration between Wyoming, Idaho, and Alaska. The idea is to create a competitive advantage for each to grow the industry and fill those first-of-a-kind applications.

SENATOR KAUFMAN commented that with a reliable energy source, he could picture the production and front-end processing of rare earth minerals in Alaska.

CO-CHAIR GIESSEL thanked the presenters and highlighted the work that's being done at the Alaska Center for Energy and Power that's located at the University of Alaska Fairbanks.

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There being no further business to come before the committee, Co-Chair Giessel adjourned the Senate Resources Standing Committee meeting at 5:01 p.m.