EnergySource Innovation Stream: Small Modular Reactors

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ABSTRACT

NuScale Power has been developing a Power Module for a Small Modular Reactor (SMR). This SMR technology will allow NuScale to provide a nuclear power generation option to a much wider variety of customers to fit their needs. The SMR's modularity and size allows it to be fabricated in a factory and assembled on the site, which drastically reduces costs and construction time. Furthermore, the refueling of the power modules can be scheduled in a way where the unit does not have to be taken offline during refueling. NuScale is working with UAMPS to demonstrate the reactor with the hopes of commercial operation by 2027.

SUMMARY

NuScale Power provides scalable advanced nuclear technology for the production of electricity, heat, and clean water to improve the quality of life for people around the world. NuScale has been trying to move the SMR technology from the lab to the market since 2005. They are expected to complete design certification in2020 with hopes of a first SMR delivery by 2025.

- NuScale's core technology is the NuScale Power Module (NPM). A NPM includes the reactor vessel, steam generators, pressurizer, and containment in an integral package. The simplicity of the NPM allows for passive safety through natural convection for cooling.
- The SMR has reduced construction costs and schedule because of its modularity. This allows module construction in parallel with civil construction at the site. The module can be refueled once every two years, and it can be scheduled in a way where the plant is always producing power by alternating the module refueling.
- NuScale's SMR allows adaptation to a variety of siting needs. The NPM can be used in black-start and island mode following loss of offsite power, load following, along with a number of other capabilites. The SMR can also provide hydrogen production and desalination in addition to power generation.
- The first deployment of SMR's NPM is expected to be at UAMPS Carbon Free Power Project for commercial operation in 2027.

QUESTION & ANSWER

Q: *You mentioned load following, which is a game changer for nuclear in some ways. Can you expand on how this can help us move to a zero carbon system?*

A: This load following allows integration with renewables that provide inconsistent power to the grid. There is also load shaping that allows us to shut down modules one at a time if we are working with hydro. We published a paper with data on load following, and it's on the NuScale website.

Q: *Can regulatory harmonization be done with Europe and Asia to reduce costs?*
A: That would be a tremendous advantage for all nuclear technologies. There is much information being shared, as I experienced during my time at IAEA. The challenge is that each nation has its own regulations and guidelines, so to harmonize that is difficult and has not yet happened. It would eliminate the need to relicense nuclear technology in different countries.

Q: *How do you see NuScale's technology providing cost savings across the board?*
A: By doing the modules and the containment vessel in a factory, you save a considerable amount of money because you're not building the system on the field. If we look at cost saving from the nuclear navy's experience, we can also further reduce costs as we produce more of these through learning. Our target for the first plant is 6.5-cents/kilowatt hour. This is competitive in their region with natural gas. Many states are requiring clean energy standards that may help as well.

Q: *How does NuScale align with the goals with the nuclear fuels working group report in competing internationally?*
A: I think the report is quite insightful and it includes suggestions that are actionable. I think it's a key report that allows us to move forward. In terms of the fuel, there are some new accident tolerant fuels being developed by Lightbridge. I think there are opportunities there to move us forward.

Q: *What impact would availability of HALEU have on your plants when you were originally designing the system?*
A: We look at HALEU fuel as a possibility and an opportunity in the future, but our design currently uses 5% enriched fuel. HALEU could provide further performance capabilities as well as increased safety from not having to refuel as often.

Q: *Nuclear has some of the highest capacity factors in the energy industry. Because you can replace NuScale fuel sequentially, is your capacity factor higher?*
A: What we tell folks is we're looking at our first plant to run around 95%. We know we have the capability for 98%.

Q: *Can you share the progress between NuScale and Doosan Heavy Industries?*
A: Doosan are great partners with great manufacturing capabilities. They sent an engineer to work with us. We're looking at the supply chain and where we see opportunities in the world.

Q: *If 6.5-cents/Kilowatt hour is your target for the 12-module unit, how does it affect your numbers for 4 and 8 module units?*
A: Depending on where you're putting modules, you're not competing with natural gas, you're usually competing with diesel. If you can even do 8-10 cents/kilowatt hour, you are still competitive in many

markets.

Q: *Can you explain the economics of desalination with NuScale's modules and how it competes with natural gas?*
A: We've looked at reverse osmosis, but with RO filters, they're fairly economic to do it that way. The only difference between the power source is that nuclear is carbon free. If people are looking for a carbon free source to produce clean water, then nuclear is what you're looking for.

Q: *Another possible use of nuclear is process heat for steel or aluminum. Can NuScale's technology provide this application?*
A: Our output temperature is 300 degrees Celsius, which is low for some processes. With a 6-module plant, you can produce 600 metric tons of hydrogen per day. We did a study that found that we only need to use 2% of the power to produce at 600 degrees Celsius. So even with a lower pressure system, you can producehigh temperature steam.

Q: *What was the role of the national labs in supporting your efforts in advancing your technology?*
A: Whenever you have a new technology, working with a national lab provides you with the appropriate background and the laboratory space to do the critical work. We worked closely with Idaho National Lab, and we still continue to work with them closely for the first UAMPS plant. The main benefit is de-risking thenew technologies. Most people want to be the second owner, not the first owner. Having the government come in and provide cost sharing, facilities, site opportunities, are massive for de-risking first of a kind technology. I think this is true for all advanced reactor.

Q: *We have this great ecosystem that helps technologies develop at home, but what do US firms need help with to sell reactors abroad?*
A: We're a small company, but when we go to other countries to sell, we are competing with foreign governments so the playing ground is not quite level. This report that recently came out from the nuclear fuels working group does address this, and if we follow the recommendations, we might be able to go a long way. This will help us deliver the best technology throughout the world. If we had a level playing field, we would win. I'm interested to see what comes out of the DOE studies and what happens regarding progress with the recommendations from the report.