Future of Nuclear is Here

Jack Bailey, SVP, Business Development, NuScale, with Steve Mitnick at the APPA National Conference

PUF's Steve Mitnick: What's distinctive about this kind of nuclear plant?

Jack Bailey, SVP, NuScale: First of all, we're very excited about our groundbreaking technology. It's innovative, more flexible, cheaper and faster to build, all while relying on the proven experience of the light water reactors that have been operating for over sixty years, both in the United States and around the world.

We've been able to take those concepts to the next level in terms of how well we can meet some of the challenges that nuclear has had in the past and do it in a way that makes it simple for people to own, operate, and maintain these power plants.

Our plant has an integral design, which means it puts all the separate components of a reactor plant that you see with the big ones into one vessel. It uses natural physics to recirculate the water and cool the nuclear fuel, and then make the steam that's going to make the electricity.

We do this in a module that's only sixty megawatts in size. But it is configured in a licensed plant that can have up to twelve of these independent modules, all on the same building, that produces up to seven-hundred and twenty megawatts of power.

It's scalable, which means you don't have to have all of them installed to start producing power. They're independent, which means if one plant were to be shut down to refuel or because it had an upset condition of some type, the other eleven out of the twelve, if they're all installed, would continue to operate. This scalable design offers the benefits of carbon-free nuclear power and reduces the financial commitments associated with gigawatt-sized nuclear facilities.

It doesn't rely on offsite power to operate like large reactors do today. That means we could go into an island mode, if you had highly reliable power needs, and continue to operate at least one of our reactors out of the number that were installed, to supply those critical loads.

You could even use our plant to start up the grid. If the grid were to be lost, we could be the black-start capability to bring the whole grid back up, because we don't have to shut down and rely on somebody else to get us started up to do that.

It's going to have some benefits to the transmission grid. It's going to have benefits to the customers that want a simple and reliable nuclear option. It's going to be clean in terms of no carbon-dioxide emissions while it's operating.

It's going to have all the benefits that nuclear has but it's going to have these additional advanced innovative features that allow companies to own and operate these in a much more reliable and confident way.

PUF: There are similarities, but big differences?

Jack Bailey: Yes. Every technology over time gets better. This is taking a leap forward in terms of making nuclear power better while relying on the experience, the materials and the other factors that we have learned to rely on in existing operating plants.

Some of the new small reactor technologies are trying to go the totally untested route of using fuel and other things that have not been done before. Therefore, it's going to take a lot longer to demonstrate to the regulators that need to approve them that they can accomplish what they're trying to.

We are the only small module reactor vendor that is having their design certification application reviewed by the NRC, not only in the U.S., but in the world.

PUF: You're going through NRC review and might have one or more of these built soon?

Jack Bailey: Yes. We are the only small module reactor vendor that is having their design certification application reviewed by the NRC, not only in the United States, but in the world. Nobody else has submitted one of those applications.

We've had that application in review for over a year now. We're through the most difficult and intensive phase, phase one. This means we've essentially met all challenges so far, and we're ahead of schedule. We expect that NuScale's design will be approved by September 2020 with its first operational plant in Idaho by the mid-2020s.

Our first customer is the Utah Associated Municipal Power Systems. They are going to move forward with a site that they have selected on the Idaho National Laboratories Reservation. They would do a site license and use this technology certification or license to go with that to make an application to build and operate a plant.

PUF: How fast can that happen if everything goes right?

Jack Bailey: This plant will be commercial by 2026. It's only eight years away. In the future, once we have everything done, and you have a site that's licensed, you can build a plant, and have it completed in about three to four years.

NuScale control room simulator.

Source: NuScale

The schedule is getting smaller. That's another item that's different than the big plants, which take much longer to build. That's because the module itself, which includes all your safety-related systems for a nuclear plant, is going to be built in a factory.

It's not going to be built in the field with all the large construction workforces. Therefore, you're going to be building them over and over again in a controlled environment, and then ship them from a factory to an actual site where they have to be installed.

PUF: What do these look like?

Jack Bailey: They look like a large cylinder. The reactor is fifty-eight feet tall. Normally when you see a nuclear power plant, you see these big concrete domes from a distance, and they are semi-spherical on the top.

Ours is a cylinder around the reactor that's made from steel, and it's built in the factory too. Both the reactor systems and the containment are called our NuScale Power Module and can be shipped by truck or barge or rail. You may have to put it into three different sections to ship it, and then put it back together, and re-bolt it when you're at the site, but all of it would be manufactured and tested in the factory.

PUF: Where did your company and this idea come from?

Jack Bailey: NuScale Power originated out of a collaborative project with Oregon State University, the Idaho National Engineering and Environmental Laboratory, and Nexant. Our cofounder and chief technology officer, Jose Reyes, was a professor at that university at the time. The original concept, designated as Multi-Application Small Light-Water Reactor, was refined by Oregon State after the conclusion of the initial three-year project and became the basis for the current NuScale design.

We officially incorporated NuScale in 2007 and have been growing ever since. We originally had some initial startup money coming from a hedge-fund investor. In October 2011, Fluor Engineering became the majority investor and a key strategic partner for engineering, procurement and construction services. We are now owned by them predominantly.

We think we can build thirty-six of our reactor modules in the factory per year initially. As orders increase, we can build more than one factory.

We applied through a bid process that the government had for cost-share money back in 2012 and 2013, and we won one of the phases of that. We received two-hundred and twenty-six million dollars of cost share, which means we have to put up at least that much also. To date, we have spent over eight-hundred million dollars to advance our technology.

PUF: People might say, why should we be interested in this? What are its competitive advantages over other energy types?

Jack Bailey: We just announced recently, a major step in making our technology more competitive with other energy sources. Our modeling analysis and reviews by the regulator have indicated we can get twenty percent more power output of that same module without making it any bigger for essentially a two-percent increase in cost, which means it lowers the levelized cost of electricity up to eighteen percent.

Our target is to make it at equal to, or less than, sixty-five dollars per megawatt-hour, which is at the high end of a natural gas combined cycle plant now. But not if gas prices were to increase a little bit.

If you're going over a forty-year period of time in the future, it could be higher than people are currently forecasting by a little bit. If you add for the first few plants we're going to build, the fact that there are nuclear production tax credits by the federal government – and there are also loan guarantees that can give you a slightly lower cost of financing – that levelized cost of electricity may even be less than sixty dollars per megawatt-hour for some customers. Particularly the public power entities or municipal

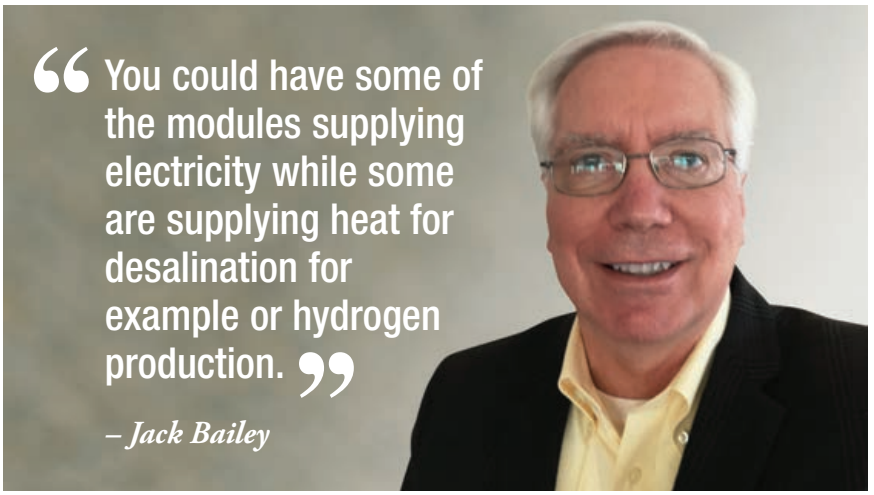
borrowers because their rates of financing are lower than an investor in their own utility to start with.

If you get the extra benefits we're talking about – its safety features, the carbon-free energy, the flexibility, then it becomes even more competitive with energy alternatives.

PUF: This could really get going because these are built in a factory?

Jack Bailey: Right. We think we can build thirty-six of our reactor modules in the factory per year initially. As orders increase, we can build more than one factory. We're not only talking about the United States. NuScale is working to put the U.S. on a path to be a leader internationally in the global small modular reactor race, a market estimated to be worth as much as five hundred and fifty billion dollars.

We're talking about a very large world market, so we could expand that manufacturing capability into other areas. The best case is that by 2030 we will build several of these plants. After 2030, we think we could build hundreds of these modules to supply plants around the world. Even with just a small share of the global small module reactor market – say ten to twenty percent – NuScale would need to be manufacturing roughly three to six power modules every month to keep up with the demand. That's about three to six billion dollars annually for a manufacturing business.



Looking ahead to concerns about climate change and the need for carbon-free energy generation, we know we need something dispatchable and reliable, like a nuclear plant, to complement renewable energy deployment. It used to be coal, and now it's gas. People are using gas to do that.

However, if carbon becomes a bigger concern, the gas plants are going to be reduced too. Some states are already talking about limiting gas plants in terms of generation, so what are you going to balance your renewables against?

We see NuScale and other small modular reactors as fitting in that balancing ability with renewables to have a fully carbon-free generation option for the country, and for the world.

PUF: With conventional nuclear power plants, we always want to keep them at full load between refueling outages. But with yours, would you dispatch them?

Jack Bailey: We've looked to the future. We tried to ask what is it going to be, ten or twenty years from now, that a nuclear power plant needs to be able to do. If it's going to operate on a transmission system that has a lot of renewables on it, it's going to have to be able to do certain things that we might not have done with nuclear power plants in the past.

The ability to load-follow is one of the big ones. We've designed three ways that our plant can load-follow. That's kind of like if you know ahead of time. Weekends don't have as much load as other times. You can balance ahead of time.

The other one is if you're ramping during the day, and you have a certain pattern during the day, you can ramp the reactor up and down at a faster rate than existing reactors because we've designed it to be able to do that.

The third way, which is very compelling and interesting, is you can dump a hundred percent of the steam to the condenser on each of our turbines, take the turbine all the way down as low as you need to go, and then bring it back up without changing the reactor power because it can continue to put out the steam that it was putting out. If you had to instantaneously change your output in order to balance the grid, you could do that too.

That gives you three ways of controlling the output of the plant. We call that NuFollow, which is NuScale and load-follow together.

PUF: Do you feel like you are making headway, compared to where you were a year ago, given how things are developing?

Jack Bailey: Absolutely. Our licensing was submitted on schedule. It was accepted by the NRC on schedule. It's ahead of schedule on its review right now. Our lead customer is signing power sale agreements right now, to be able to start site project work. It will move forward and have that project online by 2026 according to the schedule right now.

We have TVA, which is doing an early site permit application that potentially would utilize our technology. We have customers in Canada and elsewhere in the world that are looking for that first project to move forward before they jump on board.

We're extremely optimistic. Our mission is that we want to have this scalable energy that can improve lives globally. It's not just electricity. It can be used to desalinate water. It can be the energy for oil refineries to lower their carbon emissions. And we're able to do that with a design that has unparalleled safety

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Four CEOs on Innovation/Tom Flaherty

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Engaging Employees

The companies represented on this roundtable have been active in establishing and leading their respective innovation efforts over several years. Some were borne out of necessity, while others were the result of perceived opportunity to unlock internal creativity.

These CEOs collectively believe that innovation is not about a program, process or initiative – it needs to be more sustaining. It's instilling a mind-set that permeates the organization and establishes an environment of creative thinking and individual enterprise.

Formalization of internal innovation efforts has increased with companies adopting alternative approaches that incorporate enterprise-wide contests on ideas, collaborative centers for performance enhancement and breakdown of barriers to surfacing new ideas. These may be coupled with external alliances involving think tanks, incubators or university labs.

The CEOs recognize that quality ideation forms within the business rather than conceived at the top of the organization. Consequently, they are creating an internal environment that nurtures ideation and encourages involvement across the business.

Aligning Incentives

The CEOs know that changing a hundred years or more of legacy company tradition does not happen rapidly. It takes visible and sustained leadership and demonstrated commitment to changes and outcomes.

Shifting the philosophy on how incentives are established has been a difficult effort at many utilities given their historical practices.

Making it easy for employees to see and feel their contributions are both valuable and needed is a fundamental underpinning. Sending the message that leadership values thoughtful creation allows employees to take a risk, even though their ideas may not come to fruition.

But more formality in incentive design and reward is required to fully support sustained changes in how companies utilize incentives. Direct alignment between innovation outcomes and incentives definition, evaluation and reward would further support leadership's objectives.

The CEOs recognize the need to realign current metrics and messages in support of these expectations and more variability in incentive approaches, employee and team assessment and award flexibility are important.

Lessons Along the Way

The CEOs have individually experienced a range of challenges as they have pursued the stand-up of an innovation mind-set within their companies. While helping an organization to embed this conviction is a multi-year undertaking, some short-cuts exist for other companies at different points on their innovation journey.

All the CEOs inherently recognize that success starts with their employee base. Accordingly, they focus their efforts on creating messaging that is both aspirational and inspirational. And they continue this messaging to ensure it is heard, understood and reinforced.

These CEOs also understand that successful long-term innovation is continuous, not episodic, and supported by creating and embedding a culture that relishes change. Continuous innovation is enabled by emphasizing the new critical capabilities, for example, advanced data science, that informs strategies and actions.

Organizationally, these CEOs believe over-structuring innovation, that is, establishing a particular group with this responsibility, is not the right approach. They believe successful innovation comes from within and is best encouraged through enterprise level engagement, not through organizational roles.

Utilities are still early in their journey of creating a sustainable innovation mind-set. Incorporating the experiences of these CEOs may not solve all the challenges companies face, but it can simplify elements of the voyage. PUF

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and reliability features, and the modular design makes it flexible, and cheaper and faster to build.

NuScale is on the frontier of innovation in energy. It can do a lot of things with the same plant. You could have some of the modules supplying electricity while some are supplying heat for desalination, for example, or hydrogen production, or something else if that's the economy we want in the future.

It's an energy source, and the whole idea was to improve the quality of life for people around the world. A lot of those people still don't have electricity or water, and we could accomplish both of those as we go forward. What we've designed is a total game changer for the nuclear industry. PUF