UAMPS Proposal to Construct
NuScale's Small Modular Reactor (SMR) System

Frequently Asked Questions

Are small reactors a new technology?

Well, no. Nuclear power started with small reactors, both in the United States and in other countries. In the 1950s, the U.S. Atomic Energy Commission funded the construction of several small power reactors that were declared to be "suitable both for use in rural areas and for foreign export." But all these reactors ended up shutting down early because they were not economically competitive.

Do newer nuclear plants produce electricity at competitive prices?

Nuclear power plants are very costly to build. The Wall Street firm Lazard's 2019 annual report on costs of generating electricity, estimated that a new nuclear plant costs between $6,900 and $12,200 for each kilowatt of generation capacity; in other words a nuclear plant that is designed to generate a gigawatt of electricity could cost around $7 to $12 billion. This is much higher than any of the other standard forms of generation, especially renewable sources like solar photovoltaics and wind energy, which cost around $1,000 or $1,500 per kilowatt of generation capacity. Not surprisingly, the cost of electricity produced by new nuclear plants is very high. Further, operating a nuclear plant is also more expensive than renewables. This is why even nuclear power plants that have already accounted for construction costs are having trouble competing in electricity markets with wind, solar, and gas-fueled electricity.

Will Small Modular Nuclear Reactors be economically competitive?

There are good reasons why SMRs will cost more than large nuclear reactors on a per kW basis. One reason is that they lose out on economies of scale. A nuclear power plant that generates 1,000 MW of

electricity does not require five times as much concrete or metal, nor does it employ five times as many workers as one that generates only 200 MW. If one goes by a standard rule of thumb used in cost estimates of power plants, if a 1,000 MW nuclear power plant costs $10 billion (i.e., **$10000/kW**), an SMR with a power capacity of 200 MW would be expected to have a construction cost of $3.8 billion or around **$19,000/kW**. Although SMR vendors claim that they can compensate for the loss in economies of scale through mass manufacture and learning, this is unlikely because historically nuclear power plants have not demonstrated learning. If SMRs will be more expensive than large nuclear reactors, which are themselves not competitive, then SMRs will also not be economically competitive.

Does NuScale meet its production goals?

The date for when a NuScale reactor would be producing electricity has been repeatedly pushed back. The company announced in January 2008 that "NuScale Power intended to submit an application for design certification in 2010." By 2010, the anticipated submission date got pushed back to 2012, and *SNL Energy Power Daily* reported that NuScale was hoping "to have its first reactor online in 2018." NuScale officials themselves admit that the NuScale design "faced significant challenges meeting Nuclear Regulatory Commission (NRC) regulations".

By 2018, the date for commencement of construction had been pushed back to 2023 and commercial operation of its first module was to start in 2026 with the remaining 11 modules in 2027. In 2020, UAMPS announced that these dates have been pushed back; the first module is now "slated for 2029" with completion of the remaining eleven now scheduled for June 2030.

Can we expect more delays?

There are many reasons to expect delays in the future. In 2020, the NRC's Advisory Committee on Reactor Safeguards issued a letter warning that the "design and performance of the steam generators have not yet been sufficiently validated". The design of this structure is unique; no other commercial nuclear power plant uses a steam generator of a similar design. This, the Advisory Committee pointed out, "introduces different failure modes" resulting in their "design and performance" not being sufficiently validated. There are two concerns with the steam generator, one having to do with instability and the other to do with corrosion, due to "accelerated wear of the alloy 690TT steam generator tubing material." The decision not to require resolution before the design certification is issued, indicates that NuScale and the NRC expect that it will take a lot of time to address the problem. Thus, whoever is going to apply for the license to construct and operate the reactor will have to deal with the concerns highlighted by ACRS and NRC, in addition to needing to raise the finances and sell the power.

There is another problem that arose recently because NuScale is carrying out another round of design changes. This is because NuScale realized that "under certain conditions, the emergency core cooling system (ECCS) actuated later than expected and resulted in higher containment water level accumulation than previously determined." This has pushed back the timeline for NRC's completion of the next phase of the safety review of the design by nearly six weeks.

Another important source of future delay is NuScale's decision to increase the power rating per module from 50 MW to 60 MW because what NuScale has submitted for review by the NRC is the older design with a power rating of 50 MW.

What financial problems might NuScale face?

The development of the NuScale design has cost nearly a billion dollars but even under the company's optimistic projections, the new 60 MW design will require an additional investment of half a billion to $700 million. At least half of this will have to come from the private sector.

Fluor's financial troubles.

NuScale's majority shareholder is the Fluor Corporation. In recent years, Fluor Corporation has experienced severe financial trouble. Fluor Corporation's stock prices have declined from roughly $60 in October 2018 to under $10 in August 2020, going down to as low as $3.40 in March 2020. Ongoing financial problems have led some financial analysts to advise Fluor to abandon NuScale. NuScale's CEO stated that the company's "funding in the second half of 2019 was provided by third-party investors", namely companies other than Fluor. The continued availability of such funding is by no means guaranteed and could well affect NuScale's design completion.

Is there a risk of cost overruns?

There are two sets of reasons why the cost of constructing NuScale might go up. First, estimates of constructing the NuScale design have increased considerably. The cost estimate in 2003 for a precursor to the NuScale design was $1,718/kW (in 2019 dollars). In 2015, NuScale announced that the (then) 600 MW unit would be $5,499/kW (in 2019 dollars). The figure of $6.1 billion put out by UAMPS in 2020 translates to around $8,500/kW. Even with a substantial subsidy of $1.4 billion from the Department of Energy, the UAMPS project will cost about $6,500/kW. Because the reactor's design is changing and will likely have to change further in response to problems identified by the Nuclear Regulatory Commission's Advisory Committee on Reactor Safeguards, the cost can be expected to increase further.

The second reason why NuScale might prove more expensive than advertised is that there is a long history of cost overruns with nuclear power plants around the world. One study showed that 175 out of the 180 nuclear projects examined had final costs that exceeded the initial budget on average by 117 percent; and they took, on average, 64% more time than projected. This history and the applicability of the many underlying drivers identified in the literature to the proposed UAMPS project suggest that there is a high likelihood that NuScale will also experience cost and time overruns.

Recent examples of cost overruns in the United States.

The only nuclear plants that were constructed in the United States over the last decade, two each in the states of South Carolina and Georgia, ended up costing much more than what was initially projected. These were all AP1000 reactors. The initial cost estimate provided by Westinghouse Corporation, the equivalent of NuScale Corporation for the AP1000 design, was $1,365/kW (in 2000 dollars, or $1,966/kW in 2019 dollars). The South Carolina project was cancelled after spending over $9 billion and customers are now on the line for a substantial fraction of these costs even though the two nuclear reactors were unfinished and never generated any electricity. The last public estimate for the two remaining AP1000 reactors under construction in Georgia is $8,700/kW (in 2019 dollars), or nearly 4.5 times the initial cost estimate.

Can utilities exit contracts in the event of a cost overrun?

Events that occurred in 2019 to the City of Jacksonville suggest otherwise. Jacksonville's electric utility (JEA) is subscribed to buy electricity from the Vogtle Nuclear Power Plants. When the estimated cost of constructing Vogtle rose dramatically, JEA tried to void the agreement to purchase power but the court ruled that the contract was valid. As a result, JEA is stuck with having to purchase power at high costs.

Have utilities been left with financial problems because of investment in nuclear power projects?

Yes, there are many examples of such problems. Perhaps the most expensive of these occurred in 1983 when the Washington Public Power Supply WPPSS formally declared that it could not repay $2.25 billion in bonds used to finance partial construction of two now abandoned nuclear power plants in Washington State. It was the largest municipal bond default at that time. Overall, in the 1980s, electric utilities lost about $100 billion on nuclear plants that were unfinished.

What will electricity cost from NuScale's SMR?

The short answer is that we do not know. UAMPS has talked about a target price of $55/MWh but this is inconsistent with the dramatic increase in construction cost that has already taken place. Most independent estimates of the cost of electricity from NuScale come up with significantly higher numbers. In 2018, Pacificorp estimated a cost of $94/MWh for a NuScale plant operating at a 86 percent capacity factor. In its 2019 Integrated Resource Plan, Idaho Power estimated a cost of $121/MWh for a NuScale plant operating at a 90 percent capacity factor.

Is NuScale an economical way to back up intermittent renewables?

As renewable energy sources become a larger fraction of the electricity being generated in the grid, NuScale will become less economical. This is because when renewables are generating, they cost very little to operate. Thus, it is economically rational to use their electricity when it is available and decrease the outputs from other sources. When electricity from the nuclear reactor is not needed, the same fixed costs to construct and operate the plant will have to spread out over fewer units of electricity sold. As a result, the cost of operating a nuclear plant as a backup to renewables could be quite expensive.

Are there cheaper alternatives to electricity from NuScale?

Renewable sources of energy are experiencing a much more rapid reduction in cost. An independent study released in 2019 by the Healthy Environment Alliance of Utah (HEAL Utah) developed a number of "resource portfolios, including those that are carbon-free,… at approximately 40% ($24-28/MWh) less than" the costs then quoted by NuScale for the UAMPS project, and that on "a present value basis, the alternative portfolios offer between $298 – $355 million in savings compared to the SMR Base Case portfolio". One portfolio with exclusively wind and solar power comes out at $38.26/MWh whereas a portfolio with wind, solar, and battery storage (Lithium based, assumed to store for 4 hours) came out at $39.04/MWh

More examples of lower cost renewables

The Wall Street firm Lazard's 2019 annual report on costs of generating electricity, estimated that new wind and solar energy plants would provide power at $40 per megawatt hour. (In comparison, it estimated that a new nuclear plant will generate electricity at an average cost of $155 per megawatt hour.) Renewables make even more sense going forward because the costs of wind and solar power are

becoming cheaper year after year; just during the last decade, they have declined by around 70 to 90 percent.

Utah's Rocky Mountain Power obtained approval from Utah's legislature to move gradually to a 100% renewable energy portfolio; the rationale given was that it would "meet customer demand for choice and allow utilities to replace coal generation with lower cost renewables."

Are there safety concerns with NuScale?

Because of the complexity of nuclear reactor designs, it is hard to envision all possibilities for accidents and so it is not possible to build safety systems to protect against all possible contingencies. A specific problem with NuScale is that the design involves a group of 12 reactors at the same site. As a result, an accident at one unit might either induce accidents at others or make it harder to take preventive actions to prevent accidents at other units. If the underlying reason for the accident is a common one, such as an earthquake that affects all of the reactors, it is possible that many, or even all, units could undergo accidents. In that case, the combined radioactive inventories are sizable, even in comparison with a large reactor.

NuScale is also chipping away at safety margins through various changes in design and implementation. For example, one of its design updates listed "Reduced depth of reactor building pool" as one change. This would mean that there is less water to boil off in the event of an accident, which means that there will be less time to deal with the accident before radioactive materials are released. Likewise, NuScale, like many other SMR vendors, have been pushing the NRC to allow them to have a smaller Emergency Planning Zone. This is to reduce operating costs. Typical costs include training emergency service providers so that they are prepared to implement protective actions such as the evacuation of citizens. Such reductions of cost can only increase the radioactive doses that would accrue to those living in these areas.

Does NuScale produce radioactive waste?

Like all nuclear power plants, the proposed NuScale reactor design will also produce radioactive wastes of many kinds if and when it is operated. The problems of nuclear waste—its long life and the challenge of stewarding it for hundreds of thousands of years—are well known. The problem could even be a bit more acute for small reactor designs like NuScale because they will produce more, not less, nuclear waste per unit of electricity generated. This is because more neutrons escape out of the core of a smaller nuclear reactor and because of differences in the proposed fuel management practices. In the specific case of NuScale, it has been estimated that in addition to the roughly 60 percent increase in spent fuel generated, the volume of long-lived low and intermediate level waste generated by the SMR could be more than an order of magnitude greater for each unit of electricity when compared to a standard large light water reactor.

SMNR vendors typically claim that managing this waste will not be difficult. However, this view is at odds with the fact there is no demonstrated solution to dealing with this material. Any community that hosts a SMNR is probably also signing up to host nuclear waste for decades, perhaps even centuries.

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