Subcommittee on Energy
Hearing on
"Building a 100 Percent Clean Economy: Advanced Nuclear Technology's Role in a Decarbonized Economy"
March 3, 2020

Mr. John L. Hopkins
Chairman and Chief Executive Officer
NuScale Power, LLC

The Honorable Fred Upton (R-MI):

1. You have recently entered the last phase for design certification for the NuScale small modular reactor design, would you walk us through what is necessary to get through the next phase of the licensing process?

   RESPONSE: NuScale became the first ever small modular reactor (SMR) to receive U.S. Nuclear Regulatory Commission (NRC) design approval and is bringing the first SMR power plant online in the U.S. this decade. We received this approval ahead of schedule on August 28, 2020. NuScale has achieved tremendous success to date in the licensing of its technology. NRC design approval of NuScale's SMR technology was the fastest on record and has set the standard for future SMR design certification proceedings, involving about a quarter-million staff hours of review. Design certification will occur in 2021 and NuScale's Standard Design Approval (SDA) application is scheduled for submission to the NRC in 2022.

   NuScale continues to maintain strong program momentum toward commercialization of its SMR technology, including supply chain development, standard plant design, planning of plant delivery activities, and startup and commissioning plans. We are actively engaged with our manufacturing partners and will be ready to deliver the first NuScale Power Modules to a client in 2027. The NuScale SMR design will be incorporated into customers' combined license applications (COLAs).

   a. I note you have a number of Utah Associated Municipal Power System (UAMPS) customers. Will each of the states deploy their own NuScale modules? Give us a sense of where and how rapidly you could ramp up.

      RESPONSE: The Utah Associated Municipal Power Systems (UAMPS) is a political subdivision of the State of Utah that provides comprehensive wholesale

electric-energy, transmission, and other energy services, on a nonprofit basis, to community-owned power systems throughout the Intermountain West. UAMPS members are located Utah, California, Idaho, Nevada, New Mexico, and Wyoming. NuScale's customer is the UAMPS consortium, and it is UAMPS that works directly with and manages all aspects of membership, not NuScale.

By the end of this decade, a NuScale small modular reactor (SMR) power plant will become part of UAMPS' Carbon Free Power Project (CFPP), an initiative that will provide clean, reliable, and cost competitive energy to its Members across the West. The first NuScale Power Module™ (our SMR technology) will begin generating energy for the CFPP in mid-2029 and the remaining modules will come online for full plant operation by 2030.

b. What does this mean for domestic manufacturing and the related jobs and economic benefits of that?

RESPONSE: The direct economic benefits for the UAMPS region include:

- A NuScale plant will employ about 270 people full-time, with 1,200 peak construction jobs.
- Domestic supply chain for manufacturing 36 modules (SMRs) per year generates about 13,500 manufacturing jobs.
- $2 billion in direct and indirect benefit from manufacturing and construction activities over the 4 years of the construction period.
- Once built, ongoing plant operations will add $48 million to local labor income each year.
- In addition to the jobs generated, the supply chain implications are vast: cables, piping, steel, all the necessary components– those are million-dollar business opportunities for local and regional manufacturers.

Source of data listed above is the Regional Economic Development of East Idaho (REDI) Report, August 2018 (report accessible on NuScale's technical publications webpage https://www.nuscalepower.com/technology/technical-publications). Also, according to a 2016 study by the Nuclear Energy Agency, the SMR market size through 2035 is more than $100B. Even with just a small share (10%-20%) of the SMR market, NuScale would expect to manufacture around 3-6 modules every month to keep up with demand, which translates to about $3B-$6B annually for a manufacturing business.

c. You talk about placing your units at the site of former coal units. This would reduce the need for new transmission siting, is that correct?

RESPONSE: Yes, that is correct. The NuScale plant can be located at the "end of the line" or off-grid, without the requirement for offsite transmission source(s) to the station. The scalable, multi-module design of the NuScale power plant makes it ideally suited to replace retiring coal-fired plants, many of which are between 300 MWe and 600 MWe. NuScale power plants also bring benefits via a small land footprint: only 20 acres are needed for siting for our 4-module (308 MWe) and 6-module (462 MWe) plants and just 34 acres for our 12-module plant (924 MWe). With the ability to maximize power outputs while minimizing the amount of land required, NuScale plants can be located across a diverse range of retiring coal power plant sites.

Specific coal plant infrastructure can be repurposed and reused, such as cooling water delivery systems, demineralized water, potable water, site fire protection, and switchyard, as well as administrative, warehouse, and other existing buildings. These systems can be repurposed at significant savings; our analysis estimates that on average, approximately $100M of existing coal plant infrastructure could be reused for a NuScale plant.

More important than the infrastructure is the existing coal plant workforce, which can easily transition to operating a NuScale plant, effecting a just transition to clean energy. I provide more details on this in my response to the Honorable Pete Olson.

d. How do you address the question that coal plants and other facilities were not sited for nuclear? How does your SMR design overcome site permitting issues?

RESPONSE: This connects to the second-to-none safety features of NuScale's small modular reactor technology with capability and performance not found in current nuclear power facilities. NuScale offers a fully passive safety system design, rigorously proven by our Triple Crown for Nuclear Plant Safety™ which ensures that reactors will safely shut down and self-cool, indefinitely, and do so with no need for operator or computer action, AC or DC power, or the addition of water—a first for LWR technology. Our strong safety case justifies an emergency planning zone in the U.S. that only extends as far as the site boundary (as opposed to 10 miles for current U.S. plants)—further reinforcing NuScale's ability to accommodate a variety of coal power plant sites.

The unparalleled safety of NuScale's SMR provides a new level of nuclear power plant resilience. Following a loss of offsite power or the loss of the transmission system grid, our plant can run in island mode, provide first responder power, and black start from cold conditions. The NuScale plant can be located at the "end of the line" or off-grid, without the requirement for offsite transmission source(s) to the station. The plant is resilient to natural events, with the modules and fuel pool located below grade in a Seismic Category 1 building; it is designed to withstand an aircraft impact and is also resilient to EMP/GMD events. Finally, our non-microprocessor-based module and plant protection systems use field programmable gate array technology that is invulnerable to cyber-attacks.

The Honorable Pete Olson (R-TX):

1. In your testimony, you stated NuScale can replace retiring coal facilities. Can the worker base at current coal facilities transfer to the NuScale?

   RESPONSE: Yes, the existing coal plant workforce can be retained and cross-trained to operate and maintain a NuScale plant, as most coal plant positions are directly transferrable to the NuScale plant. Each 12-module plant will employ around 270 people full-time, high-quality, high-paying jobs. For nuclear-specific positions, the coal plant workforce can transition to the nuclear plant through professional development and training. Examples of the types of jobs that transfer from a coal power plant to a NuScale plant include, but are not limited to:

Department	Coal Plant Position	NuScale Equivalent Position
Senior Management	Plant Manager Operations Manager	Plant Manager Operations Manager
Operations	Assistant Operations Manager Control Room Operator	Shift Manager Reactor Operator
Outage Planning	Outage Manger Planner	Generation & Planning Manager Planner
Maintenance Planning	Maintenance Supervisor Engineering Technician	Maintenance Supervisor Work Control Scheduler
Maintenance	Boilermaker, Steam Fitter I&C Technician	Mechanic I&C Technician

	Heavy Equipment Operator	Site Support Craftsman
Engineering	Thermal Station Engineer System Engineer Project Manager	Design Engineer System Engineer Supply Chain Specialist
Environmental	Environmental Board Operator Environmental Operator	Radwaste Operator Non-licensed Operator
Coal Yard Railroad	Coal Yard or Railroad Specialist	Site Support Craftsman

The Honorable David B. McKinley, P.E. (R-WV):

1. The Shippingport Atomic Power Station in Pennsylvania took around three or four years to build, and less than a year to get a permit. In 1979, an exhaustive CBO report indicated that it then took 10 to 11 years to receive a permit.

   Mr. Hopkins, you indicated that you started the design certification application in 2016, and that you will be finished with that process in 2020.

   You also stated that, "the owner who has to also apply to get through their Construction and Operations License will generally take 2 years beyond that."

   On top of that timeline, you have to consider the actual time it takes to build a station.

   a. What costs are associated with delay in total time it takes to receive a permit and construct a nuclear facility?

      RESPONSE: NuScale became the first ever small modular reactor (SMR) to receive U.S. Nuclear Regulatory Commission (NRC) design approval and is bringing the first SMR power plant online in the U.S. this decade. We received this approval ahead of schedule on August 28, 2020.

      NuScale has achieved tremendous success to date in the licensing of its technology. NRC design approval of NuScale's SMR technology was the fastest on record and has set the standard for future SMR design certification proceedings, involving about a quarter-million staff hours of review. To answer

your question, based on our pre-licensing engagement with the NRC in connection with our Standard Design Approval (SDA) application submittal, we have high confidence in meeting all schedule objectives for this next review process and in this case do not anticipate any delays, and therefore no additional costs.

NuScale Power Modules (our SMR technology) are fully factory-manufactured with no in-field construction, erection, or fabrication and they are transported to the power plant site—making our power plants less expensive to build, operate, and maintain. Compared to large nuclear plants, our simplified SMR design results in greater use of "commercial off-the-shelf" items that need not be supplied under stringent and costly nuclear standards.

Because NuScale's SMR technology is smaller and simpler, our plant offers lower costs and a shorter nuclear construction period of less than 36-months from the first safety concrete. This brings our SMR technology online sooner, with the very first module generating power and revenue while additional modules are being planned for or installed. This incremental approach is being employed by our first customer, the Utah Associated Municipal Power Systems (UAMPS), who wished to have one module online by mid-2029, and remaining modules to follow for full plant operation by 2030. UAMPS is already active performing site characterization activities on the Idaho National Laboratory site where our plant will be located.

Our current plan with UAMPS is to use the NRC's 10 CFR, Part 52 process, as has been used for all new designs to date. Under this process, the standard design approval application (SDAA) must be submitted concurrent with or before the combined license application (COLA). The SDAA must be approved before the COLA, and those approvals can be close together (i.e., within weeks). Not all construction activities must wait for approval of the COLA. Some general construction, and under an NRC approved limited work authorization (LWA) some nuclear-related construction, can occur in the period prior to approval of the COLA. More generally in the U.S., the licensing process pursued will depend on what works best for each customer. In most cases, this will be 10 CFR, Part 52. For others, the 10 CFR, Part 50 process may allow a faster path to commercial operation.

The Honorable Richard Hudson (R-NC):

1. As you may know, I represent the tremendous men and women of Fort Bragg in North Carolina. I am very interested in how we can improve the safety and security of our soldiers in the field and our military installations. A number of studies have identified the potential benefits of applying advanced nuclear reactor designs to fill specific national security needs. I introduced legislation which became law in the FY 2019 NDAA that requires the Department of Energy, in collaboration with the Department of Defense, to develop a report on a pilot program to construct and operate micro reactors at national security locations. NuScale is a leader in the developing Small Modular Reactors and I am interested to hear your take on the deployment of small modular reactors at critical DOE and DOD facilities.

    a. Would you talk about the potential benefits of this, both for energy reliability, national security, and also as a path to building a market for advanced technologies?

    RESPONSE: The NuScale power plant offers mission critical facilities including hospitals, government and military installations, digital data storage centers, and other industrial facilities a level of certainty for achieving close to the "Five 9s" (99.999 percent) for exceptionally reliable power. A 924 MWe (gross) NuScale 12-module power plant can assure 154 MWe net power to a dedicated microgrid at 99.95% reliability over the 60-year lifetime of the plant, while 77 MWe (gross) of power can be provided at a remarkable 99.98% reliability. The NuScale plant can also be located at the "end of the line" or off-grid, without the requirement for offsite transmission source(s) to the station.

    The unique resilience features of the NuScale power plant include:

    Black-Start and Island Mode: Following a loss of offsite power event, a single NuScale Power Module™ (NPM) can be black-started from cold conditions and continue to power the entire plant without the plant being connected to the grid. This is referred to as operating in Island Mode.

    First Responder Power: If a loss of transmission system grid occurs, the NuScale plant employs variable (0% to 100%) steam bypass so that all 12 modules can remain at power operating in Island Mode and be available to provide electricity to the grid as soon as the grid is restored.

Resilience to Natural Events: In the NuScale plant, the modules and fuel pool are located below grade in a Seismic Category 1 Building that can withstand a Fukushima type seismic event and can withstand hurricanes, tornados, and floods.

Resilience to EMP/GMD Events: The NuScale plant has numerous geomagnetic disturbance (GMD) and electromagnetic pulse (EMP) resilience features, including plant safety equipment that is electrically isolated from the main plant distribution system, a reactor vessel shielded by a stainless-steel containment vessel, a GMD/EMP hardened concrete reactor building with steel liner and reinforced steel rebar, and widespread use of optical fiber links that are not susceptible to GMD/EMP.

Resilience to Aircraft Impact: The NuScale power plant reactor building can withstand aircraft impact as specified by the U.S. Nuclear Regulatory Commission (NRC) aircraft impact rule.

Cybersecurity: Module and plant protection systems are non-microprocessor based using field programmable gate arrays that do not use software and are therefore not vulnerable to internet cyber-attacks.

These resilience features are bolstered by NuScale's Triple Crown for Nuclear Safety™, which means that even upon loss of grid power, no operator or computer actions, AC or DC power, or additional water is needed to keep the reactors safe—a first for commercial nuclear power that provides an unlimited coping period. Our plant design incorporates several simple, redundant, and independent safety features offering unparalleled system resilience, which we continue to improve upon. To learn more, please visit our Built for Resilience webpage at https://www.nuscalepower.com/Benefits/Built-for-Resilience

Regarding a path to building a market for advanced technologies like NuScale's, we see energy as essential to human development and economic growth – yet 1.1 billion people in the world still live without any access to electricity – and many more live in energy poverty. Climate change, increasing water scarcity, population growth, demographic changes and urbanization already pose global challenges for energy and water supply systems. The resilience features outlined above that are inherent to the NuScale power plant design make our technology especially well-suited to provide resilience against an increased frequency of severe weather events and other natural hazards expected because of climate change.

Recent policy changes, such as those to the U.S. Development Finance Corporation's Environmental and Social Policy Procedures that remove the legacy prohibition for support of nuclear power projects like NuScale's, means that these countries will have a viable option to expand their clean energy resource portfolios for economic growth, poverty reduction, and climate change mitigation. The market potential for SMR nuclear technology is not to be understated – most recent estimates show that the SMR market could be worth over $100 billion by 2035, proving to be a real benefit to the American economy.

A 2018 Nuclear Energy Institute (NEI) article (https://www.nei.org/advocacy/compete-globally/export-import-bank) revealed that over the next decade, exports of more than 15 new nuclear plants could hinge on the availability of EXIM Bank financing. At roughly $3 billion to $5 billion per plant, there could be more than $45 billion to $75 billion in U.S. exports that will need EXIM Bank support. With EXIM, U.S. nuclear exporters can better compete against state-owned and state-supported rivals such as Russia and China, which have used favorable export financing to achieve dominance in the global nuclear energy market.

Our operationally flexible, modular design is also ideally suited to address different energy needs as it can direct the heat energy produced in the reactors in the form of superheated steam for either baseload or extensive load following electricity production, or to a variety of process heat applications such as thermal distillation, and hydrogen, cement, pulp & paper, and petrochemical production. Studies have shown that integrating NuScale plants with renewables offers the least cost path to achieving U.S. state clean energy mandates when compared to renewables plus storage alone (see E3 study https://www.ethree.com/wp-content/uploads/2020/02/E3-Pacific-Northwest-Zero-Emitting-Resources-Study-Jan-2020.pdf). NuScale power plants, while offering highly flexible load-following capability, also support grid stability by being able to provide critical system voltage and frequency support, which allows for an increased penetration of renewables, and a reliable grid. Some facts regarding a single 77 MWe/250 MWt module:

- It can produce 2,053 kg/hour of hydrogen, or nearly 50 metric tons per day, which would avoid about 460 tons of CO2 emissions per day, or 168,000 tons of CO2 per year, as compared to producing hydrogen from natural gas.

- A single module can also produce enough hydrogen to power 38,000 fuel cell vehicles or 1,500 long-haul fuel cell trucks at average annual fuel usage rates in the United States.
- A single NuScale power module coupled to a desalination plant can produce 77 million gallons per day of clean water, while a 4-module NuScale plant could provide all of the water for a city the size of Cape Town, South Africa, about 4 million people using over a billion liters of clean water per day.

In conclusion, NuScale continues to explore global market opportunities with stakeholders in the United Kingdom, Canada, Central and Eastern Europe, southeast and central Asia, Africa, and the Middle East. Over the past two years, NuScale has initiated several memoranda of understanding (MOUs) with several domestic and international entities to explore the potential deployment of NuScale SMR power plants, and global interest in our safe, resilient, and reliable carbon-free SMR technology continues to grow.