Committee Secretariat
Standing Committee on Environment and Energy
PO Box 6021
Parliament House
Canberra ACT 2600

September 4, 2019

Subject: NuScale Power Submission to the Standing Committee on Environment and Energy

RE: The Inquiry into the Pre-Requisites for Nuclear Energy in Australia

Dear Committee Secretariat:

Founded in 2007, NuScale Power, LLC ("NuScale") is a small module reactor (SMR) technology development company headquartered in Portland, Oregon, United States, and is America's leading SMR developer, paving the way for a revolution in how nuclear power is harnessed as a sustainable, carbon-free energy source. Please accept this letter as NuScale's submission to the referenced inquiry.

With over $850M (US) invested to date to develop, license, and commercialize our technology, and over 485 patents granted or pending in 20 countries, NuScale is developing a groundbreaking scalable nuclear power plant based on the revolutionary NuScale Power Module™ ("NPM" or "power module"). This design features a fully factory-fabricated small modular reactor and containment system capable of generating 60 MW of electricity using a safer, smaller, and scalable version of pressurized water light reactor technology. A single power plant is capable of housing up to 12 individual power modules offering the benefits of 720 MWe (gross) of carbon-free nuclear power without the financial commitments associated with gigawatt-sized nuclear facilities.

Our groundbreaking technology has the potential to improve quality of life for people around the world, and we're especially excited about the zero carbon potential our technology can provide for Australia. We already have a first adopter in the United States; our SMR is the first and only to undergo design certification review by the U.S. Nuclear Regulatory Commission (NRC). Utah Associated Municipal Power Systems (UAMPS), a municipal power company in the western United States and our first customer, will commercialize the first SMR power plant in the state of Idaho in 2026. Unlike our competition, we are well beyond the conceptual and detailed design phases of development, and rather readying the design for manufacture and construction, including the establishment of a world-class supply chain. Site mobilization at the Idaho site will occur in 2021, with nuclear construction commencing in 2023.

We believe that NuScale's technology is a great fit for Australia, both from an energy and business perspective. Our technology prioritizes safety, delivering cost effective baseload and load-following electricity production, and offers other features and capabilities not found in currently offered large nuclear power plants. With regard to safety, our advanced design is second-to-none for light water technology eliminating the need for two-thirds of the systems and components found in today's large reactors. For example, in the postulated event of a complete loss of power, NuScale's design safely shuts down and self-cools, indefinitely, with no need for operator or computer action, no need for AC or DC power, and no

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need for additional water. It is a revolutionary solution to one of the biggest technical challenges for the current fleet of nuclear energy facilities.

Earlier this year, an Early Site Permit application under review by the U.S. NRC requested an exemption to the current regulatory mandated 10-mile emergency planning zone (EPZ) for a specific site in Tennessee. The exemption, which seeks approval to limit the size of the EPZ to the site boundary, identified the specific conditions that must be satisfied by an advanced/SMR technology to be eligible for such an exemption. NuScale's technology, should it be deployed at that site, would meet those conditions, which further demonstrates its exceptionally safe design and ability to reduce overall plant risk.

NuScale's plant has a significantly lower overnight capital cost and annual operating costs on a dollar per MW-hour basis significantly better than the current U.S. nuclear fleet average, and can be constructed in considerably less time compared to large nuclear plants. That's in part because of fully factory-fabricated elements of the modular design that takes safety-related fabrication work out of the field, lessening the risk to both cost and schedule.

The flexibility of our modular design and its suitability for diverse energy applications is another benefit for Australia. Besides delivering high operating capacity base load or flexible load following electricity generation, our technology has the ability to provide process heat for a variety of industrial applications such as the production of clean water and generation of hydrogen for fuel cells. The scalable nature of our design also allows generation capacity to be added to the grid in 60 MWe increments, as needed. Additionally, unlike current large nuclear plants that must shutdown when the off-site transmission grid is lost, NuScale's SMR can operate in "island mode" making it an excellent option for the continued delivery of electricity to dedicated micro-grids, or as a provider of "first responder power" to support grid restoration. Other features unique to the NuScale design include: being highly resistant to natural and man-events such as earthquakes or typhoons and aircraft impacts respectively, nuclear equipment electronic protection systems not vulnerable to internet cyber-attacks, the ability to provide highly reliable power to critical infrastructure, "black start" capable, a small physical and environmental footprint, and resilience to electromagnetic pulse and solar-induced geomagnetic disturbances.

We firmly believe that NuScale's SMR technology and renewable energy sources like wind and solar are complementary. The NuScale SMR can provide the reliable, load-following power needed to address the intermittency of renewable power.

Should Australia decide on nuclear generation as one of its energy sources, we are confident that NuScale's technology can help Australia meet its low carbon energy needs in a safe, reliable, efficient and cost-effective manner. It would be our honor to work with the Australian government and industry to strengthen Australia's energy future.

Finally, attached herewith are PowerPoint slides on NuScale SMR Progress to Deployment. I will present these slides to the Parliament Committee for New South Wales on September 26, 2019. I respectfully request that this letter and the attached PowerPoint be made part of our submission and the official record.

Thomas P. Mundy
Chief Commercial Officer

Standing Committee on Environment and Energy
September 4, 2019

Attachment: “NuScale SMR - Progress to Deployment,” September, 2019.

cc: File

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NuScale SMR
Progress to Deployment

September, 2019

Tom Mundy
Chief Commercial Officer

Acknowledgement and Disclaimer

This material is based upon work supported by the Department of Energy under Award Number DE-NE0000633.

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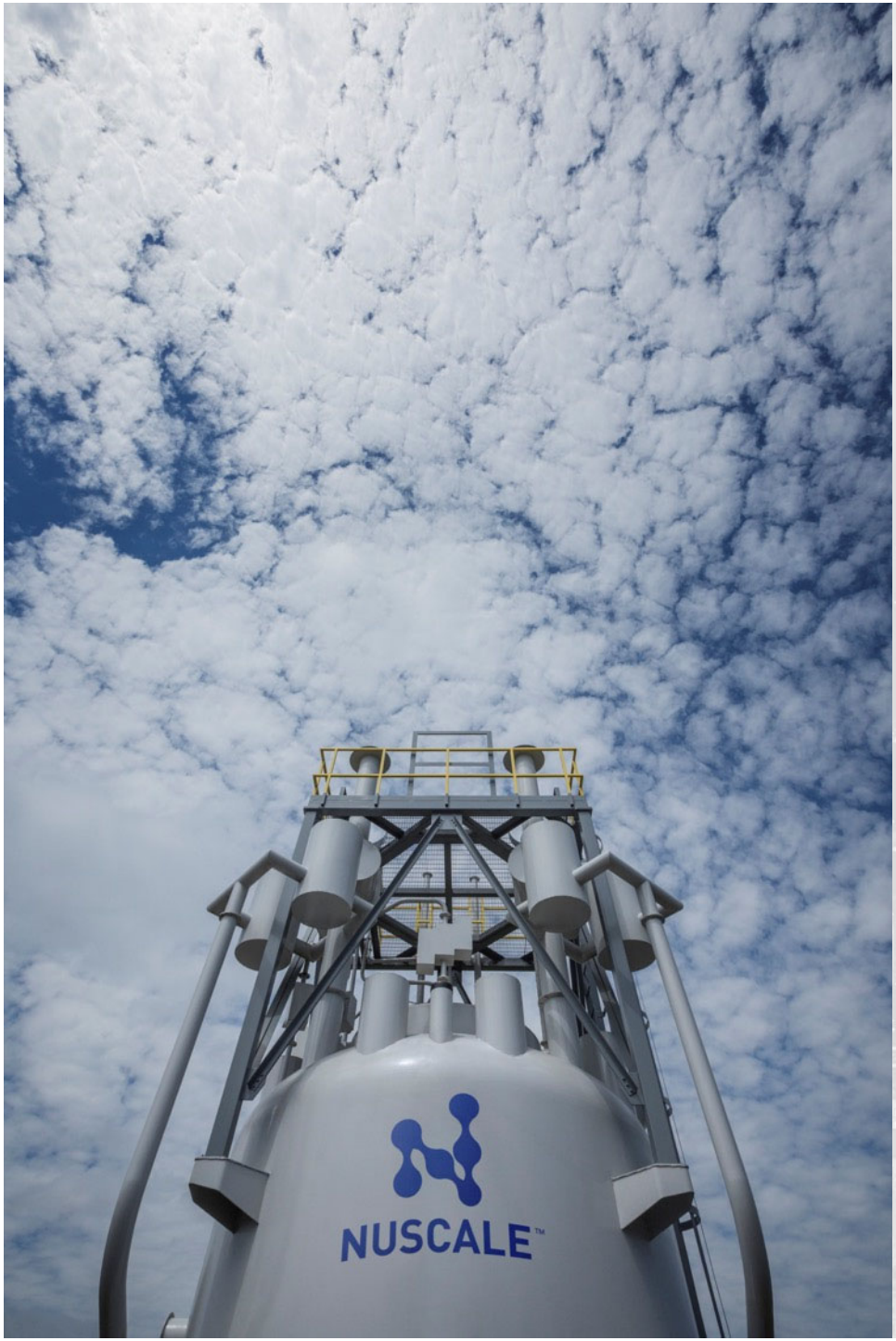

A bold, new energy source

- **Smarter energy** – flexible design can support multiple applications, integrate with renewable resources, provide highly reliable power to mission critical facilities, and serve as clean baseload power.
- **Cleaner Energy** – 100% carbon-free energy – as clean as wind or solar – with a small land footprint.
- **Safer Energy** – should it become necessary, NuScale's SMR shuts itself down and self-cools for an indefinite period of time, with no operator action required, no additional water, and no AC or DC power needed.
- **Cost Competitive –** the NuScale SMR is far less complex than other designs. Off-site fabrication and assembly reduce cost. Components are delivered to the site in ready-to-install form. All of this results in construction occurring in a shorter, more predicable period of time.

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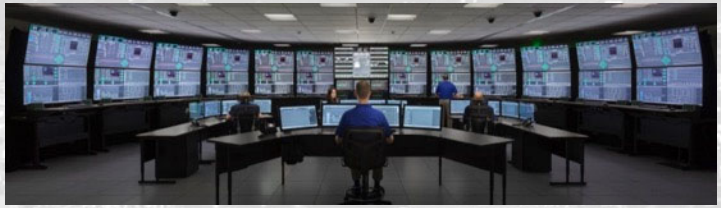
Who is NuScale Power?

- NuScale Power was formed in 2007 for the sole purpose of completing the design and commercializing a small modular reactor (SMR) – the NuScale Power Module™.
- Initial concept had been in development and testing since the 2000 U.S. Department of Energy (DOE) MASLWR program.
- Fluor, global engineering and construction company, became lead investor in 2011.
- In 2013, NuScale won a $226M competitive U.S. DOE Funding Opportunity for matching funds.
- >485 patents granted or pending in nearly 20 countries.
- >350 employees in 6 offices in the U.S. and 1 office in the U.K.
- Making substantial progress with a rigorous design review by the U.S. Nuclear Regulatory Commission (NRC).
  - Phase 4 of NRC Review is on schedule for completion December 2019.
- Total investment in NuScale to date more than US$850M.
- On track for first plant operation in 2026 in the U.S.

NuScale Engineering Offices Corvallis

One-third scale NIST-1 Test Facility



NuScale Control Room Simulator

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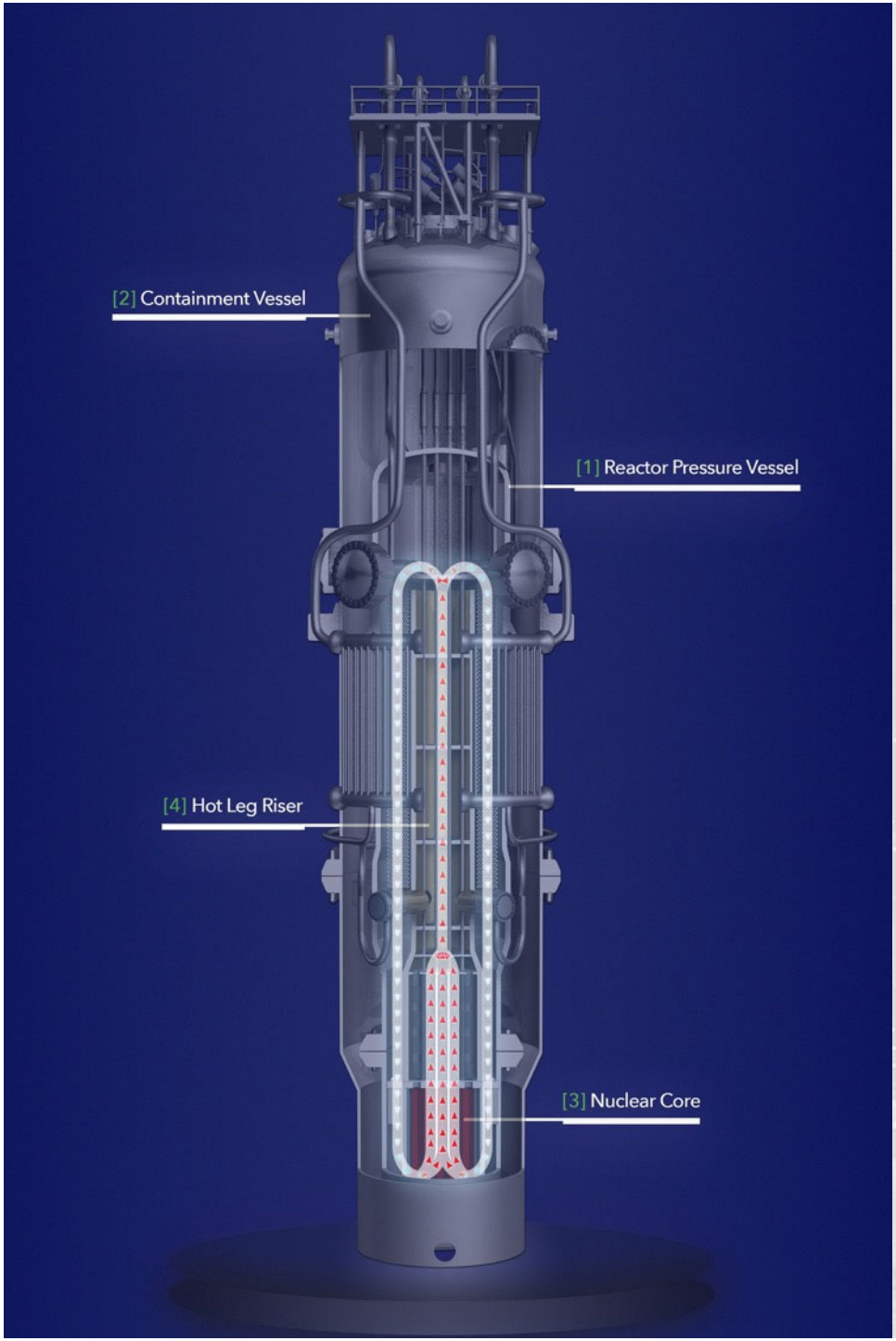

Core Technology: NuScale Power Module

- A **NuScale Power Module**™ (NPM) includes the reactor vessel, steam generators, pressurizer, and containment in an **integral package** – simple design that eliminates reactor coolant pumps, large bore piping and other systems and components found in large conventional reactors.

- Each module produces **up to 60 MWe**
  - small enough to be factory built for easy transport and installation
  - dedicated power conversion system for flexible, independent operation
  - incrementally added to match load growth
    – up to **12 modules for 720 MWe** gross (684 MWe net) total output

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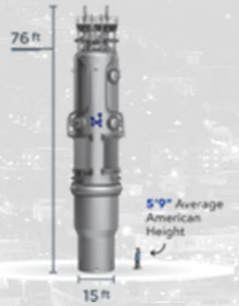
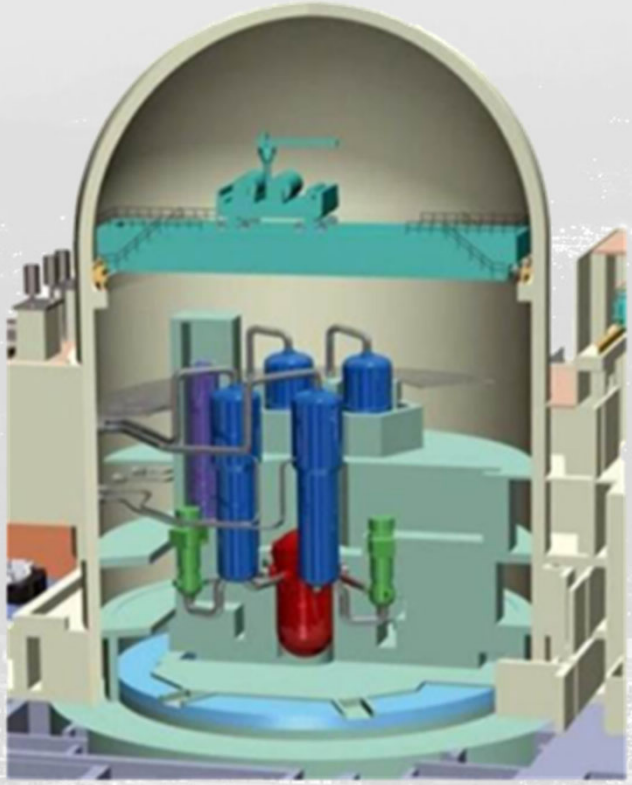
Comparison to a Large Pressurized Water Reactor (PWR)



NuScale Power Module



Typical Large PWR

Image: U.S. Nuclear Regulatory Commission

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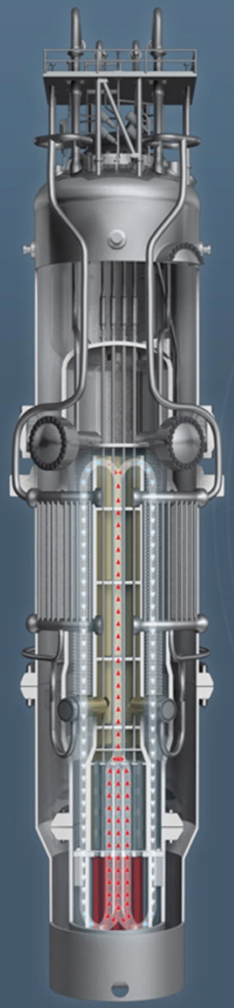
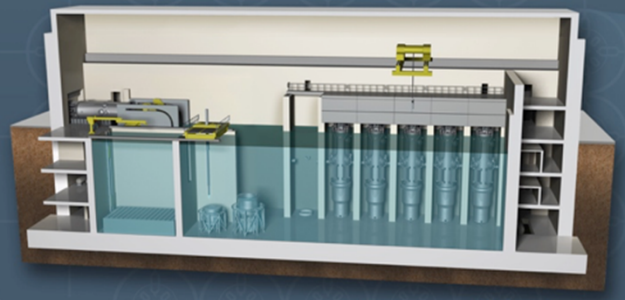
A New Approach to Construction and Operation



Factory Fabrication

Low carbon, secure electricity



Housed in a 12 module reactor building

To the plant site

NuScale Power Module™ including containment and reactor vessel

Shipped by truck, rail or barge

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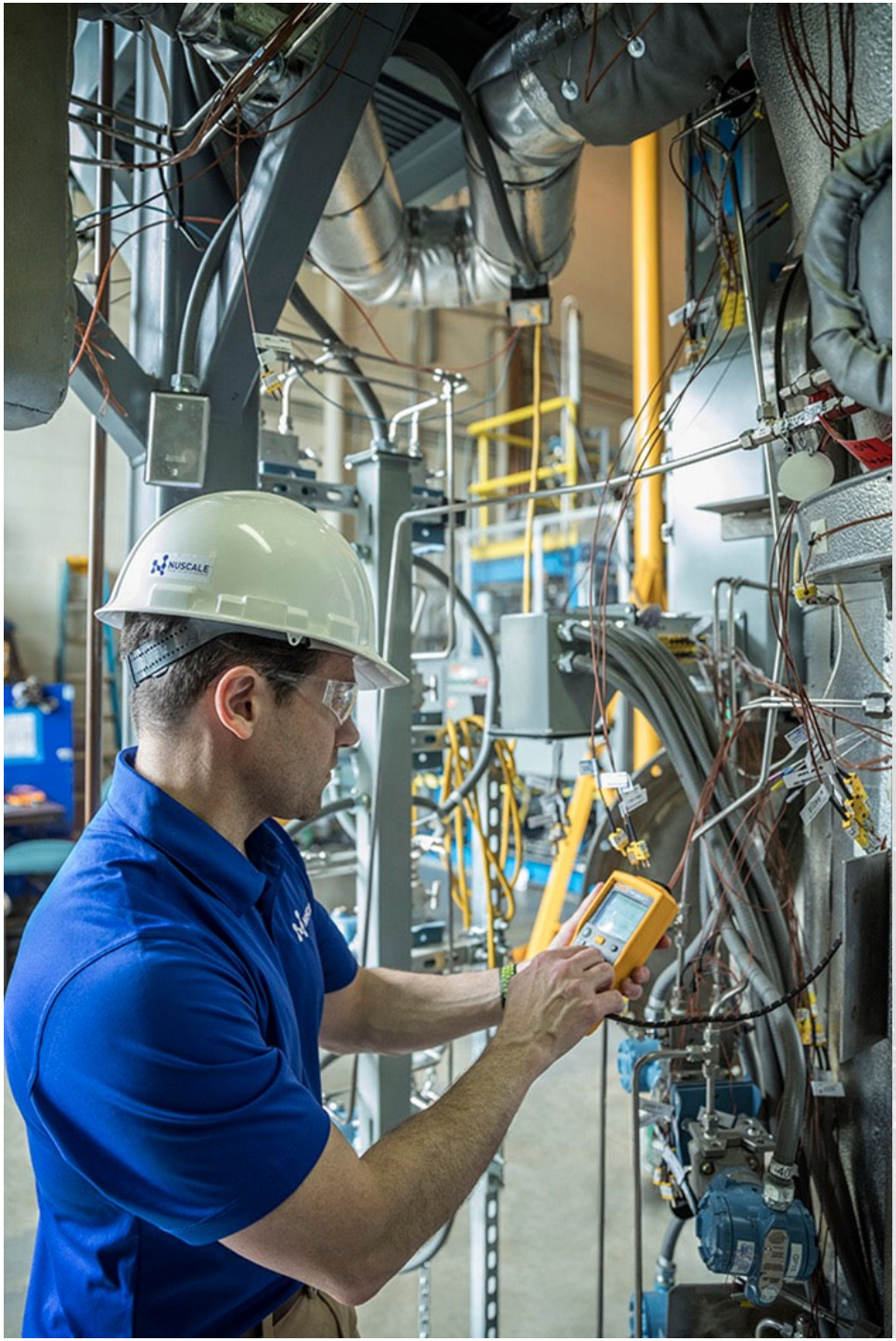

Technology Validation

- **NuScale Integral System Test (NIST-1)** facility located at Oregon State University in Corvallis, Oregon
- **Critical Heat Flux** testing at Stern Laboratories in Hamilton, Ontario Canada
- **Helical Coil Steam Generator** testing at SIET SpA in Piacenza, Italy
- **Fuels testing** at AREVA's Richland Test Facility (RTF) in Richland, Washington
- **Critical Heat Flux** testing at AREVA's KATHY loop in Karlstein, Germany
- **Control Rod Assembly (CRA)** drop / shaft alignment testing at AREVA's KOPRA facility in Erlangen, Germany
- **Steam Generator** Flow Induced Vibration (FIV) testing at AREVA's PETER Loop in Erlangen, Germany
- **Control Rod Assembly Guide Tube (CRAGT)** FIV at AREVA's MAGALY facility in Le Creusot, France

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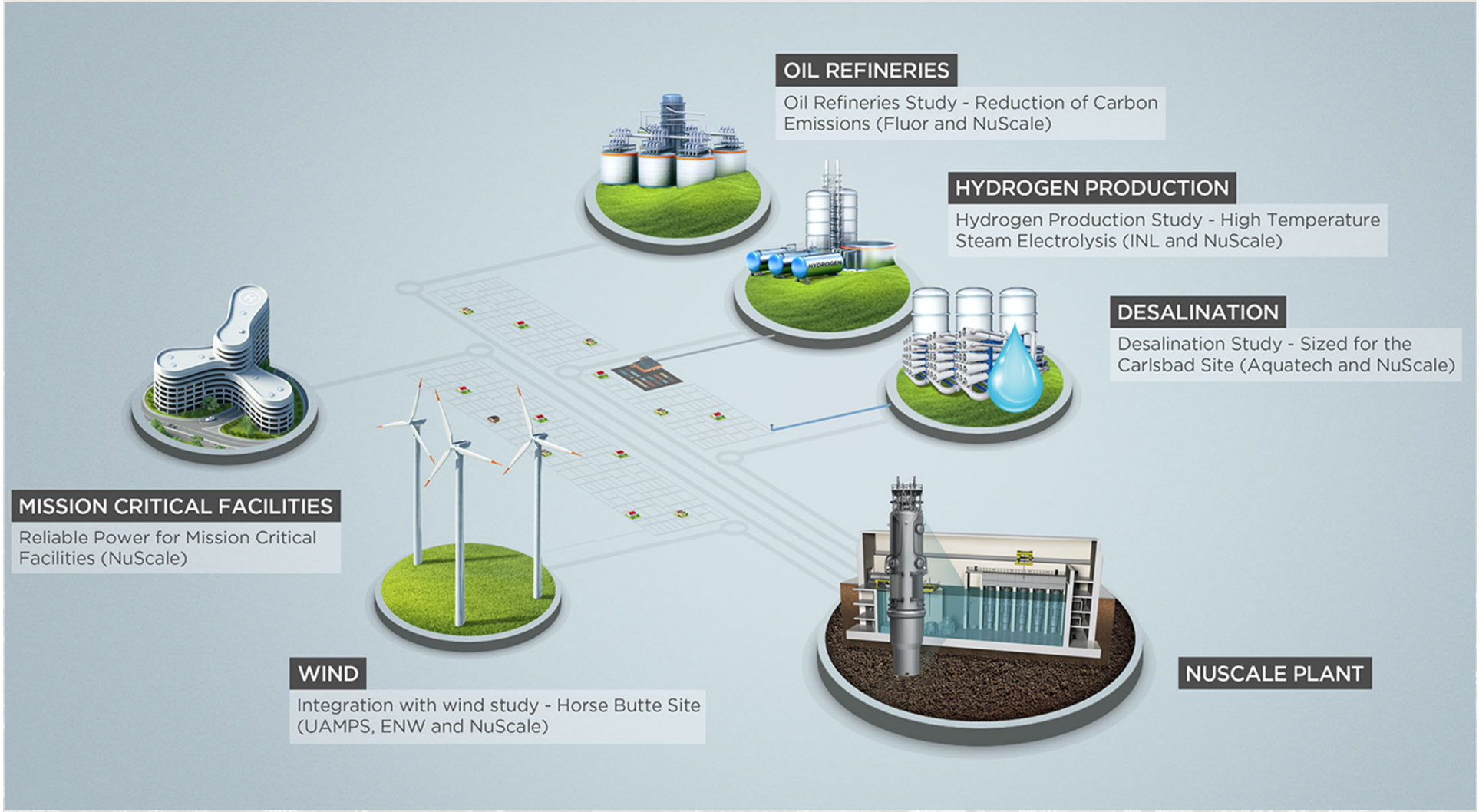
Beyond Baseload: NuScale Diverse Energy Platform



Reports for associated technical studies are available at: www.nuscalepower.com/technology/technical-publications

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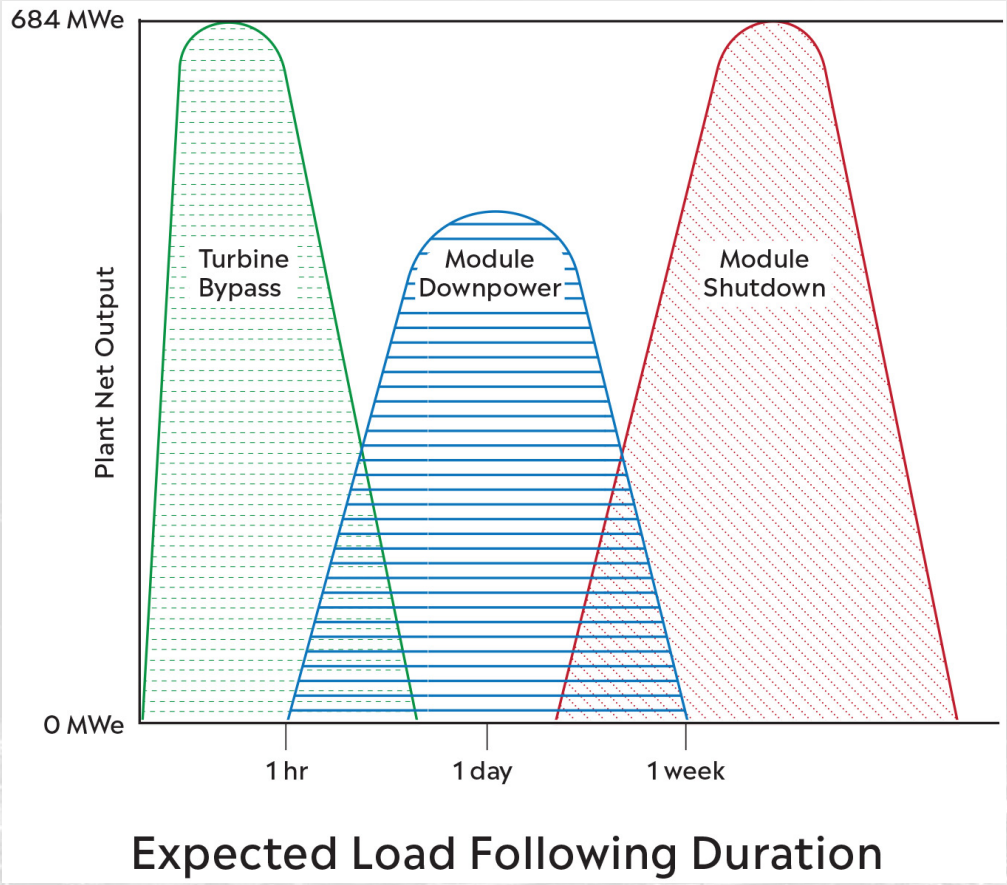
Integrating Renewables: Load Follow Strategies



Method	Up Power	Down Power
Turbine Bypass	20% to 100% (27 min) 3%/min	100% to 20% (8 min) 10%/min
Reactor Power Change	20% to 100% (96 min) 50%/hr	100% to 20% (≤ 24 min) 200%/hr
Module Dispatch	HSD to 100% (13 hrs) Refueling	100% to HSD (30 min) 200%/hr

See, *Can Nuclear Power and Renewables be Friends?*
Published in: Proceedings of ICAPP 2015
May 03-06, 2015 – Nice (France). Paper 15555

NuScale design meets or exceeds EPRI Utility Requirements Document (URD), Rev. 13, load following and other ancillary service requirements.

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NuScale Co-Generation Studies

Oil Refinery Study Reducing Carbon Emissions *(Fluor and NuScale)*

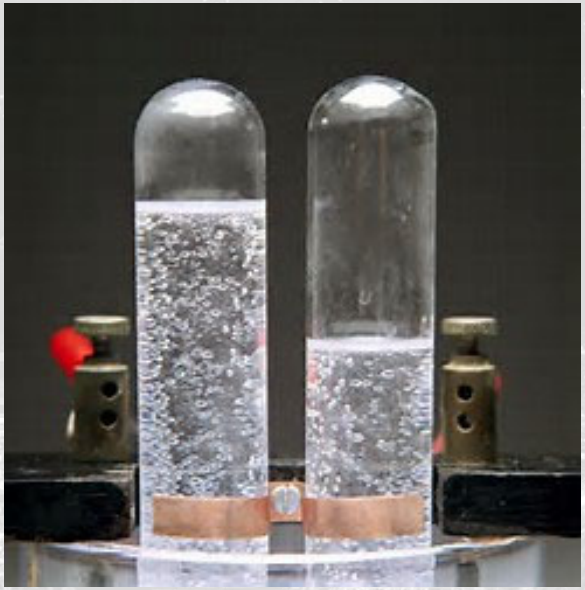
10-Module Plant coupled to a 250,000 barrels/d refinery, thus avoiding ~230 MT/hr CO_2 emissions

Desalination Study for Clean Water and Electricity *(Aquatech and NuScale)*

8-Module Plant producing 60 Mgal per day of clean water plus ~400 MWe to the grid

High-Temp Steam Electrolysis for Carbon-free Hydrogen Production *(INL and NuScale)*

6-Module Plant producing ~240 tons per day carbon-free hydrogen for ammonia plant



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A New Level of Plant Resiliency

Island Mode/Loss of Offsite Power

A single module can power the entire plant in case of loss of the grid; no operator or computer actions, AC/DC power or additional water required to keep the reactors safe

First Responder Power

On loss of the offsite grid, through variable (0% to 100%) steam bypass, all 12 modules can remain at power and be available to provide electricity to the grid as soon as the grid is restored

Resilience to Natural Events

Reactor modules and fuel pool located below grade in a Seismic Category 1 Building

- Capable of withstanding a Fukushima type seismic event
- Capable of withstanding hurricanes, tornados, and floods

Resilience to Aircraft Impact

Reactor building is able to withstand aircraft impact as specified by the 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

Electromagnetic Pulse (EMP/GMD)

Resilience to solar-induced geomagnetic disturbances (GMDs) and electromagnetic pulse (EMP) events beyond current nuclear fleet.

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Reliable Power for Mission Critical Facilities

UTILITY MACROGRID

684 MWe (net)
> 95% Capacity

- Connection to a micro-grid, island mode capability, and the ability for 100% turbine bypass allows a 720 MWe (gross) NuScale plant to assure **120 MWe net power at 99.95% reliability over a 60 year lifetime**
  - 60 MWe at 99.98% availability
- Using highly robust power modules and a multi-module plant design can provide **clean, abundant, and highly reliable power** to customers
- Working with utilities and customers to achieve “Five 9s”

NuScale 12-Module Plant

DEDICATED MICROGRID
120 MWe (net)
> 99.95% Availability

MISSION CRITICAL FACILITY

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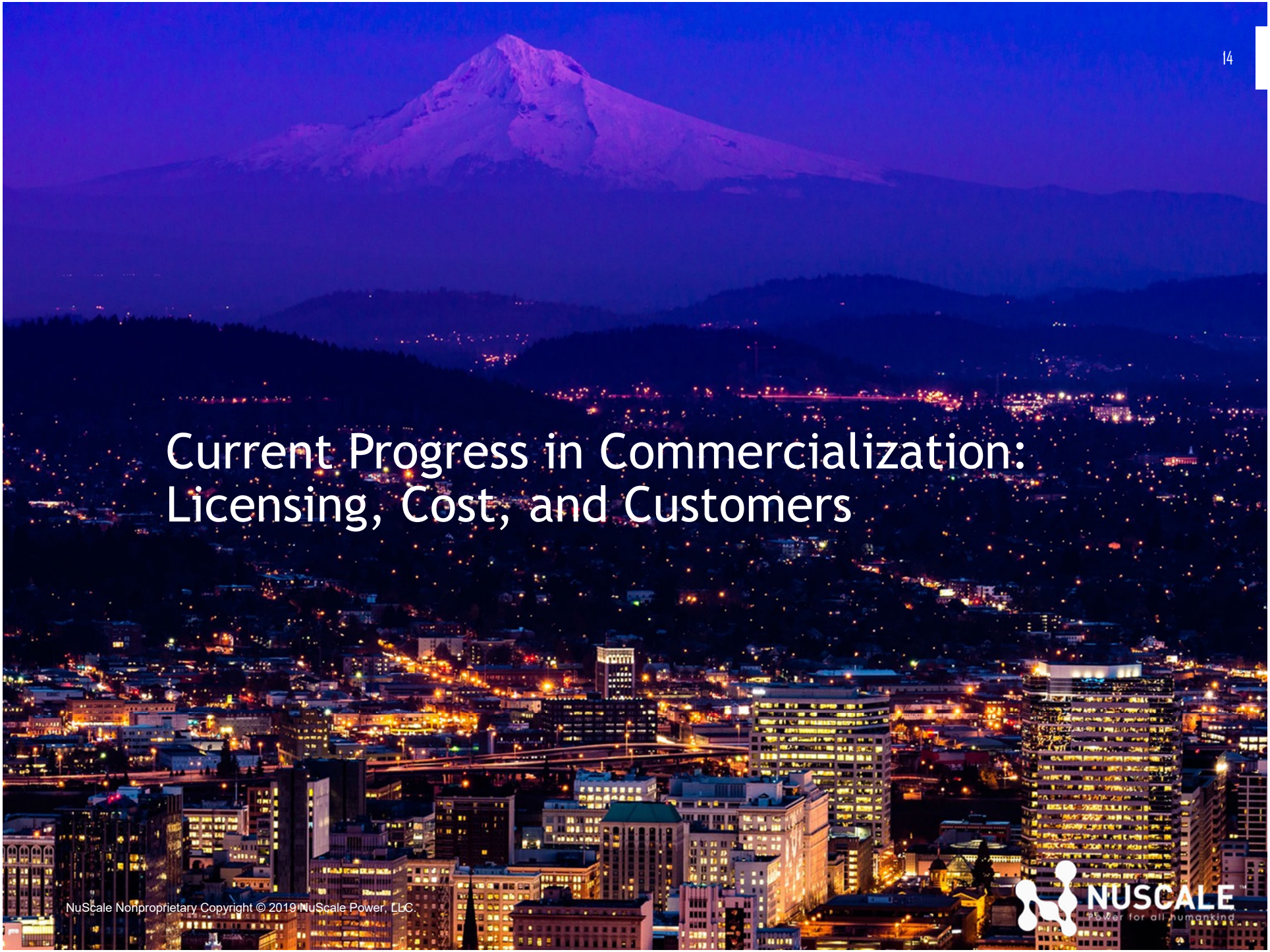
Current Progress in Commercialization: Licensing, Cost, and Customers



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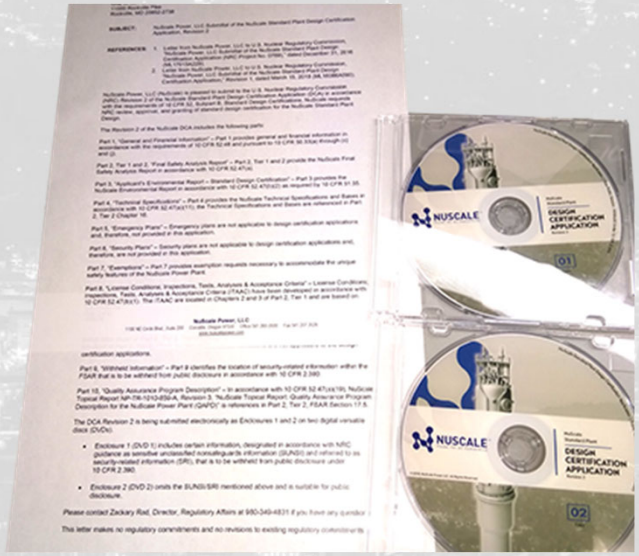
First SMR to Undergo Licensing in the U.S.

- Design Certification Application (DCA) completed in December 2016
- Docketed and review commenced by U.S. Nuclear Regulatory Commission (NRC) in March 2017
- Phase 4 of the NRC review on schedule for completion December 2019. Technical review would be completed.
- NRC has published its review and approval schedule; **to be approved in September 2020**



DCA Statistics

- 12,000+ pages
- 14 Topical Reports
- >2 million labor hours
- >800 people
- >50 supplier/partners
- Over $500M

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Image courtesy of Third Way Nuclear Reimagined

Right-sizing the Emergency Planning Zone (EPZ)

- NuScale's small core size and exceptional safety, defense-in-depth make the case for a **reduced EPZ to the site boundary**.
  - NuScale plants could be sited closer to population and industrial centers – where energy is needed most
- **Tennessee Valley Authority (TVA) demonstrating that site boundary EPZ possible for SMRs**
  - TVA analysis included information on Clinch River early site permit application using NuScale Plant design
  - Shows any accident radiological impact would be limited to within site boundary
  - Analysis provides basis for exemption from 10-mile EPZ
  - NRC preliminary findings agree with TVA analysis that reduced-size EPZs for SMRs are feasible

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NuScale 720 MWe U.S. Plant Cost Summary

First-of-a-Kind Cost

$4,350/KW

$2,974,654,000

- ✓ 2017 USD
- ✓ **Generic Southeast U.S. Site**
- ✓ 12 module plant
- ✓ 683 MWe net

Nth-of-a-Kind Cost

$3,600/KW

$2,458,735,000

Excludes:
- Warranty
- Contingency
- Fee

- Design maturity
  - 2014 original estimate updated in 2017
  - Equipment lists, P&IDs, 3D plant models, etc.
- Rigorous and systematic “bottoms up” approach
  - Conforms to American Association of Cost Engineers (AACE) 18R-97 – Class 4 cost estimate
  - Over 14,000 line items (equipment, material, etc.) priced using Fluor’s current proprietary cost data or actual vendor quotes
  - Labor costs and productivity data from recent U.S. new build projects or applicable Fluor EPC experience and industry data

- NuScale Power Module™ cost estimate – conforms to AACE Class 3 cost estimate
  - Performed by experienced large nuclear component manufacturer Includes:
    - Manufacturing bill of material
    - Welding, machining, and non-destructive examination processes developed
  - Transportation costs developed by expert heavy load transport engineering team
  - Fluor estimated EPC scope

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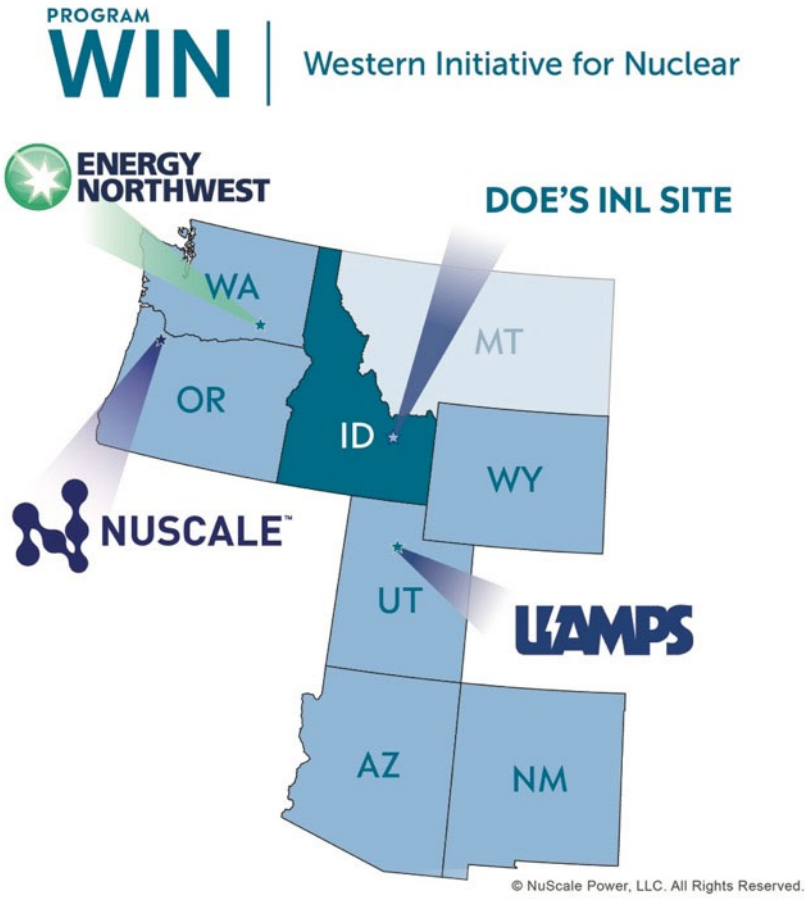
First Deployment: UAMPS Carbon Free Power Project

- **Utah Associated Municipal Power Systems (UAMPS)** provides energy services to community-owned power systems throughout the Intermountain West.
- First deployment will be a **12-module plant (720 MWe)** within the Idaho National Laboratory (INL) site, slated for **commercial operation in 2026.**
- DOE awarded $63.3 million in matching funds to perform site selection, secure site and water, and prepare combined operating license application to NRC and advance the site specific design.
- **Joint Use Modular Plant (JUMP)** Program: INL-DOE will lease one of the modules in the 12-module plant, for research purposes, an additional module may be used in a Power Purchase Agreement (PPA) to provide power to INL.



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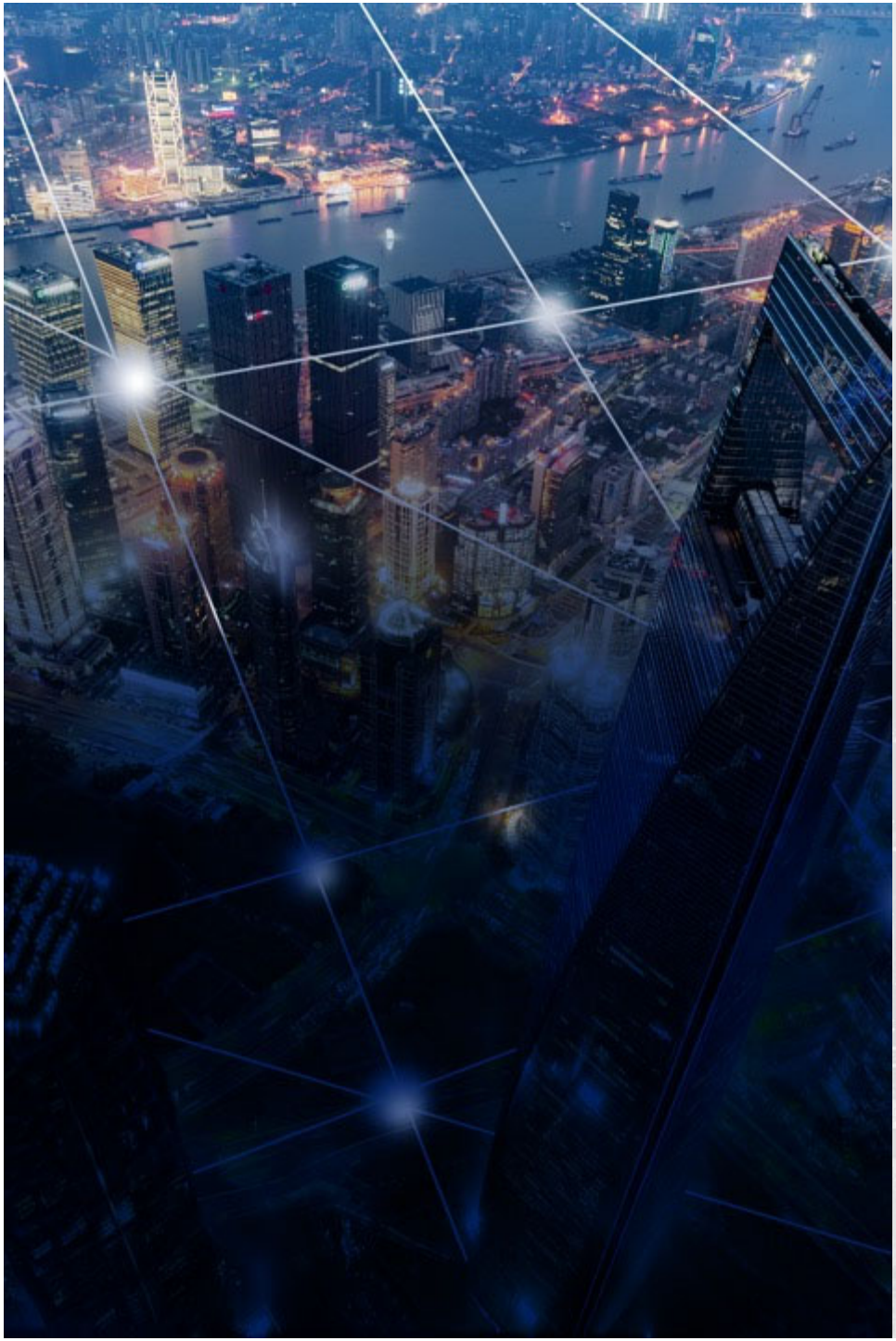

International Opportunities

- International opportunities for NuScale SMR deployment in **Canada, UK**, **Europe**, the **Middle East**, **Southeast Asia**, and **Sub-Saharan Africa**
- NuScale has announced MOUs to explore NuScale deployments in **Canada**, **Romania, and Jordan**

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The Future of Energy is Here

NuFuel HTP2 Testing

One-third scale NIST-1 Test Facility

NuScale Control Room Simulator

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Chief Commercial Officer

[redacted]

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