NUSCALE™
Power for all humankind

NuScale Power Overview –

- Technology
- Applications
- Path to Commercialization

August 23, 2021

Dom Claudio

Director of Sales

Acknowledgement and Disclaimer

This material is based upon work supported by the Department of Energy under Award Number DE-NE0008928.

The Global Reality

Energy is essential to human development. 1.1 billion people still live without any access to electricity.

Source: International Energy Agency (IEA)

NUSCALE™ Power for all humankind

The Global Reality

By 2025, half of the world's population will be living in water-stressed areas.

Source: World Health Organization (WHO)

NUSCALE™
Power for all humankind

The Global Reality

More than 1 billion metric tons of food is lost or wasted each year for lack of cooling.

Source: Food and Agriculture Organization (FAO)

NUSCALE™ Power for all humankind

The Global Reality

Air pollution in developing economies routinely exceed U.S. standards.

NUSCALE™ Power for all humankind

Artistic concept of the NuScale Power Plant

NuScale's Mission

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.**

We will achieve this mission by providing technology that is:

- SMARTER
- CLEANER
- SAFER
- COST COMPETITIVE

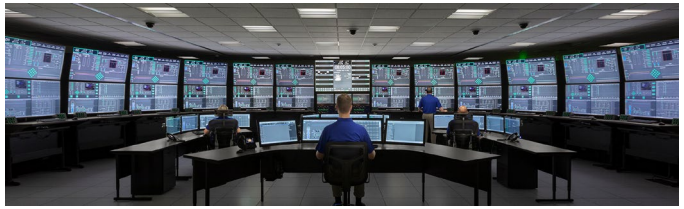
NUSCALE™ Power for all humankind

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™
  - NuScale is not a equipment manufacturer; program presents substantial local supply chain opportunity
- Initial concept was 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 competitive U.S. DOE Funding Opportunity for matching funds, and has been awarded over $400M in DOE funding since then
- >560 patents granted or pending in nearly 20 countries
- >400 employees in 5 offices in the U.S. and 1 office in the U.K.
- Rigorous design review by the U.S. Nuclear Regulatory Commission (NRC)—NuScale received Design Approval in August 2020
- Total investment in NuScale to date is greater than US$1.1B

NuScale Engineering Offices Corvallis

One-third Scale NIST-2 Test Facility



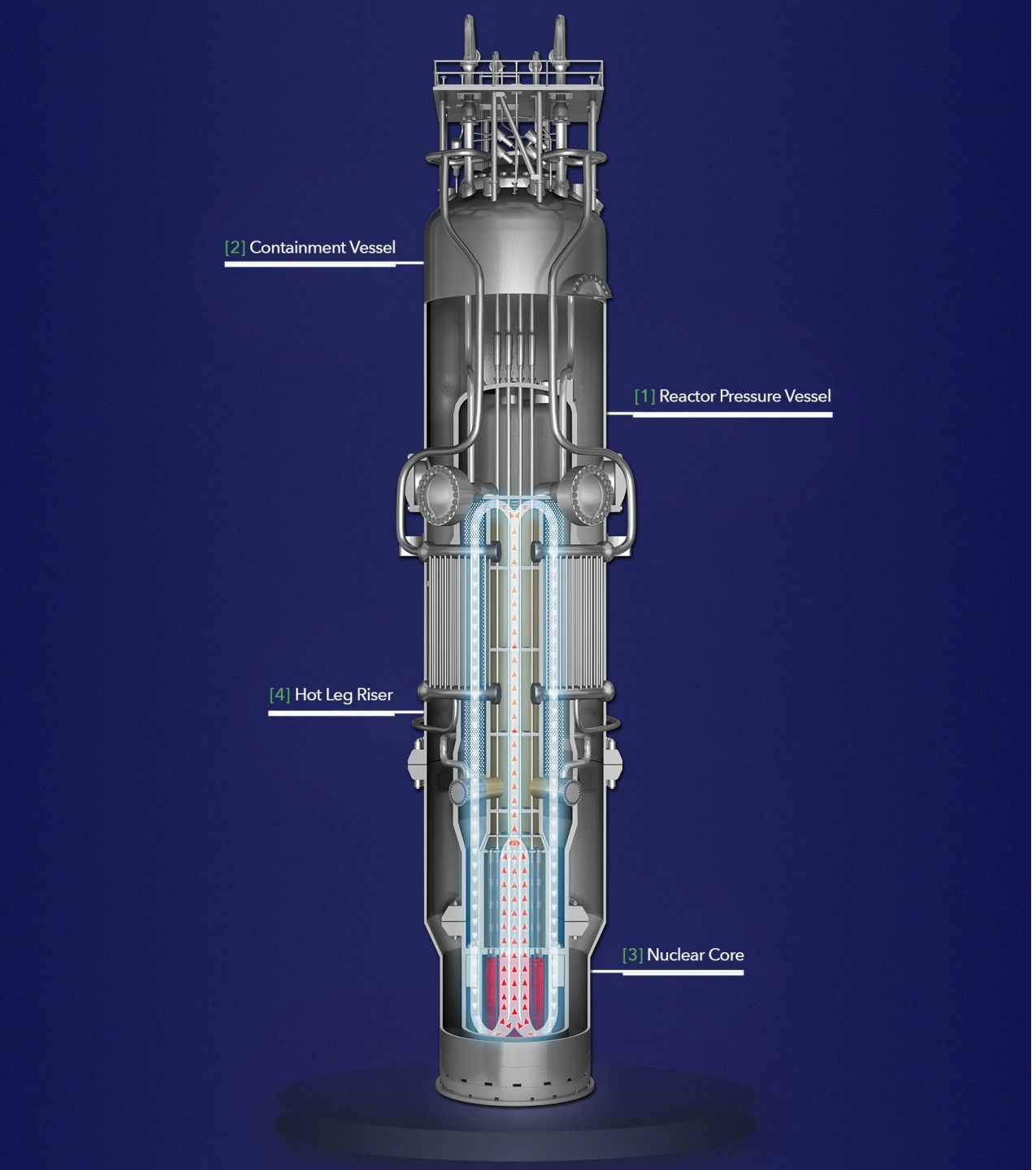
NuScale Control Room Simulator

NUSCALE™ Power for all humankind

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.

NUSCALE™
Power for all humankind

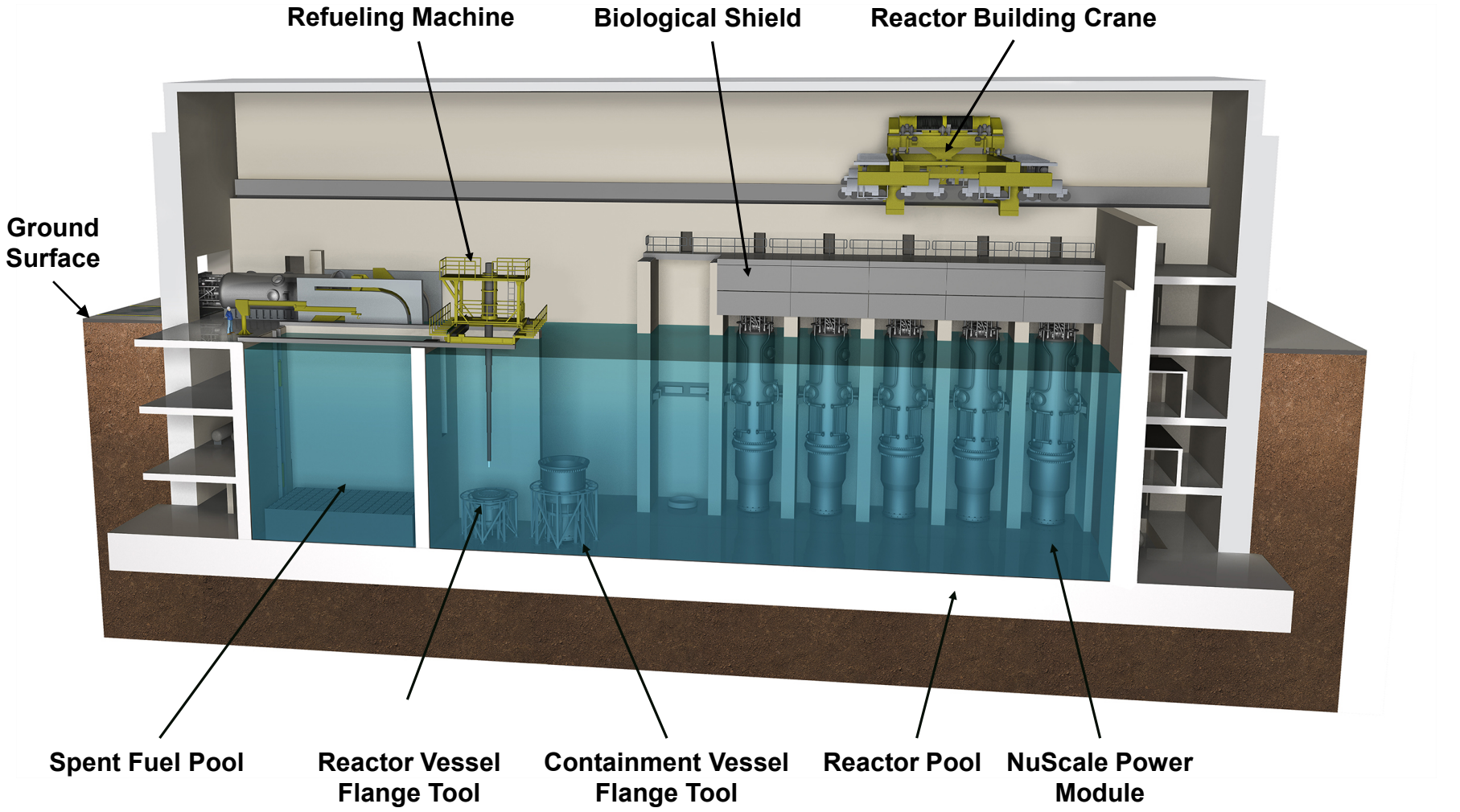


Core Technology: NuScale Power Module™

- 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 conventional reactors
- Each module produces up to 77 MWe
  - Small enough to be factory built for easy transport and installation
  - Dedicated power conversion system for flexible, independent operation
- Modules are incrementally added to match load growth
  - Up to 12 modules for 924 MWe gross output
  - Smaller power plant solutions available for 4-module (308 MWe) and 6-module (462 MWe) plants

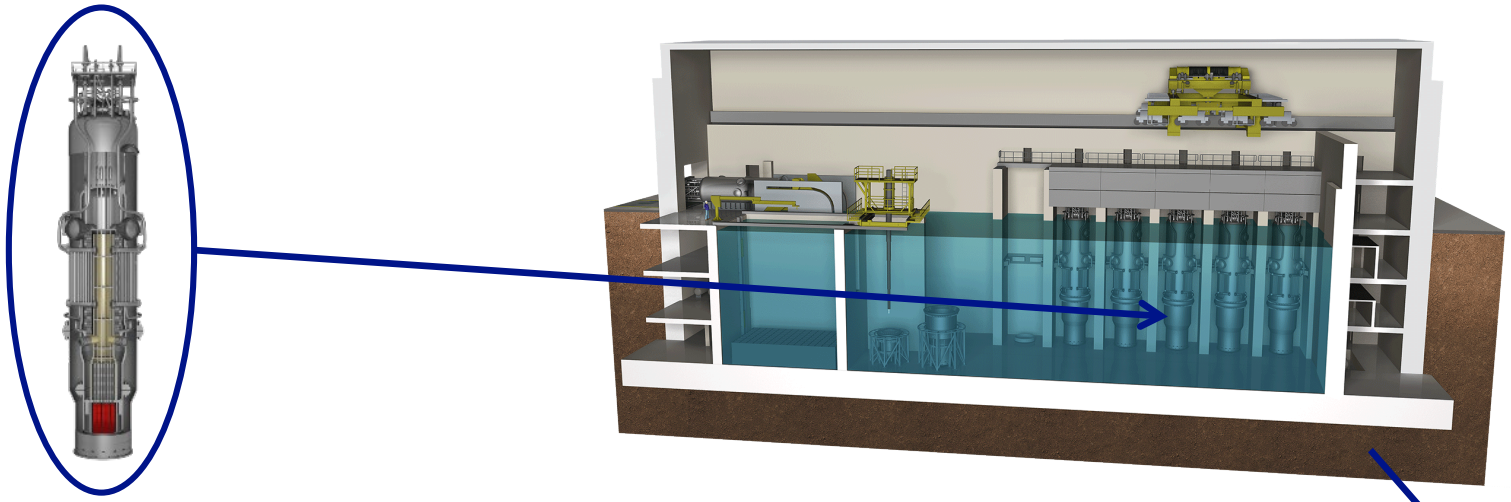
NUSCALE™ Power for all humankind

Reactor Building Houses NuScale Power Modules™, Spent Fuel Pool, and Reactor Pool



NUSCALE™ Power for all humankind

NuScale Advanced Small Reactor Overview

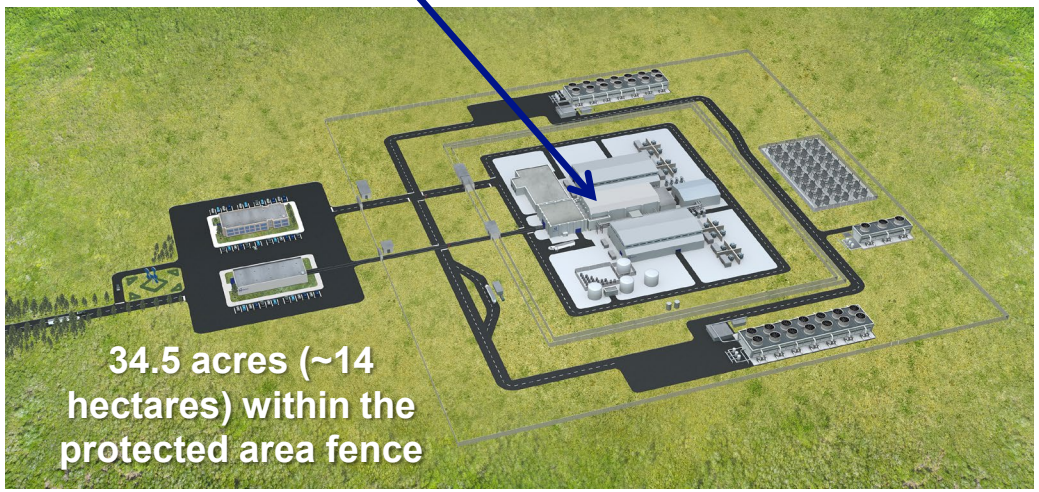


- Each module produces up to **77 MWe**
- Up to **12 modules** for **924 MWe** gross plant output
- Smaller power plant solutions available for 4-module (308 MWe) and 6-module (462 MWe) plants

Triple Crown of Safety - NuScale Plant safely shuts down with:

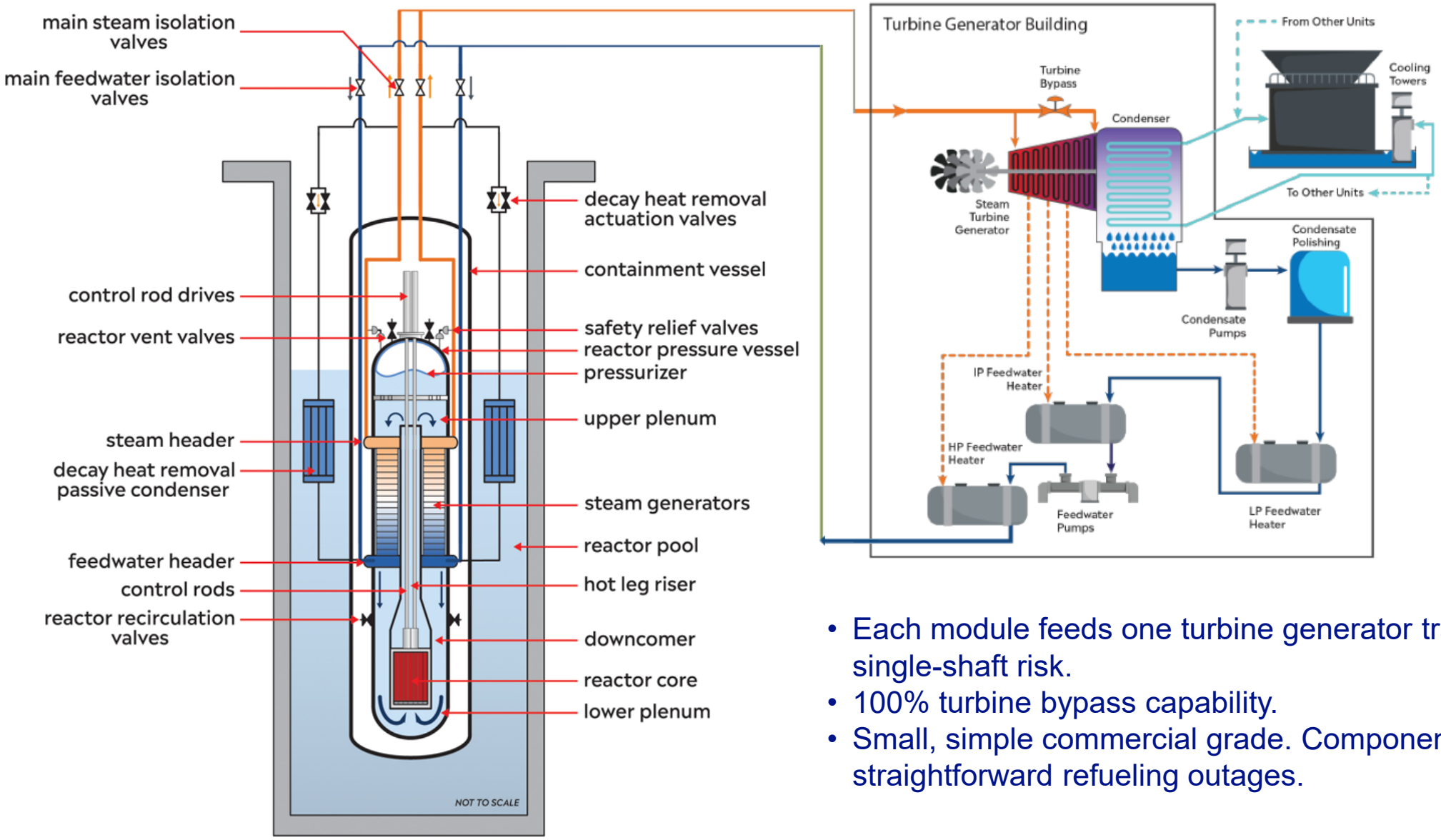
- No operator or control system actions
- No AC/DC power
- No additional water

Emergency planning zone (EPZ) ends at site boundary



NUSCALE Power for all humankind

NuScale Power Train

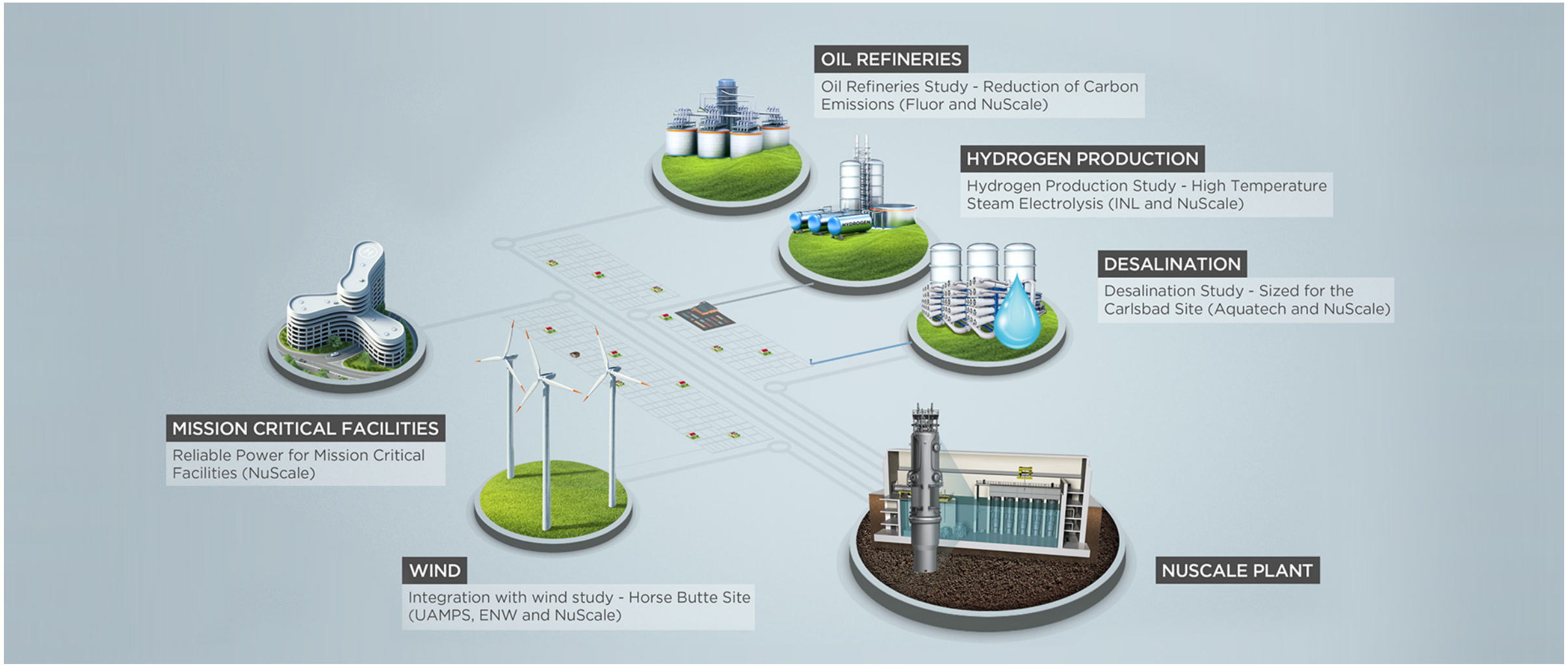


- Each module feeds one turbine generator train, eliminating single-shaft risk.
- 100% turbine bypass capability.
- Small, simple commercial grade. Components support short straightforward refueling outages.

NUSCALE Power for all humankind

Beyond Baseload: NuScale Diverse Energy Platform

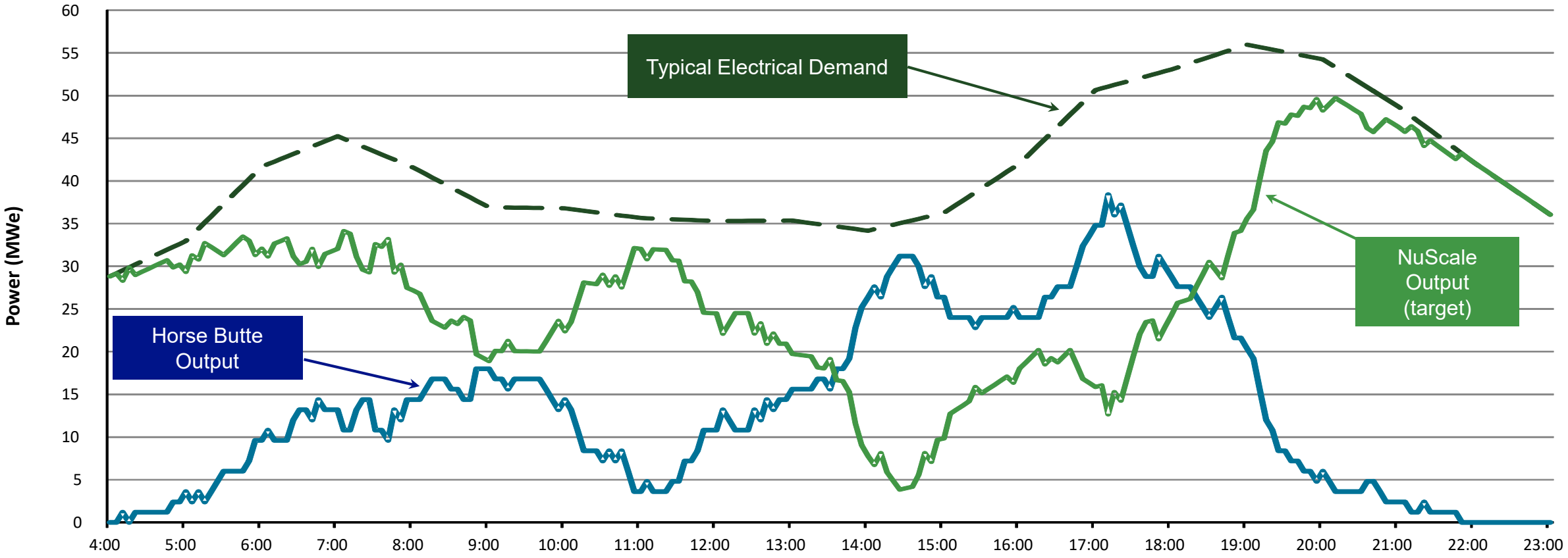
More Than Reliable Baseload and Load-following Electricity Generation



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

NUSCALE™ Power for all humankind

Flexible Operations Enable Further Growth in Renewables



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

NUSCALE Power for all humankind

Image courtesy of Third Way Nuclear Reimagined

Desalination for Clean Water

- A single power module coupled to a reverse osmosis desalination plant can produce **77 million gallons** (290 million liters) **per day of clean water**.
- A 6-module plant can produce 290 million liters (77 Mgal) of desalinated water per day plus 385 MWe to the grid, enough to **power a city of about 330,000 people**.
- A 4-module 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 water per day.

NUSCALE™ Power for all humankind

NuScale Oil Industry Study

With Fluor Corporation

Conducted a study of NuScale application to oil recovery and refining

- Oil recovery processes such as steam assisted gravity drain
- Advanced in situ oil refining such as for shale oil
- Refineries and upgraders

Good fit for refinery/upgrader applications

- Centralized energy demand with extended plant lifetimes
- NuScale-supplied electricity and heat augments refinery fuel gas by-product use
- Natural gas used as process feedstock rather than combusted for heat/electricity

Source: Ingersoll, D., Colbert, C., Bromm, R. and Z. Houghton, NuScale Energy Supply for Oil Recovery and Refining Applications, Proceedings of ICAPP 2014, Charlotte, N.C. April 6-9, 2014

NUSCALE™ Power for all humankind

Cost-Competitive, Carbon-Free Hydrogen Production

- Hydrogen has the capability to help decarbonize both the electricity and transportation sectors by being used for energy storage or as a fuel for hydrogen fuel-cell vehicles, trains, ships, and airplanes.
- Most hydrogen today is produced by fossil fuels and is not carbon-free.
- NuScale's innovative technology is ideal for producing clean hydrogen in a cost-competitive manner:
  - A single NuScale module can produce 2,053 kg/hour of hydrogen, or 50 tons/day – enough hydrogen to power 38,000 fuel cell vehicles or 1,500 long-haul fuel cell trucks annually
  - Hydrogen produced by a high temperature steam electrolysis system using heat and electricity from a NuScale module is forecasted to be cost competitive with green hydrogen (produced from renewable electricity)

NUSCALE™ Power for all humankind

Many Countries Have Established National Hydrogen Strategies

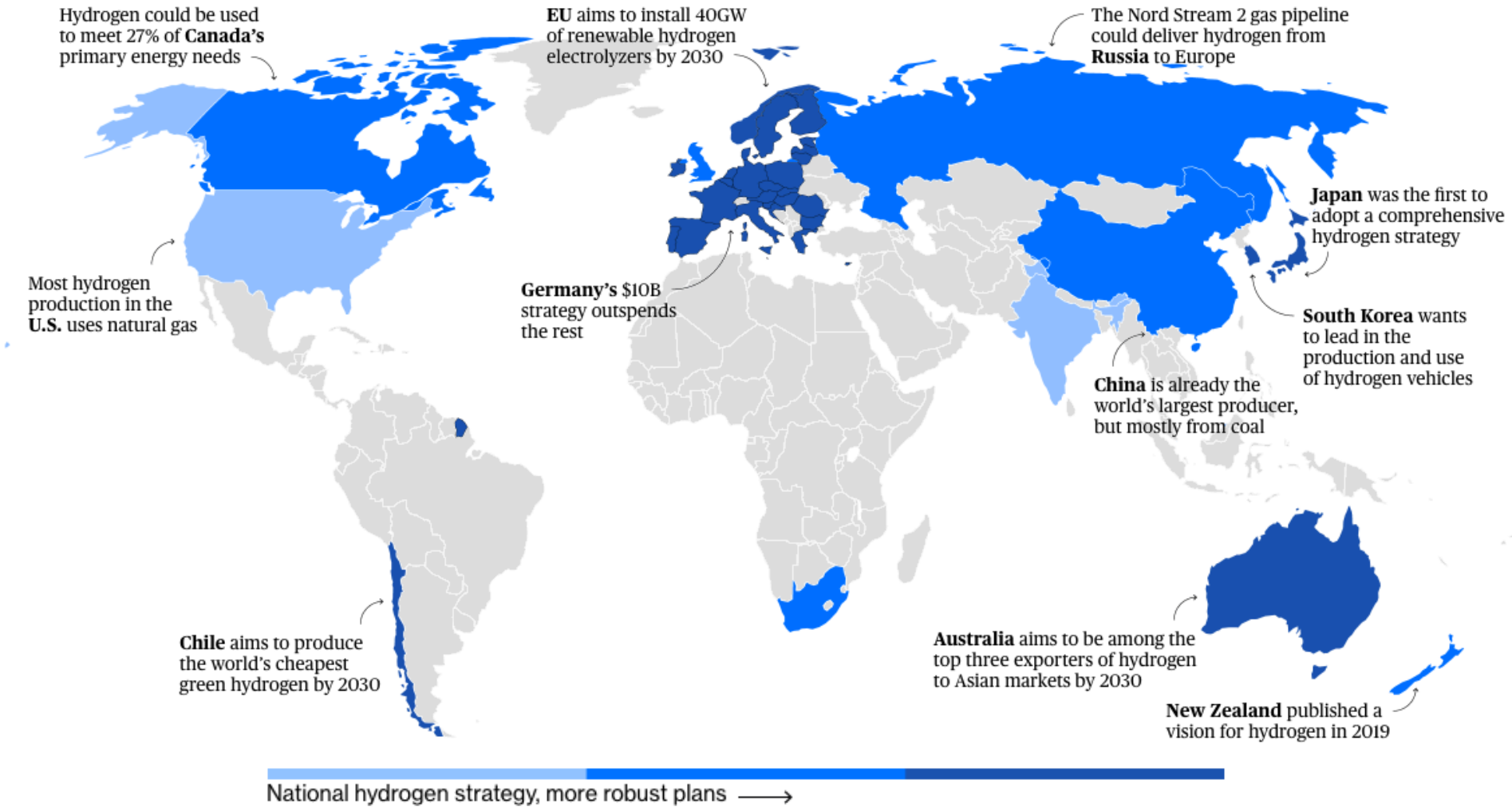


Image Source: Bloomberg

Reliable Power for Mission Critical Facilities

UTILITY MACROGRID

924 MWe
> 95% Capacity

NuScale 12-Module Plant

DEDICATED MICROGRID
154 MWe
> 99.95% Availability

MISSION CRITICAL FACILITY

- Connection to a micro-grid, island mode capability, and the ability for 100% turbine bypass allows a 924 MWe (gross) NuScale plant to assure **154 MWe net power at 99.95% reliability over a 60-year lifetime.**
  - 77 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 Power for all humankind

A New Level of Plant Resiliency

SAFETY CASE, FEATURES, CAPABILITIES AND PERFORMANCE NOT FOUND IN OTHER NUCLEAR PLANTS

Climate Adaptation

Black-Start, "Island Mode" and Off-Grid siting

The power plant can "Black-Start" and run in "island-mode" using the power from an individual module to power the facility until transmission system is restored, and can be sited at end of line or off-grid locations.

First Responder Power and Highly Reliable Power

With island-mode capability, first responder power can be provided to restore grid. Provide power to micro-grid connected loads and provide154 MWe net power at 99.95% reliability over a 60-year lifetime.

Resilience to Natural Events

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

- Capable of withstanding a Fukushima magnitude 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.

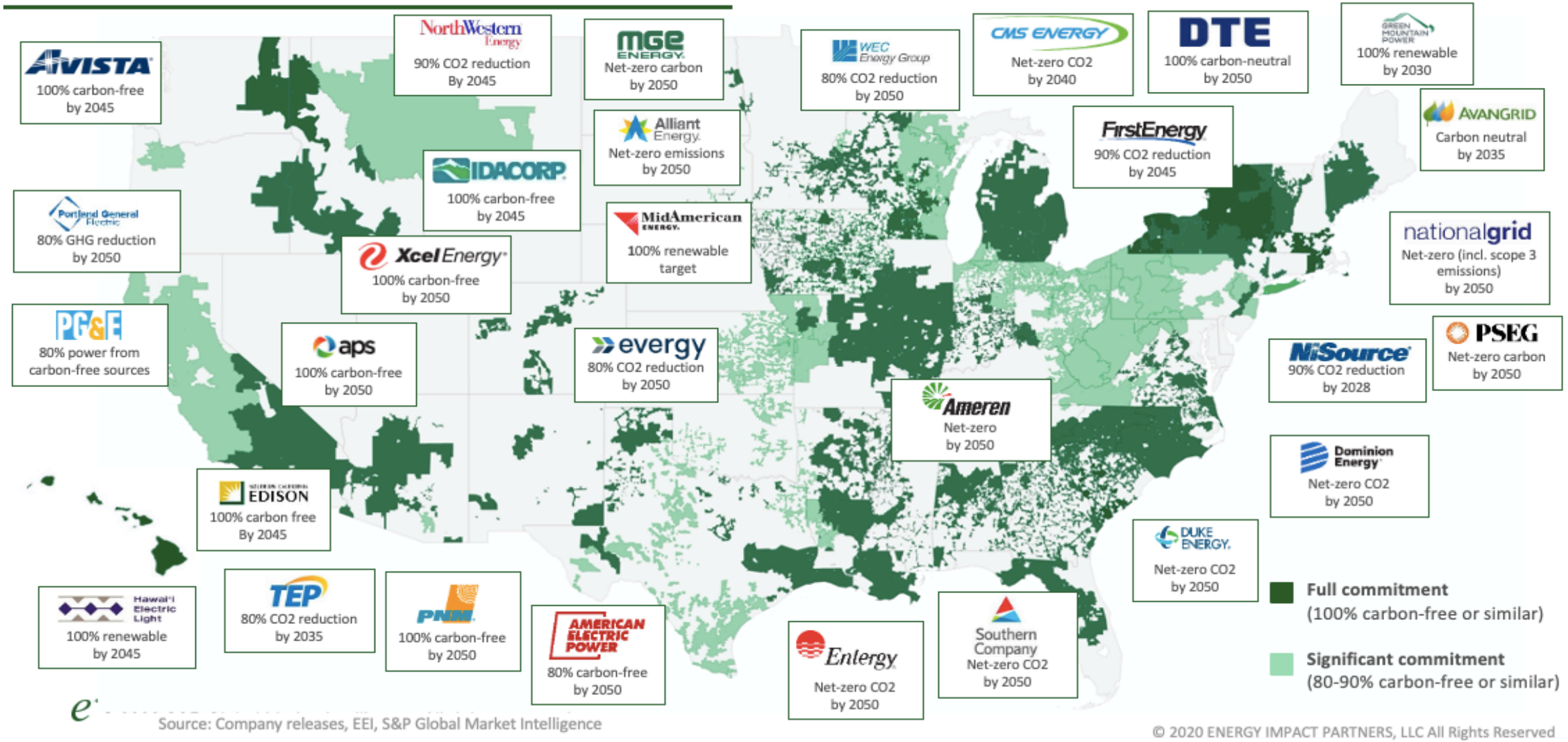
Electromagnetic Pulse (EMP/GMD)

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

NUSCALE Power for all humankind

Utilities across the country are setting their own emissions goals

30 IOUs have made commitments to lower their emissions by 80% or more, 21 at 100% or carbon-neutral



Source: Company releases, EEI, S&P Global Market Intelligence

Source: Madison Freeman, Energy Impact Partners, updated November 2020

NUSCALE Power for all humankind

Support for Nuclear Energy

Deep decarbonization is needed to achieve global climate change mitigation goals and nuclear energy is critical to reducing carbon emissions. A growing and diverse group is advocating for nuclear to be part of the low carbon solution; recent actions include:

- **Natural Resources Defense Council (NRDC),** and others ask the Federal Energy Regulatory Commission to "preserve states' ability to achieve clean energy policy goals," including Zero-Emission Credit programs.
- **United Nations IPCC** report predicts that severe effects from climate change are coming by 2030 and identifies nuclear power as one of the strategies to hold warming to 1.5 °C.
- **Google** white paper recognizes the importance of nuclear power as part of a clean energy portfolio.
- **Union of Concerned Scientists** report stresses the role of nuclear power in limiting carbon emissions.
- **The Nature Conservancy** report calls for increasing nuclear energy to one third of total energy output for a sustainable path to meet increasing energy demand and keep the climate in "safe boundaries."
- **MIT study** shows that nuclear energy must be part of the mix of low-carbon energy technologies needed to combat climate change. Without nuclear energy, deep decarbonization goals would be significantly more expensive to achieve.

Sources: Nuclear Energy Institute and organizations listed above.

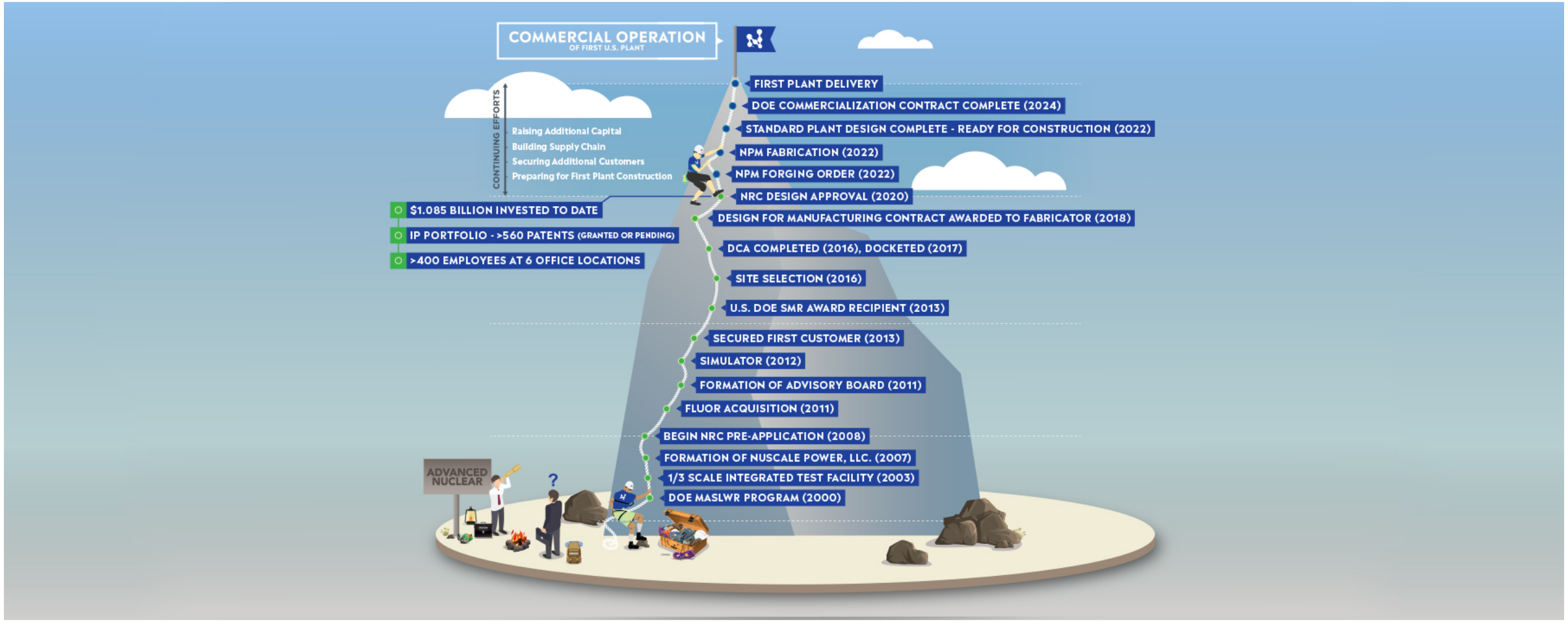
NUSCALE™ Power for all humankind

Bipartisan Support for NuScale and Advanced Nuclear

- U.S. DOE $330M cost-share contribution to NuScale over two administrations and four sessions of Congress
- Advanced Nuclear Production Tax Credit statutes amended in 2018 to secure benefit for municipally-owned nuclear projects, like UAMPS CFPP
- Nuclear Energy Innovation and Modernization Act (NEIMA) enacted Dec 2018
- Nuclear Energy Infrastructure and Capabilities Act (NEICA) enacted Sep 2018
- Better Utilization of Investments Leading to Development (BUILD) Act enacted Oct 2018
  - Established U.S. International Development Finance Corporation (DFC)
  - DFC policy changed in 2020 to permit funding of advanced nuclear projects such as the NuScale Power Plant.
- Nuclear Energy Leadership Act (NELA) provisions incorporated into 2020 National Defense Authorization Acts – pending in Senate and House
- Emerging Energy Technology Credit – introduced in House Sep 2019 and under consideration in Senate

NUSCALE™ Power for all humankind

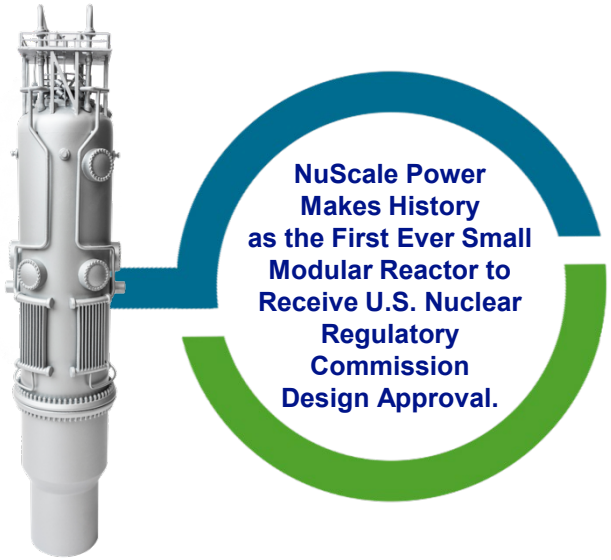
Blazing the Trail to Commercialization



NUSCALE™
Power for all humankind

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.
- NuScale received standard design approval in September 2020.
- Final Rule Publication Date: March 22, 2022.

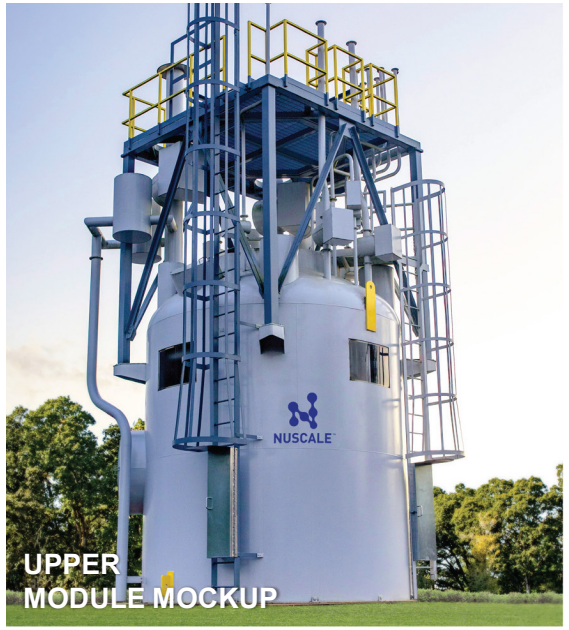


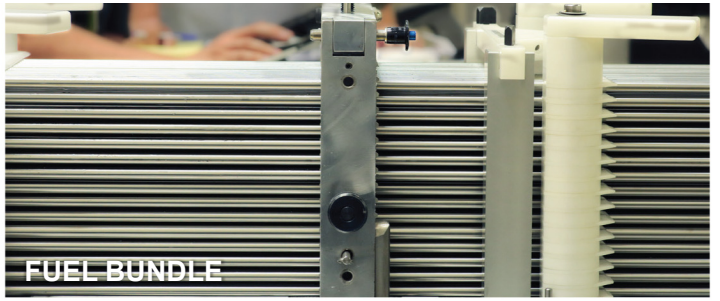
DCA Statistics

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

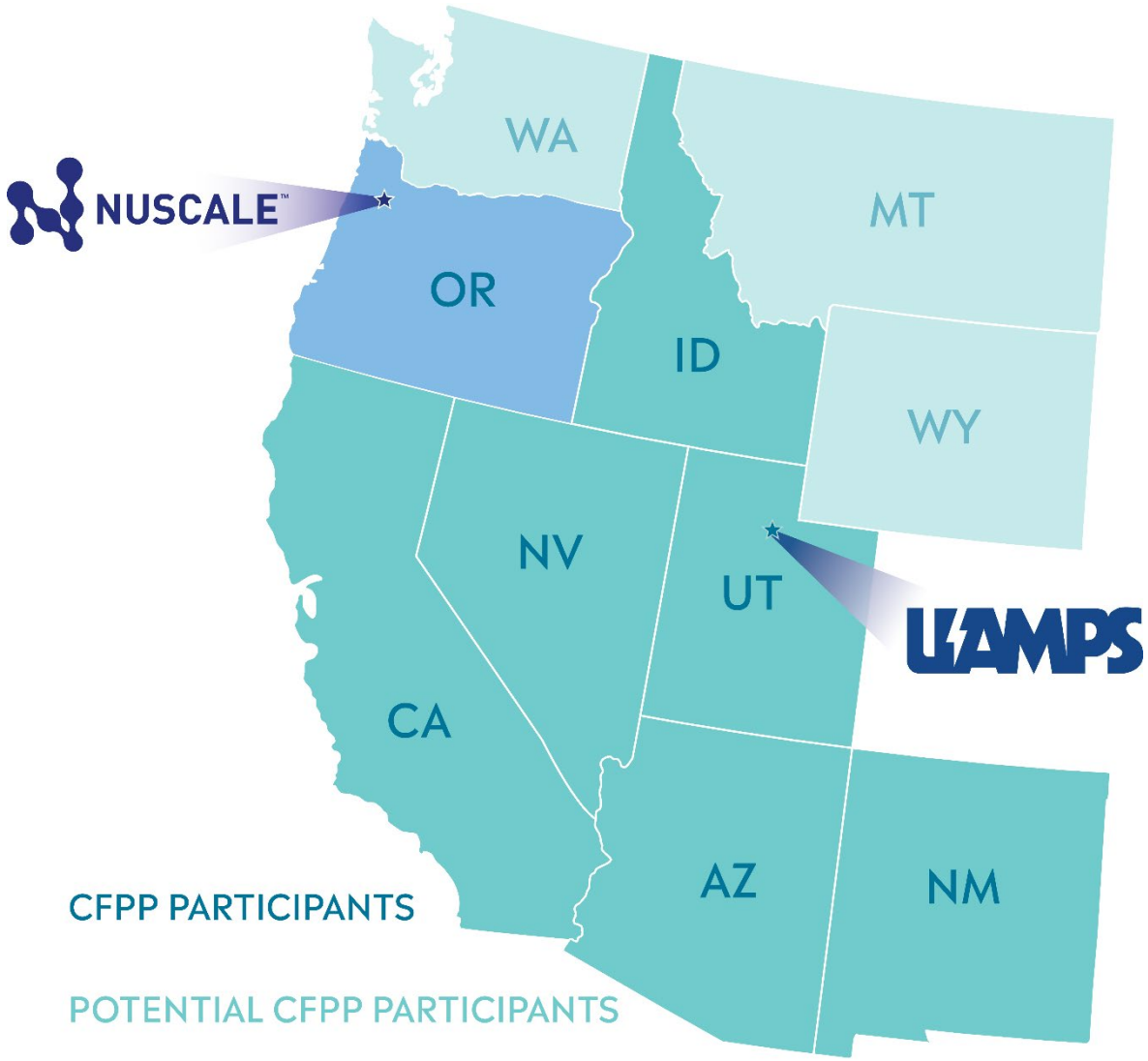
NUSCALE™ Power for all humankind

Manufacturing and Testing of Real Components





NUSCALE
Power for all humankind



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
  - 49 members in Utah, California, Idaho, Nevada, New Mexico and Wyoming.
  - 28 members are ***CFPP participants*** in Utah, Arizona, California, Idaho, Nevada, New Mexico
  - Discussions with ***potential CFPP participants*** in Montana, Wyoming, Arizona and Washington.
- First commercial deployment of the NuScale plant will be at the Idaho National Laboratory (INL) as part of the UAMPS Carbon Free Power Project
- In January 2021, UAMPS and Fluor signed a cost-reimbursable development agreement to provide estimating, development, design and engineering services to develop the site-specific cost estimates for deployment of the NuScale technology at the INL site.

Carbon Free Power Project (CFPP) Timeline

2020

2020
Site characterization activities began

2021-2023
Site characterization activities increase

2024
Full site mobilization for construction

2029
First NuScale Power Module™ installed

2030
Remaining modules installed for full plant operation

2030

Artistic concept of the NuScale Power Plant

NUSCALE™
Power for all humankind

Image courtesy of Third Way Nuclear Reimagined

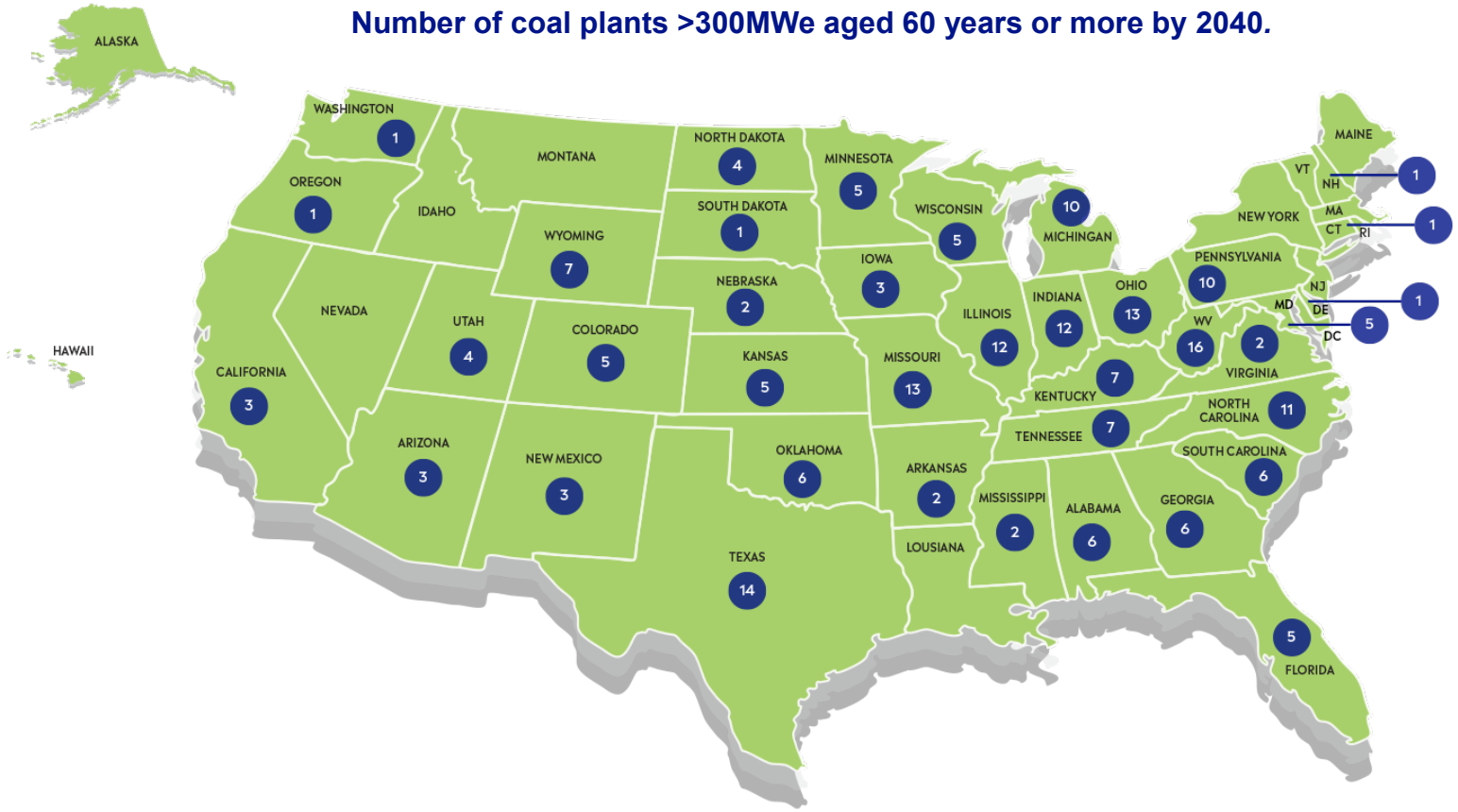
Right-sizing the Emergency Planning Zone (EPZ)

- 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.
  - NuScale EPZ methodology currently undergoing NRC review.

- Tennessee Valley Authority (TVA) Early Site Permit approved by NRC demonstrates 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.

NUSCALE™ Power for all humankind

Repowering Our Energy Communities



- Replacing 145 GWe of retiring coal with ~150 NuScale plants through 2050
  - Mobilizes $600 billion of clean energy investment
  - Creates 1.7 billion man-hours in construction employment
  - Preserves or creates 40,000 power plant jobs
  - Preserves or creates 40,000 manufacturing jobs
  - Eliminates one billion tons of CO_2 per year

Source: GlobalData Analysis, May 2020

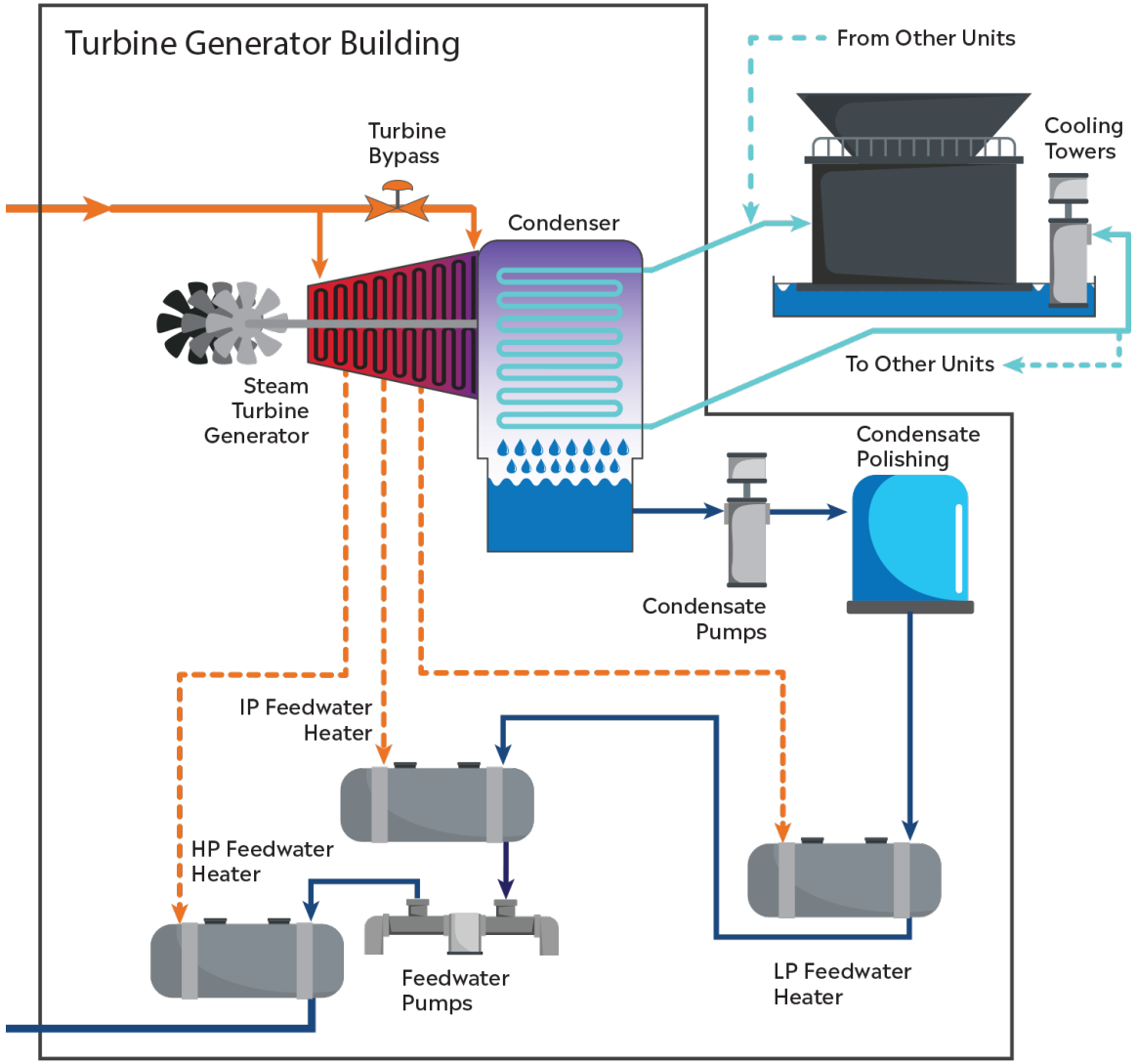
NUSCALE™ Power for all humankind

Repurposing Coal Power Plant Sites

- A NuScale plant can be **built on an existing coal power plant site**
  - 12-module NuScale plant has a protected area of around 30 acres
- Some coal plant **infrastructure can be repurposed and reused**, such as:
  - Cooling water delivery systems, demineralized water, potable water, site fire protection, switchyard, and buildings (e.g., administrative, training, warehouse)
- **Capital cost savings could be approximately $100M** depending on site
- Preservation of local tax base; continued economic benefit to community

NUSCALE™ Power for all humankind

Construction and Balance of Plant Numbers



- Over 830,000 ft^2 of buildings
- Over 200,000 cy of concrete
- Over 6,000 tons of structural steel
- Over 7 million feet of wire and cable
- Over 7,000 instruments
- Over 10,000 I/O points
- Over 1.5 million feet of conduit
- Over 48,000 linear feet of cable tray
- Over 500 items of electrical equipment
- Over 400,000 linear feet of pipe
- Over 48,000 valves
- Over 1,000 misc. mechanical components

NUSCALE™ Power for all humankind

Retaining Coal Power Plant Workforce

Department	Coal Power Plant Position*	NuScale Equivalent Position
Station Management	Plant Manager Operations Manager	Plant Manager Operations Manager
Operations	Control Room Operator	Reactor Operator
Maintenance Planning	Maintenance Supervisor Engineering Technician	Maintenance Supervisor Work Control Scheduler
Maintenance	Boilermaker, Steamfitter Heavy Equipment Operator	Mechanic Site Support Craftsman
Engineering	Thermal Station Engineer System Engineer	Design Engineer System Engineer
Environmental	Environmental Board Operator Environmental Operator	Radwaste Operator Non-licensed Operator
Coal Yard Railroad	Coal Yard or Railroad Specialist	Site Support Craftsman
Outage Planning	Outage Manager Planner	Generation & Planning Manager

**Representative of some of the typical positions. Others also apply.*

NUSCALE™ Power for all humankind

Job Creation

- Each NuScale Plant will employ approximately **270 people full-time**. Examples of types of jobs include:

Estimated Number of Job Positions	Required Education Level	Job Position Examples
45	Bachelor of Science	Department Managers Technical Supervisors System Engineers
162	Associates Degree, Vocational Education	Plant Operators Maintenance Craftsmen Radiation Protection Technicians Training Staff
61	High School or GED	Sit Support Craftsmen Security Officers Storekeeper
2	Entry Level	Administration Support

- The **domestic supply chain** for manufacturing 36 modules (3 plants) per year could **generate about 13,500 jobs**.

NUSCALE™ Power for all humankind

Construction Jobs

Construction jobs per 12-module plant	**1,171**
• Carpenter, heavy equipment operator, laborers, welders	388
• Electricians	182
• Pipefitters, plumbers	90
• Painters, insulators, laborers	89
• Electrical Technicians	76
• Ironworkers, welders	53
• Mason, sheet metal workers, plasterer	51
• Home Office: Engineers, Project Management, Supply Chain, QA, Security, HR	242

NUSCALE™ Power for all humankind


CHANGING THE POWER
THAT CHANGES
THE WORLD
NUSCALE™
Power for all humankind