

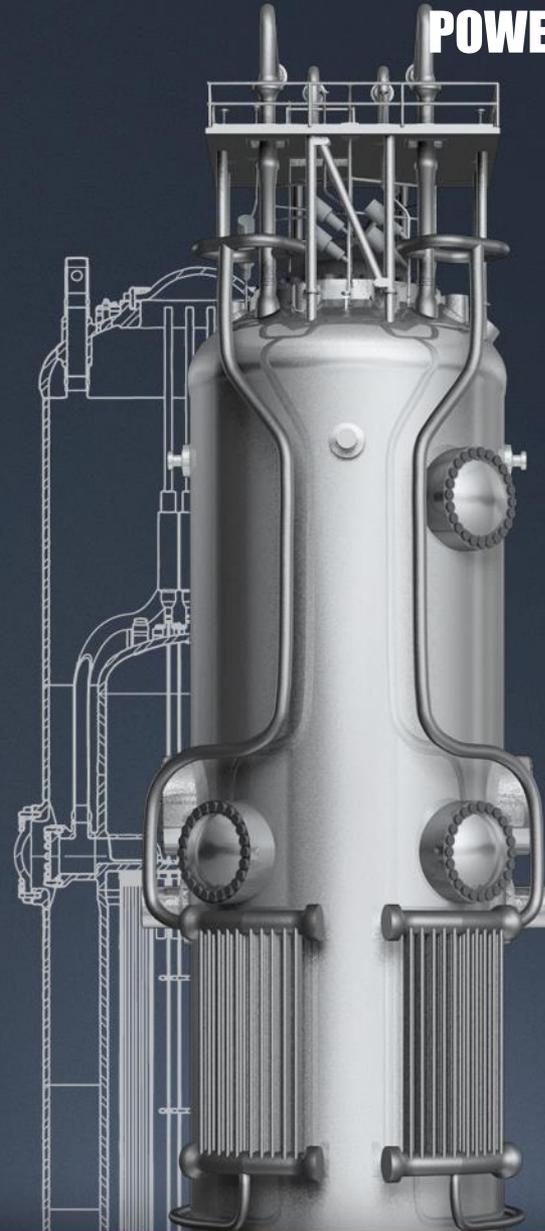


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Arkansas Joint Energy Committee

## New Nuclear: Small Modular Reactors and Opportunities for Kansas

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# Acknowledgement & Disclaimer

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# The Global Reality

An additional 197 quadrillion BTUs of energy are needed to lift 5.9 billion people out of energy poverty.



783 million people do not have access to clean water.

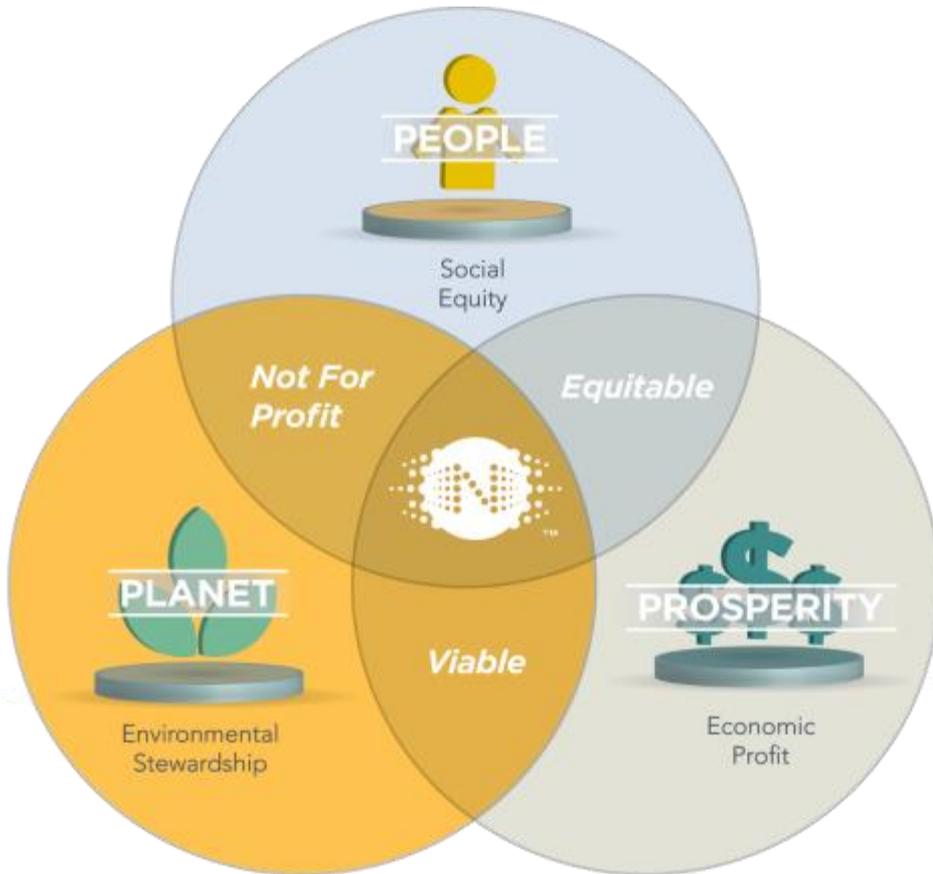


Air pollution in developing economies routinely exceed U.S. standards



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

# Commitment to People, Planet, Prosperity



NuScale Power provides scalable advanced nuclear technology for the production of electricity, heat, and water to improve the quality of life for people around the world.

# Who is NuScale Power?

- Initial concept started with Department of Energy MASLWR program at Oregon State University.
- **NuScale Power** was formed in 2007 for the sole purpose of completing the design of and commercializing a small modular reactor – the NuScale Power Module (NPM).
- **Fluor**, global engineering and construction company, became lead investor in 2011.
- In 2013, NuScale won \$217M in matching funds in a competitive DOE funding opportunity.
- **>350 patents** granted or pending in 20 countries.
- **>300 full-time employees** in 5 offices in the U.S. and 1 in London
- NuScale design currently undergoing rigorous review by the **U.S. Nuclear Regulatory Commission (NRC)**



*NuScale Engineering Offices Corvallis, OR*

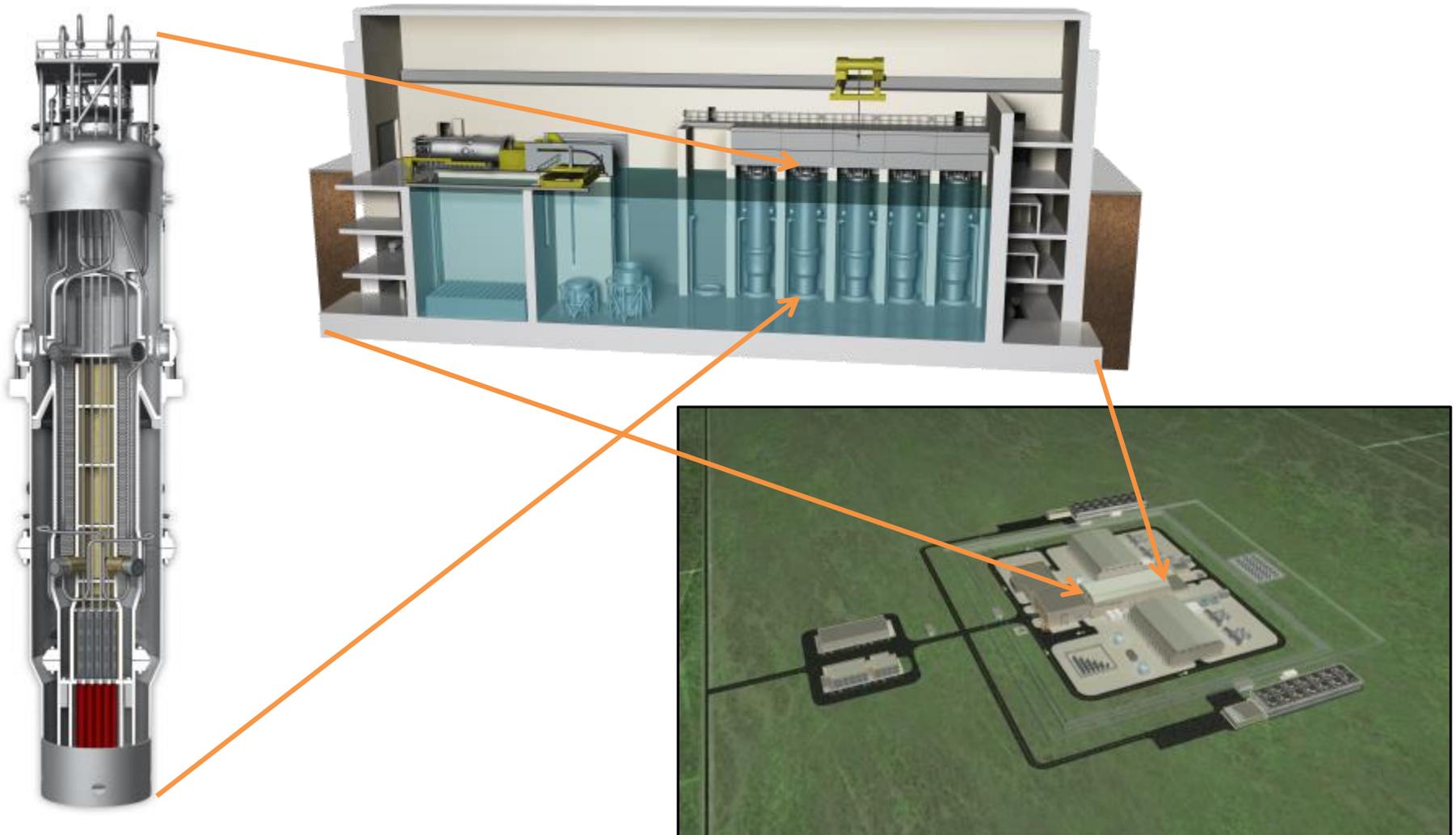


*One-third scale NIST-1 Test Facility*



*NuScale Control Room Simulator*

# NuScale Power Plant



# Core Technology: NuScale Power Module

- A NuScale Power Module 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 50 MWe module:
  - is small enough to be factory built for easy transport and installation
  - has a dedicated power conversion system for flexible, independent operation
  - can be incrementally added to match load growth – up to 12 modules for 600 MWe gross (~570 net) total output



# Advantages of Small Modular Approach



Factory Fabrication



Small Footprint



Transportable

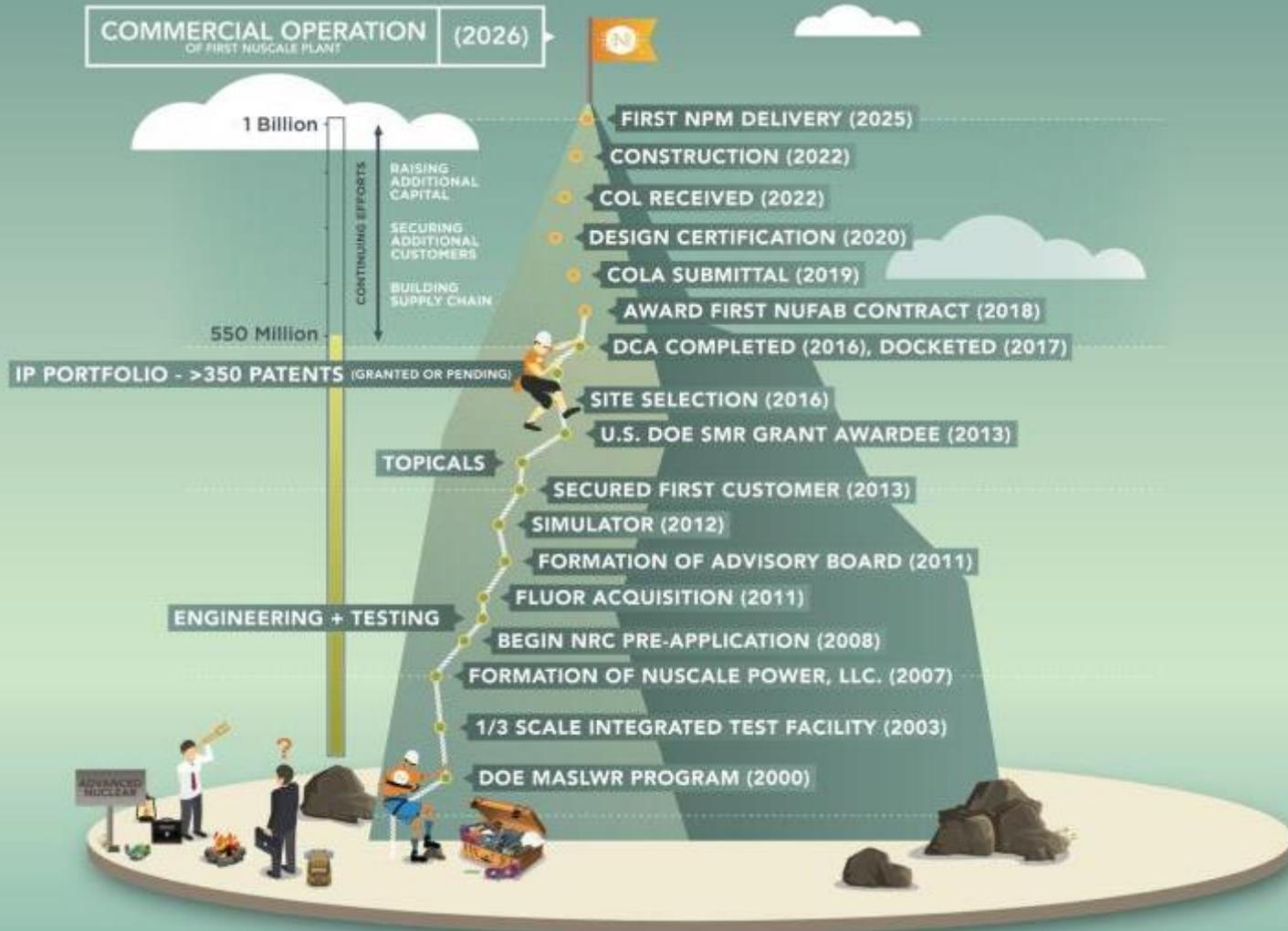


Flexible Operation

# Lowering Costs of Nuclear Power

- **Small, Modular, and Scalable Approach:**
  - Streamline reactor fabrication in a factory
  - Transport modules to plants around the world
  - Reduce on-site construction burden
  - Add modules as energy demand increases
  - Flexible operation to match energy demand
  - Flexible uses for electricity, heat, and water
  
- **Lower up-front cost and lower operating cost as compared to large light-water nuclear reactors**

# Blazing the Trail to Commercialization

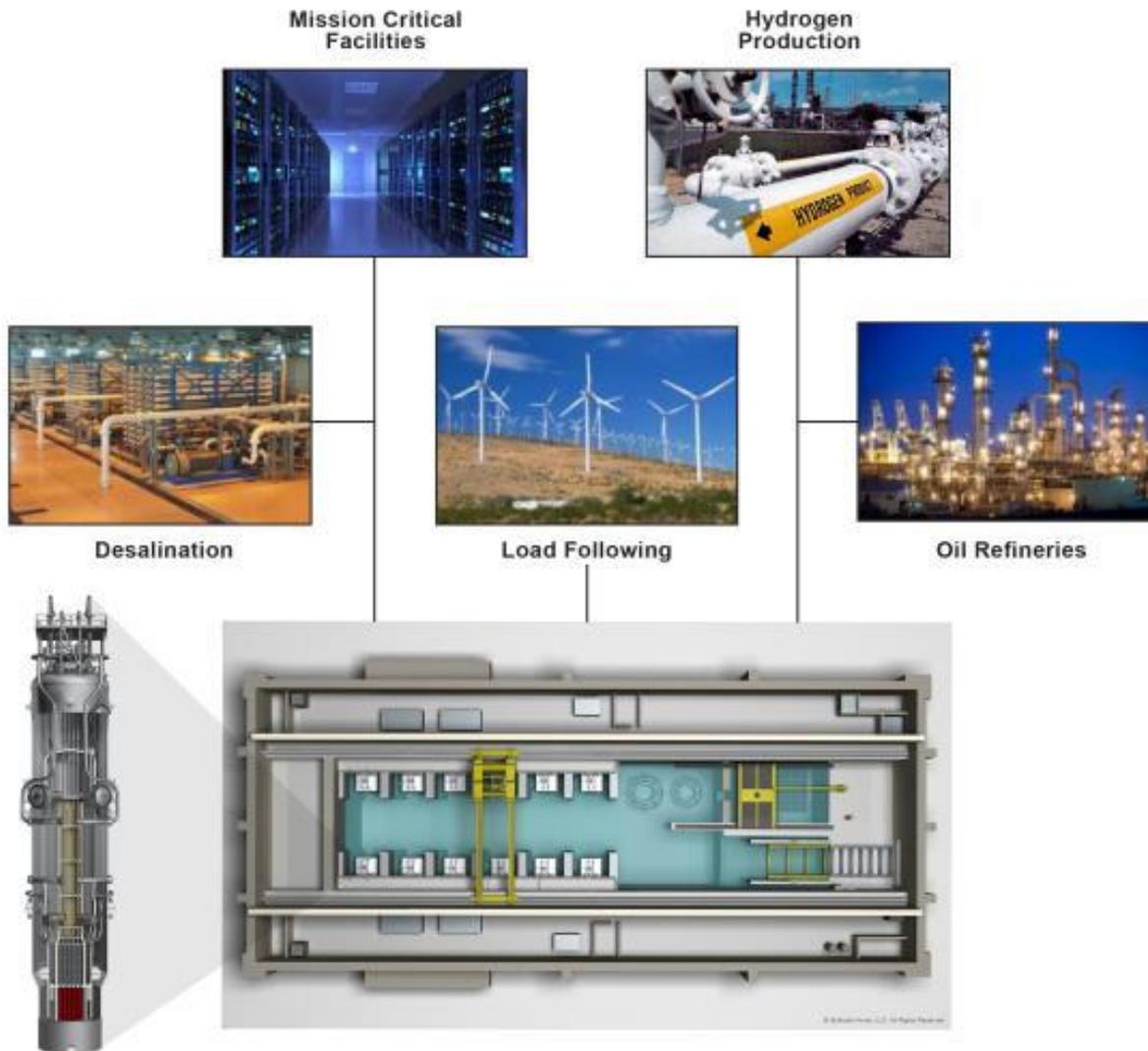


# Design Certification Application Completed 12/31/16

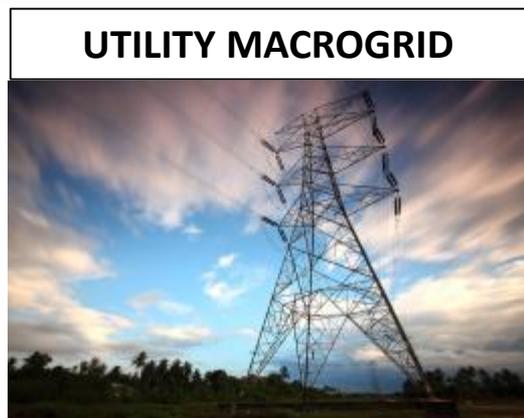
- Pre-application accomplishments
  - >130 meetings
  - >45,000 NRC billable hours (~\$11MM)
  - 15 NRC audits and inspections
  - >1,000 documents on our docket
  - September Readiness Assessment
    - 84 NRC personnel
    - 8 working days
    - Cost >\$1 Million
    - 85 docketing items identified
- 12,000 pages, 13.5 feet of bookshelf space
- 14 Topical Reports
- 2 million labor hours
- 8.5 years
- 800 people
- >50 supplier/partners
- \$505 Million



# Beyond the Grid: NuScale Diverse Energy Platform



# Reliability for Critical Infrastructure



**470 MWe (net)  
> 95% Capacity**

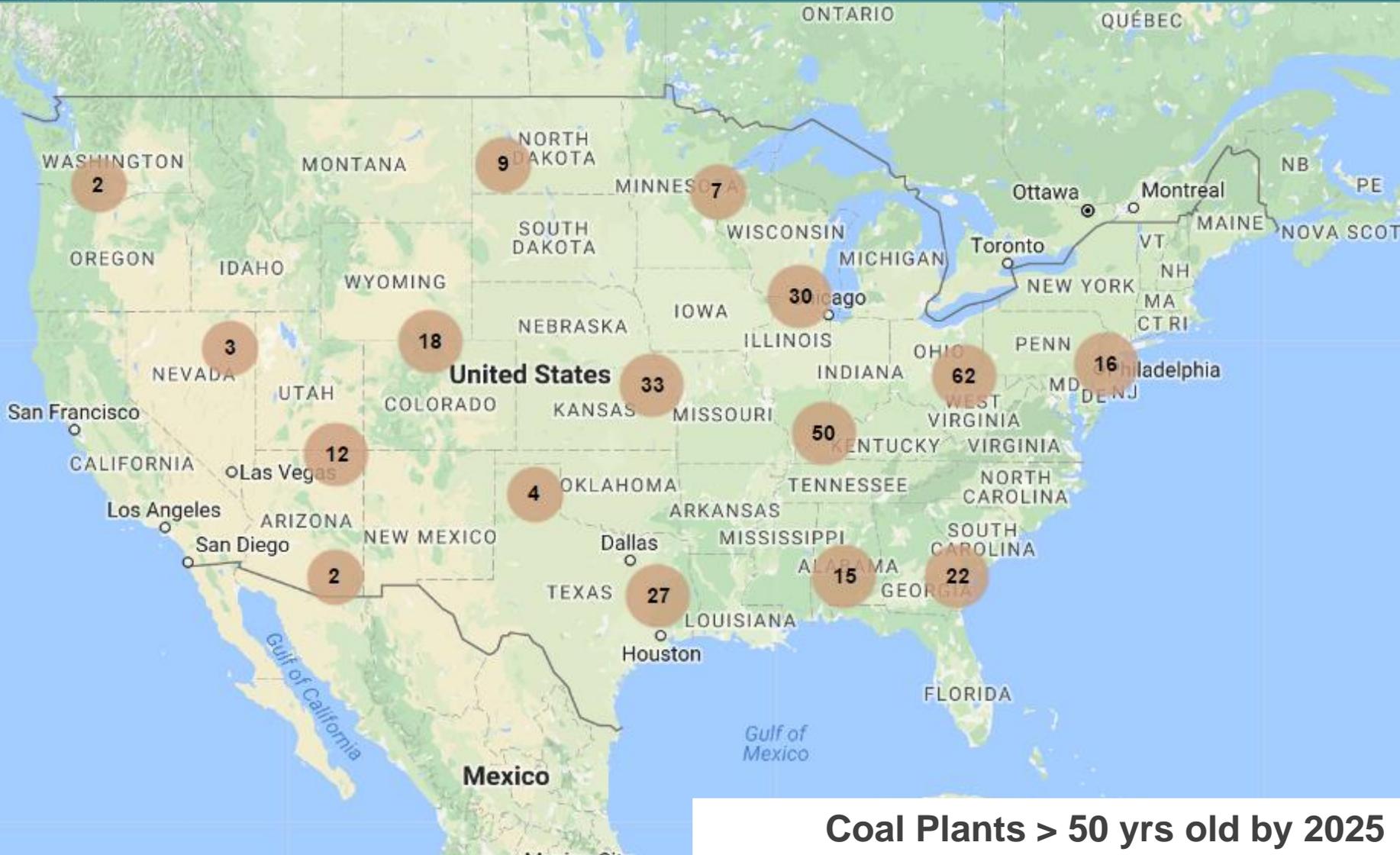


- Connection to a micro-grid, island mode capability, and the ability for 100% turbine bypass allows a NuScale plant to assure 100MWe net power at 99.99% (“Four 9s”) reliability over a 60 year lifetime
- Using highly robust power modules and a multi-module plant design can provide clean, abundant and highly reliable power to those utility customers who require it
- Working to provide “Five 9s” reliability
- The design, development and operation of the NuScale safety I&C systems is consistent with the NIST 2014 Cyber-security Framework.

**DEDICATED  
MICROGRID  
100 MWe (net)  
> 99.99% Availability**



# Potential Construction Locations



Coal Plants > 50 yrs old by 2025

# Construction

<b>Construction Jobs per 600 MW Plant</b>	<b>1,171</b>
Carpenter, heavy equipment operator, laborer, 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

# Operation

## Plant Staffing for Typical Baseload Power Plants

	Coal	Natural Gas Combined Cycle	NuScale Power Plant
Plant Employees (per 600 MWe)	146	24	365
Average Annual Wage for Staff	\$71,800	\$75,130	\$89,940

## Jobs by educational requirement at 600 MW NuScale Power Plant

- Associates Degree, Vocation, or Military 170
- High School Diploma 110
- BS Engineering 85

➤ *Opportunity to train current coal plant workers to work at NuScale plant*

Sources: Utah Associated Municipal Power Systems (UAMPS); NuScale Power; Occupational Employment and Wages, May 2015, Bureau of Labor Statistics

# Local Economic Impacts of a NuScale Plant

- Project will create ~1000 construction jobs at peak, for duration of 2-3 years
- Indirect economic benefits and associated job multipliers
- Full-time plant employment ~360 at average U.S. salaries \$85K
- Indirect economic benefits
- 12,000+ manufacturing jobs in NuScale supply chain
- Reliable power for development of local resources

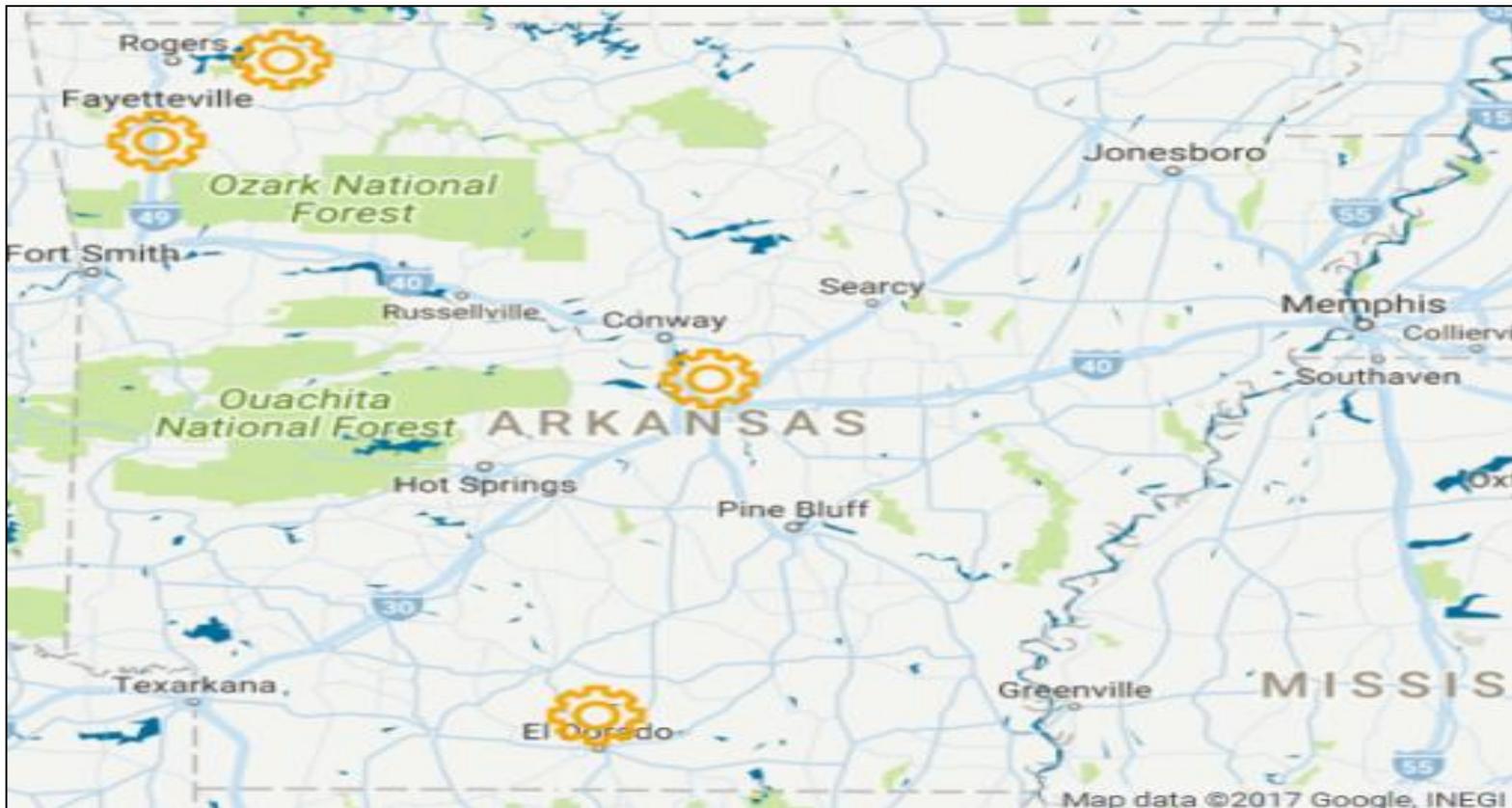


# Coal Re-Powering in Arkansas



- Over **4000 MW** of coal capacity will be over 40 yrs old by 2025
- That's nearly **7 NuScale Plants**, each employing **360 people full-time** and creating **1200 peak construction jobs**
- On average, a nuclear power plant generates **\$470M in sales** of goods and services in the local community and pays about **\$16M in state/local taxes** each year

# Supply Chain Opportunities in Arkansas



- Domestic supply chain for manufacturing 36 modules per year generates about **12,000 jobs** across the country
- Several existing **Arkansas companies can manufacture** civil, mechanical, and electrical equipment for power plants

# Summary

## *Flexible & Scalable Technology*

- Allows customers to build or add units “on demand” as 1 to 12 (50 to 600 MWe gross) can be installed within a single facility
- Lowers construction cost and financial risks as the majority of the plant can be manufactured off-site in a controlled environment
- Broadens the range of industrial and utility applications due to smaller unit size allowing NuScale to reach markets that other LWR SMR vendors can’t reach

## *Safety*

- Only light water SMR to have achieved the “Triple Crown” in safe nuclear power generation – provide an unlimited period of reactor nuclear fuel cooling without the need for AC/DC power, operator intervention, or external supplies of coolant
- Supported by a robust approach to testing and validation that reduces risks

## *Large & Addressable Market*

- World market for electricity generation is expected to increase by 80% over the next 25 years to require 5,221 GW of new electrical generating capacity by 2042.
- 50 MWe size is suitable for a variety of markets – remote markets, multiple applications beyond electricity, inadequate transmission infrastructure
- Low Natural Gas Prices Exist Mainly in the U.S. While recent trending in world natural gas pricing has lowered the cost of natural gas outside the US, global gas pricing remains significantly above US gas pricing

## *Clean Technology*

- Clean, reliable, carbon-free base load power, nuclear is an increasingly attractive alternative to fossil fuels
- It has the smallest environmental footprint of the technologies available today for generating electricity.

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