The Time is Now: Nuclear Energy's Past, Present, and Promise for the Future

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Principal Consultant and Expert Witness

Nuclear ROSE Consulting, LLC

"La Reine" 1998
Alexander Reznichenko, Ukrainian
Private Collection

Introduction and Background

Academic Background

Bachelor of Science, 1988, Virginia Tech

Double Majors in Psychology and English, Minor in Sociology

Master of Science, 1991, Virginia Tech

Industrial and Systems Engineering, Human Factors Engineering Option

Executive Leadership Certification and Training

The Institute for Ethical Leadership, Rutgers Business School, Newark, NJ

Executive Ethical Leadership Certificate (2015)

John F. Kennedy School of Government, Harvard University, Boston, MA

Strategic Management of Regulatory and Enforcement Agencies (2009)

Nicholas School of the Environment, Duke University, Durham, NC

The Law of the National Environmental Policy Act (2008)

Implementation of the National Environmental Policy Act (2006)

American Nuclear Society

- Secretary, Advanced Reactors Working Group
- Member, Risk-informed, Performance-based Principles and Policy Committee
- Member, Working Group for ANS Standard 57.11, "Integrated Safety Assessments for Fuel Fabrication Facilities"

Career in Reactor Regulation & Policy

US Nuclear Regulatory Commission (1991-2021)

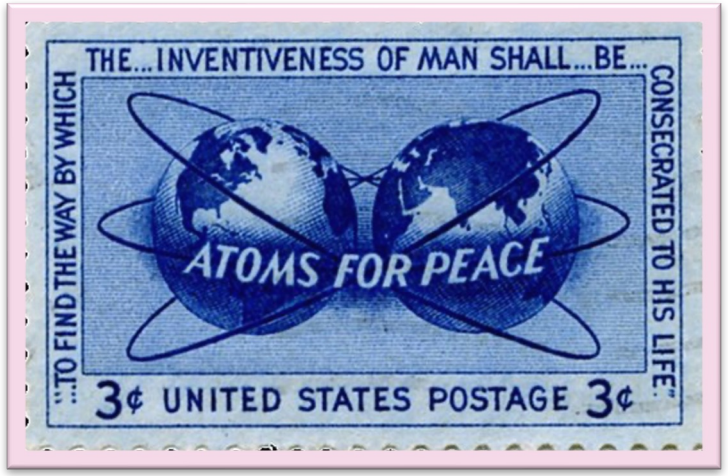
Reactor Engineer Intern (1991-1993)
Project Engineer, Region II, Atlanta, GA (1993-1995)
Resident Inspector, Catawba Nuclear Station (1995-2001)
Reactor License Renewal Project Manager, NRC HQ (2001-02)
Senior Materials Engineer, Reactor License Renewal (2002-03)
Special Assistant and International Liaison, Office of Reactor Regulation (July 2003)
Technical Assistant for Enforcement (2003-05)
Technical Assistant (Reactors) to Commissioner Jeffrey Merrifield (2005)
Chief, Environmental Branch B, Reactor License Renewal (2005-07)
Chief, Projects Branch 2, Reactor License Renewal (2007-08)
Chief, Performance Assessment Branch, Inspection & Regional Support (2008-14)
Member of the NRC's emergency response team, Fukushima Daiichi (2011)
Chief, Security Training and Support Branch, Security Operations (2014)
Senior Policy Advisor, Division of Preparedness and Response (2014-2015)
Branch Chief, Project Aim Team, Executive Director for Operations, (2015-16)
Senior Project Manager, New Reactor Licensing (2016-2021)

Non-government Organizations, Legislators, and Advanced Reactor Developers (2022-present)

Atoms for Peace Program in 1950's

Launched by President Dwight Eisenhower in 1954

- Shippingport Atomic Power Station near Pittsburg, PA
  - 1958 – First commercial nuclear power plant in the United States (US)
- Nine Mile Point Unit 1 in Oswego, NY
  - 1969 – Commenced commercial operation
  - Oldest operating commercial plant in the US



Source: Wikipedia

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Source: Wikipedia

Atomic Energy Act of 1954

Established the Atomic Energy Commission (AEC) and defined its mission:

Sec. 1. Declaration

Atomic energy is capable of application for peaceful as well as military purposes. It is therefore declared to be the policy of the United States that –

a. *the development, use, and control of atomic energy shall be directed so as to make the maximum contribution to the general welfare, subject at all times to the paramount objective of making the maximum contribution to the common defense and security; and*
b. *the development, use, and control of atomic energy shall be directed so as to promote world peace, improve the general welfare, increase the standard of living, and strengthen free competition in private enterprise.*

Source: https://www.nrc.gov/docs/ML1327/ML13274A489.pdf#page=23

Energy Reorganization Act of 1974

Separated the R&D and licensing functions of the AEC

> ***Sec. 2. Declaration of Purpose***
>
> *(a) The Congress hereby declares that the general welfare and the common defense and security require effective action to develop, and increase the efficiency and reliability of use of, all energy sources to meet the needs of present and future generations, to increase the productivity of the national economy and strengthen its position in regard to international trade, to make the Nation self-sufficient in energy, to advance the goals of restoring, protecting, and enhancing environmental quality, and to assure public health and safety.*
>
> Source: https://www.nrc.gov/docs/ML1327/ML13274A489.pdf#page=241

Established

- **Nuclear Regulatory Commission (NRC)** – Mission: Licensing and related regulatory functions
- **Energy Research and Development Administration (ERDA)** – Mission: Research and development

ERDA later evolved into the Department of Energy (DOE)

NRC's Principles of Good Regulation

Independence

Nothing but the highest possible standards of ethical performance and professionalism should influence regulation. However, independence does not imply isolation.

Openness

Nuclear regulation is the public's business, and it must be transacted publicly and candidly.

Efficiency

NRC must establish means to evaluate and continually upgrade its regulatory capabilities. Regulatory activities should be consistent with the degree of risk reduction they achieve. Where several effective alternatives are available, the option which minimizes the use of resources should be adopted. Regulatory decisions should be made without undue delay.

Clarity

Regulations should be coherent, logical, and practical.

Reliability

Regulations should be based on the best available knowledge from research and operational experience. Once established, regulation should be perceived to be reliable and not unjustifiably in a state of transition. Regulatory actions should always be fully consistent with written regulations and should be promptly, fairly, and decisively administered so as to lend stability to the nuclear operational and planning processes.

Source: https://www.nrc.gov/docs/ML1413/ML14135A076.pdf

Big Coincidence at a Very Bad Time

March 16, 1979

March 28, 1979

Nuclear Weapons & Nuclear Energy

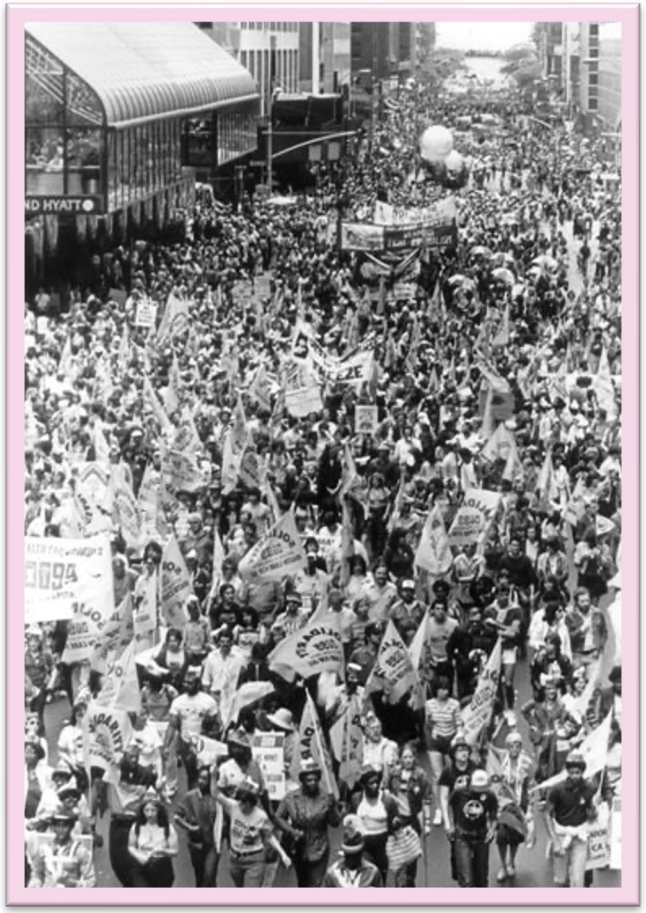


Photo: WagingNonViolence.org

- Cold War in the 1980's
  - Conflation of military and peaceful applications of nuclear physics
- New York City's Central Park
  - June 12, 1982
  - 1,000,000 people
  - Largest anti-nuclear protest in American history
  - Demonstrated against nuclear weapons
  - Called for an end to the cold war arms race

Button for purchase on Ebay!

Chernobyl Accident in Ukraine,1986

Photo: The Atlantic

Causes:

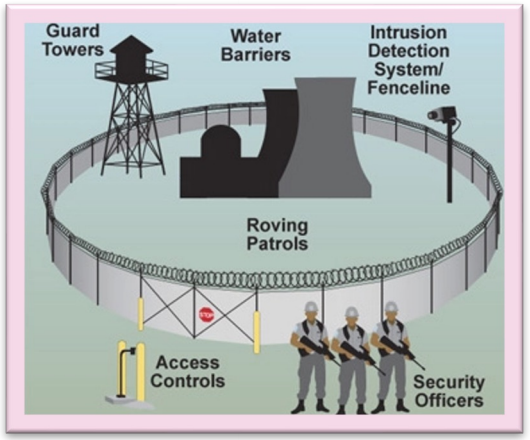
- Flawed reactor design
- Inadequately trained operators

Fatalities and Human Health Impacts:

- 2 plant workers died from the explosion on the night of the accident
- 28 people died within a few weeks from acute radiation syndrome
- 15 people died from thyroid cancer
- No evidence of a major public health impact from radiation exposure 20 years later

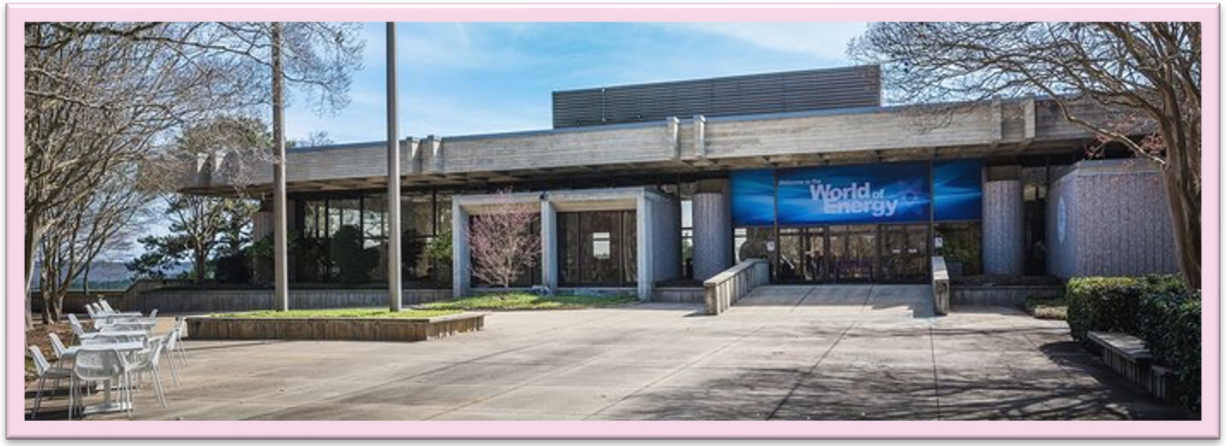
New Design-basis Threat on 9/11/01

- No nuclear plant targeted
- Raised concerns about vulnerability to attack and sabotage, insider threat
- NRC orders required nuclear utilities to take immediate actions
- Tests revealed U.S. plants are robustly designed and constructed
- Some site area boundaries and visitor centers were affected



US Nuclear Regulatory Commission

Joe Readle/Getty Images



World of Energy, Oconee Nuclear Station, Duke Energy

Fukushima Daiichi Accident in 2011

Photo: The New York Times

- No deaths or cases of radiation sickness from the nuclear accident
- Over 100,000 people evacuated from their homes as a preventative measure
- Government nervousness has delayed the return of many
- 2,313 disaster-related deaths among evacuees from Fukushima prefecture
  - These are in addition to 19,500 killed by the earthquake or tsunami

Shrinkage and Expansion of the Fleet

- 2012 – U.S. nuclear generation peaked at about 102,000 MW
  - 104 operating power reactors
- 2016 – Watts Bar Unit 2 commenced commercial operation
  - First commissioned reactor since 1996 when the Watts Bar Unit 1 came online
- 2021 – Operating fleet
  - 93 operating commercial nuclear power reactors
    - 55 nuclear power plants in 28 states
  - Combined generating capacity of about 95,492 MW
  - 23 decommissioning commercial nuclear power reactors at 19 sites
  - 40 years – the average age of US nuclear reactors
- 2023 – Vogtle Unit 3 commenced commercial operation
- 2024 – Vogtle Unit 4 expected to enter commercial operation

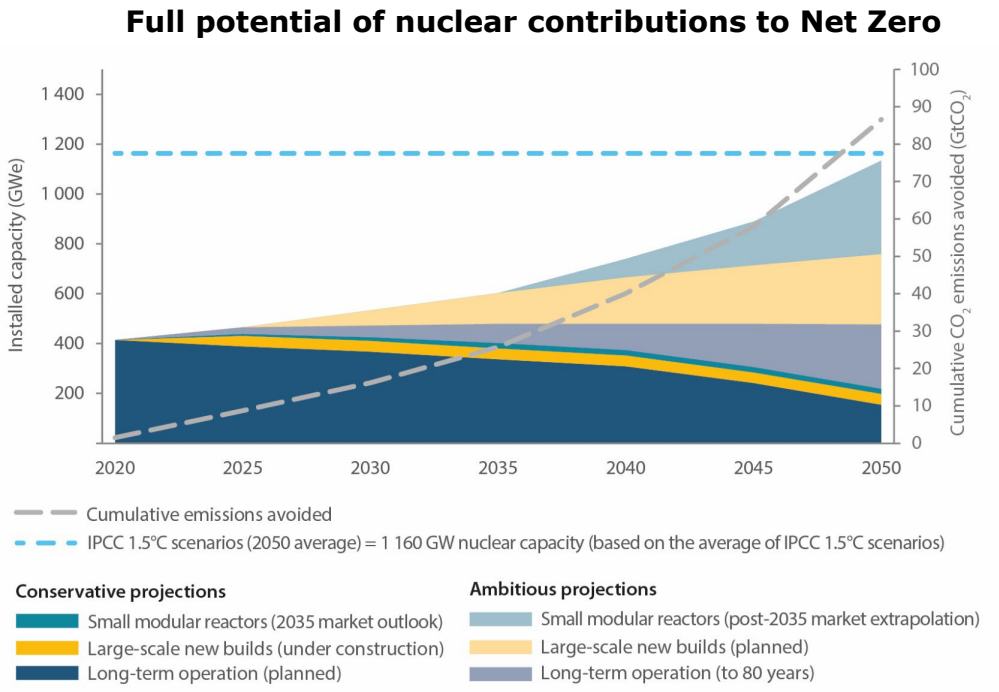
Global Capacity Demand for Net Zero

Global installed nuclear capacity needs to triple by 2050 for Net Zero

Reaching the target of tripling global installed nuclear capacity by 2050 will require a combination of:

1. **long-term operation**
2. **large-scale new builds**
3. **small modular reactors**
4. **non-electric applications**

(NEA 2022)



Source: https://ric.nrc.gov/agenda/agenda-presentation.aspx?SessionSpID=150

Realizing the Vision and Promise

To fully realize the vision of Atoms for Peace, we need:

- A domestic supply of nuclear fuel;
- A modern regulatory apparatus; and
- Research institutions to
  - advance state-of-the-art knowledge and
  - develop a skilled nuclear workforce from a variety of disciplines.

Nuclear Fuel Supply

National Defense Authorization Act, NDAA (December 2023)

- Nuclear Fuel Security Act (NFSA)

December 2023 Statement by Senator Barrasso (R-WY):

> *The Nuclear Fuel Security Act will help secure the future of American nuclear fuel production. We are stronger and safer as a nation when our nuclear fuel supply chain starts and ends here at home. The inclusion of this legislation in the NDAA is the first step towards taking uranium production out from under the thumb of Vladimir Putin and his corrupt regime. Russian energy has no place in the American marketplace.*
>
> Source: https://www.energy.senate.gov/2023/12/barrasso-hails-broad-support-for-bipartisan-nuclear-fuel-security-act#:~:text=Including%20the%20Nuclear%20Fuel%20Security%20Act%20in%20the%20National%20Defense,uranium%20for%20many%20advanced%20reactors.

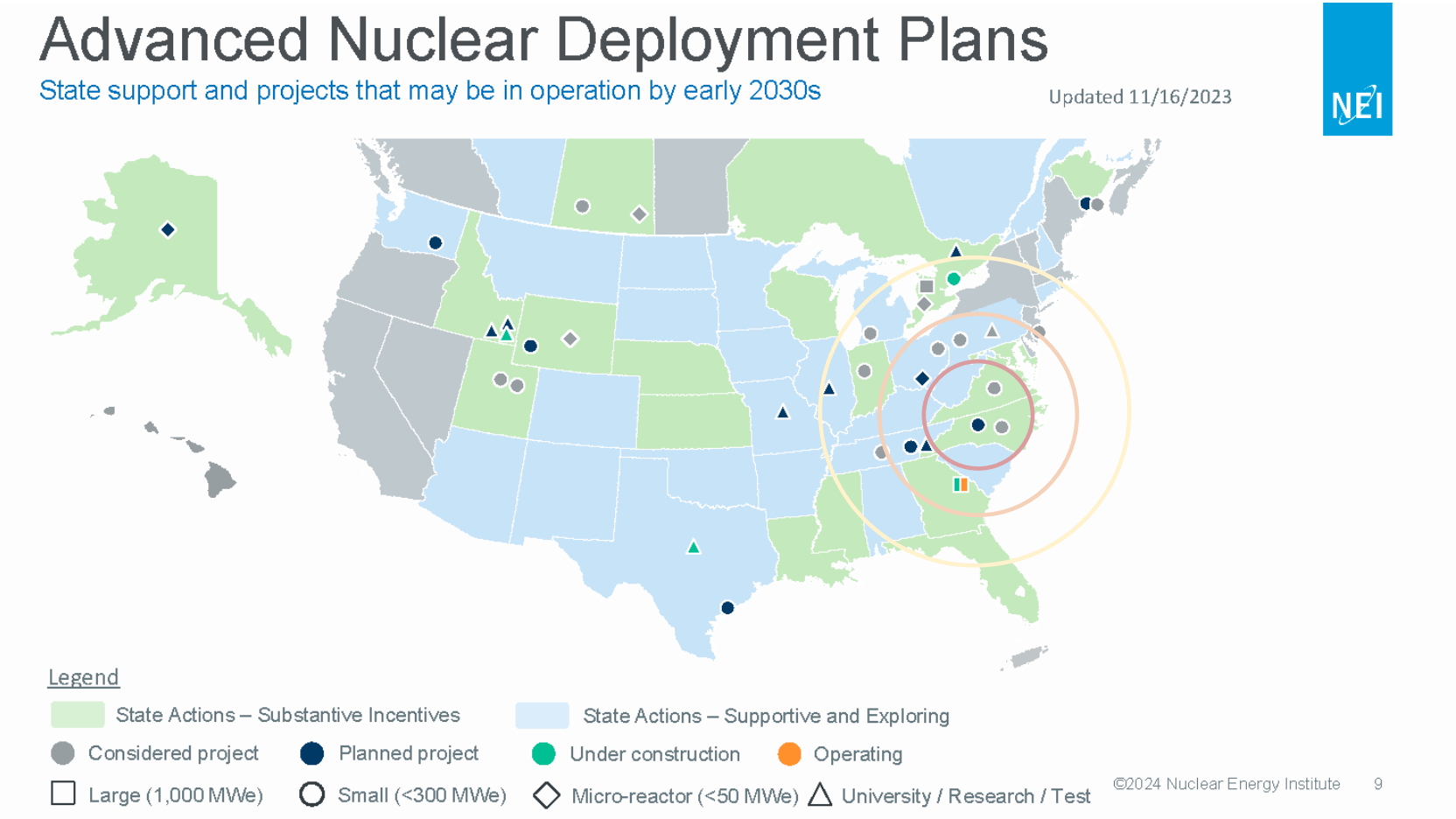
The Regulatory Apparatus

- Recurrent Congressional Scrutiny and Pressure to Modernize
- Early History of NRC's Inspection and Oversight
  - Towers Perrin Report (1994)
  - Congressional Hearing and "Near Death Experience" (1998)
  - Risk-informed, performance-based regulatory approach (1999)
    - "… the Commission is advocating certain changes to the development and implementation of its regulations through the use of risk-informed, and ultimately performance-based, approaches."
    - "The transition to a risk-informed regulatory framework is expected to be incremental."
  - Transition to Reactor Oversight Process (ROP) in 2000
- 9/11 reversed security oversight efficiencies gained under ROP (2001)
- Modernization of licensing frameworks stalled (2001 to 2019)

Congressional Calls for Modernization

- Congressional Hearing, Clean Air and Nuclear Safety Subcommittee of the Senate Environment and Public Works (EPW) Committee (2016)
- Nuclear Energy Innovation and Modernization Act, NEIMA (2019)
  - Develop a technology-inclusive licensing framework that applies risk-informed, performance-based principles to regulatory decision-making
  - Complete the work NRC began in the late 1990s
- NRC Staff delivered 10 CFR Part 53 to Commission (March 2023)
- House Bill 6544, Atomic Energy Advancement Act (Feb 2024)
- NRC Commission Direction re 10 CFR Part 53 (March 2024)

Advanced Reactor Interest in the US



Source: https://ric.nrc.gov/agenda/agenda-presentation.aspx?SessionSpID=149

VNEC's "Virginia By the Numbers"

The Commonwealth leads the industry and the nation in nuclear capability & expertise.

32%	of the Commonwealth's power coming from zero emission nuclear power.
95%	of the carbon-free energy in the Commonwealth is generated by nuclear.
5+	Research, degrees programs, and workforce training – Virginia Commonwealth University, Virginia Tech, University of Virginia, Old Dominion University, Liberty University, and community colleges.
24/7	Availability of nuclear – the only carbon-free energy source that is available without interruption.
100,000	Estimated number of jobs across the Commonwealth tied directly to the nuclear sector.
2	Federal non-nuclear facilities in Virginia are engaged in research, development and use of nuclear technology.
#1	Virginia is the prime location for next-gen reactors due to existing nuclear assets, expertise & capability.

Source: https://virginianuclear.org/virginia-by-the-numbers/

Research, Innovation and Workforce

Research and Innovation

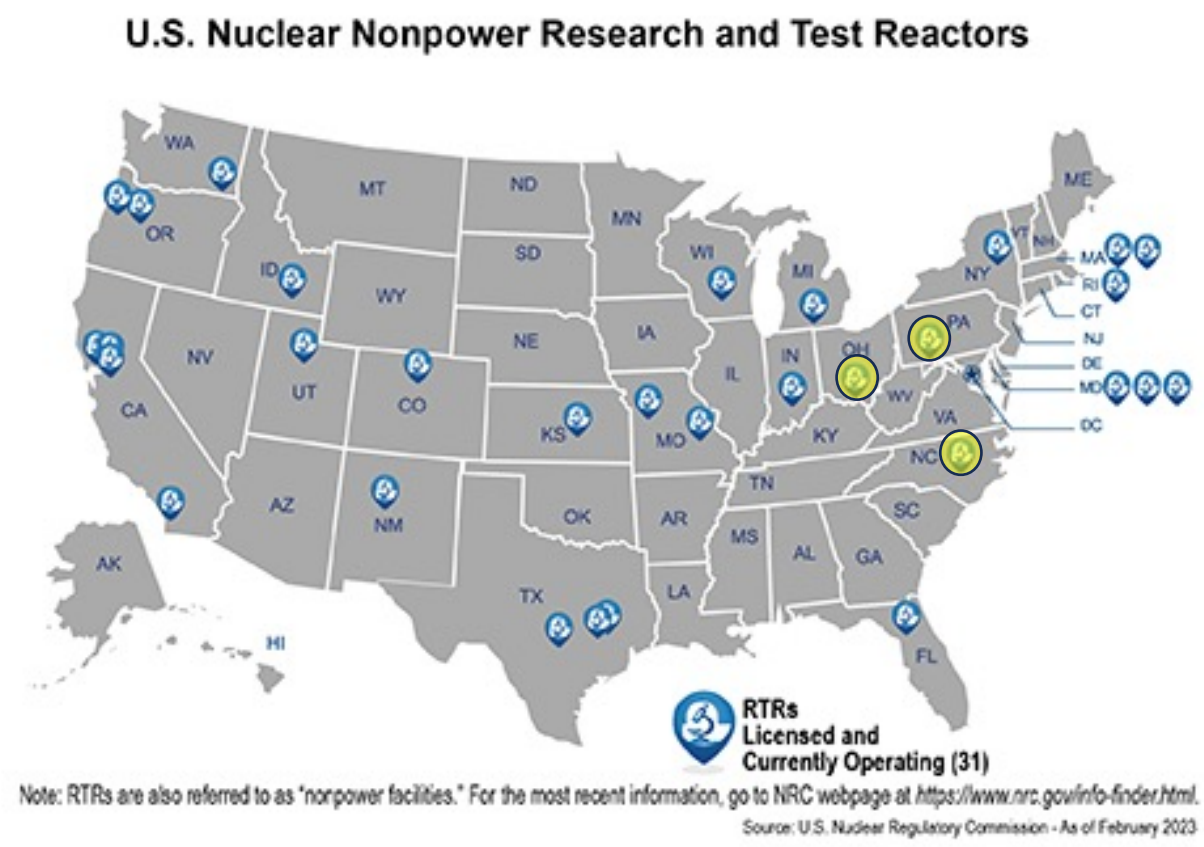
Virginia's institutions of higher learning offer degree programs for nuclear engineering.

Energy Workforce

A workforce survey conducted in August of 2015 revealed a number of factors that affect the industry's short-term and long-term employment outlook. The industry is facing a wave of attrition as the original generation of industry workers approaches retirement age. There is, as a result, a strong demand for new employees across the industry, and in Virginia specifically. In addition, an increasing number of contracts and needs for Naval propulsion system operators is creating additional labor demand.

Source: VNEC, https://virginianuclear.org/

Research & Test Reactors



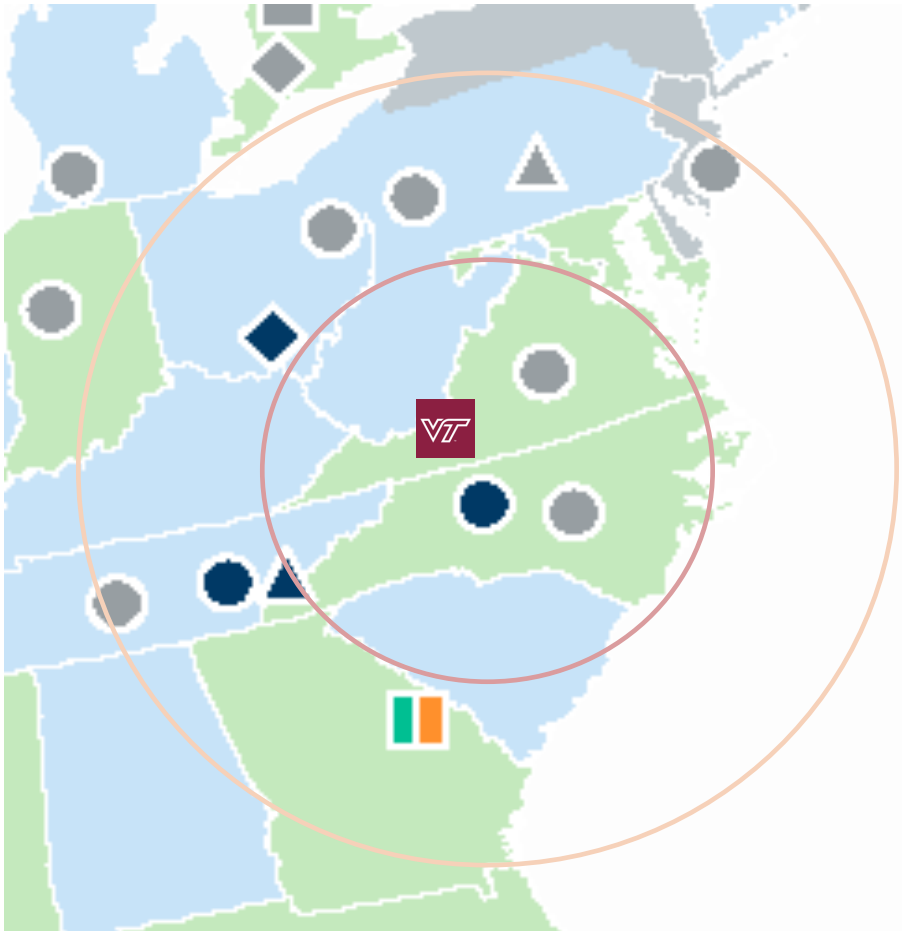
Source: https://www.nrc.gov/reactors/operating/map-nonpower-reactors.html

Operational Research Reactors Worldwide

Countries	Number
Russia	52
USA	50
China	16
India	7
Argentina, Canada, Germany, Italy	5 (each)
Brazil, Iran, Kazakhstan	4 (each)
Belarus, Belgium, Czech Republic, France, Indonesia, Japan, Ukraine	1 (each)
Other	45

Source: World Nuclear Association

Strategic Opportunity for Virginia Tech



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CARDINAL NEWS
SERVING SOUTHWEST AND SOUTHSIDE VIRGINIA

Virginia Tech once had its own nuclear reactor

If Gov. Glenn Youngkin succeeds in locating a small nuclear reactor in Southwest Virginia, it won't be the first. From 1960 to 1985, Virginia Tech operated its own small reactor in Robeson Hall, just off the Drillfield.

-Ralph Berrier Jr., April 10, 2023

Source: https://cardinalnews.org/2023/04/10/virginia-tech-once-had-its-own-nuclear-reactor/

Closing, Questions and Discussion

Adobe Stock Image

Source: https://www.vt.edu/about/locations/buildings/torgersen-hall.html