The background features an abstract graphic with several overlapping curved lines in shades of purple, blue, and green. Three large, glossy spheres are also present: one purple on the left, one larger purple in the center, and one green on the right. The top right corner is a solid dark blue rectangle containing the title and subtitle.

Virginia is Nuclear

2020-2024 Strategic Plan

Prepared By:

Virginia Nuclear Energy Consortium Authority

Virginia Nuclear Energy Consortium

In Coordination:

Virginia Department of Mines, Minerals and Energy

Virginia Economic Development Partnership

Virginia Secretary of Commerce and Trade
Virginia Secretary of Education

Prepared For:

The Commonwealth of Virginia

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.

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2	The Virginia Nuclear Energy Mission
3	Virginia Nuclear Capabilities
4	Guiding Principles
5	Nuclear Energy is <i>Clean</i> - <i>Ensuring Nuclear Energy's Contribution to Virginia's Carbon-Free Future</i>
6	Nuclear Technology is <i>Innovation</i> - <i>Prioritizing Nuclear Energy Innovation</i>
7	Nuclear Technology is the <i>Future</i> - <i>Developing Infrastructure and Research & Development</i>
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Executive Summary

The Virginia is Nuclear 2020 Strategic Plan is a blueprint for leveraging the power of the atom for the benefit of all residents of the Commonwealth of Virginia. The principles, objectives, and near-term goals described in this plan promote economic development, environmental stewardship, and national security. The plan positions Virginia to advance its unparalleled strategic advantage in nuclear energy and related technologies.

Key guiding principles for the plan include:

- Ensuring nuclear energy's continued contribution to Virginia's carbon-free future
- Prioritizing nuclear innovation
- Leveraging existing in-state infrastructure and identify capability gaps
- Growing related educational opportunities for the future nuclear workforce

Key strategies are organized around:

- Advanced electrical generation technologies
- Economic development
- Education
- Research & development

Critical near-term objectives for 2020-2024 are:

- Developing a roadmap for the deployment of economical and technically feasible generation sources and associated energy storage technologies for meeting electricity demand profiles and carbon-free energy plan targets
- Consider a public-private partnership for siting and construction of a small modular or other advanced reactor
- To ensure that education and training programs are providing the necessary educational and work-based knowledge required to meet the demands of tomorrow's nuclear energy workforce
- Consider a generation mandate for nuclear energy if it is in the interest of the Commonwealth's long-term clean energy targets
- Promote diversity and inclusion in STEM disciplines in order to shift patterns of representation – addressing ways to change the STEM culture to be more welcoming and inclusive of diverse cultures and backgrounds

The plan will require industry and the Commonwealth to work together to establish specific milestones for meeting the Commonwealth's 2045 carbon-free energy generation goal (§ 67-102 Commonwealth Energy Policy), and to accomplish advanced nuclear demonstration projects that will promote Virginia's leadership in nuclear energy solutions for the world's pressing energy, economic, environmental, and national security needs.

This plan was developed in accordance with state statute by:

Virginia Nuclear Energy Consortium Authority (VNECA)

Established by the Legislature and signed into law in 2013, VNECA's mission is to make Virginia a national and global leader in nuclear energy, science and technology, and to serve as an interdisciplinary study, research and information resource for nuclear energy in Virginia. VNECA established the Virginia Nuclear Energy Consortium (VNEC) as a non-profit corporation, responsible for conducting activities to achieve the goals set by VNECA.

Virginia Nuclear Energy Consortium (VNEC)

VNEC's mission is to sustain and enhance the Commonwealth of Virginia as a national and global leader in nuclear energy; serve as an interdisciplinary business development, research, training, and information resource on nuclear energy issues; and to advocacy for the nuclear industry.

Virginia is Nuclear

Virginia's nuclear industry serves a critical role in the Commonwealth, the United States, and globally as a center for nuclear technology. In diversity and strength, Virginia's nuclear capabilities are unparalleled.



Mission Statement for Virginia's Leadership in Nuclear Energy

To preserve and advance Virginia's global advantage in research, education, electrical generation, advanced manufacturing, and expertise while providing carbon-free power, innovations in nuclear technology, and defense applications to ensure national security.



Background

2020 legislation (HB 1303 and SB 549) directed the Virginia Department of Mines, Minerals, and Energy; the Secretary of Commerce and Trade; and the Secretary of Education to work in coordination with the Virginia Nuclear Energy Consortium Authority and the Virginia Economic Development Partnership Authority to develop a strategic plan for the role of nuclear energy in the Commonwealth's overall strategy for moving toward carbon-free energy.

The plan was directed to be completed by October 1, 2020, and updated every four years thereafter. The plan recognizes the industry's key priorities of maintaining, growing, and improving the Commonwealth's nuclear generation capacity through economic development, research and development, and workforce development, while maintaining Virginia's role as a world leader in nuclear capability and expertise. This plan is based upon a set of clear, guiding principles.

The facilities and expertise in the Commonwealth, combined with its proximity to the federal agencies in the Washington, DC area, position Virginia to be the nation's center for nuclear technology development.

Nuclear technology can remain a driving force in economic development, environmental stewardship, and national security, but only if we act.

Virginia is Nuclear

In diversity and strength, Virginia's nuclear capabilities are unparalleled.

Electrical Generation

- Two commercial nuclear power stations
- Four nuclear power reactors
- Operated safely over 40 years
- Generate over 95% of the Commonwealth carbon-free electricity
- Over 2,000 employees

Advanced Manufacturing and Services Capabilities

- Small modular or other advanced reactor
- Nuclear Fuel Fabrication
- Manufacturing
- Services Equipment
- Engineering Design
- Cybersecurity
- Modular fabrication
- Visualization
- Welding & Robotics
- Thermal Propulsion

Defense

- Commercial defense industry employs over 28,000
- Virginia is the home of the sole manufacturer of naval nuclear reactors for U.S. submarines and aircraft carriers
- Norfolk Naval Shipyard is the oldest naval shipyard in the United States
- Navy operates 97 reactors

Research & Development

- World-class universities including: Virginia Commonwealth University, Virginia Tech, University of Virginia, Old Dominion University and Liberty University
- NASA Langley
- Advanced manufacturing companies

Workforce

- Energy career cluster
- Community Colleges
- University degree programs
- Workforce training programs - highly skilled labor

Our Guiding Principles

On August 23, 2019, VNEC convened a forum of industry stakeholders to discuss workforce, infrastructure, and research & development as drivers of Virginia's nuclear innovation and commerce. From that discussion came a list of four guiding principles for the nuclear industry.

Ensuring nuclear energy's continued significant contribution to Virginia's carbon-free future – Maintaining its critical role in the Commonwealth's energy infrastructure during the transition to 100% carbon-free generation through the development of next-generation nuclear power.

Prioritizing nuclear energy innovation - Encouraging deployment of new technologies and economic opportunities to increase the Commonwealth's commercial nuclear infrastructure, as well as equipment and services exported around the globe.

Developing infrastructure and research & development – Establishing an energy research center and encouraging public-private partnerships between the Commonwealth and local, and federal government entities, academic institutions, and commercial entities to grow Virginia's nuclear industry.

Developing the nuclear workforce and educational opportunities – Creating programs to support innovation in the nuclear industry, and promoting education in fields that meet the future workforce demands.

Ensuring Nuclear Energy's Contribution to Virginia's Carbon-Free Future

Nuclear Energy is *CLEAN*

To meet the Commonwealth's goal of 100% carbon-free energy by 2045, it is critical for Virginia to utilize *all* available clean energy sources, including nuclear energy. Nuclear energy is a foundational component of an economical and technically feasible electrical generation structure for meeting Virginia's clean energy goal.

Goals

- Conduct an economic impact study on nuclear energy development and the role of the Commonwealth's nuclear fleet during the transition to 100% carbon-free energy.
- Continue operation of the Surry and North Anna nuclear stations (80-year life) which today provide more than 95% of Virginia's clean energy.
- Include nuclear energy in any and all clean energy discussions consistent with legislation passed in the 2020 legislature:
 - SB 828 Carbon-free energy and clean energy; definition
 - SB 817 Nuclear energy; considered a clean energy source
- Consider enacting legislation to establish specific milestones for meeting Virginia's 2045 carbon-free generation goal.
- Ensure nuclear energy is presented as a valuable resource for end-users in Virginia seeking to transition to carbon-free generation.
- Conduct a roadmap study of available technologies and their associated economics for meeting Virginia's 24/7 electrical demand profile while meeting established milestones for the Commonwealth's 2045 carbon-free generation goal.
 - If found in the interest of the Commonwealth, consider establishing a generation mandate for nuclear energy to ensure 2045 goals are achieved.
- Investigate pairing of advanced nuclear electricity generation with hydrogen generation for energy storage and promotion of a new Hydrogen Economy that will even further displace hydrocarbon-intensive applications and accelerate achievement of the Commonwealth's zero-carbon goal.
- Ensure new, advanced nuclear can be part of the generation mix by supporting new projects in Virginia when appropriate.
- Adopt policies that incentivize the use of zero-carbon generation – including nuclear energy – to power electric vehicle infrastructure.



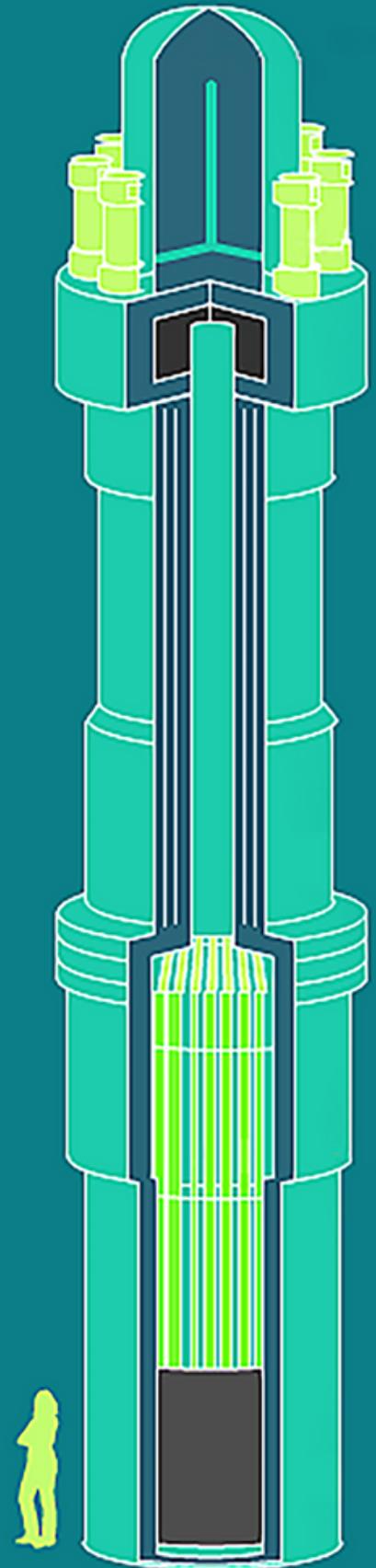
Prioritizing Nuclear Energy Innovation

Nuclear Technology is *INNOVATIVE*

Virginia can become a national leader in clean energy and advanced technological research, and at the same time reduce carbon emissions, promote economic growth, and protect the environment for future generations. Nuclear innovation has the potential to power us to Mars and beyond, and Virginia's equipment and expertise can power that innovation.

Goals

- Support federal legislation promoting the advancement of nuclear energy and related technologies.
- Provide resources for obtaining grants or financing to enhance outside funding (federal or private) for advanced nuclear energy projects, manufacturing, fuel fabrication, nuclear medicine, integrated computational materials engineering for modeling and simulations, and other nuclear-related economic development initiatives.
- Promote new projects and innovations across the nuclear energy technology spectrum, including advanced manufacturing, fuel, aerospace, medicine, and defense micro reactors, to locate in Virginia.
- Encourage companies exploring advanced nuclear generation technologies, such as molten salt, high-temperature gas, and sodium fast reactor technologies to consider Virginia as a site for pilot projects.
- Analyze available site data of potential sites for new nuclear projects, especially small modular or other advanced reactors. Particular preference should be given to areas with workers who have been displaced from other energy jobs.
- Leverage resources (universities, existing businesses, and infrastructure) within the Commonwealth to encourage the development of new business opportunities.



Department of Energy Diagram of a Small Modular Reactor

Developing Infrastructure and Research & Development

Nuclear Technology is the *FUTURE*

Virginia is home to a world-class university system whose renowned research programs attract students from around the Commonwealth and around the world to complete their education in Virginia. As a global leader within the nuclear industry, Virginia is also home to companies developing the next generation of nuclear technologies, including new nuclear fuel technologies, next-generation nuclear projects, and even the nuclear technologies that have the potential to propel us to Mars.

Virginia's expertise, infrastructure, and physical/human resources can make it a global leader in nuclear technologies far into the future.

Goals

- Encourage coordination by the Commonwealth and federal officials advocating for more federal research investment in Virginia.
- Consider a public-private partnerships to establish an advanced technology project to study advanced electrical generation and energy storage technologies, including hydrogen production, and economics for meeting 24/7 the electrical demand while achieving the Commonwealth's carbon-free generation milestones.
- Encourage universities and companies to develop cooperative proposals for advanced nuclear prospects in the Commonwealth.
- Explore strategic opportunities for a new Virginia-based nuclear national lab or consolidation of select national lab functions in Virginia.



Continuing Development of the Nuclear Workforce and Educational Opportunity

Nuclear Technology is Opportunity

In 2018, the Virginia legislature passed legislation establishing the 17th Energy Career Cluster for the Commonwealth. Students now have the opportunity to learn about career opportunities in energy, and to focus their education on jobs that will meet the needs of the industry's growing workforce. We must continue to ensure today's education will meet the demands of tomorrow's nuclear energy workforce.

Goals

- Work with the K-12 system to include nuclear energy in Career & Technical Education (CTE) programs by supporting and promoting the newly implemented Energy Career Cluster and monitoring implementation of the 17th Cluster to ensure educational curriculum align with changes in workforce demands and next-generation nuclear jobs.
- Encourage early introduction in students' academic journeys of the career opportunities available in the energy sector.
- Encourage Virginia universities to establish full nuclear engineering programs (B.S. to PhD).
- Establish nuclear-specific workforce training and associate degree programs.
- Support University investment in advanced capabilities that meet industry educational and training needs.
- Encourage graduate education in nuclear related fields.
- Ensure students at all levels of education have opportunities to participate in big idea forums.
- Monitor the effectiveness of investment in the education and training of the energy workforce.
- Share employment opportunities in areas with workers who have been displaced from other energy jobs.
- Recognize more work must be done and take steps to foster an inclusive and diverse industry, and encourage participation in nuclear educational and professional opportunities for under-represented groups to grow and diversify the workforce.



Strategic Goals for 2020-2024

Goal: Carbon Roadmap

Developing a roadmap for deployment of economical and technically feasible electricity sources needed to meet actual electrical demand profiles and carbon-free energy plan targets.

Goal: Siting for Small Modular or other Advanced Reactor

Consider public-private partnerships for siting and construction of a small modular or other advanced reactor.

Goal: Workforce Development

To ensure that education and training programs are providing the necessary educational and work-based knowledge required to meet the demands of tomorrow's nuclear energy workforce .

Goal: Generation Targets

Establishing a nuclear energy generation target for nuclear energy if it is in the interest of the Commonwealth's long-term clean energy goal.

Goal: Promote Diversity & Inclusion

Promote diversity and inclusion in STEM Disciplines in order to shift patterns of representation – addressing ways to change the STEM culture to be more welcoming and inclusive of diverse cultures and backgrounds.

Key Strategies



Advanced Technologies

- Prioritizing advanced nuclear energy in electrical generation planning
- Building small modular or other advanced reactors in Virginia
- Reaching the Commonwealth's goal of 100% carbon-free energy
- Utilizing the core of a small modular or other advanced reactor as a test bed for advanced fuels and materials

Economic Development

- Promoting Virginia as an ideal market for new technology development and facilities
- Promoting existing Virginia Nuclear capabilities for export
- Utilizing Virginia's ports for export of small modular or other advanced reactors

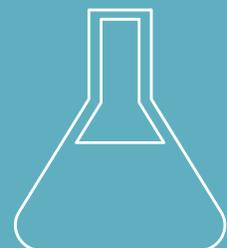


Education

- Promoting the Energy Career Cluster
- Supporting community colleges for workforce training and skilled labor
- Supporting universities for training of engineers and scientists who support the nuclear industry

Research & Development

- Promoting advanced technology research
- Developing a roadmap study for the commonwealth's carbon-free energy generation goal
- Partnering in acquiring Federal funding grants



**More than 50
companies are
developing
Advanced Nuclear
Reactors in the US
backed by \$1.3
billion in private
capital**

"The Advanced Nuclear Industry – Third Way." –
Third Way, www.thirdway.org/report/the-advanced-nuclear-industry.

**Commercial
nuclear energy
contributes more
than \$40
million/year per
plant to the US
labor market**

"Jobs." Nuclear Energy Institute, 30 Apr. 2020,
www.nei.org/advantages/jobs.

**Annual Federal
Investment in
Nuclear Energy
University
Programs = \$50+
million**

"Department of Energy Invests \$65 Million at
National Laboratories and American Universities
to Advance Nuclear Technology." Energy.gov,
www.energy.gov/articles/department-energy-invests-65-million-national-laboratories-and-american-universities.

**Global New Nuclear
Reactor Market
Growth = 15
GW/year through
2040 (IAEA
projection for
sustainable growth)**

iea. "Nuclear Power – Analysis." IEA, 1 June 2020,
www.iea.org/reports/nuclear-power.

**Projected Federal
Investment in
Advanced Nuclear
Technology in the
next 7 years = \$3.2
billion**

"U.S. Department of Energy Announces \$160
Million in First Awards under Advanced Reactor
Demonstration Program." Energy.gov,
www.energy.gov/ne/articles/us-department-energy-announces-160-million-first-awards-under-advanced-reactor.

**Federal Advanced
Reactor
Demonstration
Program = \$160
million/year**

"It's Time for the United States to Demonstrate
Advanced Reactors." Energy.gov,
www.energy.gov/ne/articles/it-s-time-united-states-demonstrate-advanced-reactors-0.

Acknowledgments

BWX Technologies, Inc.

Dominion Energy

Framatome Inc.

GE Hitachi

Lightbridge Corporation

Liberty University

University of Virginia

Virginia Commonwealth University

Virginia Tech

Jefferson Labs

Huntington Ingalls Industries

Virginia Nuclear Energy Consortium

Virginia Nuclear Energy Consortium Authority

Central Virginia Community College

George Washington University

ClearPath

Nuclear Energy Institute

Virginia Energy Workforce Consortium

Location of significant employers, facilities,
and institutions within the Commonwealth

