

VIRGINIA NUCLEAR ENERGY CONSORTIUM AUTHORITY

2016 Annual Report

Commonwealth of Virginia
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EXECUTIVE SUMMARY

Charge and Responsibilities

In 2013, the General Assembly created the Virginia Nuclear Energy Consortium Authority (the Authority) as a political subdivision of the Commonwealth for the purposes:

- Making Virginia a national and global leader in nuclear energy, science and technology;
- Serving as an interdisciplinary study, research and information resource for nuclear energy in Virginia; and
- Establishing the Virginia Nuclear Energy Consortium (the Consortium), a non-stock corporation responsibly for conducting activities to achieve these goals.

Enclosed is the Authority's 2016 Annual Report, which details its strategic plan, activities over the last year and recommendations to advance nuclear energy in Virginia.

Authority Activities

Since its establishment and organization on 2013, the Authority has worked diligently to:

- Set goals and define the responsibilities for the Authority and the Consortium;
- Recruit members to the Consortium, securing commitments from eight companies and higher education institutions;
- Produce an annual inventory of nuclear education and industry assets in Virginia, illustrating that the nuclear sector is driving Virginia's economy in every region, with high skilled jobs, research and technology development and generation of revenue at both the state and local level; and
- Provide technical support and policy recommendations to the development of the Virginia Energy Plan and its biennial status updates;
- Provide information and expertise to stakeholders, elected and non-elected officials, and policymakers at all levels of government.

Recommendations

The Authority offers the following recommendations to policy makers to support and advance nuclear energy in Virginia:

1. Recognize and support Authority efforts to establish the Commonwealth as a national and global leader in nuclear energy, science and technology and serve as an interdisciplinary study, research and information resource for the Commonwealth on nuclear energy issues.

2. Leverage Virginia international corporate outreach and intergovernmental efforts to support the Virginia-based nuclear design, repair and installation industries. Virginia is home to global leaders in the nuclear energy sector, such as AREVA Inc., BWX Technologies, Inc., Bechtel and Newport News Shipbuilding. In addition, dozens of other companies located all across Virginia provide services, supplies and support to nuclear facilities inside the Commonwealth and globally. The nuclear sector drives Virginia's economy in every region, creating highly skilled jobs, supporting research and generating revenues at the state and local level.
3. Virginia is home to two of only 31 nuclear engineering programs in the U.S. (Virginia Commonwealth University and Virginia Tech.) The Commonwealth should strengthen Virginia's existing nuclear science, engineering and research programs to provide the pipeline of highly educated and highly skilled workers necessary to continue creating high-paying jobs for Virginians and to sustain our nuclear industry for the long term.
4. The Authority supports the efforts of Governor Terry McAuliffe and his Administration and companies such as Dominion, AREVA Inc. and others to encourage the EPA to level the playing field and treat nuclear generation equitably to other non-emitting generation resources.
5. Virginia's current diverse energy generation portfolio is a significant component to our low, stable energy prices and reliable service. The Authority supports efforts to maintain a diverse energy generation mix to avoid over-reliance on any single source of energy.
6. Regulatory certainty is important given the long-lead decisions required for the continued safe and efficient operation of existing nuclear assets and the substantial capital commitments associated with constructing new nuclear units. Virginia's energy policy should view nuclear assets in light of their capacity to reliably deliver power and provide source diversity for an energy portfolio that achieves the emission reductions required by pending federal regulations.
7. Recognize and support nuclear energy issues and innovative nuclear technologies identified and pursued by the Virginia Nuclear Energy Consortium.
8. Encourage the Governor, Secretary of Natural Resources, Secretary of Commerce and Trade, Director of the Department of Environmental Quality, Director of the Department of Mines, Minerals and Energy and Deputy Attorney General for Commerce, Environment and Technology to consider the critical role nuclear energy can and should play in carrying out the carbon reduction goals established by

Executive Order 57.

9. Support legislation to clarify that expenses associated with re-licensing a nuclear powered electric generation unit should receive the same regulatory treatment and cost recovery as investments in new around-the-clock generation.

INTRODUCTION

Virginia is home to tremendous nuclear energy assets. The Commonwealth's commitment to reliable, clean, low-cost nuclear energy is a significant economic and workforce driver, promoting cutting-edge research and development; employing thousands of highly skilled, well-paid workers; and expanding higher education programs for a stronger future in every corner of Virginia.

To capitalize on these existing strengths, the General Assembly in 2013 created the Virginia Nuclear Energy Consortium Authority (Authority) as a political subdivision of the Commonwealth for the purpose of establishing Virginia as a national and global leader in nuclear energy and providing an interdisciplinary study, research and information resource for nuclear energy in Virginia. The Authority was also charged with establishing the Virginia Nuclear Energy Consortium (Consortium), a non-stock corporation responsible for collaborative activities in pursuit of these goals.

As required by Code of Virginia § 67-1403, the Authority submits this 2016 annual report including its strategic plan, a summary of its activities and recommendations for the support and expansion of the nuclear energy industry in Virginia, to the Governor and the Chairmen of the House Appropriations Committee, the Senate Finance Committee and the House and Senate Commerce and Labor Committees.

Since its creation in 2013, the Authority has worked diligently to 1) Set goals and define the responsibilities for the Authority and the Consortium; 2) Recruit members to the Consortium, securing commitments from eight companies and higher education institutions; 3) Produce an annual inventory of nuclear education and industry assets in Virginia; 4) Provide technical support and policy recommendations to the development of the Virginia Energy Plan and its biennial status update; 5) Provide information and expertise to stakeholders, elected and non-elected officials, and policymakers at all levels of government.

This report and related appendices provide details of the Authority's strategic goals and priorities, activities, resources, and recommendations to advance nuclear energy in Virginia.

STRATEGIC PLAN AND PRIORITIES

The Authority's mission is to establish the Commonwealth as a national and global leader in nuclear energy; to serve as an interdisciplinary study, research, and information resource for the Commonwealth on nuclear energy, science and technology issues; and to establish the Consortium to facilitate private sector activities and partnerships with our higher education institution to advance these goals. In developing its strategic plan, the Authority evaluated and allocated responsibilities and priorities to either the Authority or the Consortium, as appropriate.

Responsibilities

The Authority is the public body responsible for communicating with the state government, the Governor's Office, and the General Assembly; providing direction for the Consortium; and receiving reports from the Consortium. The Consortium is a non-profit entity for responding to commercial, research and education needs and interests of the industry. It is overseen and directed by the Authority and is the entity that conducts day-to-day activities to promote and advance Virginia's nuclear industry.

The statute passed by the General Assembly enumerated various charges for the Authority and the Consortium. The Authority assigned the following responsibilities to the Consortium:

1. Promote and facilitate agreements among public and private institutions of higher education in the Commonwealth and other research entities to carry out research projects relating to nuclear energy, science and technology;
2. Identify and support, in cooperation with Virginia's nuclear entities and the public and private sectors, the development of education programs related to Virginia's nuclear industry;
3. Develop a policy regarding any interest in intellectual property that may be acquired or developed by the Consortium;
4. Facilitate the collaboration of members toward the attainment of grants and the expenditure of funds;
5. Encourage, facilitate, and support the application, commercialization, and transfer of new nuclear technologies;
6. Provide advice, assistance, and services to institutions of higher education and to other persons providing services or facilities for nuclear research or graduate education; and
7. Foster innovative partnerships and relationships among the Commonwealth, the Commonwealth's public institutions of higher education, private companies, federal laboratories, and not-for-profit organizations to accomplish the purposes set out by this chapter.

The Authority retained the following responsibilities:

1. Develop and adopt a strategic plan;
2. Provide for the establishment of the Consortium; and
3. Provide public information and communication about nuclear energy and related educational and job opportunities.
4. Develop and Maintain an inventory of Nuclear Assets Justifying Position of Leadership
 - a. Workforce
 - b. Private Entities
 - c. Research and Federal Labs
 - d. Public Universities and Educational Programs
5. Serve as an Expert voice for Government
 - a. Notification of Congressional Delegation of Board and Resources
 - b. An information resource for policy makers at all levels

The statute also provides for communication of nuclear-related information and research results. The Authority believes that the two organizations should share this responsibility.

Goals and Priorities

The Authority has identified as priorities several specific goals for their 2017 activities:

1. Reevaluate and refine the VNECA strategic plan to better reflect the current climate of the nuclear industry (at the state, national and international levels) as well as Authority priorities.
2. Expand existing coordination and identify new chances for collaboration and support between VNECA and VNEC
 - a. Collaborate with VNEC to prepare and publish a more detailed, more thorough analysis of Virginia's nuclear economy and job statistics.
3. Support efforts to retain existing nuclear assets and investments in Virginia
 - a. Support positive regulatory climate to preserve existing assets
 - b. Support public policy initiatives to enable investments needed to preserve existing nuclear assets
 - c. Help document and disseminate findings related to the economic benefits of existing nuclear assets and continued investments in such assets
4. Provide technical expertise and promote greater awareness amongst policymakers of the role nuclear energy can play in the commonwealths environmental and energy initiatives.

AUTHORITY ACTIVITIES

Asset Inventory

To better understand and communicate the significant impact of the nuclear industry on Virginia's economy and workforce, the Authority conducted an inventory of nuclear assets in Virginia including private industry, utilities, educational institutions, and federal research laboratories.

The key findings from the asset survey are highlighted by the following summary. The full database of nuclear energy assets, including company employment and annual revenue figures, can be found in [Appendix A](#).

The Critical Role of Nuclear Energy in Virginia's Economy

Nuclear power supplies 35 - 40% of the electricity used in Virginia. Operating at more than 95% capacity, nuclear generation provides reliable, inexpensive electricity to Virginia consumers and helps keep our energy costs low, making Virginia a competitive location for existing and new business. But that's only the beginning of the story of nuclear energy in Virginia's economy. A recent preliminary economic asset survey, produced by the Authority, reveals:

- The nuclear energy sector is driving Virginia's economy in every region, offering highly skilled jobs, supporting research and technology advancement and generating revenues at the state and local level.
- Dominion operates four nuclear units in Virginia: two at the North Anna Power Station in Louisa County, and two at Surry Power Station in Surry County. In addition to their substantial contribution to Virginia's energy mix, these four units collectively employ more than 2,000 professionals at an average salary of more than \$80,000 per year. These four units supply the majority of Virginia's carbon free electricity and are substantial economic drivers for their host regions.
- Virginia is home to facilities and operations of half a dozen global leaders in the nuclear energy sector. They include AREVA Inc., BWX Technologies, Inc., and NovaTech (Lynchburg), Bechtel (Reston), Dominion (North Anna and Surry) and Newport News Shipbuilding (Newport News).
- Three major federal facilities located in Virginia – NASA Langley, Jefferson Lab and the Norfolk Naval Shipyard – are active in research, development and the use of nuclear technology. Between the Naval Shipyard and Newport News Shipbuilding, the nation's nuclear-powered Navy has its home in Virginia.

- Dozens of other companies, located all across Virginia, provide services, supplies and support to these major Virginia facilities. Testing services, materials and supplies, security, engineering services and much more are provided to the industry by Virginia businesses
- These companies operate and employ Virginians in towns as diverse as Abingdon, Alexandria, Arlington, Ashland, Chantilly, Charlottesville, Chester, Colonial Beach, Fairfax, Goochland, Hampton, Lynchburg, McLean, Mechanicsville, Roanoke and Virginia Beach to name but a few.
- Because many of these Virginia businesses have operations around the country and the world, it is difficult to determine total jobs and revenue numbers for Virginia alone, but it is likely the number exceeds 100,000 jobs across the Commonwealth and tens of billions of dollars that are tied directly to the nuclear energy sector. These generate substantial state and local tax dollars.
- Virginia Tech, Virginia Commonwealth University, the University of Virginia and Old Dominion University have established degree programs and research relationships to train the next generation of expertise and leadership needed to support the nuclear energy sector in the U.S. and around the world.
- The universities, labs and industrial base in Virginia are involved in cutting-edge, nuclear-related research and development that will drive the Virginia nuclear economy of the future.

Additionally, the Authority performed a survey of nuclear engineering degrees, programs and related fields of study at Virginia public and private universities ([Appendix B](#)). In addition to the established degree programs at Virginia Tech, VCU, UVA and Old Dominion, many institutions, such as Virginia Military Institute and Central Virginia Community College, offer numerous nuclear energy, nuclear medicine and other related programs, degrees and research.

Executive Order 57

On June 28, 2016, Governor McAuliffe issued Executive Order 57 directing Virginia Secretary of Natural Resources Molly Ward to convene a workgroup and recommend concrete steps to reduce carbon pollution from Virginia's power plants. The group, comprised of the Secretary of Natural Resources, the Secretary of Commerce and Trade, the Director of the Department of Environmental Quality, the Director of the Department of Mines, Minerals and Energy, and the Deputy Attorney General for Commerce, Environment and Technology, has been tasked with evaluating options to address carbon pollution.

Recognizing the important and necessary role that nuclear energy has in powering the Commonwealth and reducing carbon emissions, the Authority agreed to present to this working group. The Authority plans to present their recommendations in late 2016 or early 2017 and highlight the positive impacts nuclear energy has and will continue to have on pollution reduction, grid stability, electric rates, and job creation.

57 Executive Order can be found in full in [Appendix C](#).

Deputy Vice Chairmen for Specific Issues

Given the broad array of topics, technologies, and issues that exist within nuclear energy, in 2016 the Board established a system of Deputy Vice Chairmen for the Authority – issue-based chairs that would focus on a particular area of nuclear energy and report back to the Board. This allows for greater concentration on particular issue areas from Board Members most knowledgeable and passionate about them without overstressing the Authority at large. These chairs enjoy the full support of the Authority in pursuing these particular issue areas through research, conference participation, and other similar activities.

At the August 25, 2016 meeting of the Authority, Ganapati Myneni was formally named Deputy Vice Chairman for Accelerator-Driven and Molten Salt Designs.

Conferences and Symposiums

In 2016, the Authority continued to strategically interface with a number of national nuclear science and technology organizations in order to ensure that the Commonwealth remains a national leader in nuclear energy. These organizations include, but are not limited to: the American Nuclear Society (ANS); the ANS Special Committee on Nuclear in the States; the Nuclear Energy Institute (NEI); the Electric Power Research Institute (EPRI); the United States Nuclear Infrastructure Council (NIC); and the National Energy Agency (NEA).

Additionally, Authority members were extremely active across the state and country, presenting on a wide variety of topics pertaining to the nuclear industry in Virginia. These engagements include presentations by Donald Hoffman at the Virginia Nuclear Energy Summit in Richmond, VA; David Christian at Senator Mark Warner’s Virginia Energy Policy Forum in Hampton, VA; Ganapati Myneni at the International High-Level Radioactive Waste Management Conference in Charlotte, NC; and many more.

2016 also saw Virginia maintain its status as an international leader in nuclear energy as well. In September, the Virginia Accelerator-Driven Systems (ADS) Consortium hosted the 4th International Workshop on Accelerator-Driven Systems and Thorium Utilization. The Virginia ADS Consortium plans to host the 5th International Workshop in in Virginia in October of 2018.

AUTHORITY ADMINISTRATION

Virginia Nuclear Energy Consortium Authority Administration

The Virginia Nuclear Energy Consortium Authority Board elected the following slate of officers to lead the Board for 2016:

Chairman – Donald Hoffman
Vice Chairman – Gary Tepper
Treasurer – Mary Alice Hayward
Secretary – Bob Bailey

Deputy Vice Chairmen for Specific Issues:

Deputy Vice Chairman for Accelerator-Driven and Molten Salt Designs – Ganapati Myneni

The full list of Authority Board Members is included in [Appendix G](#).

Additionally, the Authority maintains a webpage on the Secretary of Commerce and Trade's website that serves as an information resource for nuclear energy in Virginia and the activities of the Authority. Authority Website - <https://commerce.virginia.gov/initiatives/va-nuclear>

VIRGINIA NUCLEAR ENERGY CONSORTIUM UPDATE

The Virginia Nuclear Energy Consortium (VNEC or the Consortium) was formally launched in 2015 and now has been in operation for over a year.

Membership:

All eight Founding Members of the Consortium renewed their memberships and served on the VNEC Board in 2016. These members are:

AREVA, Inc.
BWX Technologies, Inc. (BWXT)
Dominion Resources Services
GE Hitachi Nuclear Energy
Newport News Shipbuilding
University of Virginia (UVA)
Virginia Commonwealth University (VCU)
Virginia Polytechnic Institute and State University (Virginia Tech)

Officers:

Chairman – Sama Bilbao Y Leon (Virginia Commonwealth University)
Vice Chairman – Alireza Haghighat (Virginia Tech)
Treasurer – William A. Fox (BWXT)
Secretary – Tom Deonty (AREVA, Inc.)

Activities and Accomplishments:

In 2016, VNEC continued their efforts to support continued and expanded research at the Center for Advanced Engineering's (CAER) Integrated System Test Center (IST). This work entailed a number of activities:

- Developed and executed an advocacy strategy resulting in financial backing in the Commonwealth of Virginia's 2017 Budget;
- Signed a Memorandum of Understanding with CAER promoting joint efforts to bring more nuclear research funding into Virginia and create more nuclear workforce opportunities;
- Helped promote and market the facility and its capabilities to the Department of Energy, Nuclear Regulatory Commission, national labs, and other interested parties, companies, and organizations.

VNEC also worked throughout the year to strengthen and build upon Virginia's nuclear research network.

- Worked with Virginia’s various nuclear engineering programs to help awareness and recognition of their research assets and capabilities and promote them to potential funding agencies, such as the DOE, NRC, NNSA, DHS, DOD, and NASA, as well as Virginia’s nuclear research, industry, and utility stakeholders;
- Worked with Virginia legislators and officials to help them develop awareness and recognition of the research assets and capabilities of Virginia’s nuclear engineering programs;
- Supported the coordination and joint development of novel nuclear reactor concepts indigenous to Virginia with the goal of eventually deploying these unique facilities in the Commonwealth and making Virginia the true innovation center of the world for future nuclear designs.

As identified in 2015, VNEC continued to focus on and prioritize workforce development. In furtherance of this goal, VNEC conducted a number of activities:

- Advocated for the Development of an official Energy Workforce Cluster to become Virginia’s 17th Career Cluster;
- Advocated for the expansion of nuclear energy training programs and certificate programs statewide through strategic partnerships with Virginia’s Community College System;
- Communicated state nuclear workforce needs and recommendations to state government and legislative officials as well as Virginia’s congressional delegation;
- Coordinated advocacy efforts with the Virginia Energy Workforce Consortium (VEWC), International Brotherhood of Electrical Workers (IBEW) and others;
- Planned for a 2017 Nuclear Energy Career Day for high school, community college, and university students and faculty;
- Developed a nuclear energy job postings board through the VNEC website.

Beyond VNEC’s emphasis on workforce development needs and goals, the Consortium also embraced a public policy advocacy role on a number of other relevant nuclear energy topics, working with legislators and other government officials at the local, regional, state and federal levels of government. Through coordination of the government affairs offices of VNEC member organizations, the Consortium focused on raising awareness on topics such as the potential impact of nuclear plant closures, the role nuclear generation can play in meeting clean air goals, the importance of extending the operating licenses for Virginia’s nuclear plants, and more.

While advocacy work comprised the nearly the majority of VNEC’s activities and focus this year, the Consortium also hosted the first Virginia Nuclear Energy Summit in Richmond, VA in June 2016. The conference, held in partnership with the Nuclear Energy Institute (NEI), welcomed nearly 100 attendees from government, industry, labor and academia and

included a variety of engaging panels and presentations, including a keynote address from Virginia's Secretary of Commerce and Trade, Maurice Jones.

Finally, VNEC continued to embrace its role as a key voice for the Commonwealth's nuclear industry through engagements with various Virginia publications, participation in and support of a variety of energy conferences, and public support of numerous grants through Virginia's education institutions.

RECOMMENDATIONS

The Virginia Nuclear Energy Consortium Authority (Authority) offers the following recommendations to policy makers to advance nuclear energy in Virginia.

1. Recognize and support Authority efforts to establish the Commonwealth as a national and global leader in nuclear energy, science and technology and serve as an interdisciplinary study, research and information resource for the Commonwealth on nuclear energy issues.
2. Leverage Virginia international corporate outreach and intergovernmental efforts to support the Virginia-based nuclear design, repair and installation industries. Virginia is home to global leaders in the nuclear energy sector, such as AREVA Inc., BWX Technologies, Inc., Bechtel and Newport News Shipbuilding. In addition, dozens of other companies located all across Virginia provide services, supplies and support to nuclear facilities inside the Commonwealth and globally. The nuclear sector drives Virginia's economy in every region, creating highly skilled jobs, supporting research and generating revenues at the state and local level.
3. Virginia is home to two of only 31 nuclear engineering programs in the U.S. (Virginia Commonwealth University and Virginia Tech.) The Commonwealth should strengthen Virginia's existing nuclear science, engineering and research programs to provide the pipeline of highly educated and highly skilled workers necessary to continue creating high-paying jobs for Virginians and to sustain our nuclear industry for the long term.
4. The Authority supports the efforts of Governor Terry McAuliffe and his Administration and companies such as Dominion, AREVA Inc. and others to encourage the EPA to level the playing field and treat nuclear generation equitably to other non-emitting generation resources.
5. Virginia's current diverse energy generation portfolio is a significant component to our low, stable energy prices and reliable service. The Authority supports efforts to maintain a diverse energy generation mix to avoid over-reliance on any single source of energy.
6. Regulatory certainty is important given the long-lead decisions required for the continued safe and efficient operation of existing nuclear assets and the substantial capital commitments associated with constructing new nuclear units. Virginia's energy policy should view nuclear assets in light of their capacity to reliably deliver power and provide source diversity for an energy portfolio that achieves the emission reductions required by pending federal regulations.








7. Recognize and support nuclear energy issues and innovative nuclear technologies identified and pursued by the Virginia Nuclear Energy Consortium.
8. Encourage the Governor, Secretary of Natural Resources, Secretary of Commerce and Trade, Director of the Department of Environmental Quality, Director of the Department of Mines, Minerals and Energy and Deputy Attorney General for Commerce, Environment and Technology to consider the critical role nuclear energy can and should play in carrying out the carbon reduction goals established by Executive Order 57.
9. Support legislation to clarify that expenses associated with re-licensing a nuclear powered electric generation unit should receive the same regulatory treatment and cost recovery as investments in new around-the-clock generation.

Appendix A:

Virginia Nuclear Energy Asset Inventory



Nuclear in Virginia - Educational Institutions

[Link to Google Maps Database \(Best with Chrome or Firefox\)](#)

Entity	Logo	Nature of Activity	Applicable Program(s)	Leadership	Virginia Presence	Founded	Revenue/ Funding, \$IM	Employees	Website
Virginia Polytechnic Institute and State University		Public University, Research Institution	Nuclear Engineering Program (Ph.D., MS,ME)	Dr. Timothy D. Sands, President	Blacksburg, VA, 24061-0002	1872	1,284.3 budget (FY13)	7,263	www.vt.edu
University of Virginia		Public Research University, Health System	Physics (Ph.D, MS, MA, MAPE, BS, BA), Division of Nuclear Medicine	Teresa A. Sullivan, President	Charlottesville, VA 22904-4203	1819	1,410 (academic division, FY13-14)	8,311	www.virginia.edu
Virginia Commonwealth University		Public Research University, Health System	Nuclear Engineering Concentration (B.S), Nuclear Engineering (M.S., Ph.D.), Department of Radiation Sciences	Michael Rao, President	821 West Franklin St, Richmond, VA, 23284	1838	967.4 budget (FY13-14)	20,241 (incl. medical center)	www.vcu.edu
Liberty		Private University	Mechanical Engineering (B.S.)	Jerry Falwell, Jr.	1971 University Blvd, Lynchburg, VA, 24515	1971		~2,500 faculty	www.liberty.edu
Christopher Newport University		Public Liberal Arts University	Applied Physics (B.S.), Computational and Applied Mathematics (B.S)	Paul S. Triple Jr, President	Christopher Newport University, 1 Avenue of the Arts, Newport News, VA 23606	1961	166.5 (total revenue FY12)	~400 faculty	www.cnu.edu
Virginia Community College System		Community College Network	Engineering (AS), Engineering Technology (ASS)	Glenn DuBois, Chancellor	101 N. 14th Street, 15th Floor, Richmond, VA, 23219	1966	1,276 (total revenue FY13)	11,000+ total faculty	www.vccs.edu
George Mason University		Public University	Systems Engineering (B.S.), Applied and Engineering Physics (M.S.)	Ángel Cabrera, President	4400 University Dr, Fairfax, VA 22030	1957	911 budget (FY14)	1,801 (includes part-time FTE)	www.gmu.edu



Nuclear in Virginia - Federal Research Labs

[Link to Google Maps Database \(Best with Chrome or Firefox\)](#)

Entity	Logo	Nature of Activity	Leadership	Virginia Presence	Founded	Revenue/ Funding, \$IM	Employees	Website
Thomas Jefferson National Accelerator Facility		Nuclear Physics Research	Hugh E. Montgomery, Director	12000 Jefferson Ave, Newport News, VA 23606	1984	133.9 (FY13)	700	www.jlab.org/
US Navy (Norfolk Naval Shipyard)		Manufacturing, R&D, and support for US Navy	Capt. Mark Bridenstine, Commander	Norfolk Naval Shipyard, Portsmouth, VA, 23709	1767	1,016 (FY11-12)		www.navsea.navy.mil/shipyards/norfolk/








Nuclear in Virginia

[Link to Google Maps Database \(Best with Chrome or Firefox\)](#)












Entity	Logo	Nature of Activity	Leadership	Virginia Presence	Founded	Revenue/ Funding, \$1M	Employees	Website
Dominion Resources		Power Generation, Transmission, Distribution	Thomas F. Farrell II	One James River Plaza (OJRP), 701 East Cary Street, Richmond, VA, 23219	1983	13,120 (FY13)	14,500 (total)	www.dom.com
Old Dominion Electric Cooperative		Electricity Provider	Jackson Reasor, President and CEO	4201 Dominion Blvd, Glen Allen, VA, 23060	1948	842.1 (FY13)	~100	www.odec.com/












Nuclear in Virginia - Private Industry

[Link to Google Maps Database \(Best with Chrome or Firefox\)](#)

Entity	Logo	Nature of Activity	Leadership	Virginia Presence	Founded	Revenue/ Funding, \$/M	Employees	Website
Huntington Ingalls		Shipbuilding, Nuclear Operations, Engineering Services	Mike Petters, President and CEO	4101 Washington Ave., Newport News, VA, 23607	2008	6,800 (FY13)	39,000+ (total)	www.huntingtoningalls.com
AREVA Inc		Nuclear Fuel Cycle Products, Services, Testing, Support	Gary Mignogna, CEO	Multiple sites in Lynchburg, VA	2001	~1.1	1400	www.us.areva.com/
Mitsubishi Nuclear Energy Systems		Vendor, Nuclear Services	Makoto Toyama, President and CEO	1001 19th St N #2000, Arlington, VA	2006		200+ (site-specific)	www.mnes-us.com/
BWX Technologies, Inc.		Design, Engineering, Manufacturing, Site Operations, Technical Services	John A. Fees, Executive Chairman; Peyton S. Baker, President and	800 Main Street, Lynchburg, VA 24504		~1,400	~5,200	www.bwxt.com
Bechtel		Engineering, Construction	Riley Bechtel, Chairman	12011 Sunset Hills Rd, Reston, VA, 20190	1898	37,900 (FY12)	53,000+ (total)	www.bechtel.com/
Excel Services Corporation		Consulting, Technical Services	Donald R. Hoffman, President and CEO	8000 Towers Crescent Drive, Suite 1350, Vienna, VA 22182	1985			www.excel-services.com/
Aerofin		Heat transfer applications supplier	David Corell, President	4621 Murry Place, P.O. Box 10819, Lynchburg, VA, 24502	1923			www.aerofin.com

Nuclear in Virginia - Private Industry

F.N. Anderson & Associates		Floyd N. Anderson, President	87 Braxton Lane, Forest, VA, 24551	1993	~4	www.fnaai.com
Ares Security Corporation		Ben Eazzetta, President	8045 Leesburg Pike, Suite 400, Tysons Corner VA 22182	2012	850+ (incl. ARES Holding)	www.aressecuritycorp.com
Bauer Compressors, Inc.		Tony Bayat, President	1328 Azalea Garden Rd, Norfolk, VA 23502	1946		www.bauecomp.com
Chemetrics, Inc.		Bruce H. Rampy, President	4295 Catlett Rd, Midland, VA, 22728	1969	55+	www.chemetrics.com
Coastal Network of Virginia, LLC			600 Plantation Ct, Charlottesville, VA, 22903	1987	5	www.nuclearsupply.com
Communications-Applied Technology		Seth Leyman, President and Founder	11250-14 Roger Bacon Drive, Reston, VA, 20190	1982	~15	www.c-at.com
Donley Technology		Elizabeth M. Donley, Founder and Executive Director	P.O. Box 152, Colonial Beach, VA, 22443	1988		www.donleytech.com
Electric Motor and Contracting Company, Inc.		James L. King, President Margareta Ludde mann, CEO	3703 Cook Blvd, Chesapeake, VA, 23323	1960	~200	www.emc-co.com
Interdevelopment, Inc.			P.O. Box 15249, Arlington, VA, 22215	1967	~10	www.interdevelopment.com
KSB, Inc.		Ed Harvie, President (KSB USA)	4415 Sarellen Rd, Henrico, VA, 23231		~3,125	www.ksb.com
Innovative Technologies International, Inc. (NovaTech)		Hawk Rochow, President/COB	220 Jefferson Ridge Parkway, Lynchburg, VA 24501	1994	16,500+ (global)	www.novatechusa.com

Nuclear in Virginia - Private Industry						
Mega-Tech Services, LLC		Tooling, Engineering Consulting	Deanna R. Bowen, President	11118 Manor View Drive, Mechanicsville, VA, 23116	1964	www.mech-techservices.biz
MPR Associates, Inc.		Engineering and Management Services	Bob Coward, Principle Officer	320 King St, Alexandria, VA, 22314	1964	www.mpr.com
Proxtronics, Dosimetry LLC		Dosimetry Services	W. Guy Davis, President and CEO	85 S. Bragg St, Suite 400, Alexandria, VA, 22312	1990	www.proxtronicsdosimetry.com
Radium, Inc.		Steam Generator Services, Products	Cam Abernethy, President and Owner	463 Dinwiddie Ave, Waynesboro, VA, 22980	2004	www.radiuminc.com
River Technologies, LLC		Radiological Decontamination	Robert Kozma, COO	2107 Graves Mill Rd, Suite A, Forest, VA, 24551	2003	www.rivertechtechnologies.biz
Robatel Technologies, LLC		Engineering Services	Teo Grochowski, CEO	5115 Bernard Drive, Suite 304, Roanoke, VA, 24018	2009 (US subsidiary)	www.robateletech.com
TeamBest		Radiation Protection, Cancer Treatment	Krishnan Suthanthiran, President and Founder	7643 Fullerton Rd, Springfield, VA 22153	1977	www.teambest.com
Applied Technical Services		Nondestructive Testing	Jim Hills, President	2312 Commerce Center Drive, Suite A, Rockville, VA 23146; 5566 General Washington Drive, Alexandria, VA, 22312; 1325-B Cavalier Blvd, Chesapeake, VA	1967	www.atslab.com
Fuji Electric America		Power Electronics Technology	Michihiro Kitazawa, President and Chairman (Fuji Global)	5115 Bernard Drive, Suite 102, Roanoke, VA, 24018 (Drives and Inverters Dept.)	1923	www.fujielectric.com
JGW Group		Business Development, Training, Consulting	Andrew Wilson, President	1801 Robert Fulton Drive, Suite 400, Reston, VA, 20191	1980	www.jgwgroup.com
Honeywell (Uvex Safety Frames)		Safety Products, Eye + Face Protection	David M. Cote, Chairman and CEO	690 HP Way, Chester, VA, 23836	1906	www.honeywellsafety.com

Nuclear in Virginia - Private Industry

Action Technology, Inc.		Staffing, Consulting, Training	Bonnie Lonon, President and CEO	3121 E. Boundary Ct., Midlothian, VA, 23112	1982	24	~250	www.action-tech.com
American Operations Corp.		Analysis, Consultancy, Specialist Services	L. Frank 'Smokey' Field, Chairman and CEO	14030 Thunderbolt Place, Suite 700, Chantilly, VA, 20151	1983		~200	www.aocwins.com
Beta Analytics International, Inc.		Access Control, Security, Fire Protection	Darden Hood, President	2677 Prosperity Avenue, Suite 400, Fairfax, VA, 22031	1979		~300	www.radiocarbon.com
Boh Environmental, LLC		Container Systems	Eric Hediger, President	14520 Avion Pkwy, Chantilly, VA 20151	1998		~15	www.bohfupsystems.com
Calliper Inc.		Staffing and Recruitment	Robert Y. Green, Jr, President and CEO	512 Central Drive, Virginia Beach, VA, 23454; 4907 Fitzhugh Ave, Suite 201, Richmond, VA, 23230; 11325 Random Hills Rd, Suite 360, Fairfax, VA, 22030	1984			www.calliper.net
CraneTech Solutions CTS		Cranes & Lifting Equipment	Frank Hegan, President	2030 Ponderosa St, Portsmouth, VA, 23701	1958			www.ct-sol.com
Abbitz Measurement, Inc.		Pressure Systems Instrumentation	Tammy Nicoll, President	1619D Diamond Springs Rd, Virginia Beach, VA, 23455	2009		~10-20	www.abbitz.com
Dominion Engineering, Inc.		Technical Consulting Services	Robert D. Varrin, JR, Ph.D, Principle Officer	12100 Sunrise Valley Drive, Suite 220, Reston, VA, 20191	1980		<50	www.domeneng.com
Invensys Eurotherm		I&C sales, support, repair	Mike Callie, President and CEO (Invensys)	44621 Guilford Drive, Ashburn, Virginia, 20147	1952			www.eurotherm.com
Flowserve		Pumps, Valves, Tubing	Mark A. Blinn, President and CEO	5114 Woodall Rd, Lynchburg, VA 24502	1997	4,954 (FY13)	15,000+	www.flowserve.com
Lightbridge		Fuel Cycle Consulting and Design	Seth Grae, President and CEO	1600 Tysons Blvd, Suite 550, Tysons Corner, VA, 22102	1992			www.ltbriidge.com
Thermal Spray Solutions		Thermal Spray Coatings		1105 International Plaza, Suite B, Chesapeake, VA, 23323				www.thermal-sprayusa.com
ABZ, Inc.		Fluid Flow Consulting	Ed Abbott, President	4451 Brookfield Corporate Drive, Suite 101, Chantilly, VA, 20151	1986		~10	www.abzinc.com

Nuclear in Virginia - Private Industry






Advex Corporation		Machining and Fabrication	George Hill Jr, President	121 Floyd Thompson Drive, Hampton, VA, 23666	1969	180	www.affordablefast.com
Affordable Fastener Supply Company		Hardware Supply	Carl Grunthamer, President and CEO	312-G Old York Hampton Highway, Yorktown, Virginia, 23692	2005		
Air Systems, Inc.		Filtration, Air Systems	David Angelico, President	821 Juniper Crescent, Chesapeake, VA, 23320		42	www.airsyste.ms.cc
Axiom Quality Assurance		Consulting and Analysis		P.O. Box 328, McLean, VA, 22101			www.axiomqa.com
CBG, LLC		Metal Disintegration & Stud Removal	Ken Guthrie, Owner	4013 Seaboard Court, Suite A-3, Portsmouth, VA, 23701	2002		www.cbgmaintenance.com
CMC Technical		Staffing and Recruitment		502 Viking Drive, #102, Virginia Beach, VA, 23452	1978		www.cmc-jobs.com
Eddy Current Technology, Inc.		Eddy Current Testing		201A Horace Ave, Virginia Beach, VA, 23462			www.eddy-current.com
Finite Matters, Ltd.		Management Solutions, Consulting, Software	Anthony Luca, Owner	3064 River Road West, Suite B, Goochland, VA, 23063	1991	<10	www.fml.com
ICF International, Inc.		IT Services, Research, and Consulting	Sudhakar Kesavan, Chairman and CEO	9300 Lee Hwy, Fairfax, VA, 22031	1969	4,500+	www.ifi.com
ITC Learning		Industrial Skills Training	Gloria MacCorkindale, Vice President	13515 Dulles Technology Drive, Herndon, VA, 22171		~40	www.itclearning.com
Limitorque Corp. (subsidiary of Flowserve)		Actuators	Mark A. Blinn, President and CEO (Flowserve)	5114 Woodall Rd, Lynchburg, VA 24502	1929 (Limitorque)	15,000+ (Flowserve)	www.flowserve.com/Limitorque
Nuclear Energy Support International, LLC		Staffing and Recruitment	Mary Ann Snyder, Owner	209 58th Street, Suite B, Virginia Beach, VA, 23451	1983		www.nesillc.com

Nuclear in Virginia - Private Industry

OFI Custom Metal Fabrication		Safety Related Fabrication	Jim Clifford, President	10412 Design Road, Ashland, VA, 23005	1982	www.osfi.com
AMEC		Engineering, Project Management, Consulting	Samir Brikho, CEO	14424 Albemarle Point Place, Suite 115, Chantilly, VA, 20151; 1070 West Main St, Suite 5, Abingdon, VA, 24210; 2028 Dabney Rd, Suite E-18, Richmond, VA, 23230; One Colubums Center, Suite 600, Virginia Beach, VA, 23642	1982	www.amec.com
DynCorp International		Security Training and Consulting	Steven F. Gaffney, Chairman and CEO	1700 Old Meadow Road, McLean, VA 22102	1946	www.intellpros.com
Radiological Training Services, LLC		Radiological Training	John Duley, Producer	6538 Koziara Drive Burke, VA, 22015	1999	www.radiationvideos.com/abou.html
SC&A, Inc.		Environmental and Energy Consulting	Gregory P. Beronja, President and CEO	1608 Spring Hill Road, Vienna, VA, 22182	1981	www.scainc.com
Seaward Marine Services		Cleaning and Inspection	Edward A. Wardwell, Founder	5409 Beamon Road Norfolk, VA 23513 United States	1972	www.seaward-marine.com
TalentHunter		Recruitment and Staffing	Al Visco, Vice President	PO Box 275, Ashburn, VA, 20146	1982	www.talenthunter.com
Weidmuller Inc.		IT Products and Services	Brian Schofner, President	821 Southlake Blvd., Richmond, VA, 23235	1850	www.weidmuller.com

Nuclear in Virginia - Other

[Link to Google Maps Database \(Best with Chrome or Firefox\)](#)

Entity	Logo	Nature of Activity	Leadership	Virginia Presence	Founded	Revenue/ Funding, \$1M	Employees	Website
American Nuclear Society		Not-for-profit, International, Scientific and Educational Organization	Donald R. Hoffman, President	555 North Kensington Avenue, La Grange Park, Illinois, 60526	1954		11,000 members	www.ans.org
Department of Mines, Minerals, and Energy		Governmental research and regulatory body	John Warren, Director	Washington Building, 8th Floor, 1100 Bank St, Richmond, VA, 23219				www.dmme.virginia.gov
Virginia Economic Development Partnership		State Authority for business advocacy, development, and support	Don Seale, Chairman of the Board	P.O. Box 798, 901 East Byrd Street, Richmond, VA, 23218	1995	17.8 (State General fund, FY2014)	~100	www.yesvirginia.org
Center Advanced Engineering and Research		Non-profit educational and research corporation	Board of Directors; Bob Bailey, Executive Director	1173 Research Way, Forest, VA 2455	2006		3	www.caer.us
International Critical Infrastructure Security Institute		Non-profit membership organization with a focus on cyber security technology training and deployment	Board of Directors; Bob Bailey, Interim Director	1173 Research Way, Forest, VA 24551	2014			www.icisi.org

Appendix B:

Nuclear Engineering Schools and Programs

Nuclear Engineering and Related Fields of Study in VA Higher Education

Various Virginia universities have programs aimed at addressing needs in nuclear energy or related fields. There are two programs that have received State Council of Higher Education for Virginia (SCHEV) approval for offering nuclear engineering related degrees. Virginia Commonwealth University (VCU) offers MS and PhD hybrid degrees in Mechanical and Nuclear Engineering. Virginia Tech offers MS, MEng, and PhD degrees in Nuclear Engineering. A more complete listing of nuclear-related degrees follows.

Virginia's Public Universities and Educational Program in Nuclear-Related Fields of Study

Degree Inventory at Virginia's Colleges and Universities in Nuclear-Related Fields of Study:

Institution	Degree	Program Area
VCU	BS	Mechanical Engineering with a Nuclear Engineering Concentration
VCU	MS	Mechanical and Nuclear Engineering
VCU	PhD	Mechanical and Nuclear Engineering
VCU	BS	Nuclear Medicine Technology (Clinical Radiation Sciences)
VCU	MS	Medical Physics
VCU	PhD	Medical Physics
VCU	BS	Radiation Science
VCU	PhD	Radiation Science
VCU	BS	Radiation Therapy
VCU	BS	Radiography
Virginia Tech	Certificate	Nuclear Engineering
Virginia Tech	Master's	Nuclear Engineering
Virginia Tech	Doctorate	Nuclear Engineering
Old Dominion University	Bachelor's	Nuclear Medicine Technology
Averett University	Bachelor's	Radiologic Technology
Jefferson College of Health Science	Bachelor's	Radiologic Science
Virginia Western Community College	Certificate	Medical Radiologic Technology
Virginia Western Community College	Associate's	Radiation Oncology
Virginia Western Community College	Certificate	Radiation Oncology
Central Virginia Community College	Associate's	Nuclear Technology, Radiologic Technology, Health physics

Related Areas of Study:

- Civil Engineering
- Mechanical Engineering
- Engineering Technicians
- Physics
- Occupational Health and Safety Specialists

Nuclear Programs and Related Areas of Study at Virginia's Universities:

Virginia Tech

The Nuclear Engineering Program is located within the Mechanical Engineering Department and consists of five faculty members and one staff person along with several supporting faculty from the department. The program offers M.S./M.Eng. (thesis and non-thesis options) and Ph.D. degrees in Nuclear Engineering. A Graduate Certificate in Nuclear Engineering is also open to all engineering and science graduate students. An undergraduate Minor in Nuclear Engineering is under development.

Virginia Tech revived its nuclear engineering program in 2007 and immediately started offering undergraduate and graduate coursework. The program received its SCHEV approval for offering MS, MEng and PhD degrees in Nuclear Engineering effective spring 2014. The first MS degree in Nuclear Engineering was conferred in the 2014 spring semester. Since 2011, the program also has issued over 44 graduate certificates in nuclear engineering. The majority of graduate nuclear engineering courses are available online via distance learning.

Typical enrollment in nuclear engineering courses varies from 140 to 175 students. This enrollment number is expected to rapidly increase now that Virginia Tech has the authority to issue graduate nuclear engineering degrees and is developing an undergraduate Minor in nuclear engineering.

Virginia Commonwealth University

The Virginia Commonwealth University Department of Mechanical and Nuclear Engineering offers an accredited B.S. degree in Mechanical Engineering with a nuclear engineering concentration (program is ABET accredited for BOTH Nuclear Engineering and Mechanical Engineering criteria) as well as an M.S. degree in Mechanical and Nuclear Engineering and a Hybrid Ph.D. in Mechanical and Nuclear Engineering.

The nuclear engineering programs were created in 2007 in response to the strong demand for new nuclear engineers in both the public and private sector.

The Department Mechanical and Nuclear Engineering is the largest in the VCU School of Engineering, currently enrolling approximately 550 undergraduate students and 70 M.S. and Ph.D. students. The department has 24 full-time faculty members who teach and perform research in cutting-edge areas such as smart materials, drug delivery systems, nanoscale materials, biomedical devices, robotics, energy conversion systems, nuclear engineering, surface science and air filtration.

Quick facts of the VCU Mechanical and Nuclear Engineering Department:

- Degrees offered:
 - B.S. in Mechanical Engineering (Optional nuclear engineering major concentration)
 - M.S. in Mechanical and Nuclear Engineering
 - Online M.S. in Mechanical and Nuclear Engineering
 - Hybrid Ph.D. in Mechanical and Nuclear Engineering
- Undergraduate enrollment (2014-2015): 550
- Graduate enrollment (2014-2015): 70
- Faculty (2014-2015): 24

Old Dominion University

The Old Dominion University Program in Nuclear Medicine Technology: The Nuclear Medicine Technology (NMED) program is a nationally accredited program that offers undergraduates an opportunity to earn a Bachelor's of Science degree in Nuclear Medicine Technology. The ODU NMED program has graduated nearly 150 students since its inception in 1987. The program leads to a Bachelor of Science in Nuclear Medicine Technology (BSNMT). The Program is accredited by the Joint Review Committee on Educational Programs in Nuclear Medicine Technology (JRCNMT) and can accept 12 students annually. The NMED program includes a variety of on and off-campus courses, over 1300 hours of clinical experiences, as well as one distance class - offered through TELETECHNET.

The Nuclear Technology option in Mechanical Engineering Technology is a special program available only to graduates of the U. S. Navy Nuclear Power School. Graduates of this program receive advanced standing credits that apply to the MET degree based on their professional education in nuclear power systems.

University of Virginia

The University of Virginia offers educational programs and performs research in the following areas closely related to Nuclear Technology, listed in alphabetical order:

Within the College of Arts and Sciences, the Physics Department and the Institute of Nuclear and Particle Physics support leading research groups in this basic area of physics. Faculty members are the spokesmen for experiments that test fundamental aspects of nucleon and nuclear structure. These include experiments at the Stanford Linear Accelerator Center (SLAC) in Menlo Park, CA on the origin of the nucleon's spin, the details of the charge distribution of the neutron at Thomas Jefferson National Accelerator Facility (TJNAF) in

Newport News, VA, and a precision measurement of pion beta decay at the Paul Scherrer Institute (PSI) in Switzerland. 36 full-time tenured and tenure track faculty the Physics Department offer B.A., B.S., M.S., and Ph.D. degrees.

Within the School of Engineering and Applied Science (SEAS), researchers in the Department of Civil and Environmental Engineering investigate the long-term containment of low-level radioactive waste (LLW) and mixed waste (MW, blended LLW and hazardous waste). They collaborate with a larger research group called the CRESPI Landfill Partnership sponsored by DOE and NRC. The group works on all issues regarding LLW and MW disposal. However, most of the work focuses on barrier systems (liners and covers) for LLW disposal facilities. Much of the emphasis is on understanding and predicting long-term performance (1000 – 10,000 yr).

The Department of Materials Science and Engineering offers a wide variety of courses relevant to nuclear applications of materials to both undergraduate and graduate students. These range from courses on the structure of materials, including defect structures arising from irradiation, to materials behavior (electronic, optical, magnetic, mechanical, and electrochemical). There are 18 full-time tenured or tenure track faculty in the department. At this time, there are approximately 100 undergraduate students enrolled in Engineering Science and there are approximately 100 graduate students enrolled in Materials Science and Engineering or Engineering Physics (also administered by the department.) Degrees in Engineering Science (B.S.), Engineering Physics (M.S. and Ph.D.), and Materials Science and Engineering (M.Eng., M.S., and Ph.D) are offered.

Researchers within the Department of Materials Science and Engineering (MSE) perform a wide range of computational modeling and experimental research capabilities relevant to nuclear technology. Current nuclear technology-related research programs include investigations of stress corrosion cracking a phenomenon relevant to nuclear power plant operation as well as nuclear waste storage. Researchers in the department are collaborating with others throughout the nation on materials degradation issues related to long-term (80-100 year) dry storage of spent nuclear fuel. Research is also underway related to the manufacture (casting and deformation processing) of uranium metal and uranium alloy-based components.

In addition, the MSE department is home to the Center for Electrochemical Science and Engineering (CESE) originally founded as the Applied Electrochemistry Laboratories in 1974. In 1986, the Virginia Center for Innovative Technology (CIT) identified CESE as a Technology Development Center. It has grown to become one of the nation's leading research centers of its kind. CESE is a multi-disciplinary research effort, which includes activities in the Departments of Materials Science and Engineering, Chemical Engineering, Electrical Engineering, Computer Science, and Physics. CESE addresses a critical field relevant to a wide range of technologies including processing such as electroplating, batteries, fuel cells,

and corrosion. Corrosion, an electrochemical process, has a massive economic impact. Studies show that the annual cost of corrosion to the U.S. economy is on the order of \$200 billion. Everyday examples include the corrosion of reinforcing bars in concrete as well as deterioration of metal structures in chemical and nuclear power plants. Corrosion has an impact on electric power generation, heat exchangers, shipping industries, food processing, transportation, packaging and assembly of electronic components, space exploration, and national defense. Finally, a major aspect of the Center is its education function. Masters and doctoral degree programs are an integral part of the Center's research effort to provide graduate engineers with skills required to address the needs of industry. Select undergraduates are also invited to become involved in Center research programs as research assistants.

The Department of Mechanical and Aerospace Engineering is home to approximately 450 undergraduate engineering students, making it the largest department in the School of Engineering and Applied Science at the University of Virginia. There are 21 full-time tenured and tenure track faculty. A wide range of courses and research opportunities relevant to nuclear technology are offered to undergraduate and graduate students. B.S., M.S., M.Eng., Ph.D. degrees in both Mechanical Engineering and Aerospace Engineering are conferred. In particular, the department is home to the Rotating Machinery and Controls (ROMAC) Industrial Program, which supports cooperative research efforts conducted by faculty, staff, and students in various departments in the School of Engineering and Applied Science at the University of Virginia.

The ROMAC Industrial Program emphasizes theoretical and experimental research in general areas of rotordynamics, turbomachinery, structural dynamics, magnetic bearings, the application of automatic controls to the dynamics of rotating machinery, internal incompressible flows, the coupling of internal flows to the dynamics of rotating machinery, fluid film bearings, and seals. The interaction between industry and university professionals through the medium of ROMAC provides the university researchers with an understanding of practical industrial problems with rotating machinery while the industrial participants obtain timely research results. For example, a current doctoral thesis research project involves developing mathematical models and simulation tools to predict U enrichment centrifuge behavior.

Of special note in 2016, the School of Engineering and Applied Science at the University of Virginia received a 4 year grant from the Nuclear Regulatory Commission entitled, "Jump Start in Nuclear Materials Education and Research Fellowship Program," to support graduate education and research. Faculty from the Departments of Materials Science and Engineering as well as Mechanical and Aerospace Engineering will mentor exceptional students as they perform research in partnership with other federal and industrial sponsors.

Within the School of Medicine, the Division of Nuclear Medicine is engaged in numerous research endeavors to advance knowledge and promote the practical application of nuclear medicine. Areas of study include:

- Small gamma camera utilization in clinic and operative room
- Dual modality (x-ray and gamma) breast imaging
- Molecular imaging (microPET) system for small animal research
- Integrated CT-SPECT system for small animal imaging
- Radiotracer tumor localization for surgical procedures

More broadly, the division of Nuclear Medicine offers a full range of diagnostic and therapeutic imaging services using radioactive materials. Positron emission tomography (PET) is available using the latest technology, PET-CT. PET-CT combines PET and CT in a single machine, which is used to provide information about metabolism linked to CT anatomy in a single exam. PET/CT is available for all approved clinical indications, including oncologic, neurologic, and cardiac. Clinical service is provided at the main hospital as well as the new Emily Couric Cancer Center, directly across the street from the main hospital. Fellows work with the latest leading edge imaging equipment at both locations. The division also has access to research PET tracers produced by a cyclotron located at UVA's research facilities in nearby Fontaine Research Park.

Finally, the division of Nuclear Medicine offers an ACGME-accredited one-year fellowship in Nuclear Radiology to candidates who have completed a residency in diagnostic radiology at an ACGME-accredited institution. Candidates must also have ABR or equivalent certification and the ability to obtain a license to practice medicine in Virginia.

The University of Virginia is licensed to work with Radioactive Materials by the Commonwealth of Virginia's Department of Health, Radiological Health Program consistent with Virginia Radiation Protection Regulations 12 VAC5-481 (10 CFR 35.2).

Virginia Military Institute (VMI)

VMI offers a degree in Mechanical Engineering. Students are able to declare a nuclear concentration in mechanical engineering.

Enrollment in Mechanical Engineering – 173 (Fall 2013)

Graduated – 27 (2012-2013)

Liberty University

The School of Engineering and Computational Sciences - Established in fall 2007, Liberty University's newest school offers degrees in electrical, mechanical, computer, and industrial engineering.

Appendix C:

Executive Order 57



Commonwealth of Virginia
Office of the Governor

Executive Order

NUMBER FIFTY SEVEN (2016)

DEVELOPMENT OF CARBON REDUCTION STRATEGIES FOR ELECTRIC POWER GENERATION FACILITIES

Part I – Importance of the Initiative

Though our coastal communities may be the first to witness the effects of climate change, the risks presented by increasingly fierce storms, severe flooding, and other extreme weather events are not confined to a single geographic area. Neither are their causes. The economic implications are significant, and we must do all we can to protect our critical military infrastructure, our ports, our homes, and our businesses. It is only by acting together with common purpose that the Commonwealth can effectively adapt and stave off the most severe consequences of climate change.

One key step forward is to continue with a strategic goal of reducing carbon emissions. Virginia has already made meaningful strides – between 2005 and 2014, Virginia reduced its carbon emissions from power plants by 21 percent. However, the electric sector is still responsible for approximately 30 percent of the carbon dioxide pollution in the Commonwealth. Moreover, electric companies are including carbon regulation projections in their long-term plans. The electric sector is changing rapidly through increasing reliance on low and zero carbon resources. As such, it is vital that the Commonwealth continue to facilitate and engage in a dialogue on carbon reduction methods while simultaneously creating a pathway for clean energy initiatives that will grow jobs and help diversify Virginia's economy.

Accordingly, by virtue of the authority vested in the Governor under Article V of the Constitution of Virginia and under the laws of the Commonwealth, I hereby direct the Secretary of Natural Resources to convene a Work Group, chaired by the Secretary, to study and recommend methods to reduce carbon emissions from electric power generation facilities. The Secretary shall receive input from interested stakeholders.

Such methods shall align with the Virginia Air Pollution Control Board's power to promulgate regulations abating, controlling and prohibiting air pollution throughout or in any part of the Commonwealth.

Part II – Scope and Guidance

In preparing their recommendations, the Secretary and the Work Group shall consider the following:

- (1) the establishment of regulations for the reduction of carbon pollution from existing electric power generation facilities pursuant to existing authority under Virginia Code § 10.1-1300 *et seq.*;
- (2) the carbon reduction requirements for existing electric power generation facilities established under § 111(d) of the federal Clean Air Act, which are currently stayed pending final disposition;
- (3) the interaction between electric utilities and regional markets, including PJM Interconnection;
- (4) the impact any reduction requirements place on the reliability of the electric system;
- (5) the impact any reduction of carbon pollution may have on electric rates and electric bills;
- (6) the impact of reducing carbon pollution on low income and vulnerable communities;
- (7) the cost effectiveness of pollution reduction technologies that may be deployed;
- (8) the economic development opportunities associated with deployment of new carbon reduction technologies;
- (9) the implementation and administration of carbon reduction regulations; and
- (10) flexibility in achieving the goals of any carbon reduction regulation.

The Secretary of Natural Resources shall complete her work, including the development of recommendations as to viable carbon reduction methods for the electric power generation facilities by April 30, 2017. The Secretary of Natural Resources shall provide a report on the recommendations to the Governor by May 31, 2017.

Effective Date of the Executive Order

This Executive Order shall be effective upon its signing and shall remain in full force and effect for one year after its signing unless amended or rescinded by further executive order.

Given under my hand and under the Seal of the Commonwealth of Virginia this 28th Day of June, 2016.

Terence R. McAuliffe, Governor

Attest:

Kelly Thomasson, Secretary of the Commonwealth

Appendix D:

2014 Virginia Energy Plan: Nuclear Energy Technical Section

SECTION 5 - NUCLEAR POWER

Nuclear Generation in Virginia

- There are four nuclear units in operation in Virginia. All four are operated by Dominion.
- Two units are located at the North Anna Power Station in Louisa County and two are located at the Surry Power Station in Surry County. These two nuclear plants provided 38 percent of the net electricity generated in Virginia during 2013.¹
 - Dominion owns an 88.4 percent share of the North Anna Station. The Old Dominion Electric Cooperative (ODEC) owns the remaining 11.6 percent share.
 - Dominion owns 100 percent of the Surry Station.
 - Generally, the Nuclear Regulatory Commission (NRC) issues licenses for reactors to operate for up to 40 years. The NRC extended both Surry's and North Anna's operating licenses in 2003 for an additional 20 years (60 years total).² Both plants have the potential for extending their operating license another 20 years, for a total of 80 years.
 - North Anna generates 1,892 megawatts from its two units — enough electricity to power 450,000 homes³. Surry Power Station generates 1,676 megawatts of electric power from its two nuclear reactors — enough electricity to power 420,000 homes⁴.
- North Anna employs 960 employees and Surry currently employs 965 employees at an average salary (exclusive of benefits) of more than \$80,000 per year.

Table 5-1: Virginia's Nuclear Generating Units and Startup Dates⁵

Unit Name	Year	End of Operating License Term
Surry Unit 1	1972	2032
Surry Unit 2	1973	2033
North Anna Unit 1	1978	2038
North Anna Unit 2	1980	2040

- Dominion has made operating and capital improvements to the plants that have reduced down time for refueling and repairs, increased plant efficiency, and improved uprates that have increased their generating capacity in excess of 150 megawatts⁶. Operating capacity for the four units in Virginia in 2013 ranged from

¹ Energy Information Administration, Virginia State Profile and Energy Estimates: Quick Facts

² National Regulatory Commission, Nuclear Reactors, License Renewal, Overview

³ Dominion North Anna Power Station, <https://www.dom.com/about/stations/nuclear/north-anna/>

⁴ Dominion Surry Power Station, <https://www.dom.com/about/stations/nuclear/surry/>

⁵ <http://www.eia.doe.gov>

⁶ 150 megawatts is reflective of summer net performance

77.7 to 96.9 percent with an average of 90.1 percent⁷. Nuclear power is considered baseload power, meaning it is designed to run around the clock.

- In addition to its nuclear generation plants at Surry and North Anna, Virginia hosts a number of nuclear-powered naval vessels, including aircraft carriers, other surface vessels, and attack and ballistic missile submarines.
- Electricity production costs of nuclear power plants are the lowest of any baseload power source, with nuclear at 2.40 cents/kW-hr, coal at 3.27 cents/kW-hr, natural gas at 3.40 cents/kW-hr, and petroleum at 22.48 cents/kW-hr.⁸
- Nuclear power has no carbon emissions and no other air emissions.

Used Nuclear Fuel Management

- According to the Nuclear Waste Policy Act of 1982, amended in 1987, the U.S. Department of Energy (US DOE) is obligated to take used nuclear fuel from the North Anna and Surry sites.
- The Nuclear Waste Fund, created by fees paid by US nuclear power plants since 1983 and with more than \$35 billion to date, is the mechanism that was used to finance the design, licensing, construction and management of a suitable repository at the Yucca Mountain site in Nevada.
- On June 2008, the US DOE completed the Yucca Mountain repository license application, and submitted it to the NRC for their review. On March 2010, the US DOE withdrew the license application and created the Blue Ribbon Commission for America's Nuclear Future (BRC) to evaluate potential paths forward for the long term management of used nuclear fuel. On September 2011 the NRC stopped the review of the Yucca Mountain license application⁹, a decision that was reversed in August 2013 by the US Court of Appeals for the DC Circuit¹⁰. The BRC issued its final report on January 2012¹¹. The US DOE review of the BRC recommendations resulted in a January 2013 report¹² that details the steps of a new program that will be implemented over the next 10 years. This plan culminates with the availability of a geologic repository for the long-term storage of used nuclear fuel by 2048.
- A US Court of Appeals has ruled that the US DOE must stop collecting nuclear waste fees from utilities until it decides how used nuclear fuel is to be managed¹³.
- Used nuclear fuel is currently stored at the North Anna and Surry sites in the spent fuel pools and in dry storage casks and will continue to be stored at North Anna and Surry until the U.S. Government is able to fulfill its obligation to the U.S. nuclear industry.

⁷ <http://www.eia.doe.gov>

⁸ <http://www.nei.org/Knowledge-Center/Nuclear-Statistics/Costs-Fuel,-Operation,-Waste-Disposal-Life-Cycle/US-Electricity-Production-Costs>

⁹ <http://www.nrc.gov/reading-rm/doc-collections/fact-sheets/fs-yucca-license-review.html>

¹⁰ http://www.world-nuclear-news.org/WR-US_court_rules_on_Yucca_Mountain-1408137.html

¹¹ <http://cybercemetery.unt.edu/archive/brc/20120620211605/http://brc.gov/>

¹² <http://energy.gov/sites/prod/files/Strategy%20for%20the%20Management%20and%20Disposal%20of%20Used%20Nuclear%20Fuel%20and%20High%20Level%20Radioactive%20Waste.pdf>

¹³ <http://www.world-nuclear-news.org/WR-Court-orders-halt-to-nuclear-waste-fees-2011134.html>



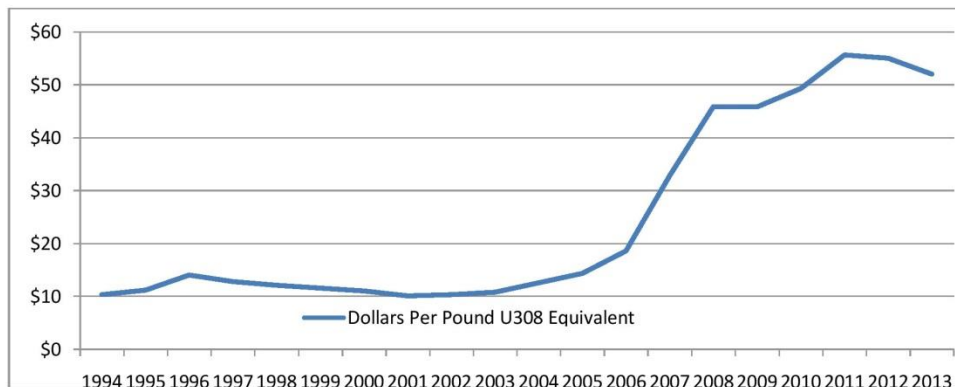
Nuclear Plant Siting and Construction

- Nuclear power plant siting is largely regulated through the licensing process of the Nuclear Regulatory Commission (NRC). Licensing requirements have been streamlined since plants were licensed in the 1960s and 1970s. Nuclear utilities now can receive an early site permit, followed by a combined construction-operating permit.
- Dominion has received its early site permit for the proposed third North Anna unit.
- Dominion's combined construction-operating permit application is pending before the NRC.
- Nuclear plant permitting and construction can take up to 8-10 years.
- Time and budget experience with new plant construction, overseas, has been mixed.
- Shared risk between utilities and project design and construction firms supports financing new nuclear projects.
- State and federal incentives, including a higher rate of return under Virginia law for utility investments in new nuclear power plants and federal loan guarantees, may help mitigate the financial risk.
- U.S. nuclear reactor manufacturing capability is growing to meet national and international demand. New facilities include the Westinghouse-Chicago Bridge and Iron plant in Lake Charles, Louisiana.
- Nuclear plants are major construction projects, involving thousands of construction workers. North Anna 3 would be one of the largest construction projects in Virginia history.

Nuclear Fuel Costs

- The average purchase price of uranium oxide was consistently below \$20/pound until the mid-2000s. Since then, the average purchase price has increased to just above \$50/pound, but is expected to return to a lower price level, as shown in Figure 5-1. The current spot market for uranium oxide is at \$29/pound.

Figure 5-1: Weighted-Average Price of Uranium Purchased by Owners and Operators of U.S. Civilian Nuclear Power Reactors, 1994-2013 (dollars per pound U3O8 equivalent)¹⁴



- The current market for nuclear fuel (i.e. prices for new contracts) is under downward price pressure and is expected to stay this way for the near-term.
 - Changes in spot nuclear fuel cost have a limited impact on the cost of nuclear generated electricity. Nuclear fuel is generally purchased through long-term contracts and amortized over multiple years. In addition, fuel costs are a smaller percentage of total nuclear power cost than with other technologies (approximately 30 percent versus 78 percent and 89 percent for coal and gas, respectively).¹⁵

Uranium Mining

- Currently, over 90 percent of uranium used in commercial nuclear reactors in the United States is imported.¹⁶

A uranium oxide resource has been identified in Pittsylvania County, in the southern region of Virginia. The resource is estimated to contain 119 million pounds of uranium oxide (at a 0.025 percent uranium oxide cutoff).

Since 1983, Virginia has had a moratorium on uranium mining. It is expected that the moratorium will remain in place for the foreseeable future.

A number of studies have been conducted and published related to uranium mining in Virginia. These include:

¹⁴ <http://www.eia.doe.gov>

¹⁵ <http://www.world-nuclear.org/info/Economic-Aspects/Economics-of-Nuclear-Power/>

¹⁶ <http://www.eia.doe.gov>

- The National Academy of Sciences study, commissioned by the Virginia Coal and Energy Commission
- Chmura Economics and Analytics Socioeconomic Study, commissioned by the Virginia Coal and Energy Commission
- RTI Socioeconomic Study, commissioned by the Danville Regional Foundation
- Michael Baker Corporation Study, commissioned by the City of Virginia Beach
- Michael-Moran Associates, LLC study, commissioned by the Roanoke River Basin Association
- Hazen and Sawyer/Tetra Tech study, commissioned by Fairfax Water

Figure 5-2: Map of Coles Hill Uranium Deposit



Appendix E:

2016 Virginia Energy Plan Update: Nuclear Energy – VNECA/VNEC

NUCLEAR

Under the leadership of Governor McAuliffe and the Virginia Nuclear Energy Consortium Authority (VNECA or the Authority), an independent, non-profit organization was created to provide a single voice to the critically important nuclear industry in Virginia. This organization, the Virginia Nuclear Energy Consortium (VNEC or the Consortium) is privately funded by a variety of stakeholders with a significant presence and investment in the nuclear industry in the Commonwealth.⁵⁴ Currently, VNEC is comprised of eight founding members representing nuclear interests from the public sector, academia, and private industry. The Consortium is working closely with the Authority, the administration, and other state entities to raise the public profile of Virginia's nuclear industry and accomplish the goals laid out in the 2014 Energy Plan.

Since its launch, the Consortium has prioritized workforce development needs and has established relationships with the Workforce Commission and the Virginia Center for Energy Workforce Development. The Consortium also partnered with the Nuclear Energy Institute (NEI) to host the first Virginia Nuclear Energy Summit in Richmond in June 2016.⁵⁵

FOUNDING MEMBERS OF THE VIRGINIA NUCLEAR ENERGY CONSORTIUM



Appendix F:

VNECA Bylaws

Virginia Nuclear Energy Consortium Authority
Approved Bylaws

Article 1 Purpose and Authority

The Virginia Nuclear Energy Consortium Authority is established by statute as a political subdivision of the Commonwealth of Virginia.

The Authority is charged with responsibility for making the Commonwealth a national and global leader in nuclear energy and to serve as an interdisciplinary study, research and information resource for the Commonwealth on nuclear issues.

The Authority is granted all powers necessary or convenient to carrying out its purposes, as more fully set out by § 67-1402 B. of the Code of Virginia, and which include the power to provide for the establishment of the Virginia Nuclear Energy Consortium.

As provided by law, on or before November 15 of each year, the Authority shall submit its updated strategic plan, an annual summary of its activities and any recommendations for the support and expansion of Virginia's nuclear energy industry to the Governor and the Chairmen of the House Appropriations, Senate Finance, and House and Senate Commerce and Labor Committees.

Article 2 Membership

The Authority is governed by a Board of Directors ("the Board"). Membership on the Board of the Authority is defined by § 67-1403 of the Code of Virginia and, except as specifically designated otherwise, shall be appointed by the Governor for terms as described by that section.

Article 3 Meetings – Meetings of the Board shall be held at the call of the chairman or of any seven (7) members of the Board.

- a. Regular Meetings – The Board shall meet four times a year to receive quarterly reports of the Consortium and to discuss and decide other business in pursuit of its purposes.
- b. Special Meetings – Special meetings may be called by the chairman or by seven (7) members of the Board as deemed necessary for the purpose of discussing and deciding any issue or question that cannot wait to be placed on the agenda of the next quarterly meeting of the Board. No business shall be transacted at such special meeting except that expressly identified in the notice of the special meeting.

- c. Quorum – Nine (9) members of the Board shall constitute a quorum and a quorum shall be necessary in order for any vote to be taken, or official decision of the Authority to be made.
- d. Notice of Meetings – Notice of meetings of the Board must be given and posted in accordance with the provisions of the Virginia Freedom of Information Act, to members of the Board and all others requesting such notice, and in no event fewer than five (5) days in advance of the meeting date.
- e. Conduct of Meetings – Meetings shall be conducted in accordance with the provisions of the Virginia Freedom of Information Act. Meetings shall be led by the Chairman or the Vice Chairman in the Chairman’s absence. Should both the Chairman and the Vice Chairman be absent from the same meeting, the members present may elect a Chairman pro tempore to serve for the duration of that meeting.
- f. An agenda for any meeting shall be determined by the Chairman in consultation with staff and any members of the Authority who may have items to suggest for inclusion on the agenda.
- g. Any decisions made by, or act taken pursuant to, a vote of a majority of the members of the Board present for a meeting at which a quorum is in attendance shall be an official act of the Authority.
- h. An opportunity for public comment shall be included on the agenda of at least two meetings each year, but may be included more often when deemed necessary or appropriate.

Article 4 Officers

- a. Chairman – The Board shall elect a Chairman annually from among its members who shall preside at all meetings of the Board and who shall speak on behalf of the Board when authorized by the Board to do so. The Chairman shall also appoint Committees of the Board as such are required from time to time.
- b. Vice Chairman – The Board shall elect a Vice Chairman annually from among its members. The Vice Chairman shall preside in the Chairman’s absence and assist the Chairman as needed.
- c. Treasurer – The Board shall elect a Treasurer annually from among its members. The Treasurer shall be responsible for overseeing the receipt and expenditure of funds by the Board and the maintenance of the Board’s accounts.
- d. Secretary – The Board shall also elect annually a Secretary who need not be a member of the Board. The Secretary shall be responsible for overseeing the preparation and filing of official documentation required of the Board.

Article 5 Committees

The Board shall create such standing committees as it deems to be necessary to the accomplishment of the Authority's purposes. Members of any such committees shall be appointed by the Chairman.

The Chairman may appoint such temporary committees as necessary to the accomplishment of specific tasks. Such committees shall be known as ad hoc committees and shall exist only until the task for which they were created is complete.

Article 6 Amendments

These bylaws may be amended from time to time by the vote of a majority of the members present and voting at a meeting for which a quorum is present.

Amendment of the bylaws must appear on the agenda of the meeting at which a vote to amend the bylaws will be taken.

Appendix G:

VNECA Board Members

Virginia Nuclear Energy Consortium Authority Board Members - 2016

Chairman – Donald Hoffman, EXCEL Services

Vice Chairman – Gary Tepper, Virginia Commonwealth University

Treasurer – Mary Alice Hayward, AREVA

Secretary – Bob Bailey, Center for Advanced Engineering and Research

Deputy Vice Chairman – Ganapati Myneni, Jefferson Labs

Member – Bill Briscoe, George Washington University

Member – John Capps, Virginia Community College System

Member – Regina Carter, BWX Technologies, Inc.

Member – David Christian, Dominion Generation

Member – Al Christopher, Department of Mines, Minerals and Energy

Member – Colleen Deegan, Bechtel

Member – Srinath Ekkad, Virginia Tech

Member – Mary Alice Hayward, AREVA

Member – Woody Lawman, Flowserve

Member – Maureen Matsen, Christopher Newport University

Member – Matthew Mulherin, Newport News Shipbuilding

Member – Pam Norris, University of Virginia

Member – Tim Stuller, Virginia Economic Development Partnership

Member – Mark Troutman, George Mason University