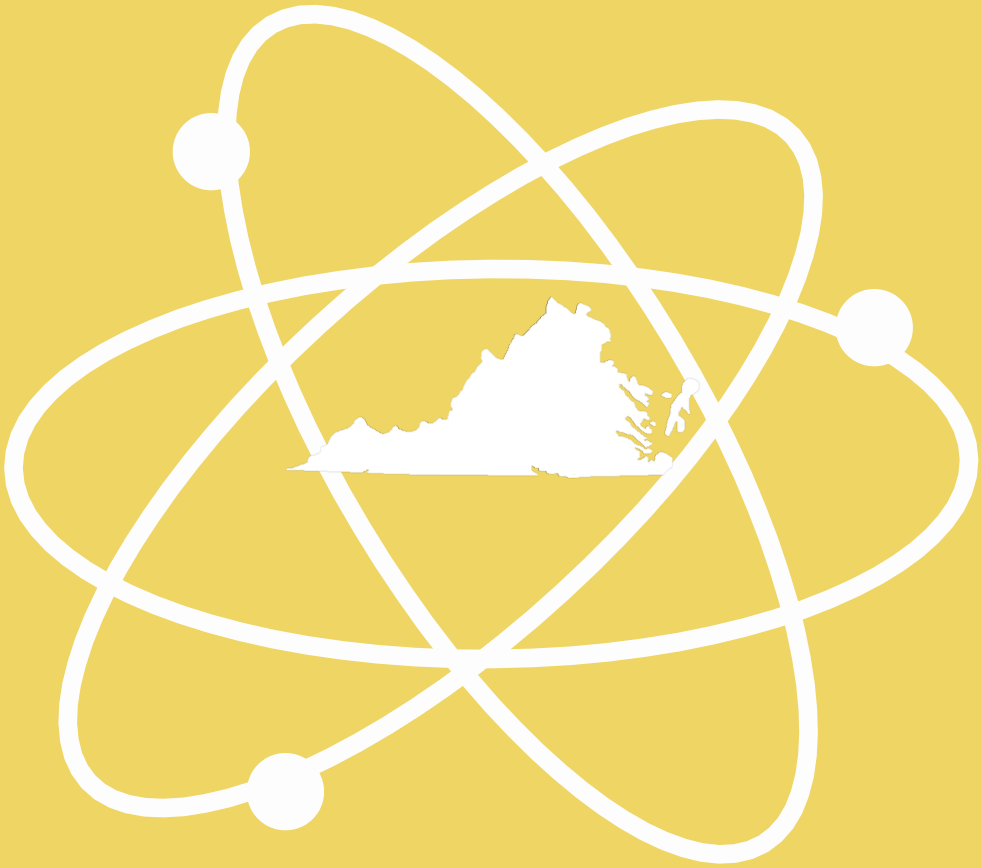
2015 Annual Report



Virginia Nuclear Energy Consortium Authority

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Virginia Nuclear Energy Consortium Authority

2015 Annual Report – Executive Summary

Charge and Responsibilities – In 2013, the General Assembly created the Virginia Nuclear Energy Consortium Authority (Authority) as a political subdivision of the Commonwealth for the purpose of:

- 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 (Consortium), a non-stock corporation responsible for conducting activities to achieve these goals.

Enclosed is the Authority's 2015 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 in 2013, the Authority worked diligently to:

- Set goals and define responsibilities for the Authority and the Consortium;
- Recruit Founding Members to establish the Consortium, securing commitments from nine companies and higher education institutions;
- Produce an 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.

Recommendations to Advance Nuclear Energy in Virginia – The Authority offers the following priorities 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 Governor Terry McAuliffe, Dominion, AREVA Inc. and others' efforts 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 Consortium.

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 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.

The Authority held its organizational meeting and elected officers in December 2013. Since then, the Authority has worked diligently to 1) set goals and define and responsibilities for the Authority and the Consortium, 2) recruit Founding Members to establish the Consortium, 3) produce an inventory of nuclear industry assets in Virginia, 4) educate policy makers on the benefits of nuclear energy and 5) provide recommendations to advance the nuclear industry in the Commonwealth.

The Authority has achieved significant progress toward its goals including setting strategic direction for the Authority and the Consortium, securing commitments from nine companies and higher education institutions to serve as Founding Members of the Consortium, conducting an inventory of nuclear energy education and industry assets in Virginia and working closely with the development of the Virginia Energy Plan to

ensure the importance and impact of nuclear energy was appropriately recognized and promoted in the Virginia Energy Plan.

This report and related appendices provide details of the Authority's strategic goals and priorities, activities and 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 a 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 educational needs and interests of the industry. It is overseen and directed by the Authority and is the entity that will conduct 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 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 & Priorities

Additionally, the Authority has identified several initial activities that will support the expansion of the nuclear industry in Virginia. The Authority assigned the following priorities to the Consortium:

1. Workforce and Educational Goals
    a. Create a strong nuclear education program in Virginia
    b. Train Virginians for Virginia jobs
    c. Incorporate into Governor's STEM Academies
    d. Facilitate middle skills training

2. Research and Development
    a. Identify critical research topics and issues
    b. Identify the research facilities needed to support the topics above
    c. Identify and pursue applicable collaborative R&D funding

3. Promotion and Outreach
    a. Develop a unified message for Virginia's nuclear energy cluster
    b. Develop and implement a communications plan

4. Other Nuclear Applications
    a. Nuclear Medicine Focus
    b. Incorporate into Commonwealth Center for Advanced Manufacturing
    c. Incorporate into Center for Advanced Engineering and Research

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 in 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.

- Virginia is home to facilities and operations of almost 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
    - For example, AREVA Inc. expanded its offer of innovative training services for nuclear reactor maintenance activities at the company's Technical Training Center in Lynchburg, VA. The facility now features additional mock-ups of large reactor components to train nuclear operations and maintenance personnel in realistic nuclear plant environments.
        - This investment expands the range of hands-on training options already available, including full-size mock-ups of steam generators, reactor vessels and a reactor fuel pool. Previously, training on these highly specialized components was difficult to complete in advance of deployments. By offering this training in a simulated and controlled setting, craft workers, technicians and engineers are able to improve worker safety and reduce operating cost, particularly during outages.

- 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 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, Virginia Commonwealth and Old Dominion, institutions including University of Virginia, Virginia Military Institute and Central Virginia Community College and others offer numerous nuclear energy, nuclear medicine and other related programs, degrees and research.

The Authority has also strategically interfaced 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).

Virginia has not merely served as a national leader in nuclear energy but has remained an international leader as well. In 2014, the Virginia Accelerator-Driven Systems (ADS) Consortium hosted the 3rd International Workshop on Accelerator-Driven Sub-Critical & Thorium Utilization at Virginia Commonwealth University in Richmond. The Virginia ADS Consortium will host the 4th International Workshop in September 2016 at Huddersfield University in England and the 5th International Workshop in October 2018 in Virginia.

Few states have as much to offer the nuclear industry as the Commonwealth does. It is important that we continue to identify and pursue every available opportunity to support and expand the industry.

VIRGINIA ENERGY PLAN

Governor McAuliffe's Executive Order 16 created the Virginia Energy Council (VEC), which was responsible for providing advice to the Governor, the Secretary of Commerce & Trade and staff in the development of the Virginia Energy Plan (VEP). The VEP is a comprehensive plan for energy in the Commonwealth updated every four years and includes both a detailed technical assessment of various energy sectors and resources and provides recommendations and priorities for energy development and generation in Virginia.

VEP Nuclear Energy Technical Section

In addition to Authority Board member Ganapati Myneni's serving on the VEC, the Authority assisted with drafting significant portions of the VEP Nuclear Energy Technical Section (Appendix C). Several key points from the Nuclear Energy Technical Section include:

- Dominion's North Anna facility employs 960 people and Surry facility currently employs 965 at an average salary (exclusive of benefits) of more than $80,000 per year.
- 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.
- Nuclear power produces no carbon emissions and no other air emissions.

Virginia Energy Plan Comments

In addition to the technical support, the Authority provided the VEP detailed formal comments and recommendations to promote nuclear energy in Virginia (Appendix D). Several highlights include:

- Energy Planning – Emphasis on the importance of long-term energy planning, baseload capacity, long-term price stability and increased energy efficiency.

- Nuclear Generation – The importance of nuclear power to Virginia's energy portfolio and the substantial economic value of Virginia nuclear science and technology stakeholders encourage support for Dominion's plans for North Anna 3, AREVA's EPR reactor, BWXT mPower and small modular reactors.
- Clean Energy – Recognition of nuclear power's ability to help Virginia comply with EPA's Clean Power Plan and renewable portfolio goals.
- Education & Research – Support additional resources for cutting-edge nuclear science research and nuclear workforce development.

Several Authority proposals were included in the VEP recommendations. Additionally, the VEP Executive Summary recognized the importance of the Authority and Consortium to nuclear energy in Virginia.

> *"Given the nuclear industry's important role in the Commonwealth's economy, Virginia must continue to be a leader in nuclear generation, research, education and workforce development. Created in 2013, the Virginia Nuclear Energy Consortium is Virginia's primary resource for interdisciplinary study, research and information on nuclear issues. The Consortium will play a critical role in providing the nuclear industry in Virginia with a viable, long-term and innovative strategic path forward."* (Virginia Energy Plan Executive Summary, Page 5)

VIRGINIA NUCLEAR ENERGY CONSORTIUM

The Virginia Nuclear Energy Consortium (Consortium) was formally launched and became completely operational in 2015 in accordance with § 67-1404 of the Code of Virginia.

In 2015, the Consortium secured eight Founding Members, each of whom contributed an initial dues payment of $25,000 and now comprise the Consortium Board of Directors:

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

At its first meeting of 2015, the Consortium selected the following slate of officers to lead the Consortium for 2015:

Chairman – Alireza Haghighat, Virginia Tech
Vice Chair – Sama Biblao Y Leon, VCU
Treasurer – William A. Fox, BWXT
Secretary – Tom Deponty, AREVA Inc.

Additionally, the Consortium secured legal and accounting services for incorporation, made the requisite federal filings, secured a tax ID, and developed Bylaws and Operating Procedures. Effective July 1, 2015, the Consortium named Marshall Cohen Executive Director.

At the July 2015 meeting, Consortium members identified its initial priorities:

- Identify nuclear energy workforce issues and begin coordinating the development of responses to those issues by engaging with other workforce developments taking place throughout the Commonwealth.
- Assist with efforts to provide operational support for the Center for Advanced Engineering & Research (CAER) in collaboration with BWX Technologies, using the Integrated System Test (IST) Facility.
- Establish a robust public presence for the Consortium by creating a new website, using social media, and engaging with other nuclear organizations.
- Research and identify nuclear issue advocacy and educational opportunities that the Consortium can support or enhance.

From July 1, 2015 through the end of the year, the Consortium undertook a number of additional activities. Several highlights include:

- Workforce Issues – Completed an initial survey of nuclear workforce issues and needs; met with Governor McAuliffe's Workforce Commission; and coordinated with the Virginia Center for Energy Workforce Development.
- CAER/IST – Developed a strategic plan for CAER; worked with Virginia Secretary of Commerce and Trade Maurice Jones to coordinate a tour of the facility and plan to implement the strategic plan.
- Outreach – Launched the new Consortium website (virginianuclear.org); developed promotional materials and presentations; engaged with the Virginia Congressional Delegation in support of reauthorizing the US Export-Import Bank; and continued to seek out additional members.

The Consortium also began to execute a number of plans for late 2015 and early 2016. These include:

- Developing a presentation given at a meeting of the Central Virginia chapter of the American Nuclear Society/American Society of Mechanical Engineers in December 2015.
- Coordinating with the Nuclear Energy Institute (NEI) and discussing the prospect of a joint NEI/VNEC nuclear supplier conference in early 2016.

- Coordinating and supporting the possibility of a Virginia Energy Workforce Summit in early 2016.

Virginia Nuclear Energy Consortium Authority Administration

The Virginia Nuclear Energy Consortium Authority Board elected the following slate of officers to lead the Board for 2015:

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

The full list of Authority Board Members is included in Appendix G.

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. Website - https://commerce.virginia.gov/initiatives/va-nuclear

NUCLEAR ENERGY 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.

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7. Recognize and support nuclear energy issues and innovative nuclear technologies identified and pursued by the Virginia Nuclear Energy Consortium.

Appendices

Appendix A

Virginia Nuclear Energy Assets

Nuclear in Virginia - Educational Institutions

Entity	Logo	Nature of Activity	Applicable Program(s)	Leadership	Virginia Presence	Founded	Revenue/ Funding, $1M	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. Trible 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

Entity	Logo	Nature of Activity	Leadership	Virginia Presence	Founded	Revenue/ Funding, $1M	Employees	Website
Thomas Jefferson National Accelerator Facility	Jefferson Lab	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 Shipyward)		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 - Utilities

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

Entity	Logo	Nature of Activity	Leadership	Virginia Presence	Founded	Revenue/ Funding, $1M	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	~1,500	~4300	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 CEO	800 Main Street, Lynchburg, VA 24504	1867	~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.excelservices.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 (continued)

Entity	Logo	Nature of Activity	Leadership	Virginia Presence	Founded	Revenue/ Funding, $1M	Employees	Website
F.N. Anderson & Associates		Engineering Analysis and Services	Floyd N. Anderson, President	87 Braxton Lane, Forest, VA, 24551	1993		~4	www.fnaai.com
Ares Security Corporation		Security Consulting and Applications	Ben Eazzetta, President	8045 Leesburg Pike, Suite 400, Tysons Corner VA 22182	2012		850+ (incl. ARES Holding)	www.aressecuritycorp.com
Bauer Compressors, Inc.		Compressors and High Pressure Systems	Tony Bayat, President	1328 Azalea Garden Rd, Norfolk, VA 23502	1946			www.bauercomp.com
Chemetrics, Inc.		Water Testing	Bruce H. Rampy, President	4295 Catlett Rd, Midland, VA, 22728	1969		55+	www.chemetrics.com
Coastal Network of Virginia, LLC		Radiation Safety		600 Plantation Ct, Charlottesville, VA, 22903	1987		5	www.nuclearsupply.com
Communications-Applied Technology		Communication Systems Design and Manufacturing	Seth Leyman, President and Founder	11250-14 Roger Bacon Drive, Reston, VA, 20190	1982		~15	www.c-at.com
Donley Technology		Environmental Health and Safety Information	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.		Motor repair, decontamination, refurbishment	James L. King,President CEO	3703 Cook Blvd, Chesapeake, VA, 23323	1960	~30	~200	www.emc-co.com
Interdevelopment, Inc.		Management Consulting and Business Research	Margareta Luddemann, President and CEO	P.O. Box 15249, Arlington, VA, 22215	1967	<1	~10	www.interdevelopment.com
KSB, Inc.		Pumps, valves, and systems suppplier	Ed Harvie, President (KSB USA)	4415 Sarellen Rd, Henrico, VA, 23231		~3,125	16,500+ (global)	www.ksb.com
Innovative Technologies International, Inc. (NovaTech)		Engineering Services and Manufacturing	Hawk Rochow, President/COB	220 Jefferson Ridge Parkway, Lynchburg, VA 24501	1994		35	www.novatechusa.com

Nuclear in Virginia - Private Industry (continued)

Entity	Logo	Nature of Activity	Leadership	Virginia Presence	Founded	Revenue/ Funding, $1M	Employees	Website
Mega-Tech Services, LLC		Tooling, Engineering Consulting	Deanna R. Bowen, President	11118 Manor View Drive, Mechanicsville, VA, 23116				www.mecha-techservices.biz
MPR Associates, Inc.	MPR ASSOCIATES INC.	Engineering and Management Services	Bob Coward, Principle Officer	320 King St, Alexandria, VA, 22314	1964		~200	www.mpr.com
Proxtronics, Dosimetry LLC	PROXTRONICS	Dosimetry Services	W. Guy Davis, President and CEO	85 S. Bragg St, Suite 400, Alexandria, VA, 22312	1990			www.proxtronicsdosimetry.com
Radium, Inc.	Radium	Steam Generator Services, Products	Cam Abernethy, President and Owner	463 Dinwiddie Ave, Waynesboro, VA, 22980	2004		~10	www.radiuminc.com
River Technologies, LLC		Radiological Decontamination	Robert Kozma, COO	2107 Graves Mill Rd, Suite A, Forest, VA, 24551	2003		~10	www.rivertechnologies.biz
Robatel Technologies, LLC	ROBATEL	Engineering Services	Teo Grochowski, CEO	5115 Bernard Drive, Suite 304, Roanoke, VA, 24018	2009 (US subsidiary)		115 (Robatel Industries)	www.robateltech.com
TeamBest	TeamBest	Radiation Protection, Cancer Treatment	Krishnan Suthanthiran, President and Founder	7643 Fullerton Rd, Springfield, VA 22153	1977			www.teambest.com
Applied Technical Services	ATS APPLIED TECHNICAL SERVICES, INC.	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		~600	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	7,315 (consolidated sales FY12)	~25,000	www.fujielectric.com
JGW Group		Business Development, Training, Consulting	Andrew Wilson, President	1801 Robert Fulton Drive, Suite 400, Reston, VA, 20191	1980		10 (+int'l associates)	www.jgwgroup.com
Honeywell (Uvex Safety Frames)	UVEX by Honeywell	Safety Products, Eye + Face Protection	David M. Cote , Chairman and CEO	690 HP Way, Chester, VA, 23836	1906	37,665 (FY12)	~132,000 (worldwide)	www.honeywellsafety.com

Nuclear in Virginia - Private Industry (continued)

Entity	Logo	Nature of Activity	Leadership	Virginia Presence	Founded	Revenue/ Funding, $1M	Employees	Website
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
Caliper 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.caliper.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.domeng.com
Invensys Eurotherm		I&C sales, support, repair	Mike Caliel, 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.ltbridge.com
Thermal Spray Solutions		Thermal Spray Coatings		1105 International Plaza, Suite B, Chesapeake, VA, 23323				
ABZ, Inc.		Fluid Flow Consulting	Ed Abbott, President	4451 Brookfield Corporate Drive, Suite 101, Chantilly, VA, 20151	1986		~10	www.abzinc.com
Advex Corporation		Machining and Fabrication	George Hill Jr, President	121 Floyd Thompson Drive, Hampton, VA, 23666	1969		180	

Nuclear in Virginia - Private Industry (continued)

Entity	Logo	Nature of Activity	Leadership	Virginia Presence	Founded	Revenue/ Funding, $1M	Employees	Website
Affordable Fastener Supply Company		Hardware Supply	Carl Grunthaner, President and CEO	312-G Old York Hampton Highway, Yorktown, Virginia, 23692	2005			www.affordablefast.com
Air Systems, Inc.		Filtration, Air Systems	David Angelico, President	821 Juniper Crescent, Chesapeake, VA, 23320			42	www.airsystems.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	949 (FY13)	4,500+	www.ifci.com
ITC Learning		Industrial Skills Training	Gloria MacCorkindale, Vice President	13515 Dulles Technology Drive, Herndon, VA, 22171		~3	~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)	4,954 (FY13) (Flowserve)	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
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	6,735 (FY13)	~27,000	www.amec.com
DynCorp International		Security Training and Consulting	Steven F. Gaffney, Chairman and CEO	1700 Old Meadow Road McLean, VA 22102	1946	~3,000 (FY10)	16,800 (2009)	www.intellpros.com
Radiological Training Services, LLC		Radiological Training	John Duley, Producer	6538 Koziara Drive Burke, VA, 22015	1999		<5	www.radiationvideos.com/about.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	~40	~100	www.weidmuller.com

Nuclear in Virginia - Other

Entity	Logo	Nature of Activity	Leadership	Virginia Presence	Founded	Revenue/ Funding, $1M	Employees	Website
ANS		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	Chris Lumsden, 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, Executive Director Bob Bailey	1173 Research Way, Forest, VA 2455	2006		3	www.caer.us

Appendix B

Nuclear Engineering Schools and Programs

Nuclear Engineering and Related Fields of Study in Virginia 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 Programs in Nuclear-Related Fields of Study

Degree Inventory 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, Heath 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 Bachelors of Science degree in Nuclear Medicine Technology. The ODU NMED program has graduated nearly 150 students since it's 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

School of Medicine, Radiology and Medical Imaging, Division of Nuclear Medicine

The Division of Nuclear Medicine at the University of Virginia is at the forefront of modern clinical medicine and technological progress in this area. The Division 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. The Nuclear Radiology Fellowship specific goals include objectives required for every level and focused area of training, with graduated levels of supervision and responsibility. All aspects of nuclear medicine imaging and therapy are incorporated into the fellowship, including cardiac nuclear medicine. During every training rotation, the fellow will read the required material and study the teaching files in nuclear medicine. Over time, the fellow will become progressively more knowledgeable about normal scintigraphic anatomy and physiology and about the scintigraphic appearance of disease processes. The structured training provides the base for Board preparation (ABR Special Competency in Nuclear Radiology) and the clinical and academic practice of Nuclear Radiology.

The Division of Nuclear Medicine provides full diagnostic and therapeutic services with radioactive materials. Usual procedures include studies such as radionuclide imaging and functional studies of the kidney, lung, bone, liver, hepatobiliary system, thyroid and infection. Tumor imaging is provided with MIBG, Octreoscan, MIBI, radiolabeled antibodies, and I-131. Studies of the gastrointestinal tract include quantitative gastric and esophageal emptying studies, and scans for Meckel's diverticulum or gastrointestinal bleeding. Brain imaging includes cisternograms, cerebrospinal fluid flow and shunt studies, and planar and SPECT scans of cerebral blood flow. SPECT/CT is also available.

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. Therapeutic procedures include treatment of thyrotoxicosis and thyroid cancer with radioactive iodine, and radioimmunotherapy for Non-Hodgkin's lymphoma, therapy for bone pain due to bone metastases, and radiosynovectomy.

Physics Department and the Institute of Nuclear and Particle Physics support some of the leading research groups in this basic area of physics. The department, with a total of 103 graduate students, has 44 student studying Nuclear and Particle Physics. The Nuclear and Particle physics group is one of the largest such university research groups in the nation. Research carried out by this group includes topics such as: using basic nuclear and particle physics concepts to develop applications in medical imaging, nuclear material detection for national security, nuclear energy and radiation detection.

Virginia Military Institute

Degree available 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

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 homes[3]. Surry Power Station generates 1,676 megawatts of electric power from its two nuclear reactors — enough electricity to power 420,000 homes[4].
- 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 Dates[5]

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

[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

- 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 megawatts[6]. Operating capacity for the four units in Virginia in 2013 ranged from 77.7 to 96.9 percent with an average of 90.1 percent[7]. 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 application[9], a decision that was reversed in August 2013 by the US Court of Appeals for the DC Circuit[10]. The BRC issued its final report on January 2012[11]. The US DOE review of the BRC recommendations resulted in a January 2013 report[12] 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.

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[6] 150 megawatts is reflective of summer net performance

[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

- 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 managed[13].
    - 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.

Nuclear Plant Siting and Construction

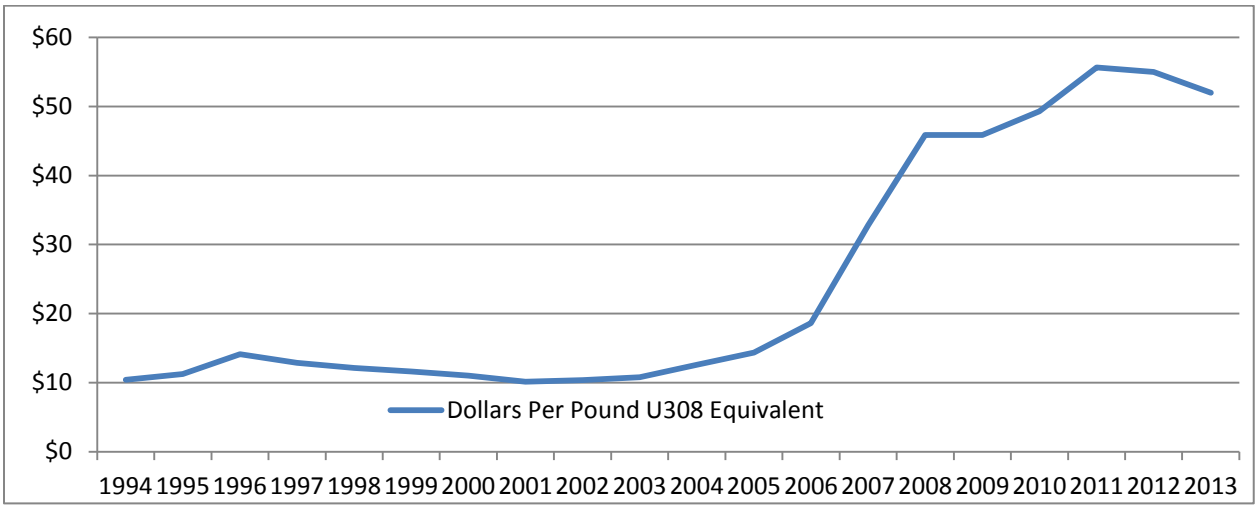
- Nuclear power plant siting is largely regulated through the licensing process of the Nuclear Regulatory Commission (NRC). Licensing requirements have been streamlined since plants were licensed in the 1960s and 1970s. Nuclear utilities now can receive an early site permit, followed by a combined construction-operating 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.

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

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).

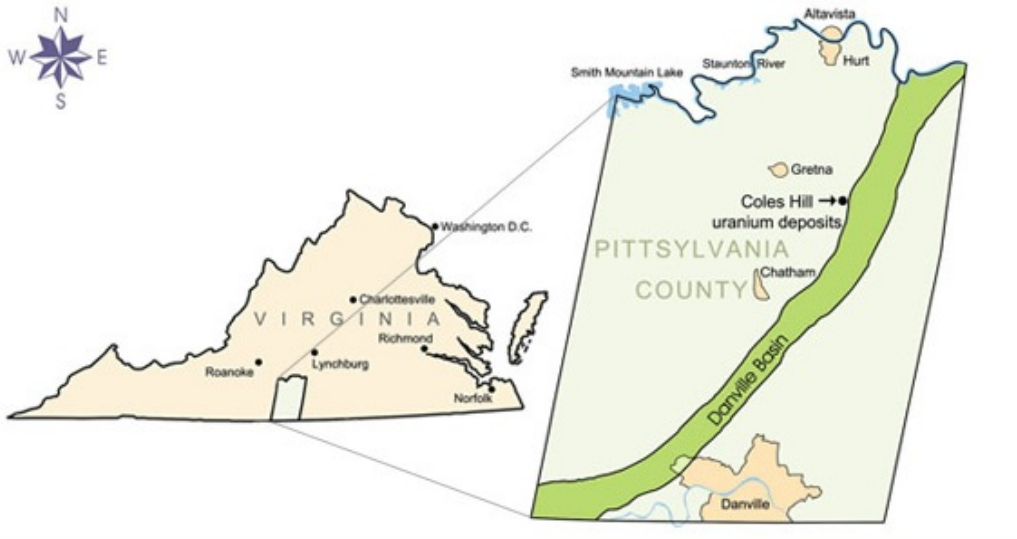
Since 1983, Virginia has had a moratorium on uranium mining. It is expected that the moratorium will remain in place for the foreseeable future.

[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

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

- 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 D

VNECA Input to the 2014 Virginia Energy Plan

VIRGINIA NUCLEAR ENERGY CONSORTIUM AUTHORITY COMMENTS FOR THE VIRGINIA ENERGY PLAN

July 31, 2014

The Virginia Nuclear Energy Consortium Authority (VNECA) was created in 2013 by the Virginia General Assembly with the purpose of making the Commonwealth a national and global leader in nuclear energy and serving as an interdisciplinary study, research, and information resource for the Commonwealth on nuclear energy issues.

Nuclear power supplies 35 - 40% of the electricity used in Virginia. Operating at more than 95% capacity, nuclear generation provides inexpensive, reliable, "24/7" electricity generation to Virginia consumers and helps keep energy costs low thus making Virginia a competitive location for business. Virginia is home to a few of the global leaders in the nuclear energy sector, such as AREVA, Babcock and Wilcox, 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 energy sector drives Virginia's economy in every region, creating high skilled jobs, supporting research and generating revenues at the state and local level.

Energy Planning

- VNECA emphasizes the importance of performing **long term energy planning**. The planning, design and implementation of the optimum infrastructure (electric grid, power plants, gas piping, etc) for an effective and efficient energy strategy takes time.
- VNECA highlights the importance of **base load capacity** ("24/7") for the reliability of the grid. Excessive reliance on intermittent energy sources (wind, solar) or on energy sources that depend on continuous delivery of fuel from offsite (natural gas) may result in instability and lack of availability of the electricity supply when it is most needed.
- VNECA stresses the importance of **long term price stability** in the selection of energy sources. Like all fossil fuels, natural gas prices have historically been volatile. Despite the present low prices resulting from the recent discovery of large reservoirs of shale gas in the US, it is unlikely that the price of natural gas will remain low in the long term, particularly in the face of increased pressure to export. The practical hedge to price volatility is to retain a diverse energy mix, including nuclear that has had historically low fuel costs.
- While the increased use of **energy efficiency (negawatts)** is certainly something that should be pursued and encouraged, VNECA recognizes the fact that the demand for energy in

Virginia is only going to increase, particularly if we want the economy in Virginia to continue to grow and we want our state to continue being economically competitive in the US and in the world. For example, we have seen a large increase in the number of data centers in Virginia and each one of them is a large consumer of electricity. Also, the use of plug-in electric vehicles has been proposed as one of the approaches to reduce carbon emissions in the transportation sector. This will result in **a net increase in the electricity demand**. Furthermore, the carbon reduction effect will only be fully realized if this electricity is produced with non-emitting electricity sources, such as **nuclear, wind and solar**.

Nuclear Power in Virginia

- VNECA encourages the 2014 Virginia Energy Plan to recognize the substantial and sustainable **contribution of nuclear power to Virginia's energy** mix, around 35 - 40% currently. This non-carbon emitting, economic and reliable base load power is key to Virginia's economy today. Virginia is one of the states with lowest electricity prices. As of July 2014, Virginia's typical residential bill is 11% below the national average, 13% below the D.C. Regional average and 19% below the East Coast average.
- VNECA encourages the 2014 Virginia Energy Plan to recognize the **substantial economic value of Virginia nuclear science and technology stakeholders**. Virginia is home to a few of the global leaders in the nuclear energy sector, such as AREVA, Babcock and Wilcox, 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 energy sector drives Virginia's economy in every region, creating high skilled jobs, supporting research and generating revenues at the state and local level.
- VNECA recommends the 2014 Virginia Energy Plan to recognize the value of nuclear power as an economic and effective way for Virginia to comply with the **new EPA GHG emissions regulations**.
- VNECA recommends the 2014 Virginia Energy Plan to support Dominion's plan to **build additional nuclear capacity** at the North Anna site.
- VNECA recommends the 2014 Virginia Energy Plan to recognize the importance of nuclear power in the reduction of carbon emissions by including nuclear power as one of the existing technologies readily available to comply with **renewable portfolio standards in Virginia.**
- VNECA recommends the support for the potential deployment of economically feasible small modular reactors, like the **Virginia-born B&W *mPower* design**, as a potential

replacement for small old coal units that may not be economically feasible to retrofit with the appropriate emissions controls necessary to meet the new EPA GHG gas regulations.

Education, Advanced Research and Technology, Workforce Development

- VNECA requests resources for **cutting-edge research in the area of nuclear science and engineering**, so that Virginia can become a leader in the US and in the world. Virginia is home of two of the only 31 nuclear engineering programs in the United States (VCU and Virginia Tech).
- VNECA requests the support for **additional nuclear workforce development** in Virginia, to continue creating high-paying jobs for Virginians, and to sustain our very important nuclear industry in the long term.
- VNECA encourages the development of **education programs** in the areas of energy generation, energy use, energy efficiency, as well as the importance of the design and implementation of a balanced energy portfolio that makes appropriate use of all available energy sources.

Appendix E

Virginia Nuclear Energy Consortium: Value Proposition

Virginia Nuclear Energy Consortium

Value Proposition

Opportunities

- Provide a stronger coordinated structure for collaboration and communication among Virginia's nuclear industry, higher education, and research assets.
- Leverage Virginia's nuclear assets and capabilities to position it as a recognized leader in the national and global nuclear energy marketplace.
- Increase the understanding of the nuclear industry's energy, economic and environmental benefits by Virginia's policy makers and the general public.

CHARGE

- In 2013, the General Assembly created the Virginia Nuclear Energy Consortium Authority.
- Purpose: "*making the Commonwealth a national and global leader in nuclear energy and serving as an interdisciplinary study, research, and information resource for the Commonwealth on nuclear energy issues.*"
- The General Assembly tasked the Authority with creating the Virginia Nuclear Energy Consortium (Consortium), a non-stock corporation, to fulfill this charge.

VALUE PROPOSITION

- The Virginia Nuclear Energy Consortium will serve as an **unified, collaborative force for nuclear science and technology in Virginia, synergizing existing resources to strengthen its overall assets and capabilities.**

- Consortium initiatives will capitalize on Virginia's unique capabilities to showcase the Commonwealth as a global Center of Excellence in nuclear and as a market destination for future growth.

- The Consortium will give nuclear in Virginia a united, powerful voice to communicate and educate policy makers and the general public on the benefits of nuclear science and technology.

CONSORTIUM INITIATIVES

Workforce Development –

Applied & Fundamental **Research** – Nuclear power, medicine, nonproliferation and safeguards

Licensing Process/Renewals

Policy – Climate change, nuclear waste, 1-2-3 agreements, CSIS (Center for Strategic and International Studies)

Education – Conferences/Workshops

University Approach – Professorships, scholarships, R&D

R&D Grants – Improved competitive position for public/private funding

Commercialization

CONSORTIUM FOUNDING BOARD MEMBER

$25K annual commitment (starting October 1, 2014)

- Performance Period: October 1, 2014 – December 31, 2015

Consortium Board will direct and prioritize activities and resources of Consortium, hire an executive director and establish bylaws, procedures and processes to govern the Consortium.

Funds will be used to hire staff, develop website and marketing materials and perform other activities and initiatives as determined by Consortium Board.

Appendix F

VNECA Approved 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

2015 VNECA Board Members

Virginia Nuclear Energy Consortium Authority
Board Members - 2015

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

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 – Woody Lawman, Flowserve
Member – Maureen Matsen, Christopher Newport University
Member – Matthew Mulherin, Newport News Shipbuilding
Member – Ganapati Myneni, Jefferson Labs
Member – Pam Norris, University of Virginia
Member – Tim Stuller, Virginia Economic Development Partnership
Member – Mark Troutman, George Mason University