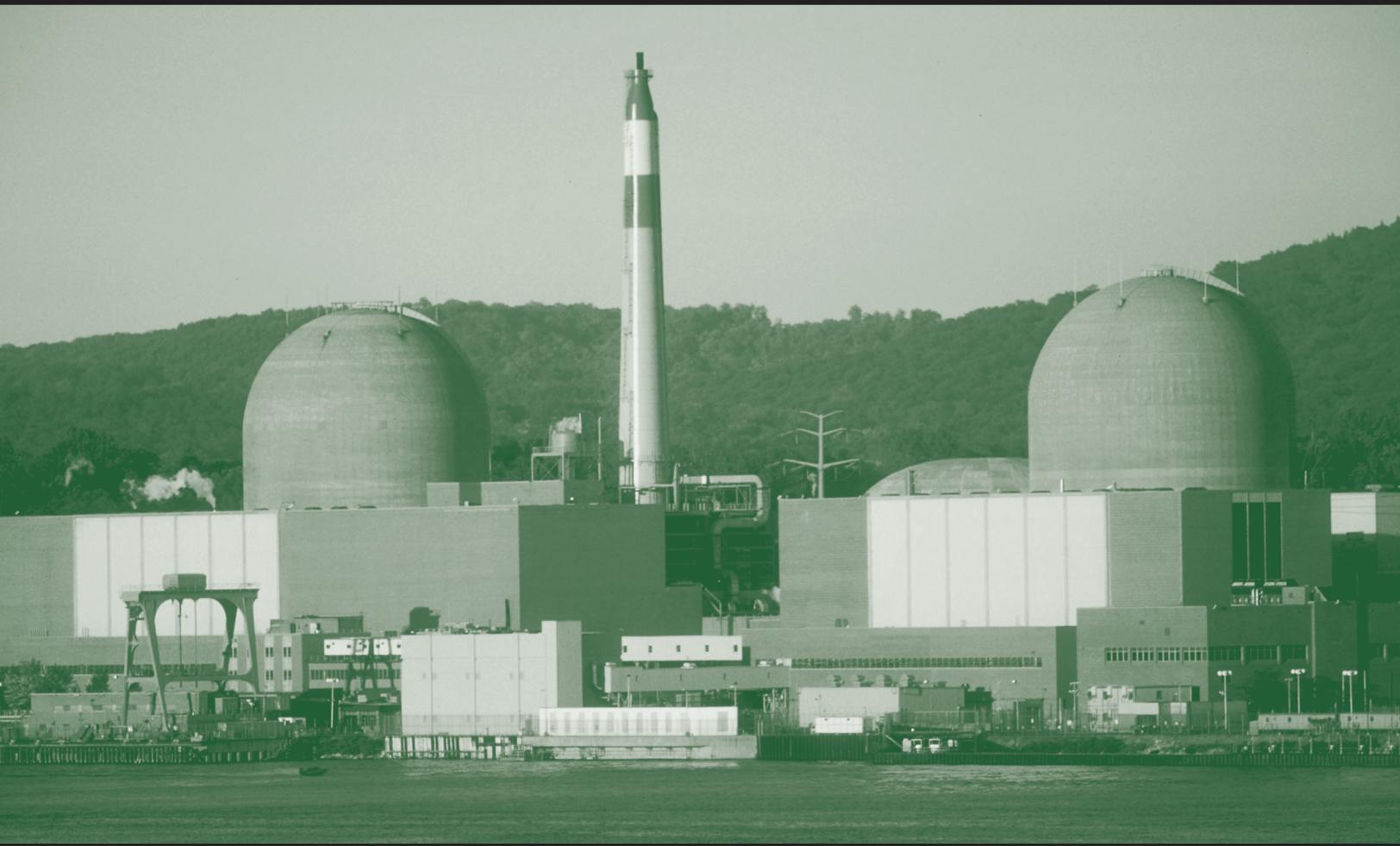


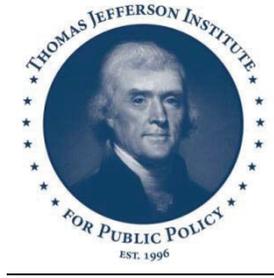
VIRGINIA CAN LEAD THE NATION'S NUCLEAR RENAISSANCE

JUNE 2015



THE THOMAS JEFFERSON INSTITUTE
FOR PUBLIC POLICY

Th. Jefferson



Thomas Jefferson Institute for Public Policy

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INTRODUCTION

The Thomas Jefferson Institute for Public Policy has long been interested in the issues of Energy and Environment here in Virginia. Indeed, our Center for Energy and Environmental Stewardship has been an important part of our activities for many years.

This paper, *Virginia Can Lead the Nation's Nuclear Renaissance*, is of particular importance to our commonwealth. As our society struggles with the issue of Climate Change, we have a sincere disagreement among our citizens on whether Global Warming exists, if it does where does human activity play a role, and regardless of this issue where should public policy be focused and what should industry do to help the environment and provide for our economic well-being.

And a big factor in all of this is how we plan to provide the required energy to keep our standard of living where it is today and growing into the future. Today, there are three proven sources of energy production: carbon based fuels, hydro-electric and nuclear power. The “renewable energy” alternatives of wind and solar are in their infant stages and may not prove to be viable for replacing carbon.

However, we do know that nuclear power works and is clean. Over the past several decades it has proven safe here in the United States. Even the famous Three Mile Island nuclear accident did not cause significant harm. Some countries such as France rely more heavily on nuclear power than we do and it has proven to be safe and reliable.

This paper is provided to allow its readers to better understand nuclear power and the key position Virginia can be in reviving this part of our energy industry. As we debate off-shore drilling and the exact avenue to be taken by the natural gas pipelines coming into Virginia, nuclear power seems to be a natural source of energy that needs more understanding and a bigger “push” for reaching our long-term energy needs.

Rob Hartwell and Don Hoffman provide us with good facts and figures on the nuclear power industry and the role Virginia is positioned to play in that industry if we take advantage of our available capabilities and resources.

I hope you enjoy reading this paper and that it provides a better understanding of nuclear power and its capabilities.



A handwritten signature in blue ink that reads "Michael W. Thompson". The signature is fluid and cursive.

Michael W. Thompson, Chairman & President
Thomas Jefferson Institute for Public Policy



Virginia Can Lead the Nation's Nuclear Renaissance

Affordable electricity and environmental stewardship are twin pillars supporting the continued economic growth of our nation. The use of non-carbon based energy generation is expanding - especially wind and solar power - but it is clear that carbon-based energy, such as coal and natural gas, will be a major contributor to electric generation for the foreseeable future. Wind and solar power are variable, unpredictable sources that rely on other forms of generation to ensure reliable power to homes and businesses. To move beyond carbon-based generation as the backbone of our electrical system, the cleanest and most reliable alternative is nuclear energy.

The enclosed paper co-written with my friend Rob Hartwell does an excellent job highlighting the potential of nuclear generated electricity, and how Virginia can expand our leadership role in this important energy field.

I am proud to add my name to this effort by the Thomas Jefferson Institute to bring better understanding of nuclear energy and its vast potential to our leaders in Virginia. Our Commonwealth and our nation should move forward in the development of this vital clean energy source.

Donald R. Hoffman

Donald R. Hoffman is Chairman of the Virginia Nuclear Energy Consortium Authority and the Immediate Past-President of the American Nuclear Society. Mr. Hoffman is President and Chief Executive Officer of Excel Services Corporation, an international nuclear engineering consulting firm.



VIRGINIA CAN LEAD THE NATION'S NUCLEAR RENAISSANCE

BY: ROBERT HARTWELL AND DONALD HOFFMAN

America is currently leading a world energy revolution! Just a few short years ago, dire predictions made headlines about America running out of fossil fuels, about our need to reduce carbon emissions to combat global warming, and the terrible accident at Fukushima set back world nuclear power just when its potential for clean green energy was being recognized globally. But now with huge oil shale deposits and fracking developing massive new oil and gas reserves, and America leading globally in carbon reduction, it is a perfect time to embrace new nuclear technologies and opportunities to ensure clean energy security for the future. Virginia can be in the vanguard of this effort and is perfectly positioned to do so.

Experts have found that the average nuclear power plant generates \$470 million in sales of goods and services annually. One plant provides approximately \$40 million in labor income each year and 400 to 700 full time permanent jobs which pay 36% more than other local jobs. Each plant also generates an average of \$16 million in state and local tax revenue for schools, roads and hospitals. Currently, Virginia has four nuclear power plants operating, North Anna 1 and North Anna 2 in Louisa County and Surry 1 and Surry 2 in Surry County, providing approximately 3500 megawatts of power to consumers and businesses across the Old Dominion. These reactors, because they run nearly full time, produce nearly 36% of Virginia's electricity. While Virginia ranks only 14th in nuclear generating capacity, it has a potential for much more, and other plants are being considered at North Anna. Virginia is in a perfect position of all the states to lead the much needed renaissance toward clean, green, carbon free nuclear power for multiple reasons. In addition to the need for 4,000 megawatts of new power generation by 2021¹, Virginia's federal government installations, military bases and pro-business climate will create a huge demand for nuclear as a key component of its energy production and policy.

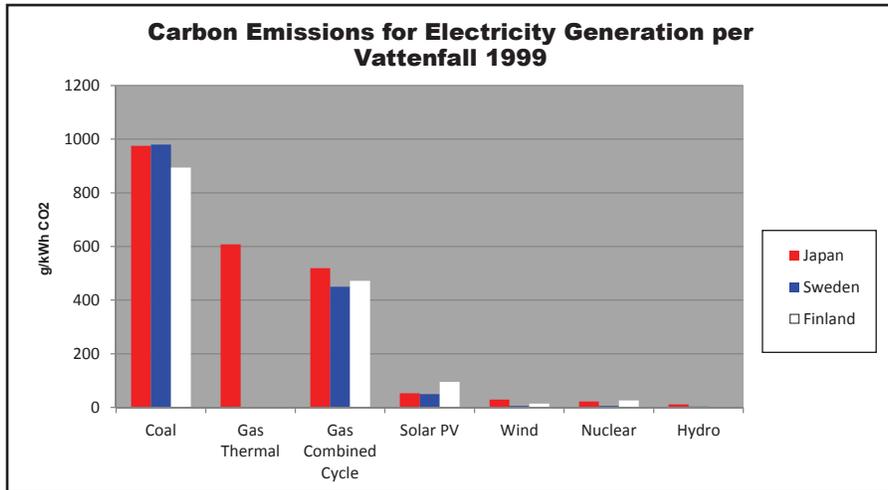
Nuclear Power is Safe, Clean, Green Energy

Despite some public perception, there has never been a nuclear power plant accident in the United States resulting in radiation being emitted into the atmosphere. While cultural and regulatory factors led to disasters in Russia and Japan at Chernobyl and Fukushima, the strict oversight of nuclear power in America by the Nuclear Regulatory Commission and close scrutiny by public advocates, the press and regulators provide us with the highest standard in the world... and safest nuclear industry as well. In addition to an exemplary safety record, nuclear power lessens the impact on climate change due to its almost nonexistent emissions, according to the United Nations' Intergovernmental Panel on Climate Change special report in 2012, "Renewable Energy Sources and Climate Change Mitigation." The following graph produced by Swedish power company Vattenfall from page 19 shows that nuclear power's calculated lifecycle emissions are comparable to other non-emitting renewables². Most reports on reducing Greenhouse Gas (GHG) emissions to mitigate climate change by non-industry organizations and sources agree that nuclear power is a key component of any carbon reduction solution.

¹ PJM long-range forecast, January 2011 – Dominion Power

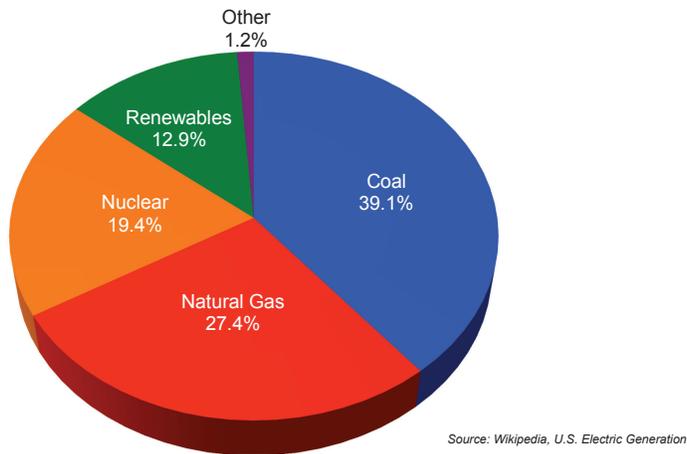
² http://srren.ipcc-wg3.de/report/IPCC_SRREN_SPM.pdf





Note that one study found nuclear to emit less GHG emissions than all power sources other than hydropower. The following chart demonstrates that nuclear power is the largest source of non-carbon emitting pollution in the world.

U.S. 2013 Electricity Generation By Type



Nuclear Plant Safety in Virginia

To date, there have been no accidents of any kind involving nuclear power in Virginia, this despite the fact that nuclear power is widespread and has even involved experimental plants and facilities over the years. In Norfolk and Newport News, dozens of nuclear powered ships have been docked, commissioned or built over the years, and experimental reactors have even been operating at Fort Belvoir, Virginia in Fairfax County close to Washington, DC and on the U.S.S. Sturgis, a liberty ship which operated with a nuclear reactor in Gunston Cove off of Ft. Belvoir before being moved to the Panama Canal and then mothballed on the James River near Richmond.

During the 5.8 earthquake centered in Louisa County in August 2011, the North Anna 1 and 2 plants automatically shut down and were carefully checked before restarting nearly 90 days later. No damage occurred although some of the nuclear storage casks were moved closer together and some slid more than 4.5 inches.



Virginia Can Lead in New Nuclear Technologies and Exportable Power

Recently, Virginia has been ranked as the second largest importer of power of all 50 states, with only California ahead of us.³ By 2021, Virginia will need over 4,000 megawatts of additional power just to meet demands, an amount equal to four large nuclear reactors. With the Japan Fukushima nuclear disaster still on the minds of the public, some are again questioning the safety of nuclear power, and those fears threaten the development of much safer, next generation technologies. One key, safe and innovative solution under design and pending approval at the Nuclear Regulatory Commission is Small Modular (nuclear) Reactors (SMRs).

First, the Fukushima disaster could have easily been avoided. Even the older plant design could have withstood the tremendous earthquake, but generators placed below sea level and a Tsunami wall that was 7 meters too low allowed the emergency power to fail, causing overheating and nuclear fuel failure. Here in the United States we have no similar scenarios. Some new technologies ready for design certification and licensing do not even need water for cooling. These SMR designs include some with no pumps or emergency power backups required. Ranging between 10 to 200 megawatts, new plants being considered by Babcock and Wilcox, Westinghouse, Starcore Nuclear and NuScale, would provide much safer, new designs that represent the best and safest technologies America has to offer.

Many are built underground with modules that can be increased in number to meet power demands, with smaller land footprints and no possibility of contaminating water. Virtually the only issue remaining with some of these designs is what to do with spent fuel or reactor cells, an issue that federal policymakers must resolve. Meanwhile, traditional nuclear power has been stymied due to high regulatory and infrastructure costs and the low but volatile cost of natural gas. This has harmed consumers, threatened our energy independence and impeded our ability to compete abroad. Until recently, no new plants had broken ground in over 30 years. In France, over 75 percent of the power is provided by clean and safe nuclear energy⁴, but in America, less than 20 percent of our power derives from nuclear sources.

Another key component of the need for a nuclear renaissance and new technologies is jobs. During the last 30 years, while America's nuclear technology has been stymied, our international competitors have thrived. Russia, China, Korea and France are exporting nuclear power and expertise, while we sit on the sidelines. Shortly, the Chinese will be building and exporting U.S. designed nuclear power plants internationally while we do nothing. A domestic resurgence of nuclear power would make us more competitive, provide consumers with lower cost, safe power, and create jobs. From site preparation, to construction, engineering, security and high tech operations, nuclear power plants could employ tens of thousands of Virginians.

A national energy "Apollo" type program should be enacted in consultation with industry, labor and government, to target creating one million new clean energy jobs⁵; energy independence; the protection of a secure power grid for security and critical infrastructure, and a secure energy supply including clean and safe nuclear power now!

Nuclear Power in Virginia: Sensible Economics

As recently as 2011, studies found that nuclear power generated in Virginia was the least expensive of any power generation source. The cost per kilowatt hour was estimated to be only .6 cents per kilowatt hour, compared to 3.5 cents for coal and 4.5 cents for natural gas.

³ PJM long-range forecast, January 2011 – Dominion Power

⁴ Wikipedia

⁵ AEHI CEO Article, Sept. 4th 2010 (1,000,000 jobs), DOE 2004 U.S., Job Creation Due to Nuclear Power Resurgence in the United States (700,000 jobs)



Why Virginia is Uniquely Suited for Nuclear Power

In addition to Virginia's favorable business climate and affirmation of its support for nuclear power via the establishment of the Virginia Nuclear Energy Consortium (VNEC) in 2013, the sheer number of nuclear operations and nuclear related facilities, engineering schools and federal facilities and critical infrastructure which could benefit from safe and secure nuclear power is breathtaking. Altogether, nuclear power in Virginia today provides tens of thousands of jobs and over a billion dollars in revenues and economic activity. Listed below are dozens of private, public and non-profit entities related to nuclear power accounting for billions of dollars in economic activity.

Some of Virginia's Nuclear-related Companies

- Areva
- Babcock and Wilcox
- Bechtel Power Corporation
- Bridgeborn
- Dominion Power
- Excel Services Corporation
- Fluor Daniel Services Corporation
- GE Hitachi Nuclear America
- Huntington Ingalls (Newport News Nuclear)
- MHI Nuclear Energy Systems Inc.
- Siemens
- The Atlantic Group
- Thorium Power (Lightbridge)
- Toshiba America Nuclear Energy

Virginia's Nuclear-related Schools, Non-profits and Engineering Programs

- American Nuclear Society (Virginia)
<http://www.ans.org/about/>
- Center for Advanced Energy Research – See Appendix I
- George Mason University
- Jefferson Laboratories/NASA – See Appendix I
- Old Dominion University
- University of Virginia
- Virginia Commonwealth University
- Virginia Polytechnic University

Government Nuclear Related Facilities or Organizations

- Newport News Shipyards -
<http://nns.huntingtoningalls.com/>
<http://nnn.huntingtoningalls.com/>
- Norfolk Navy Base -
http://en.wikipedia.org/wiki/Naval_Station_Norfolk
- Langley Air Force Base –
http://en.wikipedia.org/wiki/Air_Combat_Command



- Mount Weather - http://en.wikipedia.org/wiki/Mount_Weather_Emergency_Operations_Center
- The Pentagon - http://en.wikipedia.org/wiki/The_Pentagon
- Virginia Nuclear Energy Consortium – See Appendix I

Due to the amazing number of nuclear related facilities and Virginia’s critical infrastructure related to national security, it makes perfect sense that Virginia should lead the way in nuclear technology and new and innovative ideas to provide safe and secure power that is also, if necessary, off grid. For instance, the development of new Small Modular Reactors (SMRs) to protect critical military and security infrastructure and the availability of large tracts of government land could pave the way for the development of nuclear power for national security. Underground SMRs placed in key locations at key government facilities, underground and immune from electromagnetic pulse attacks or power grid sabotage make total sense. These new safe SMR designs with passive safety systems requiring no emergency power could showcase nuclear power in the 10 to 45 megawatt range to ensure continuous operations of key security facilities and critical infrastructure during national emergencies.

From Tidewater, to Washington, to secure classified facilities in our rural countryside, SMRs dedicated to providing emergency power or continuous power off grid could pave the way for an entire new generation of safe smaller nuclear facilities in key locations across Virginia; creating tens of thousands of high paying construction, engineering and operations jobs. From national law enforcement and security installations to the critical high tech infrastructure and internet backbone in Northern Virginia, reliable power is more critical than ever and makes us more vulnerable if not protected and secured from sabotage or attack. And due to the proposed rapid phase out of coal fired power plants, which provide a significant share of power in Virginia and the region, clean, emission free nuclear power is even more important and in higher demand.

The Virginia Nuclear Energy Consortium

In 2011, our quest began, and working with staff at Excel Services and discussing the need for SMRs and we began looking for a State to showcase nuclear innovation and exciting new designs for nuclear power plants. In Maryland, partially due to the Office of Management and Budget imposing huge fees as guarantees for new nuclear construction at Calvert Cliffs, a new facility was not able to move forward as planned by Constellation Energy. This setback had me focus even more on Virginia and its positive business climate and critical infrastructure needs.

Working with our team at Excel, we came up with the idea for a non-profit consortium to promote nuclear power in Virginia and contacted Governor Bob McDonnell and his staff to explore the possibility. We found that his Administration was already working hard on a very similar idea. His work resulted in the overwhelming passage of legislation to establish the Virginia Nuclear Energy Consortium (VNEC) and mandate the inclusion of many of the top companies, universities and non-profits as discussed previously. I (Donald) now serve as Chairman of VNEC and am hopeful that this effort will result in moving forward with plans for the location of SMR and other innovative nuclear technology in Virginia. And I hope to see the completion of plans by Dominion Power to build new plants at Lake Anna and other locations. We need a significant expansion of nuclear power in the Commonwealth and the region.



Conclusion

Virginia is poised to capture a major portion of the global nuclear technology market, recently estimated by the U.S. Department of Commerce to approach \$750 billion over the next 10 years. If we were able to capture 25% of that amount in the U.S., over 185,000 high-paying jobs would be created and sustained.

During its history, Virginia leaders have been in the forefront of American ingenuity and leadership, from George Washington and Thomas Jefferson, to Cyrus McCormick and John Paul Jones, to George C. Marshall, Dr. Walter Reed, Booker T. Washington and our former Navy Secretary and Senator John Warner. It is paramount that today's political, military and intellectual leaders in the Commonwealth band together to support Virginia's role in creating a nuclear renaissance and leading the way toward future energy security and innovation. It is a long term strategy we must embrace; one that recognizes the power of the atom, its natural clean carbon free structure, and its ability to operate safely in a future depleted of fossil fuel and clean coal resources.

Supporting the newly created Virginia Nuclear Energy Consortium is a first step, as well as backing our schools and nuclear related organizations to the fullest extent possible. Providing pathways forward for new SMRs and new build nuclear plants to ensure continued safe access to low cost on grid power for industry and off grid secure power for our critical infrastructure must be short-and longer-term goals for Virginia's leaders, who again will demonstrate their vision and leadership for our great nation.



APPENDIX

Information on Nuclear Related Entities in Virginia

Center for Advanced Energy Research (CAER)

We are an industry-led research center in Virginia's Region 2000 that provides a research university environment. We bring together private and public money, talent and resources to foster knowledge creation, facilitate technology transfer, improve the scientific and engineering workforce, and serve as an "innovation intermediary" to benefit regional industry.

The CAER targets growth industries and high tech industries in Region 2000 and works to establish effective and beneficial relationships between these industries and major R&D resources, resulting in innovation and the practical implementation of innovation in the region's industries and professional development opportunities for scientists and engineers. As a result, the CAER continues to drive a shift from traditional economic development activities to Technology-Based Economic Development (TBED) activities in the region.

Thomas Jefferson National Accelerator Facility (Jefferson Lab)

Jefferson Lab is one of 17 national laboratories funded by the U.S. Department of Energy. The lab also receives support from the City of Newport News and the Commonwealth of Virginia.

The lab's primary mission is to conduct basic research of the atom's nucleus using the lab's unique particle accelerator, known as the Continuous Electron Beam Accelerator Facility (CEBAF). Jefferson Lab also conducts a variety of research using its Free-Electron Laser, which is based on the same electron-accelerating technology used in CEBAF.

In addition to its science mission, the lab provides programs designed to help educate the next generation in science and technology, and to engage the public.

Managing and operating the lab for DOE is Jefferson Science Associates, LLC. JSA is a limited liability company created by Southeastern Universities Research Association and PAE Applied Technologies.



Virginia Nuclear Energy Consortium Authority

12/12/2013 5:08:00 PM - Press Release from Office of Governor Bob McDonnell

Consortium to promote Virginia's role as a key leader in nuclear energy

RICHMOND - Governor Bob McDonnell announced today the election of leadership to the newly formed Virginia Nuclear Energy Consortium (VNEC) Authority. The 17-member board of directors has elected as its chairman Marshall Cohen, Vice President of Government Affairs and Communications at The Babcock and Wilcox Company. The board elected Donald Hoffman, President and CEO of Excel Services Corporation and President of the American Nuclear Society, to serve as its vice-chairman. Sama Bilbao y Leon, Associate Professor and Director of Nuclear Engineering Programs at VCU was elected Treasurer for the Authority. Bob Bailey, Executive Director of the Center for Advanced Engineering & Research was elected as Secretary. "Nuclear energy is an important piece of our 'all of the above' approach to energy development not just in Virginia, but across our nation," said Governor McDonnell. "Virginia has a unique opportunity to lead in the nuclear energy sector, creating jobs for our citizens, developing a workforce that can meet the needs of the industry and conducting research to advance new nuclear technologies. We are home to two nuclear power generation facilities, operated by Dominion Virginia Power, a shipyard that builds the nation's nuclear Navy, strong research institutions expanding their work in nuclear engineering and related fields, Babcock & Wilcox, Areva and other significant companies in the nuclear energy sector. Bringing these assets together around the table to develop research partnerships, workforce pipelines, information resources and educational opportunities will support and expanding industry and be good for all Virginians. I thank the newly elected leaders for their service and commitment to making Virginia a nuclear energy leader."

Following today's meeting of the VNEC Authority, Chairman Marshall Cohen said, "I appreciate the opportunity to lead the Virginia Nuclear Energy Consortium in its first year as we work to promote Virginia's rich, diverse and important nuclear industry and encourage additional collaboration and partnerships here in the Commonwealth. Nuclear energy is responsible for thousands of good-paying jobs and millions of dollars in economic activity in Virginia. We appreciate Governor McDonnell and the General Assembly's leadership in the formation of the consortium and for recognizing the importance of nuclear industry in Virginia. I look forward to continuing our important work with Governor-elect McAuliffe in the coming years."

The VNEC Authority was formed as a result of Governor McDonnell's legislation during the 2013 session of the General Assembly. Senator McWaters patroned [SB1138](#) and Delegate Scott Garrett patroned [HB1790](#) to establish the Virginia Nuclear Energy Consortium Authority as a political subdivision of the Commonwealth for the purposes of making the Commonwealth a national and global leader in nuclear energy and serving as an interdisciplinary study, research, and information resource on nuclear energy issues.

About The Authors

Robert Hartwell is President of Hartwell Capitol Consulting LLC, a firm that specializes in technology innovation, funding and business development, concentrating in energy, environment and security. A former Congressional Chief of Staff and lobbyist, Rob was also a Virginia Commissioner on the Interstate Commission on the Potomac River Basin, a Fairfax County Virginia Planning Commissioner and serves on or held key Board positions in numerous environmental organizations.

Donald Hoffman is immediate past President of the American Nuclear Society, Chairman of the Virginia Nuclear Energy Consortium and President and CEO of Excel Services Corporation.



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John Rust: Former State Delegate and Partner, Rust and Rust law firm.

John Ryan: Former Senior Counsel and Director of Gov't Affairs for Bristol Myers Squibb.

Robert W. Shinn: President of Public Affairs, Capitol Results

Dr. Robert F. Turner: Law professor at the University of Virginia at Charlottesville.



“... a wise and frugal government, which shall restrain men from injuring one another, shall leave them otherwise free to regulate their own pursuits of industry and improvement, and shall not take from the mouth of labor the bread it has earned. This is the sum of good government, and this is necessary to close the circle of our felicities.”

Thomas Jefferson, 1801

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