COMMONWEALTH of VIRGINIA

James F. Lane, Ed.D.
Superintendent of Public Instruction

DEPARTMENT OF EDUCATION
P.O. BOX 2120
Richmond, Virginia 23218-2120

Office: (804) 225-2023
Fax: (804) 371-2099

November 21, 2019

The Honorable R. Steven Landes
Chairman, House Education Committee
Virginia General Assembly
P.O. Box 12
Verona, Virginia 23219

The Honorable Stephen D. Newman
Chairman, Senate Education and Health Committee
Virginia General Assembly
P.O. Box 480
Forest, Virginia 24551

Dear Delegate Landes and Senator Newman:

I am pleased to transmit the attached progress report for the new energy career cluster as required by House Bill 2008 and Senate Bill 1348 from the 2019 General Assembly Session.

The Virginia Department of Education's Office of Career, Technical, and Adult Education conducted research on the Virginia energy sector and on national practices in energy career clusters, as well as convened industry and educational stakeholder groups to begin the development of a new energy career cluster in Virginia. This report results in action to establish an energy cluster with four pathways, and courses for each pathway, which will be available for statewide school division implementation by July 2020. This report presents research conducted by VDOE partners, as well as deliberations and decisions made in expert working panels on the structure and content of the cluster and pathways.

If you have questions or require additional information, please do not hesitate to contact George R. Willcox, by email at George.Willcox@doe.virginia.gov or by telephone at (804) 225-2052.

Sincerely,

James F. Lane

JFL/lms

Enclosure

c: The Honorable Atif Qami

REPORT

Virginia Department of Education

House Bill 2008

and

Senate Bill 1348

SUBMITTED TO:

House Committee on Education

and

Senate Committee on Education and Health

Virginia Department of Education

November 21, 2019

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I. Introduction and Purpose

The energy industry is the foundation for and a vital economic driver of Virginia's ability to grow and thrive. It provides gainful employment to many Virginians. Homes, businesses, and economic activity statewide rely on stable, reliable, and affordable energy systems, making it vital that educational programs provide the industry with capable employees and prepare the Commonwealth's workforce with the skills needed to succeed in energy-related jobs. With this in mind, the 2019 session of the Virginia General Assembly enacted Senate Bill 1348 (Appendix A) as follows:

> *"The Department of Education, in consultation with representatives from pertinent industries such as renewable energy, natural gas, nuclear energy, coal, and oil, shall establish as its seventeenth approved career cluster an energy career cluster. In developing the energy career cluster, the Department of Education shall base the knowledge and skill sets contained in such career cluster on the energy industry competency and credential models developed by the Center for Energy Workforce Development in partnership with the U.S. Department of Labor."*

The creation of a 17th career cluster in energy will:

- promote development of needed skills for the energy workforce
- raise awareness to students of opportunities for careers in the energy industry
- elevate to schools, teachers, parents, and students the importance of an energy curriculum
- provide resources to grow programs and courses designed around energy.

CAREER CLUSTERS

are occupational categories with industry-validated knowledge and skills statements that define what students need to know and be able to do in order to realize success in a chosen field. Within each of the clusters, programs of study (also called "career pathways") outline sequences of academic, career, and technical courses and training that begin as early as ninth grade and lead to progressively higher levels of education and higher-skilled positions in specific industries or occupations

Definition of career clusters from the United States Department of Education

Pursuant to Senate Bill 1348 (2019), the Virginia Department of Education Office of Career, Technical, and Adult Education conducted research on the Virginia energy sector and on national practices in energy career clusters, and convened deliberations among industry and educational expert working groups to develop a structure for the new energy career cluster in Virginia. This report results in action to establish a new career cluster with four pathways, and courses for each pathway, which will be available for statewide school division implementation by July 2020. This report presents research conducted by the Weldon Cooper Center for Public Service at the University of Virginia, as well as deliberations and decisions made in expert working panels on the structure and content of the cluster and pathways. Those participating in the design and content of the new cluster are identified in Appendix B.

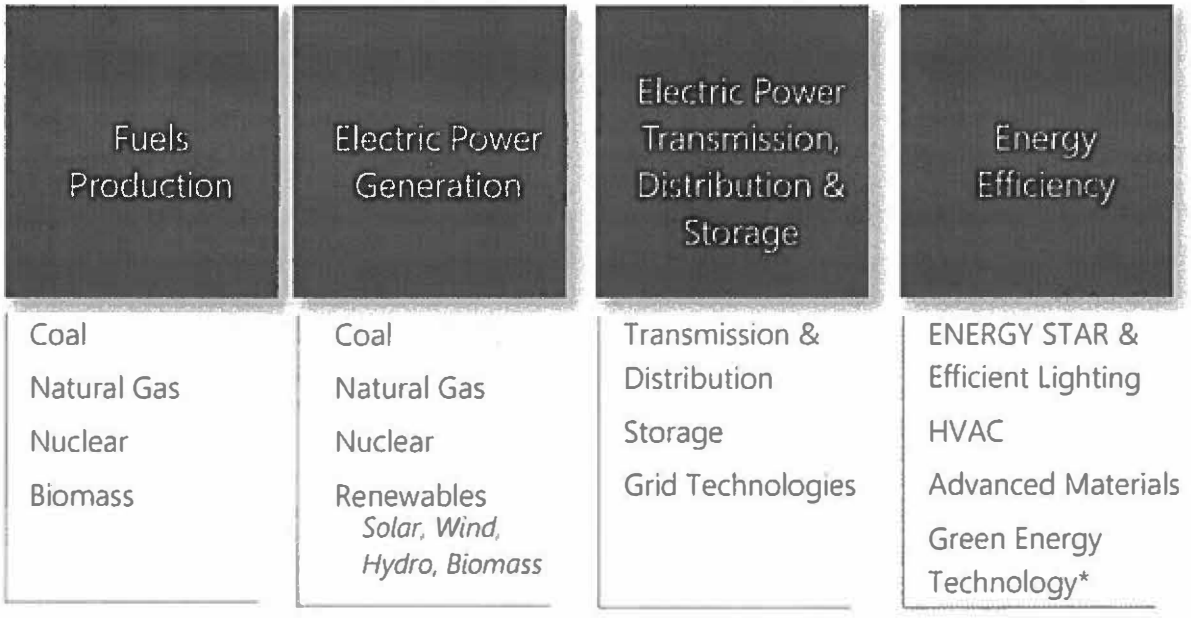
II. Research on Current and Projected Energy Industry Data

The energy industry is complex and currently comprises occupations that span other career clusters and industries. In order to structure an energy career cluster, this section of the report presents data organized into the following categories:

I. **The broad structure and sectors of the energy industry**
II. **The nature of the industry in Virginia, including trends**
III. **Identified jobs in the industry**
IV. **The Virginia Energy Plan, which will affect job growth, and**
V. **Employment projections for selected energy jobs in Virginia**

A. ENERGY INDUSTRY SECTORS

This report utilizes the sector classification identified by the Energy Futures Initiative (EFI) and the National Association of State Energy Officials (NASEO) in their annual U.S. Energy & Employment Report (USEER). This classification was originally adopted by the U.S. Department of Energy (DOE) in 2016, and has been further refined since. Jobs and occupations within the energy industry can be categorized roughly under these sectors. While not perfect, they provide the structure needed for differentiation and discussion.



**Green energy technology, generally thought to include methods of energy production, generation, transmission, distribution, and storage that provide the least environmental impact, can apply to each of the energy industry sectors outlined above. While the U.S. Environmental Protection Agency defines green power as electricity produced from renewable sources (solar, wind, geothermal, biomass, or hydroelectric), less environmentally-impacting coal or natural gas extraction techniques, nuclear fuel, and smart grid electricity transmission technologies can be understood as "green" as well.*

The Fuels Production sector incorporates occupations involved in accessing the natural resources used as fuel, including extraction, mining, and processing. It can be subdivided into four main categories: coal, natural gas, nuclear, and biomass. This sector does not include the distribution and storage of these materials.

The Electric Power Generation sector represents occupations that directly assist the utility and non-utility generation of power, including four primary technologies: coal fired electric generation, natural gas fired electric generation, nuclear power generation, and the generation of power through renewable technologies. Renewable technology as it applies to Virginia includes solar, wind, hydroelectric, and biomass.

The Transmission, Distribution, and Storage sector encompasses occupations associated with constructing, operating, and maintaining energy infrastructure such as power lines, power and pipeline construction, fuel distribution and transport, and the manufacture of electrical transmission equipment. This sector does not include retail sale of gasoline and other liquid fuels to consumers, but it does encompass careers associated with the wholesale trade and distribution of energy commodities. This sector can be divided into three main categories: traditional transmission and distribution of electricity and fuels, storage of electricity and fuels, and grid technologies.

The Energy Efficiency sector involves occupations engaged in the production and installation of energy-saving products and the provision of services that reduce end-use energy consumption. This sector can be divided into four primary categories: ENERGY STAR & efficient lighting; heating, ventilation, and air conditioning (HVAC); advanced materials; and other. This is the only sector with an "other" subsector due to the wide range of occupations that can fit into this sector. Careers in energy policy, law, or advocacy could fit under this category.

B. TRENDS IN THE VIRGINIA ENERGY INDUSTRY

Keeping the structure of the industry in mind, the energy career cluster will reflect the energy industry in Virginia, both in its current state and in light of anticipated changes. The following data provide a broad outline of the industry.

While Virginia's per capita total energy consumption is below the national average,[1] the state consumes more than two and a half times more energy than it produces.[2] Virginia receives power from thirteen Mid-Atlantic and Midwestern states plus the District of Columbia through the regional transmission organization PJM Interconnection.[3] This gap in energy production suggests potential for Virginia to grow its electric power generation sector.

The following section details data available for the first two sectors listed above, Fuels Production and Power Generation. The other two sectors, Electrical Power Transmission, Distribution, and Storage; and Energy Efficiency are more difficult to describe through data (such as quantities produced). Their employment numbers and expected growth is, however, captured by survey work done by the Energy Futures Initiative and presented in the sections below.

[1] U.S. Energy Information Administration (EIA), State Energy Consumption Estimates, 2017

[2] U.S. Energy Information Administration (EIA), State Energy Data System, 2019

[3] Federal Energy Regulatory Commission, Regional Transmission Organizations (RTO)/Independent System Operators (ISO)

Fuels Production and Production Trends

COAL

Figure 1 illustrates that coal (37 percent) and nuclear (35 percent) represented the two largest sources of energy for Virginia in 2018, with renewables (15 percent) and natural gas (13 percent) also contributing a notable supply.

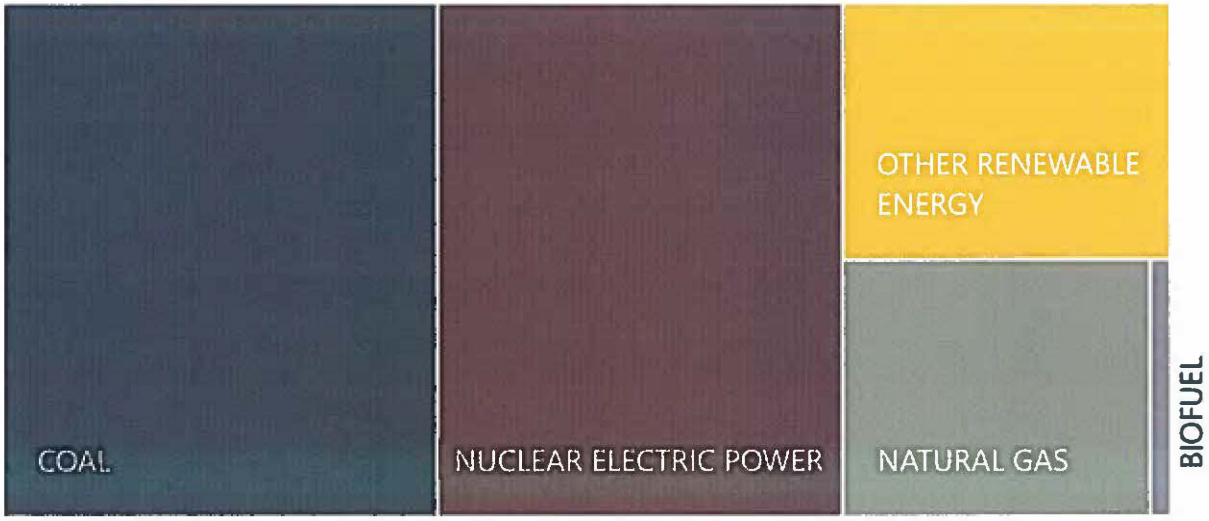


Figure 1: Fuels Production estimates by type for Virginia, 2018

Source: U.S. Energy Information Administration (EIA)

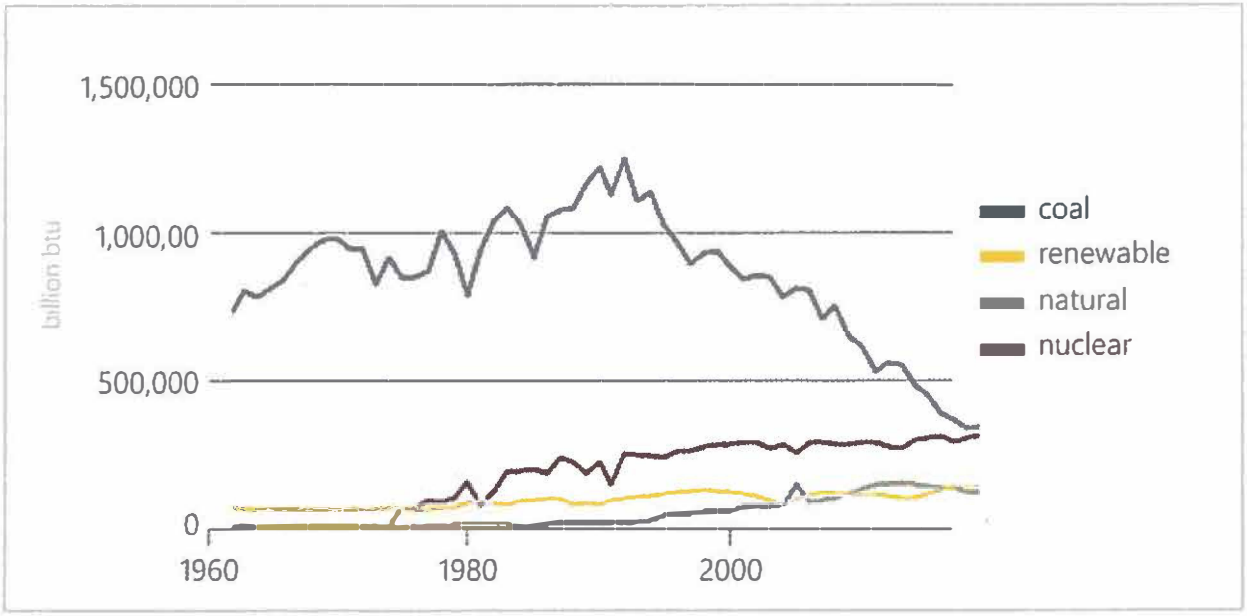


Figure 2: Fuels Production estimates by type for Virginia, 1960-2018

Source: U.S. Energy Information Administration (EIA)

However, production of coal is declining (Figure 2) as is its productive capacity,[4] which has decreased by more than half in the past 17 years.[5]

NATURAL GAS

Although Virginia's natural gas production has increased substantially during the past three decades[6] (Figure 2), production still equals only slightly more than one-fifth of state demand,[7] and has leveled off in recent years, decreasing from its peak in the early 2010s. Most of Virginia's natural gas supply is delivered by several major interstate natural gas pipelines, as the state holds less than 1 percent of the nation's total natural gas reserves.[8] There is potential for growth, however, in coalbed methane natural gas. The state contains one-fifth of U.S. coalbed methane proved reserves, the third-largest amount of any state.[9]

POWER GENERATION

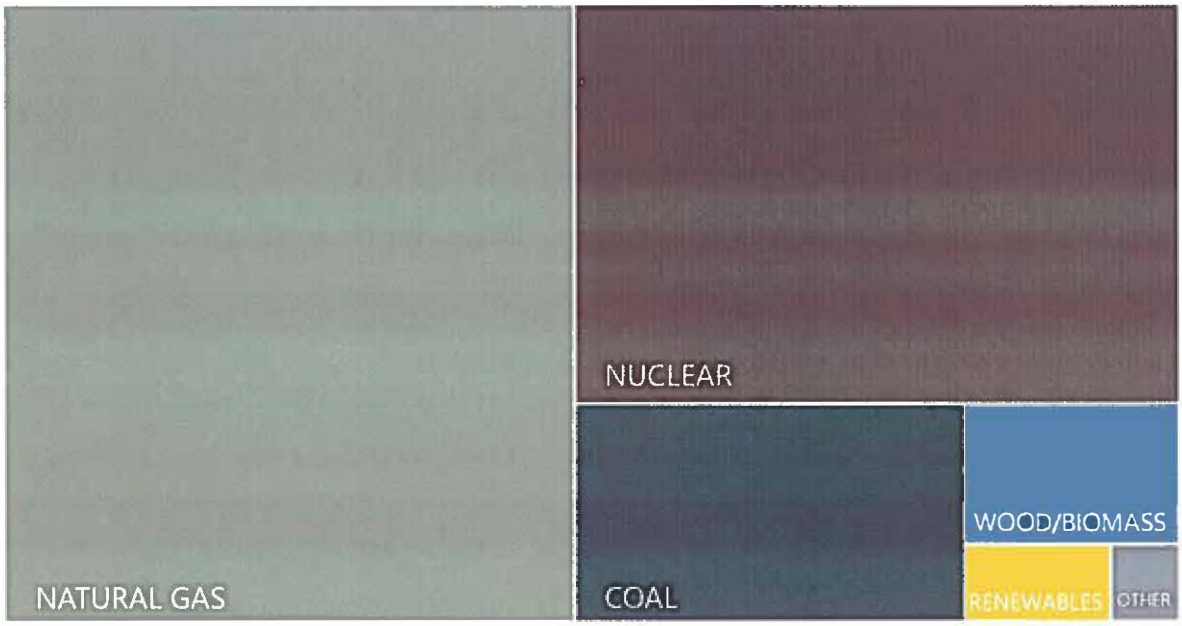


Figure 3: Electricity generation (utility-scale) by energy source for Virginia

Source: U.S. Energy Information Administration

[4] The productive capacity of coal mines indicates the maximum amount of coal that can be produced annually in the current economy – incorporating factors such as availability of raw materials, productivity, and workforce.
[5] U.S. Energy Information Administration (EIA), Annual Survey of Coal Production and Preparation, 2018
[6] U.S. Energy Information Administration (EIA), Virginia Natural Gas Gross Withdrawals, 2018
[7] U.S. Energy Information Administration (EIA), Natural Gas Consumption by End Use, Virginia, 2018
[8] U.S. Energy Information Administration (EIA), Natural Gas Reserves Summary, 2017
[9] U.S. Energy Information Administration (EIA), U.S. Crude Oil and Natural Gas Proved Reserves, 2017

Virginia ranks 16th among states in net electricity generation as of March 2019.[10] Natural gas fuels the largest share (one-half) of Virginia's net electricity generation, and the state's two nuclear power plants provide an additional one-third (Figure 3). Even though coal comprises the majority of fuel production, it fuels only about 12 percent of Virginia's power generation. The remainder (about 7 percent) of electric power generation is supplied by renewables which include biomass, hydropower, petroleum, and solar photovoltaic.

Coal-fired power supplied the largest share of the state's net generation until 2009, when it was surpassed by nuclear power. As coal-fired generation decreased, natural gas-fired generation increased and exceeded that of coal by 2012. By 2015, natural gas-fired generation surpassed that of nuclear power, becoming the state's largest power generating fuel source.[11]

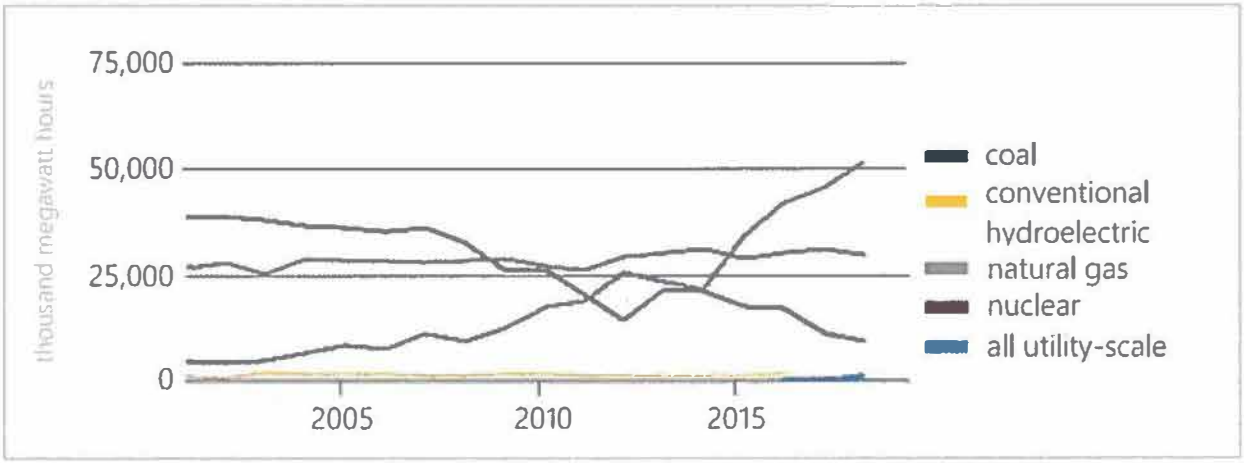


Figure 4: Net electricity generation (utility-scale) by energy source for Virginia, 2000-2018

Source: U.S. Energy Information Administration

Renewables are rapidly on the rise as sources of electricity generation in Virginia. Biomass, in the form of wood and wood waste, provides the largest share among renewables. In fact, until 2015 when it leveled off, biomass use had been increasing each year. Around the same time, solar photovoltaic began contributing a small but increasing amount of distributed and utility-scale electricity generation. Hydroelectric power, including pumped hydroelectric storage, is the renewable resource with the greatest generating capacity in Virginia, but its use has remained steady over the past ten years because it is not economically viable to build large hydropower projects in Virginia. Although not yet developed in Virginia, wind energy could provide potential opportunities off Virginia's Atlantic coast and the Chesapeake Bay.[12]

[10] U.S. Energy Information Administration (EIA), State Energy Data System, 2019

[11] U.S. Energy Information Administration (EIA), Virginia Electricity Profile, 2018

[12] U.S. Department of Energy, Energy Efficiency and Renewable Energy, WINDExchange, Wind Energy in Virginia, 2019

C. ENERGY JOBS DATA

Many energy-related jobs cross industries, and the U.S. Bureau of Labor Statistics does not provide data for the energy industry separately. This makes it difficult to estimate the availability of and demand for workers in energy jobs. For the purposes of this section, we have drawn from the U.S. Energy & Employment Report (USEER),[13] an annual report that estimates the number of energy-related jobs based on a survey administered to over 30,000 employers across 53 different energy technologies. Originally published by the U.S. Department of Energy (DOE) in 2016, the USEER was adopted in 2018 by the Energy Futures Initiative (EFI) and the National Association of State Energy Officials (NASEO) under the same, federally-approved protocols as in previous editions. In order to better represent the full range of energy-related jobs, the USEER updates their data-collection strategies every year. In the past three years, they have begun including jobs related to business activities essential to the operation of energy companies. In 2018, they expanded the range of energy storage technologies included in their data.

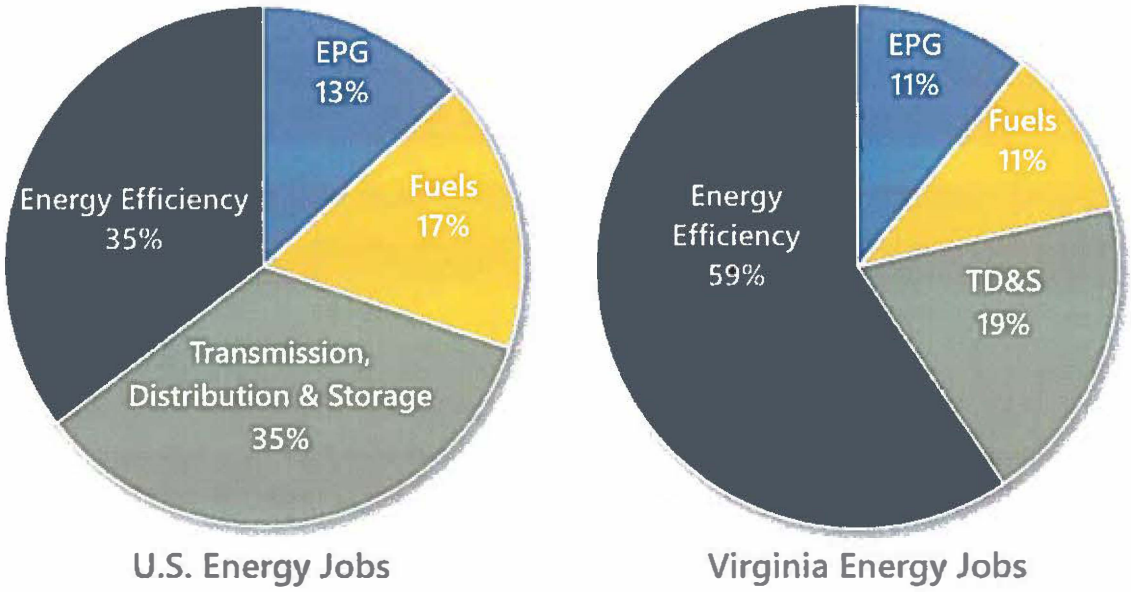


Figure 5: US and Virginia Energy Jobs 2018

Source: Energy Futures Initiative. (2019). The U.S. Energy Employment Report. Washington, DC. www.usenergyjobs.org.

[13] https://www.usenergyjobs.org/

ENERGY JOBS IN VIRGINIA

ENERGY EFFICIENCY JOBS	make up a much larger proportion of the state's total energy jobs (Figure 6) than they do in the nation: three out of five energy workers in Virginia, compared to one out of three in the U.S. In Virginia, the field grew by 2.7 percent last year, adding 2,049 jobs. ENERGY STAR and efficient lighting firms are the largest energy efficiency employers, followed by traditional HVAC.
ELECTRIC POWER GENERATION JOBS	employ 14,446 workers in Virginia, and added 550 jobs over the past year. • Solar makes up the largest segment of employment related to electric power generation, with 4,241 jobs (up 1.0 percent) • Traditional fossil fuel generation is the next largest segment at 2,765 jobs (up 3.7 percent).
FUEL-RELATED JOBS	employ 13,957 workers in Virginia, up 7.7 percent over the past year. • Petroleum and other fossil fuels make up the largest segment of employment related to fuels.
TRANSMISSION, DISTRIBUTION, AND STORAGE JOBS	employ the second highest number of workers in Virginia at 25,352, up 3.7 percent (911 jobs) since the 2018.

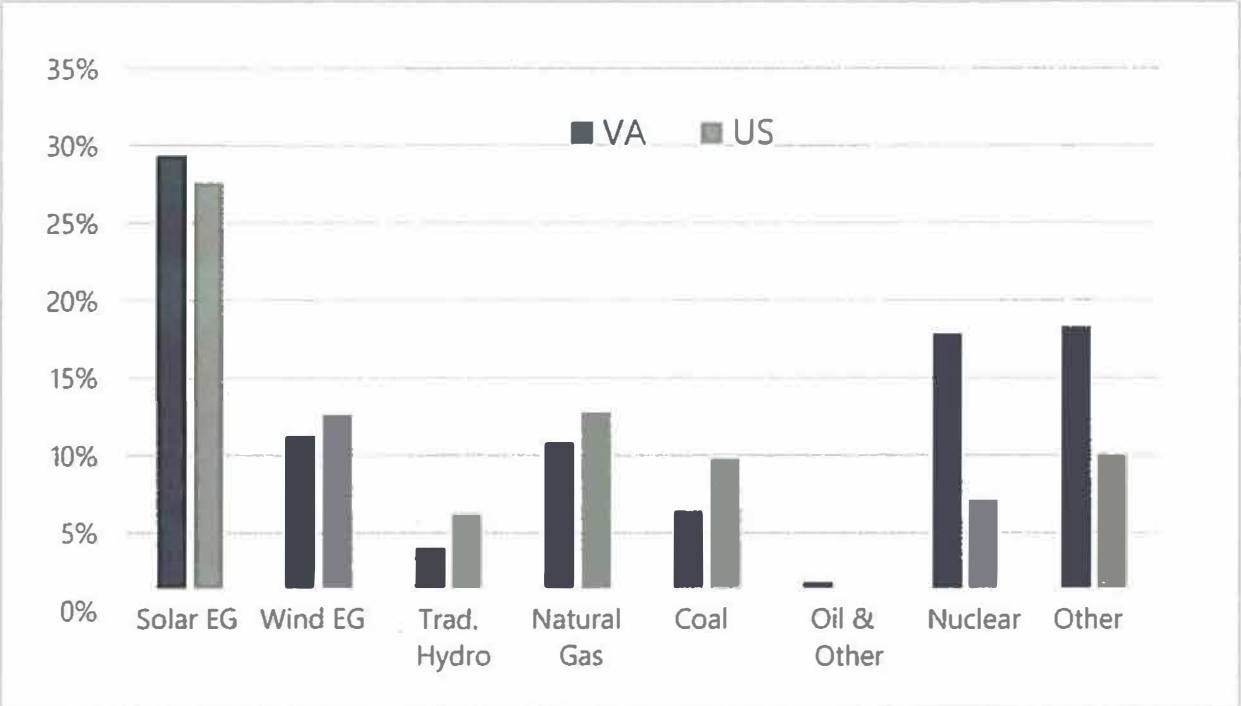


Figure 6: Energy Workforce by Electric Power Generation Type 2018

Source: Energy Futures Initiative. (2019) The U.S. Energy Employment Report. Washington, DC., www.usenergyjobs.org

D. VIRGINIA ENERGY PLAN

In addition to industry and jobs data, an energy career cluster should take into account the priorities presented in the Commonwealth of Virginia's 2018 Energy Plan,[14] which provides both a status update on Virginia's current energy system and a set of recommendations toward grid modernization. By doing so, the cluster can better present students and job seekers with information pertinent to making informed career choices.

A main tenet of the plan is the following: "Virginia's regulatory structure has historically focused on the traditional power sector model of large, centralized power stations and conventional transmission and distribution infrastructure. However, distributed energy resources such as rooftop solar, smart meters, battery storage, electric vehicles, and other innovative technologies are likely to make up an ever-increasing share of our energy system in the years to come."

Virginia's energy plan outlines current policy objectives and progress, specifically goals set by the 2018 Grid Transformation and Security Act - Senate Bill 966. Among other things, the bill mandates:

- 5,500 megawatts (MW) of utility-owned and utility-operated wind and solar resources deemed to be in the public interest;
- $1.1 billion investment in energy efficiency programs by investor-owned utilities by 2028

Solar and Onshore Wind

The plan recommends that by 2022, solar and onshore wind comprise at least 3,000 MW of the 5,500 MW of solar and wind resources deemed in the public interest (as stated under Senate Bill 966). To date, the Virginia Department of Environmental Quality (DEQ) has issued 26 permits for solar projects and one wind power project totaling 816 MW. An additional 58 notices of intent to apply are in the pipeline, which would contribute another 3,317 MW.

Two utility scale onshore wind projects have already been permitted. The first project is the Highland New Wind project which covers nineteen two-megawatt turbines (38 MW total) along Red Oak Knob and Tamarack Ridge in Highland County. The second is the Rocky Forge Wind project, a 75.6-megawatt project located in Botetourt County permitted in 2017.

Offshore Wind

The Energy Plan recommends that the remaining 2,500 MW of mandated wind and solar be fulfilled through offshore wind. A twelve-megawatt offshore wind demonstration project was recently permitted, with two test turbines under construction. The Energy Plan includes the recommendation to establish a goal that the full 2,500 MW of offshore wind potential in Virginia be developed by 2026. Dominion Virginia Power anticipates $1.1 billion in offshore wind investments through 2023 with enough energy production to power half a million homes.[15] In addition, Virginia's ports have the potential to support the supply chain of an East Coast offshore wind industry. Virginia could create thousands of jobs

[14] The Commonwealth of Virginia's 2018 Energy Plan

[15] The Commonwealth of Virginia's 2018 Energy Plan

building components such as foundations and offshore substations, according to a 2018 report produced by the consulting firm BVG Associates.[16]

Energy Efficiency

Legislation enacted in 2007 set a goal to reduce 2022 electric use by 10 percent of 2006 retail consumption through conservation and efficiency, and the Energy Plan refocuses on that goal. Due to increases in population and new businesses and industries locating in Virginia, 2016 consumption was up about 5 percent from 2006 levels, which is the baseline year for the 10 percent goal. A decade after the goal enactment, the Virginia Energy Plan identifies a pathway to achieve roughly 70 percent of those energy savings. In addition, the Virginia Energy Plan recommends that the commonwealth doubles its renewable energy procurement target from 8 percent to 16 percent by 2022.

A piece of this energy reduction goal is the Senate Bill 966 mandate that investor-owned utilities invest $1.1 billion in energy efficiency programs by 2028. Dominion Energy and Appalachian Power Company have committed to invest $870 million and $140 million, respectively, between 2018 and 2028 in energy efficiency programs.[17] These investments and goals may lead to the creation of new jobs and demand for more workers in the energy industry, which is in the midst of a significant transformation in Virginia and the nation. Due to the increased demand and resulting growth of the traditional energy sector (e.g. fuels production, traditional power generation) combined with an aging workforce, more workers will be needed in energy-specific jobs. In addition, the industry, which is rapidly transforming as a result of new technology and innovative approaches, will need a workforce that is more diverse, complex, and digitally literate.

[16] http://files.vasierraclub.org/oswvision.pdf

[17] The Commonwealth of Virginia's 2018 Energy Plan

E. EMPLOYMENT PROJECTIONS FOR SELECTED ENERGY JOBS IN VIRGINIA

For the same reason that it is difficult to classify and estimate energy jobs, it is similarly difficult to project energy-related employment. The USEER report projects that expected hiring in Virginia in energy efficiency and in electric power transmission, distribution, and storage will outpace the U.S. as a whole. As part of the collection of their data for hiring trends, the USEER study asks the following question of employers in its survey: "Do you expect to hire in the next 12 months?". Energy efficiency employers expect to hire the most, at about 9 percent growth, followed by electric power generation (6.5 percent), and electric power transmission, distribution, and storage (4 percent). The fuels sector shows the least promise for hiring.

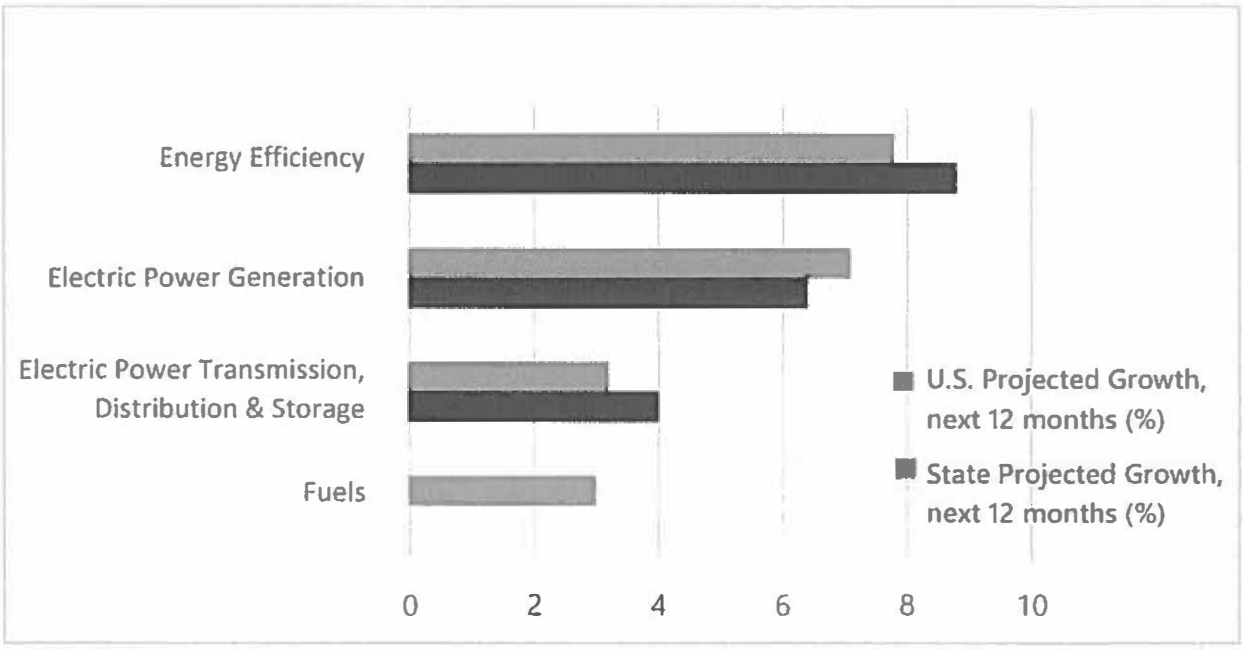


Figure 7: Projected 12 Month Job Growth by Major Technology Application

Source: Energy Futures Initiative. (2019). The U.S. Energy Employment Report. Washington, DC. www.usenergyjobs.org.

Figure 8 (page 12) displays current Virginia occupational estimates and projections for a few energy sector occupations. Of these examples, it is important to note that all require some sort of specialized training or certification, all are projected to grow, and all receive median wages above the Virginia median of $39,800 in 2017.

Career Cluster	Occupation title	Predominant level of education & training	Est. employment 2016	Proj. employment 2026	% Change 2016-26	Annual job openings	Annual VA median wage
Architecture & Construction	Plumbers, Pipefitters, and Steamfitters	HS or less & training/cert	14,322	15,787	10%	1,699	$47,270
	Electrical Power-Line Installers & Repairers	Associate/some college & training/cert	2,972	3,318	12%	279	$66,850
Manufacturing	Gas Plant Operators	HS or less & training/cert	357	367	3%	36	$71,930
	Electrical & Electronics Repairers, Powerhouse, Substation	Associate/some college & training/cert	841	864	3%	75	$81,890
STEM	Electrical Engineers	Bachelor's or more	6,443	7,215	12%	504	$100,170
	Mechanical Engineers	Bachelor's or more	6,997	7,735	11%	531	$92,870

Figure 8: Virginia Occupational Projections of Example Energy Occupations

Source: UVA Weldon Cooper Center tabulations based on Virginia Employment Commission (VEC) long-term occupational projections

Although there is a relatively good outlook for the energy industry in the next one to seven years, employers in Virginia are less optimistic than employers nationwide regarding 2020 energy-related job growth (3.6 percent versus 4.1 percent nationally). Employers in Virginia reported the following as the three most difficult occupations for which to hire: technician or mechanical support, management (directors, supervisors, vice presidents), and installation workers; and they gave the following top three reasons for this difficulty:

1. Lack of experience, training, or technical skills
2. Difficulty finding industry-specific knowledge, skills, and interest
3. Insufficient qualifications (certifications or education)

A career cluster in energy will address these concerns by pairing data for an occupation (such as the projected job growth and annual Virginia median wage) with information on the skills and knowledge necessary for the occupation. The cluster will display pathways between jobs that share requirements, demonstrating the breadth of opportunities open to students pursuing study in these areas.

Energy Jobs across Career Clusters

Energy is not one of the sixteen nationally recognized CTE Career Clusters. By creating an energy career cluster, Virginia joins only a few other states to modify the national system to add a cluster specifically for energy. As noted above, the energy sector is interdisciplinary and spans multiple industries. According to the Center for Energy Workforce Development, currently existing energy jobs fall into four of the sixteen career clusters (Figure 9): Agriculture, Food & Natural Resources; Architecture & Construction; Science, Technology, Engineering, and Mathematics; and Manufacturing.

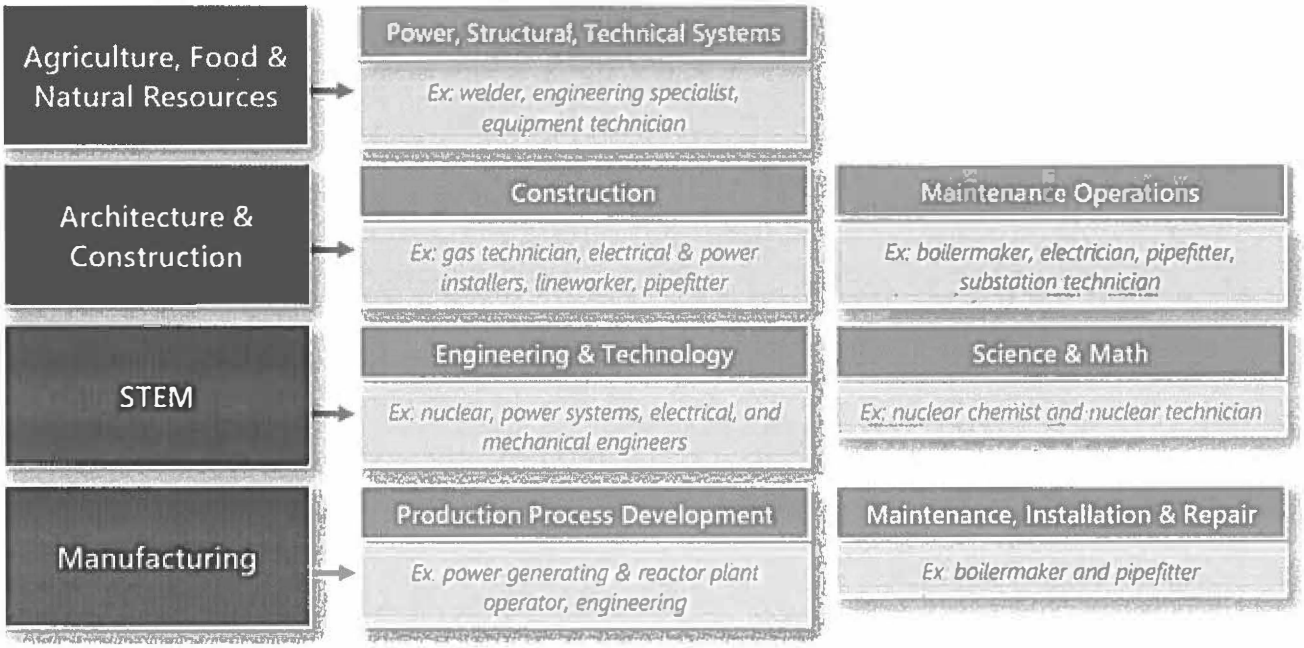


Figure 9: Energy Jobs in the 16 Career Clusters

Source: Center for Energy Workforce Development

As the graphic demonstrates, a number of careers that could pertain to an energy career cluster currently reside in other clusters. For example, equipment technicians, now part of the Agriculture, Food, and Natural Resources cluster, could also be appropriately understood under the energy cluster if their work involves the operation or installation of more energy-efficient equipment or of equipment, such as solar panels, to capture natural resources for energy supply. Similarly, many occupations not explicitly shown in the above graphic are found in the energy sector. For example, scientists, engineers, and mathematicians may be part of teams working on energy projects, or in research and development in the energy field. In addition, individuals in virtually all occupations need to be increasingly aware of energy to effectively perform in their positions, as resources become scarce and environmental impacts are of greater concern. Leaders in small and large businesses, government services and policy-making, and educators at all levels will address energy-related topics as an aspect of their careers.

Jobs across Energy Pathways

The energy career cluster will equip students with knowledge and skills common across the energy sector to prepare them for a full range of occupations/career specialties within energy.

Industry experts and educational professionals have embraced the energy cluster as directed by Senate Bill 1348. Background research suggested that the structure of the energy cluster be built upon four sectors defined in the first section of this report: Fuels Production; Power Generation; Energy Transmission, Distribution, and Storage; and Energy Sustainability and Efficiency. These sectors (slightly redefined by expert panels) will be the pathways under the energy career cluster, allowing differentiation and specialization within the larger cluster.

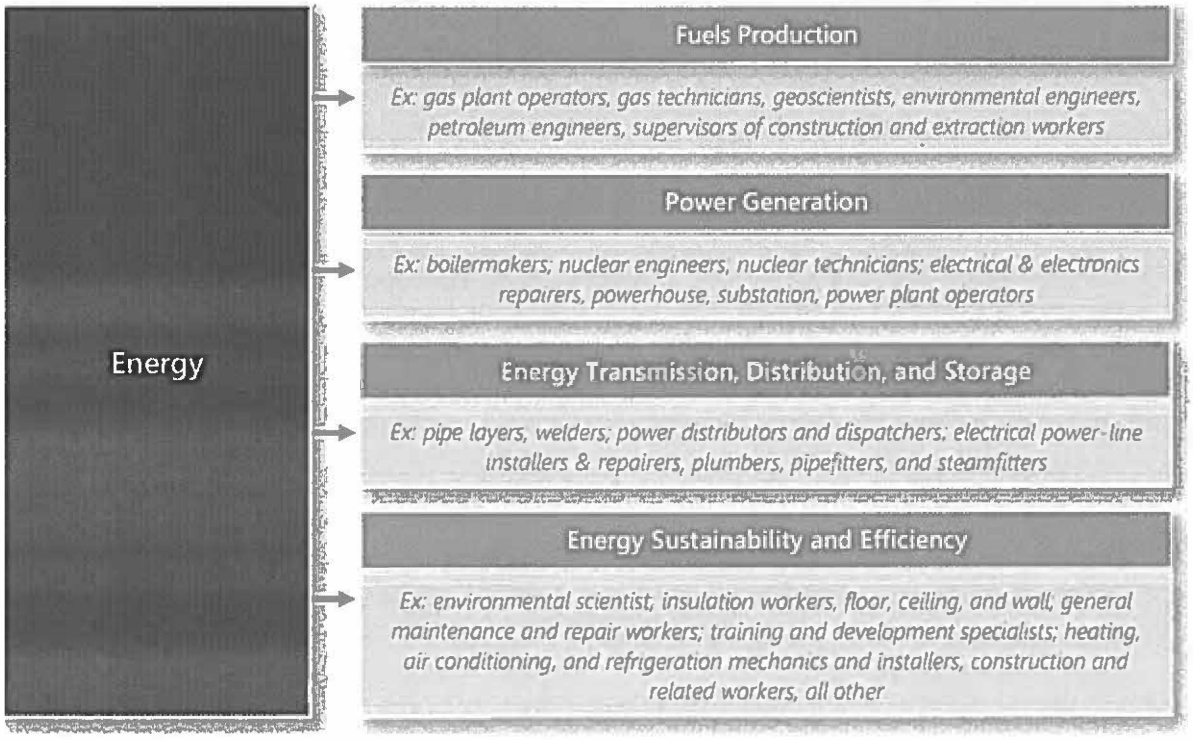


Figure 10: Examples of Occupations under Each Energy Industry Pathway

Source: The University of Virginia Weldon Cooper Center for Public Service, Demographics Research Group

This is neither an exhaustive nor final list of occupations relevant to the energy industry. In response to economic development and evolution in the Commonwealth, new courses and competencies will be developed continuously, with additional occupations added to the cluster focus.

III. Governor Northam's Executive Order #43: Expanding Access to Clean Energy and Growing the Clean Energy Jobs of the Future

Governor Ralph Northam reinforced and expanded upon the goals and standards outlined in the Virginia Energy Plan through Executive Order 43, signed on September 16th, 2019. This order directs Virginia executive branch agencies to create plans that enable the modernization of the electric grid and fulfill the potential for significant new job growth in the clean energy sector. The Executive Order calls for increased focus on economic development potential of the energy sector, the effects of climate change, and inequities experienced by vulnerable populations regarding energy.

The first directive of the Executive Order sets a goal to produce thirty percent of Virginia's electricity from renewable energy sources by 2030, and one hundred percent of Virginia's electricity from carbon-free sources by 2050. Under this standard, several agencies are directed to develop plans with resource specific considerations, as follows:

- **Solar and Onshore Wind:** In furtherance of the Senate Bill 966 statewide goal of achieving 5,500 MW of wind and solar energy by 2028, Dominion Energy has committed to procure up to 500 MW of utility-scale solar and onshore wind projects annually. Dominion has also committed to annual procurements of smaller-scale solar energy beginning in 2019, starting at 50 MW and scaling up to 150 MW by January 2022. Appalachian Power also initiated procurement for 200 MW of utility-scale solar projects to be operational by the end of 2021.
- **Energy Efficiency:** In order to meet the 2028 $1.1 billion energy efficiency investment goal from Virginia utility companies (defined by the Virginia Energy Plan and Senate Bill 966), Executive Order 43 outlines intermediate investment deadlines. By 2019, Dominion Energy and Appalachian Power are directed to increase spending to $100 million and $15 million per year, respectively. The order also recommends that various state agencies work together to develop energy-efficient policy, such as energy financing programs and enhanced building codes.
- **Offshore Wind:** The development of 2,500 MW of offshore wind by 2026 as outlined in the 2018 Virginia Energy Plan is detailed more specifically in Executive Order 43. The order recommends a timeline to achieve this offshore wind target, including working with Dominion Energy and the U.S. Bureau of Ocean Energy Management to submit the Construction and Operation Plan (COP) by 2021, with construction beginning by 2024.
- **Energy Storage:** Renewable energy generation and innovative energy storage technologies are emphasized, including distributed energy resources, such as rooftop solar.
- **Energy Equity:** Executive Order 43 dictates that energy equity considerations be integrated into the new energy plan, including measures that provide communities of color and low- and moderate-income communities both access to clean energy and a reduction in their energy burdens.

Virginia's current renewable energy procurement target of 8 percent by 2022 was recommended to be doubled to 16 percent in the Virginia Energy Plan. Executive Order 43 goes beyond this target, stating: "The Commonwealth shall procure at least 30 percent of the electricity under the statewide electric contract with Dominion Energy from renewable energy resources by 2022."

Executive Order 43 mandates the reduction of electricity consumption across all of the Commonwealth's agencies and institutions through development and execution of a comprehensive Resource Conservation Management Plan. This plan will establish the framework to achieve the legislative goal of reducing retail electricity consumption by ten percent by 2022, using 2006 as a baseline.

Finally, Executive Order 43 emphasizes the importance of the energy sector in Virginia's current and future workforce. The order directs the chief workforce advisor and the Secretary of Commerce and Trade to create an energy workforce plan in coordination with stakeholders. This plan is ordered to include an evaluation of current curricula and training programs, including K-12 curricula, and to address both awareness of energy sector career opportunities and access to career pathways and programs. The formation of the 17th Energy Cluster in Virginia supports achievement of the goals outlined in Executive Order 43.

https://www.governor.virginia.gov/media/governorvirginiagov/executive-actions/EO-43-Expanding-Access-to-Clean-Energy-and-Growing-the-Clean-Energy-Jobs-of-the-Future.pdf

IV. The 17th Energy Career Cluster Implementation

As a result of the research conducted by the Weldon Cooper Center for Public Service, University of Virginia, and meetings with the Virginia Energy Workforce Consortium, industry and economic experts, and education leaders, the career pathways and completer courses have been identified. The new Energy Career Cluster and career pathways will be available for statewide implementation beginning July 1, 2020.

The Energy Cluster plans of study begin at the secondary level and lead to postsecondary education and careers. Career and technical education (CTE) competencies at the secondary level focus on foundational knowledge, skills, and technical abilities that lead to opportunities for students to earn industry certifications or occupational licenses. The Energy Cluster will prepare students to immediately enter the workforce with a competitive advantage and/or continue with postsecondary education to earn more advanced skills.

The four energy pathways are Fuels Production; Power Generation; Energy Transmission, Distribution, and Storage; and Energy Sustainability and Efficiency. As shown in figure 11, students can enter, exit, and re-enter pathways at any point in their education, from secondary to postsecondary. Businesses and industries support students throughout the continuum of learning with continued educational and work-based learning opportunities.

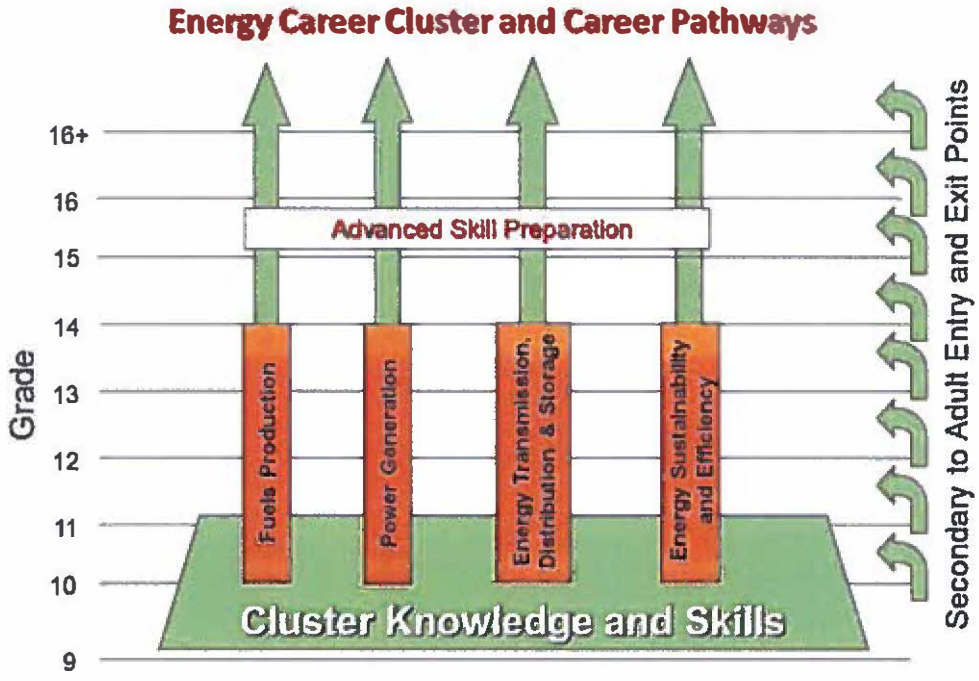


Figure 11: Energy Career Cluster and Career Pathways

The graphic was created by Benson Consulting for the Virginia Department of Education Office of Career, Technical, and Adult Education.

A. INSTRUCTIONAL COMPETENCIES FOR THE ENERGY CLUSTER

In August and November 2019, pursuant to Senate Bill 1348, the Virginia Department of Education convened panels of business and industry subject-matter experts to identify the knowledge and skills required for entry-level careers in the energy sector.

The knowledge and skills identified by the panels served as the basis for determining at least two courses in each of the energy pathways.

Expert panel meetings of business and industry, and education leaders will be convened on January 23-34, February 24-25, March 5-6, and March 23-24, 2020, to develop the detailed instructional competencies, content areas, and enabling objectives for each course. The development of the two courses in each career pathway will be designed as sequential electives. These courses will comply with the instructional program in secondary schools requirements 8VAC20-131-100. The curriculum development meetings will be coordinated by the CTE Resource Center.

The Energy and Power course previously developed by the Virginia Department of Education and the Center for Energy Workforce Development will serve as the foundation course to each of the career pathways. The course will provide fundamental knowledge and skills pertaining to the wide range of energy occupations.

Additional energy courses will be developed based on workforce demands in the 15 local workforce development areas. Such efforts will be coordinated with the chief workforce advisor and the Virginia Energy Workforce Consortium.

B. FUELS PRODUCTION PATHWAY

Course title: **Energy Source Life Cycle**	*Course title:* **Engineered Systems**
Content areas: • Distinguishing Different Sources of Energy • Understanding Extraction Techniques • Understanding Energy Transportation • Understanding Refinement Techniques • Exploring Energy Storage • Exploring Energy Delivery and Consumption • Exploring Environmental and Health Aspects of Energy Production	*Content areas:* • Exploring Applications of Energy Systems • Complying with Safety Standards • Understanding the Societal Impact of Engineered Systems • Describing the Energy Supply Chain • Describing Utility/Producer and Consumer Relationships • Exploring Career Paths in Energy and Engineered Systems

C. POWER GENERATION PATHWAY

Course title: **Energy and Power Foundations**	*Course title:* **Power Generation Design and Function**
Content areas: • Describing Energy Types and Transformations • Explaining Sources of Energy • Describing Electrical Theory • Exploring Turbines • Exploring Generators • Outlining Core Systems • Exploring Photovoltaics • Exploring Environmental Impacts in Energy and Power • Exploring Health and Safety Issues in Energy and Power • Describing Energy Policy and Trends	*Content areas:* • Analyzing Core Systems • Reading and Interpreting Technical and Engineering Drawings • Performing Tests, Calibrations, and Measurements • Operating and Maintaining Power Generation Systems • Diagnosing System Issues • Repairing Core Systems • Describing Safety Issues when Working with Power Systems • Exploring Trends and Technology Development

D. ENERGY TRANSMISSION, DISTRIBUTION, AND STORAGE PATHWAY

Course title: **Introduction to Energy Transmission, Distribution, and Storage**	*Course title:* **Advanced Energy Transmission, Distribution, and Storage**
Content areas: • Exploring Electricity Basics • Applying the Laws and Theories in Electric Energy Transmission and Distribution • Understanding the Grid • Exploring Technology Trends in the Grid • Describing Policy and Trends in Energy Transmission, Distribution, and Storage	*Content areas:* • Exploring Advanced Electricity Concepts • Reading Technical and Engineering Drawings • Performing Measurements and Circuit Mapping • Analyzing the Grid • Integrating Technology Trends in the Grid • Exploring Environmental Impacts of the Grid • Exploring Health and Safety Issues in Energy Transmission, Distribution, and Storage

E. ENERGY SUSTAINABILITY AND EFFICIENCY PATHWAY

Course title: **Energy Supply Sustainability and Efficiency**	*Course title:* **Energy Demand Sustainability and Efficiency**
Content areas: • Describing Reliability of Energy Sources • Understanding Renewable Energy • Exploring Distributed Energy Resources • Understanding Power Plant Operations • Understanding Facilities Management • Understanding Energy Regulations • Exploring Design and Infrastructure • Exploring Innovation in Energy Supply Sustainability and Efficiency	*Content areas:* • Describing Residential Sustainability and Efficiency • Describing Commercial Sustainability and Efficiency • Describing Industrial Sustainability and Efficiency • Exploring Building Science • Understanding Facility Design and Engineering Systems • Exploring Behavior Modification • Understanding Regulations • Exploring Efficiency Testing and Ratings • Exploring New and Emerging Technologies

Appendices

APPENDIX A – SENATE BILL 1348

VIRGINIA ACTS OF ASSEMBLY -- 2019 SESSION

CHAPTER 371

An Act to require the Department of Education to establish an energy career cluster.

[S 1348]

Approved March 12, 2019

Be it enacted by the General Assembly of Virginia:

1. *§ 1. The Department of Education, in consultation with representatives from pertinent industries such as renewable energy, natural gas, nuclear energy, coal, and oil, shall establish as its seventeenth approved career cluster an energy career cluster. In developing the energy career cluster, the Department of Education shall base the knowledge and skill sets contained in such career cluster on the energy industry competency and credential models developed by the Center for Energy Workforce Development in partnership with the U.S. Department of Labor. The Department of Education shall report to the Chairmen of the House Committee on Education and the Senate Committee on Education and Health no later than December 1, 2019, on its progress toward establishing such energy career cluster.*

APPENDIX B – CONTRIBUTORS

Members of the business, industry, and education panel who participated in the development of this report include:

Matt Adams	Dominion Energy
Barbara Altizer	Virginia Coal and Energy Alliance
James Barger	Virginia Beach City Public Schools
Charles Barksdale	Virginia Department of Mines, Minerals and Energy
Lynn Basham	Virginia Department of Education
Brandi Frazier-Bestpitch	Department of Mines, Minerals and Energy
Averill Byrd	CTE Resource Center
Jon Calma	Newport News Ship Building
Richard Champigny	Chesterfield County Public Schools
Harry Childress	Virginia Coal and Energy Alliance
Debi Coleman	CTE Resource Center
David Eshelman	Virginia Department of Education
Sasha Furdak-Roy	Columbia Gas/NiSource
Jason Gambill	Dominion Energy
Beth Green	Southern Regional Education Board
Meredith Gunter	University of Virginia
Drexel Harris	Dominion Energy
Jay Hooper	Dabney S. Lancaster Community College
Jon Johnson	Lightbridge
Matt Kellam	Virginia Energy Workforce Consortium
David Kenealy	Southern Virginia Higher Education Center
Emelye Keyser	University of Virginia
Kyaw Khine	University of Virginia
Lauren Lopez	Dominion Energy
Kenneth Magee	Virginia Natural Gas
Greg Meinweiser	Dominion Energy
Miles Morin	Virginia Petroleum Council
Beth Murtha	Framatome, Inc.
Nam Nguyen	Virginia Division of Energy
Shane Olson	Dominion Energy
Remy Pangle	Center for the Advancement of Sustainable Energy, JMU
Jeremy Phelps	Dominion Energy
Richard Philpot	Dominion Energy
Kevin Reilly	CTE Resource Center
Pat Roane	New Kent County Public Schools
Spencer Shanholtz	University of Virginia
Tamra Spurlock	Dominion Energy
Beth Stockner	Virginia Oil and Gas Association
Leanne Tipton	CTE Resource Center
Mark Felix Walker	Dominion Energy
Heather Widener	CTE Resource Center
George R. Willcox	Virginia Department of Education
J. Anthony Williams	Virginia Department of Education
Cathy Woody	Framatome, Inc.