VIRGINIA DEPARTMENT OF EDUCATION

Excellence in Agricultural Education

2025 Strategic Review

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ACKNOWLEDGMENTS

The success of the *Excellence in Agricultural Education Strategic Review 2025* is a direct result of the invaluable contributions made by a diverse coalition of stakeholders. These include secondary and postsecondary education, business and industry, government officials, and public policy representatives. The Virginia Department of Education (VDOE), in partnership with the Virginia Department of Agriculture and Consumer Services (VDACS), extends its sincere appreciation to the following individuals and organizations whose expertise, time, and commitment have been instrumental in advancing this critically important initiative:

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EXECUTIVE SUMMARY

The *Excellence in Agricultural Education Strategic Review 2025* was initiated in the fall of 2025 in partnership with the Secretary of Education and the Secretary of Agriculture and Forestry. This initiative was undertaken to coordinate with the VDOE Office of Career and Technical Education on the implementation of related agricultural educational programming and to develop a statewide plan for secondary agricultural education. The scope of the initiative centered around four areas that were identified and addressed in the *Strategic Review of Agricultural Education 2013*, which include curriculum innovation, modernization, and alignment; teacher recruitment, retention, and professional development; student enrollment and program completion; and agribusiness and industry, postsecondary, and community partnerships.

According to the *Strategic Review of Agricultural Education 2013*, Virginia's secondary agricultural education program should be one that:

- Articulates with postsecondary agricultural education programs
- Prepares students for careers in the agriculture career cluster
- Emphasizes sustainability, innovation, and entrepreneurship
- Aligns its curriculum competencies with industry standards, technologies, practices, and state competencies
- Integrates industry-recognized credentials
- Emphasizes high-quality work-based learning (Supervised Agricultural Experiences [SAE])
- Promotes agricultural literacy, community engagement, and economic resilience

This report has been informed by detailed and thorough research, critical review of current course offerings (see Appendix A: *Current Agricultural Education Courses*), and in-depth discussions with stakeholders.

The stakeholder meetings took place in September and October of 2025 and involved secondary and postsecondary education, business and industry, government officials, and public policy representatives. During these meetings, major themes evolved to include curriculum modernization, stakeholder collaboration, and alignment with Virginia's workforce development needs. Strengthening teacher support, updating curricula to reflect evolving technologies, and deepening partnerships among education, industry, and communities were identified as vital to the continued success and relevance of agricultural education in Virginia. This will enable the VDOE to carefully evaluate all aspects of agricultural education in the Commonwealth.

Research undertaken by the Weldon Cooper Center for Public Service at the University of Virginia (see *Occupational Outlook Brief: Virginia's Agricultural Education*) reinforces conclusions reached by the stakeholders and shows an emphasis on recent trends in Virginia's agricultural industry, such as:

- A strengthening link between the agriculture industry and the renewable energy industry

- An increase in the incorporation of precision agriculture technologies in agricultural education curricula across all career clusters (see Appendix B: *Career Clusters*)
- A growing need to support curriculum development, technical skills training, experiential learning opportunities, and credentialing opportunities for the emergence of controlled environment agriculture (CEA) (including skills in automation; heating, ventilation, and air conditioning [HVAC]; lighting systems; hydroponics and aquaponics; and data analytics)
- A rising need for technical skills in the agriculture workforce, such as data analytics, Geographic Information System (GIS) management, and autonomous machine operation
- A heightened interest in and support for regenerative agricultural methods
- The growing concerns over groundwater availability and management

The findings of the stakeholders identified action items for priority attention:

Curriculum Innovation, Modernization, and Alignment

- Focus on responding to technological change, responding to local needs and workforce demands, and being intentional when creating curriculum and when choosing industry certifications.
- Create course competencies related to leadership and management, precision agriculture, agrivoltaics, and CEA.
- Collaborate across career and technical education (CTE) program areas and other academic subjects to integrate related topics such as information technology and mathematics.

Teacher Recruitment, Retention, and Professional Development

- Recognize the unique professional responsibilities of agricultural educators, including their commitments as FFA advisors, year-round involvement in SAEs, and continued work during the summer months (including maintenance of agricultural mechanics laboratories, land laboratories, greenhouses, and equipment and machinery service and maintenance schedules).
- Reinforce the key responsibilities of operating a complete and compliant agricultural education program including the agricultural education teacher providing instruction, curriculum alignment, FFA leadership, experiential learning, career development, program management, and industry connection in a safe learning environment.
- Strengthen teacher preparation programs and incorporate FFA/SAE activities designed to prepare preservice teachers for the responsibilities of being an FFA advisor and supervisor of SAEs (see Appendix C: *The Three-Component Model, FFA*).
- Create greater consistency across Virginia for teacher preparation programming with the collaboration of postsecondary institutions.
- Streamline licensure processes to better support teachers, particularly career switchers and candidates seeking alternative licensure avenues.
- Provide professional development for school division personnel to ensure clear, consistent communication of licensure processes, enabling divisions to exercise local flexibility in recruitment and retention efforts.

Student Enrollment and Program Completion

- Provide school divisions information on the structural requirement of agricultural education's three-component model required for an agricultural education program – comprised of:
    - Classroom/laboratory instruction
    - SAE
    - Leadership development through FFA—the foundation to school-based agricultural education (SBAE)
- Strengthen outreach to administrators and school counselors; increase coordination among all agricultural education stakeholders.
- Increase opportunities for students to earn high school credit in middle school and college credit/dual enrollment during high school.
- Promote agricultural education programs in suburban and urban areas to generate broader interest.

Agribusiness and Industry, Postsecondary, and Community Partnerships

- Develop partnerships with organizations to support agricultural education programs, including summer programs and wraparound services.
- Promote research and SAE opportunities.

A detailed outline of the stakeholder discussion objectives and topics, as well as recommendations, follows in the next section of this report, *Strategic Review Meeting Topics and Recommendations*.

Strategic Review Meeting Topics and Recommendations

During the meetings convened, a diverse array of community stakeholders, including secondary and postsecondary education, business and industry, government officials, and public policy representatives, actively engaged in structured breakout discussions. All participants were invited to provide feedback and make recommendations on each of the four main topic areas, which include curriculum innovation, modernization, and alignment; teacher recruitment, retention, and professional development; student enrollment and program completion; and agribusiness and industry, postsecondary, and community partnerships. The following provides a summation of the participants' work in each of these four areas.

Curriculum Innovation, Modernization, and Alignment

Stakeholders discussed a series of strategic objectives and overarching thematic questions about curriculum innovations, modernization, and alignment. Their dialogue yielded a range of thoughtful suggestions and informed recommendations intended to guide the future planning and enhancement of agricultural education programs across the Commonwealth.

Objective

Align agricultural education curricula with and foster collaboration across:

- Industry standards, labor market demand, and industry recognized credentials
- Workforce development priorities and initiatives
- Postsecondary pathways

How is this objective accomplished?

- Review and analyze current and projected labor market data regarding all occupations and careers in agriculture in Virginia.
- Conduct a gap analysis of this labor market data with Virginia's current agricultural education course offerings.
- Align curriculum with industry standards and labor-market demand to ensure it supports relevant occupations, credentials, and postsecondary programs.
- Analyze findings and make recommendations to ensure Virginia's students are prepared for high-demand occupations.
- Strengthen industry partnerships to increase high-quality work-based learning opportunities for students.

Fundamental Considerations

- How do the current agricultural education courses prepare our students for the projected occupations and careers in Virginia's agriculture industry?

- How do the agricultural education courses align with Virginia's workforce development initiatives, academic standards of learning, National Agricultural Education program quality standards, and career pathway industry knowledge and skill requirements?
- How do current agricultural education curricula reflect emerging technologies and future career options (e.g., precision agriculture, agricultural technology, and sustainability)?
- How does current programming support preparation for high-demand occupations as defined by the Virginia Board of Workforce Development in the agriculture industry?
- What strategies can encourage school divisions to offer agricultural education courses that prepare students for high-demand occupations in the agriculture industry?
- How can superintendents, CTE administrators, principals, and school counselors be supported to better understand the required components of an agricultural education program, specifically regarding FFA and SAE?
- What are the strengths and weaknesses of the high and middle school agricultural education course offerings? Clusters? Subclusters?
- How do we strengthen FFA and SAEs for agricultural education?

Suggestions and Recommendations

Stakeholders emphasized aligning programs with local workforce needs through advisory councils and industry partnerships. Curricula should balance technical content with leadership, entrepreneurship, and soft skills, while keeping pace with technological change in artificial intelligence (AI), cybersecurity, robotics, precision agriculture, and data analytics. Recommendations included streamlining curricula, ensuring consistency while allowing flexibility for local adaptation, and expanding offerings in leadership, precision agriculture, food science, and CEA.

General curriculum recommendations focused on the need to be nimble in responding to technological change, responsive to local needs and workforce demands, and intentional when creating curriculum and when choosing industry certifications. The following specific recommendations emerged:

- Create a pacing guide and address course duration misalignment (e.g., some 36-week frameworks have 60 competencies, others have 175 competencies).
- Ensure the curriculum development cycle is nimble enough for today's pace of technological change.
- Streamline course offerings where appropriate and update competencies, striving for consistent wording across courses.
- Build a framework of flexible core objectives applicable across a variety of agricultural education course offerings.
- Increase the availability of level two courses throughout agricultural education curricula.
- Offer valuable, real-world industry certifications.
- Offer additional credit for Immersion SAEs and a diploma seal for agricultural education to those students who excel.
- Provide creative approaches to curriculum development; the day-long curriculum meetings are challenging for business and industry representatives.
- Meet with Virginia community colleges and universities regularly to coordinate programs and support. Collaborate with other states when developing curricula.

- Create consistent general agricultural competencies (e.g., agricultural mechanics) across all courses and additional infusion units to meet teacher and student needs.
- Provide curriculum that allows 30 percent of course competencies to be derived from local needs and be developed by local school divisions.
- Evaluate courses to ensure alignment with current labor market data.
- Conduct a gap analysis to identify potential new courses (such as leadership in agriculture, precision agriculture, renewable energy, and CEA) and credentials.

Suggestions for topics to integrate through agricultural education offerings (see Appendix A: *Current Agricultural Education Courses*) include:

- Agricultural biosecurity
- Agricultural mathematics
- Agricultural mechanics
- Agritourism/value-added agriculture/farm-to-table concept
- AI concepts; responsible use of AI
- Aquaculture
- Business in agriculture (e.g., agribusiness)
- Drone use and autonomous machinery and vehicles
- Entomology
- Entrepreneurship, business, data analytics, and finance
- Food-science-specific courses
    - Bioengineering
    - Dairy-specific course
    - Food processing (e.g., meat, pet food)
    - Food safety
    - Meat science
    - Sustainability in food science
- One-health programming
- Policy and communications related to agriculture
- Regenerative agriculture/sustainable agriculture
- Soil-less agriculture (sustainable use of water/land resources)
- Viticulture

There was consensus about the value of collaborative programs that integrate across CTE and academic areas (e.g., information technology and mathematics). Stakeholders noted that examples of such collaboration exist and these should be examined to help guide the expansion of this approach for Virginia's agricultural education program. Aligning secondary curricula with industry standards and credentials, incorporating emerging technologies, and strengthening education–workforce collaboration will prepare students for current and future jobs.

TEACHER RECRUITMENT, RETENTION, AND PROFESSIONAL DEVELOPMENT

Stakeholders engaged in a focused examination of designated strategic objectives and broad, forward-looking questions on teacher shortages. Through collaborative dialogue and critical analysis, the discussion resulted in a series of substantive suggestions and well-considered recommendations intended to inform and support future planning efforts within the scope of agricultural education teacher recruitment, retention, and professional development, and the impact of these on workforce development.

Objective

Address Virginia's agricultural education teacher shortage and build a sustainable educator pipeline to ensure a strong, diverse, and well-supported agricultural education teacher workforce.

How is this objective accomplished?

- Review and analyze current teacher recruitment and retention strategies.
- Analyze findings and make recommendations for sound and proven strategies to increase agricultural education teacher recruitment and retention.
- Engage business and industry and postsecondary education professionals.

Fundamental Considerations

- What is the current landscape for agricultural education teacher education programs in Virginia?
- What are some strategies/recommendations for statewide agricultural education teacher recruitment and retention? Who will be involved?
- How can Virginia school divisions attract and retain qualified teachers?
- How can partnerships serve to strengthen and grow teacher preparation programs at Virginia Tech, Virginia State University, Ferrum College, Blue Ridge Community College, and other community colleges throughout the Commonwealth?
- What can be done to attract and support career switchers or those seeking an add-on endorsement or technical professional license?
- What are recommendations for ensuring candidates are prepared to meet licensure requirements?
- What strategies can help develop business partnerships for professional development opportunities?
- How will ongoing professional development in pedagogy and industry trends be provided to agricultural education teachers?
- What types of professional development are needed for new and experienced?

Suggestions and Recommendations

Stakeholders emphasized teacher shortages and licensure confusion as barriers that can be addressed through a streamlined licensure process, expanded mentoring and student-teacher programs, and financial incentives such as signing bonuses and extended contracts. Recommendations also included restoring state-funded professional development, area/regional

agricultural education supervisors, and providing training for career switchers and technology integration. Specific recommendations emerged around the following topics:

Teacher Recruitment and Retention

- Strengthen recruitment through networking and outreach to businesses, the community, colleges/universities, and schools. Use alumni networks.
- Provide solutions related to compensation and the reduction of financial barriers for prospective teachers such as 12-month contracts to compensate teachers for year-round responsibilities (e.g., SAE oversight, FFA events that are scheduled during the summer, and program management), signing bonuses, and scholarships and loan forgiveness programs.
    - Provide teachers with the opportunity to utilize land laboratories for instruction related to current agricultural production practices (e.g., school farms, land labs, and school-based greenhouses).
    - Explore additional compensation for teachers given their supervisory responsibilities as FFA advisors and SAE administrators.
    - Promote pathways for endorsement for fully licensed teachers who are transitioning from another subject area to minimize financial burdens.
- Streamline the licensure process.
    - Create a task force to focus on licensure challenges.
    - Establish an agricultural education licensure lead within the Commonwealth. Provide clear, consistent guidance on endorsements and alternative pathways, and strengthen local flexibility, recruitment, and retention through annual training and technical assistance.
    - Provide readily accessible, comprehensive information about community colleges, accredited online programs, and both in-state and out-of-state institutions offering Agricultural Education coursework (e.g., remote, distance, virtual, asynchronous learning, and synchronous online learning) eligible for completion by provisionally licensed teachers.
    - Promote online licensure program for agricultural education.

Professional Development

- Develop a safety professional development model for agricultural education programs to include teacher preparation coursework requirements; local, state, and federal program safety compliance (school and land laboratories, SAE supervision); and professional development expectations.
- Build relationships with farm bureaus, a wide variety of industry organizations, and other stakeholders. Collaborate across institutions to create distance learning opportunities.
- Increase professional development attendance by providing financial assistance for teachers to attend. State funding for professional development (both for presenters and attendees) would be beneficial.
- Require professional development (e.g., conference participation) as part of instructor contracts.
- Hire area/regional supervisors whose roles and responsibilities would include state funding compliance monitoring, teacher and administrator support and technical

assistance, safety monitoring, data collection, networking with stakeholders, and supporting state CTSO programming.
- Encourage teachers to use the Agricultural Experience Tracker (AET) to document professional development and extended contract hours for verification, streamline data collection, and ensure consistent tracking of student competency records.
- Provide professional development that responds to the needs of teachers in different career stages (e.g., pedagogy for new teachers and career switchers, technology training for teachers who may be returning to the field).
- Provide training on the crucial role of FFA advisors.
- Establish a system of experienced teachers to mentor and support new teachers and those who may not have a network of fellow agricultural education teachers in their school division.

STUDENT ENROLLMENT AND PROGRAM COMPLETION

The stakeholders' discussions focused on strategies to increase enrollment and program completion rates within agricultural education, with the aim of aligning educational outcomes with both current and projected workforce demands. Emphasis was placed on enhancing access, fostering sustained engagement, and cultivating leadership among students.

Objective

Increase the enrollment and program completion rates in agricultural education programs to meet current and future workforce needs through access, engagement, and student leadership development opportunities.

How is this objective accomplished?

- Review and analyze current agricultural education program locations to determine areas of growth, course offerings, and sequences/program depth; strategies to increase student enrollment and retention; and agricultural education enrollment demographics.
- Analyze findings and make recommendations for sound and proven strategies to increase agricultural education student enrollment and program completion.

Fundamental Considerations

- What are some strategies/recommendations for promoting agricultural education programs to students, educators, school counselors, parents, businesses, and community partners?
- How can partnerships with Virginia Tech, Virginia State University, Ferrum College, and Virginia's community colleges serve as outreach opportunities to advertise agricultural teacher preparation programs?
- What strategies can be used to increase student participation in agricultural education leadership development and expand access to FFA events?
- What strategies can be employed to advocate for/support student ambassador programs to promote agricultural education?
- What strategies can be utilized to promote experiential learning through SAE programs?

- What strategies can be used to expand programs in urban and underserved rural divisions, especially in Virginia's major cities, Southside Virginia, and Southwest Virginia?
- How can transportation, technology, and language support be provided to remove participation barriers?

Suggestions and Recommendations

Stakeholders emphasized challenges related to teacher retention, lack of awareness of career opportunities in agriculture (see Appendix B: *Career Clusters*), and barriers to student participation in agricultural education. Stakeholders urged better collaboration with administrators and school counselors to promote the relevance and breadth of agricultural education opportunities. They recommended expanding opportunities to earn high school credit while in middle school and college credit while in high school. They also noted the value of either using the AET statewide or creating a consistent data system to track outcomes and highlight program success. Additionally, the following specific recommendations emerged:

Strengthen outreach to school administrators and school counselors.

- Involve school administrators in CTE-related initiatives.
- Provide professional development for administrators who do not have agriculture backgrounds.
- Send CTE representatives to the school counselors' annual conference.
- Encourage superintendents and other administrators to attend FFA Career and Leadership Development Events, the FFA State and/or National Conventions, and/or the Virginia Association of Agricultural Educators (VAAE) Summer and/or Winter Conferences.

Increase opportunities to earn high school credit while in middle school and college credit while in high school.

- Streamline the course application process.
- Provide more dual enrollment opportunities by strengthening connections between postsecondary institutions and high school agricultural education programs.
    - Consider micro-credentialing as an alternative to dual enrollment.
    - Ensure that school counselors inform students about articulation agreements.

Increase educator liability protections.

- Provide a uniform list of tasks that will be undertaken in the agricultural lab and allow parents and/or students to opt out of activities.
- Develop and implement comprehensive, standardized protocols and procedures governing the introduction, housing, and handling of animals within classrooms and laboratories, as well as student engagement in animal handling activities, in strict alignment with nationally recognized best practices and guidelines established by authoritative bodies such as the U.S. Centers for Disease Control and Prevention (CDC), the National Science Teaching Association (NSTA), Agricultural Education Animal Handling Standards, and Youth for the Quality Care of Animals (YQCA).
- Create a consistent system for equipment maintenance and encourage the use of industry-accredited vendors to ensure safety compliance in agricultural education laboratories and classrooms.

- Update the VDOE *CTE Safety Best Practice Guide*.
- Propose legislation requiring the Virginia Attorney General to defend school divisions from lawsuits stemming from injuries sustained while fulfilling required course competencies.

Use creative recruiting and promotion strategies for agricultural education programs.

- Involve high school students in promoting programs and recruiting students at the elementary and middle school levels (e.g., establish vegetable gardens at a nearby elementary or middle school, invite middle and elementary school students to mini fairs or SAE presentations organized by high school agricultural education programs).

Improve data gathering.

- Secure state funding for the AET. Aligning with the Agricultural Education National Standards, the AET helps document student SAEs, supports record keeping, and affords opportunities for data analysis, professional documentation, and financial and time management. Further, the AET supports awards and degrees; teachers can access real-time data for grading, advising, and program evaluation; and it generates reports that help measure student engagement, alignment with career goals, and overall program impact.
- Address challenges regarding agricultural education data. Some agriculture careers are classified in career clusters other than agriculture (e.g., advanced manufacturing), so tracking the success of agricultural education can present challenges.

Promote agricultural education.

- Provide consistent messaging from agricultural education stakeholders.
- Emphasize topics such as
    - the relevance of agricultural education in addressing concerns such as food safety, food sources, health, and sustainability;
    - how CTE courses benefit students through hands-on learning, public speaking, and competitions; and
    - how agricultural education provides opportunities for students with disabilities.
- Leverage existing Career Success Stars videos to promote agricultural education.
- Emphasize culturally sensitive communication and an understanding of target audiences.

Ensure access to agricultural education in underserved communities.

- Leverage FFA (see Appendix C: *The Three-Component Model*, FFA) as an intra-curricular component of an agricultural education program, providing students with unique opportunities for leadership training and development, goal setting and work ethic development, and community service engagement through career and leadership development events.
- Increase interest in and support for the implementation of agricultural education programs that are related to animal care, the environment, horticulture, urban agriculture, and food production and processing in urban and suburban school divisions. Ensure school divisions are aware that agricultural education programs prepare students to become veterinarians, veterinary technicians, veterinary assistants, animal care specialists and trainers, animal and plant scientists, and urban forestry technicians.

    - Involve statewide organizations (e.g., Virginia Association of Counties, the Virginia Municipal League, and the Virginia School Boards Association).
    - Examine and replicate successful best practices (e.g., the Isle of Wight farm lab providing food for schools).
- Address language barriers.
    - Translate curricula to Spanish (Virginia Tech and the Virginia Cooperative Extension have undertaken a project translating the Agricultural Mechanics curriculum to Spanish [e.g., *Spanish for the Green (Ag) Industry*]).
    - Create materials that explain agricultural education opportunities in multiple languages.
    - Identify agricultural education resources and materials available in multiple languages (e.g., National FFA contest materials are available in Spanish).

AGRIBUSINESS AND INDUSTRY, POSTSECONDARY, AND COMMUNITY PARTNERSHIPS

Stakeholder discussions emphasized the need to strengthen collaboration among Virginia's agricultural industries, institutions of higher education, and community stakeholders. Participants offered insightful suggestions and strategic recommendations designed to enhance intersectoral partnerships and support the long-term advancement of agricultural education and workforce development across the Commonwealth.

Objective

Strengthen collaboration among Virginia's agricultural industries, higher education, and community stakeholders.

How is this objective accomplished?

- Establish regional agricultural advisory councils comprised of industry leaders to include members of Virginia's Agribusiness Council; the Virginia Farm Bureau; the Virginia Foundation for Agriculture, Innovation and Rural Sustainability (FAIRS); and the Virginia Cooperative Extension.
- Provide updates from stakeholders at regional meetings of local school division superintendents, CTE administrators, business partners, and advisory groups to share agricultural education efforts in their region.
- Increase the number of registered apprenticeships.
- Partner with land-grant universities, community colleges, and other colleges and universities offering agriculture programs.
- Engage local farms and agribusinesses to support classroom and field experiences.

Fundamental Considerations

- How can we strengthen dual enrollment, articulation agreements, or early college pathways in agricultural education?
- What opportunities exist for secondary students to engage in undergraduate research or campus-based agricultural education programs?

- What technical and employability skills are most critical for entry-level employees in agriculture?
- How can we expand internships and registered apprenticeships for high school students?
- What policies or funding mechanisms support inclusive, modern agricultural education?
- How can Virginia better align secondary agricultural education programs with state and national workforce development goals?
- How can educators and community organizations co-create culturally relevant agricultural education projects that reflect community needs and values?
- What funding or volunteer support can community-based organizations and nonprofits provide for local agricultural education programs?
- How can we build sustainable partnerships that go beyond one-time grants?

Suggestions and Recommendations

Stakeholders emphasized partnerships as essential for curriculum alignment with industry standards, technologies, and practices. They highlighted the importance of building a pipeline of skilled workers for local agricultural businesses, supporting economic growth and sustainability. The participants also stressed the importance of partnerships in providing high-quality work-based learning experiences and underscored the value of industry partners providing access to equipment and technology and providing teachers with professional development that enhances the quality and relevance of instruction.

Participants proposed creating a statewide internship database and expanding funding and grant opportunities. They emphasized the importance of coordination among school divisions, postsecondary institutions, and industry to assist schools with high-quality programs that address labor market needs. The stakeholders also recommended the implementation of a statewide advisory council for agricultural education consisting of a wide array of stakeholders. Additionally, developing mentorship networks would help teachers include emerging technologies in instruction. In Virginia, these partnerships can be categorized into six key areas, each offering opportunities for collaboration, funding, and student engagement:

Higher Education and Research Institutions: These partners support teacher preparation; curriculum development; student career pathways, including dual enrollment and articulation agreements; and student recruitment and scholarships. Key institutions include

- Virginia Tech (College of Agriculture and Life Sciences) Department of Agricultural, Leadership, and Community Education; also leads the Controlled Environment Agriculture Innovation Center in partnership with the Institute for Advanced Learning and Research (IALR).
- Virginia State University includes strong 4-H and youth development programs.
- Ferrum College (Agricultural Sciences Program) offers agricultural science programs and collaborates with CEA initiatives.
- Virginia's community colleges can support VDOE teacher licensure requirements, providing a pathway for technical professional licenses in agricultural education and a springboard for four-year agricultural education teacher preparation programs (e.g., Blue Ridge Community College offers agri-business and veterinary technician programs).

Agribusiness and Industry: These partners help align curriculum with workforce needs and provide real-world experiences. Potential partners include

- Virginia Farm Bureau Federation – Advocacy and networking for agriculture and forestry sectors
- Southern States Cooperative – Agricultural supply and services
- Smithfield Foods – Food production and processing
- Virginia Agribusiness Council – Advocacy and networking for agriculture and forestry sectors
- Virginia Cooperative Council – Serves high school students through the Virginia Institute on Cooperative Education (VICE) conference; provides scholarships as well as educational resources and presentations about cooperatives
- Perdue Agribusiness – Poultry and grain operations
- Dominion Energy – Supports agricultural technology and sustainability initiatives
- Local agricultural pathways industries include
    - Agribusiness Systems
    - Animal Systems
    - Biotechnology Systems
    - Environmental Service Systems
    - Food Products and Processing Systems
    - Natural Resources Systems
    - Plant Systems
    - Power, Structural, and Technical Systems

Government and Extension Agencies: These partners provide policy and program alignment, funding, and technical expertise. Key agencies include

- VDOE
- VDACS
- Virginia Cooperative Extension
- U.S. Department of Agriculture (USDA)
- Natural Resources Conservation Service (NRCS)
- Farm Service Agency (FSA) local offices
- Virginia Department of Forestry (VDOF)
- Virginia Racing Commission (VRC)
- Virginia Department of Wildlife Resources (DWR)
- Virginia Department of Health (VDH)
- Virginia Marine Resources Commission (VMRC)
- Virginia Economic Development Partnership (VEDP)

K–12 School Divisions and Regional Collaborations: These partnerships ensure local implementation and sustainability.

Innovation and Workforce Development Hubs: These centers focus on emerging technologies and workforce pipelines. Examples include

- CEA Innovation Center, Danville, VA – A collaboration between Virginia Tech and the IALR, focusing on CEA, robotics, and agricultural technology

- SmartFarm Innovation Network – A Virginia Tech-led initiative supporting precision agriculture and sustainability
- Future Harvest – Chesapeake Alliance for Sustainable Agriculture
- Virginia Association for Environmental Education
- Virginia Agriculture in the Classroom
- Local food banks and urban farming initiatives

Additional recommendations include:

- Increase awareness of high-quality work-based learning opportunities.
    - Expand opportunities for internships (e.g., paid, on farms).
    - Partner with the Virginia Community College System to assist with locating opportunities.
    - Provide professional development for business partners and educators about apprenticeships (e.g., how to follow the process and work with community organizations; how to access partners).
- Develop partnerships with organizations to support agricultural education programs.
    - Seek support from organizations that have historically assisted (e.g., Farm Credit of Virginia, John Deere dealerships, and extension agents).
    - Leverage alumni networks.
    - Advocate for the Virginia General Assembly to pass a Section 1 bill for a state agency to provide funding for agriculture programs.
    - Promote USDA and VDACS workshop grants for teachers.
    - Expand collaboration between local government, the extension agency, and agricultural programs.
    - Educate administrators about alternative sources of funding.
    - Establish or find grants that reward cooperation.
- Leverage key research opportunities.
    - Partner with land-grant universities, land labs, and the extension service for research opportunities.
    - Engage with Agricultural Research and Extension Centers (AREC).
    - Promote participation in the Governor's School for Agriculture, a summer program run by Virginia Tech.
- Provide wraparound services.
    - Seek industry partners to provide grants that remove financial barriers for students to attend agricultural education events outside the classroom.
    - Address food insecurity by partnering with local food banks.
    - Provide transportation to allow underserved students to attend competitions (e.g., state fair).

Occupational Outlook Brief: Virginia's Agricultural Education

Courtesy of The Weldon Cooper Center for Public Service at the University of Virginia

Introduction

The purpose of this resource is to provide insight into labor market demand for occupations associated with Virginia's agricultural education CTE program area during stakeholder meetings and program review discussions. It organizes occupations by CTE career cluster and subcluster using the new CTE Career Clusters® framework (Advance CTE, 2025) as a guide; however, it also includes occupations associated with relevant CTE career clusters and pathways in the *old* career cluster framework. For this reason, the career clusters and subclusters as defined by occupations in this resource should not be construed as representing their definitions in the new framework.

The five-year labor market projection data displayed in the occupational outlook tables in each section is sourced from the Virginia Office of Education Economics (VOEE) and is based on United States Bureau of Labor Statistics (BLS) 2018 Standard Occupational Classification (SOC) system occupation definitions. You can access VOEE's data directly and read more about how they define high-demand and high-value occupations by going to the Virginia 2024 High-Demand Occupations Dashboard (Virginia Office of Education Economics (VOEE), 2023). The occupational outlook tables in this document also provide location quotient information for each occupation and are grouped by the predominant education level of each. The location quotient data is sourced from BLS May 2024 Occupational Employment and Wage Statistics (United States Bureau of Labor Statistics (BLS), n.d.-c) and indicates whether employment in the occupation is more (>1.00) or less (<1.00) concentrated in Virginia compared to the U.S. as a whole. A higher location quotient suggests the occupation may represent a regional workforce specialization, which might be attractive to potential employers wishing to relocate to or hire within the Commonwealth. The predominant education level is defined as the highest level of education when comparing two BLS data sources: 1) typical entry-level education required for entrance into an occupation (BLS, n.d.-b) and 2) the most prevalent level of educational attainment among all workers in the occupation age 25 years or older (BLS, n.d.-a).

Follow the link provided for more detailed information about each occupation. The link connects you to detailed O*NET information about each occupation (National Center for O*NET Development, 2025), including:

- associated occupations and job titles
- job tasks and work activities
- technology skills
- work activities
- training requirements
- apprenticeship opportunities
- worker requirements
- worker characteristics
- wages and employment trends
- job openings
- professional associations

VIRGINIA'S OCCUPATIONAL OUTLOOK – AGRICULTURE

Trends

This In Virginia from 2011 to 2021 …

- The value-added impact of the agriculture industry increased from 6.04% to 7.40% of Virginia's total GDP;
- The value-added impact of the forestry industry decreased from 2.04% to 1.92% of Virginia's total GDP (Rephann, 2013; 2022, November).

In Virginia from 2012 to 2022 …

- The number of farms decreased by 15% (from 46,030 to 38,995);
- Total farm acreage decreased by 12% (from 8.3 million acres to 7.3 million acres);
- Average farm size increased by 4% (from 180 acres to 187 acres);
- Livestock, poultry, and their products increased their share of the total market value of all agricultural products sold in Virginia by two percentage points (from 64% to 66%), while the market value proportion of crops, including nursery and greenhouse crops, decreased from 36% to 34% (USDA, 2014; 2024).

With many solar sites located on former or currently active farmland, there is a strong link between the agriculture and renewable energy industries. From 2012 to 2022, the number of farms in Virginia with renewable-energy-producing systems more than doubled from 1,165 to 2,559 (+120%), and the number with solar panels tripled from 717 to 2,173 (+203%) (USDA, 2014; 2024). Agrivoltaics, which is the practice of combining land use for both agricultural purposes and solar energy production, is an example of how course content bridging the Agriculture and Energy and Natural Resources clusters might be useful to both future farmers and solar photovoltaic installers.

Precision agriculture made its first appearance as a category in the 2024 USDA Census of Agriculture, with just over 5% of Virginia's farms reporting its use (USDA, 2024). Incorporation of precision agriculture technologies is increasingly becoming the norm in Virginia since it can boost productivity and reduce resource use (Hardbarger, 2022; Hart, 2025; Madlom, 2014; McBryde, 2016; Pruitt, 2025; Roth, 2021). Examples of this technology include GPS systems for accurate guidance of farm machinery, variable rate technology (VRT) that distributes seeds, fertilizers, and other materials based on unique location needs within a field, use of drone and satellite imagery for monitoring crop conditions, and soil- and yield-monitoring sensors for real-time information on crop and soil needs.

Controlled environment agriculture is growing as a desirable agriculture technique, considered highly suitable for Virginia due to its two-day-drive proximity to 75% of the U.S. population and its hosting of the Controlled Environment Agriculture Innovation Center, a joint venture between Virginia Tech and the Institute for Advanced Learning and Research in Danville (Mamon, 2022; Virginia Economic Development Partnership, n.d.; Virginia Tech Center for Economic and Community Engagement, 2023). Some refer to Virginia as the leader in CEA farms (Dickens, 2025).

Agricultural worker skills are trending towards the technical. With the rise of precision agriculture methods and CEA sites in Virginia, necessary farming skills are expanding to include technological skills, such as data analytics, GIS management, and autonomous machine operation (Itzhaky, 2021). Even some of the entry-level occupations in the Agriculture cluster with the lowest formal education requirements mention use of database query tools, mapping software, and Global Positioning System (GPS) tools in their O*NET descriptions (National Center for O*NET Development, 2025).

Regenerative agriculture methods have received more interest and research support in recent years (Cather et al., 2022; Rinehart, 2024; Sabas, 2025). In Virginia from 2012 to 2022, the percent of farms practicing no-till methods grew from 11.53% to 14.43%; the percent engaging in other conservation and reduced-tilling regenerative practices grew from 3.58% to 5.74%; and the percent practicing cover crops increased from 8.14% to 9.52%. In contrast, the percent of Virginia's farms practicing rotational grazing dropped during the same time frame from 20.23% to 18.40%. Other regenerative practices, including alley cropping, silvopasture, and agroforestry, have also been adopted by a growing number of Virginia's farms in recent years (USDA Census of Agriculture, 2014; 2024).

Groundwater availability is becoming a global concern, with a newly released report detailing how overextraction of groundwater is depleting our freshwater sources faster than they can be replenished (Lustgarten, 2025). This may make managing water as a natural resource more of a pressing issue in Virginia, especially as data centers, which consume considerable water resources for cooling, continue to be built (Yañez-Barnuevo, 2025). The Agriculture cluster in the new CTE Career Cluster® framework now includes a Water Systems subcluster.

Occupational Outlook Statistics for Virginia – Key Points

Acquiring an accurate picture of agricultural labor market demand can be challenging due to the fact that many publicly available data sets exclude certain types of agricultural workers. See Terance Rephann's 2022 report "Employment Data for Regional Labor Analysis: Application to the Agriculture, Food, and Natural Resources Career Cluster" for more details.

Although the Landscaping and Groundskeeping Workers occupation is projected to expand only moderately (5%) between 2023 and 2028, it sustains the most jobs of any in the Agriculture cluster (32,906) and offers the greatest number of annual job openings (4,746). First-Line Supervisors of Landscaping, Lawn Service, and Groundskeeping Workers is also a large occupation, consisting of 5,366 jobs in 2023. Both are considered VOEE high-demand occupations, and the latter is also considered a VOEE high-value occupation.

Animal care occupations make up seven of the top 10 occupations with the highest projected job growth rates in the Agriculture cluster from 2023 to 2028 and half of the occupations expected to create the most new jobs. Despite being roughly one third the size of the largest occupation in the

Agriculture cluster, the Animal Caretakers occupation is expected to create more new jobs (1,725) over the five-year period than any other in the Agriculture cluster.

The 2% job growth projected at the state level for Farmers, Ranchers, and Other Agricultural Managers masks greater regional variation in job growth rates across Virginia—from higher growth rates in the Capital (16%) and Crater (13%) Local Workforce Development Areas (LWDAs), to moderate growth rates in the Shenandoah Valley and Greater Roanoke area (both 6%), to job decline in the South Central (-15%) and Bay Consortium (-9%) regions. Apart from projected rates of job growth or decline from 2023 to 2028, certain regions will continue to offer more than 100 job openings annually in this occupation, including the Shenandoah Valley (212 annual job openings), Piedmont (180 annual job openings), Capital (123 annual job openings), and Bay Consortium (117 annual job openings) LWDAs.

The number of jobs for Agricultural Equipment Operators in Virginia is projected to expand by 10% from 2023 to 2028. This occupation does not currently include drone operators or remote sensing or precision agriculture technicians. Job growth related to drone operation is captured in the Electro-Mechanical and Mechatronics Technologists and Technicians (173024) occupation in Advanced Manufacturing. Job growth related to remote sensing is captured in the Life, Physical, and Social Science Technicians, All Other (194099) and Physical Scientists, All Other (192099) occupations in the Energy and Natural Resources cluster. Precision agriculture technicians are part of the Agricultural Technicians (194012) occupation.

Although three occupations in the timber and forest product industry are likely to consist of fewer jobs statewide in 2028 compared to 2023, this forecast masks some regional variation in occupational demand. For example, while most regions are forecasted to see a decline in the number of Logging Equipment Operators during the five-year time frame—especially the Bay Consortium LWDA—some regions may see job growth in this occupation, including the Crater region, Hampton Roads, and the Greater Roanoke area.

OCCUPATIONAL OUTLOOK STATISTICS FOR VIRGINIA

VOEE High-Value Occupations

First-Line Supervisors of Farming, Fishing, and Forestry Workers
First-Line Supervisors of Landscaping, Lawn Service, and Groundskeeping Workers Food Batchmakers (*Advanced Manufacturing)
Veterinary Technologists and Technicians

VOEE High-Demand (But Not High-Value) Occupations

Agricultural Equipment Operators Agricultural Workers, All Other Animal Trainers
Bakers (*Advanced Manufacturing) Butchers and Meat Cutters
Food Cooking Machine Operators and Tenders (*Advanced Manufacturing) Food Processing Workers, All Other (*Advanced Manufacturing) Landscaping and Groundskeeping Workers

Packaging and Filling Machine Operators and Tenders (*Advanced Manufacturing) Slaughterers and Meat Packers (*Advanced Manufacturing)
Tree Trimmers and Pruners
Veterinary Assistants and Laboratory Animal Caretakers

Largest Occupations, Virginia, 2023 (Top 10)

Landscaping and Groundskeeping Workers (32,906 jobs)
Animal Caretakers (11,384 jobs)
Farmers, Ranchers, and Other Agricultural Managers (8,240 jobs)
Packaging and Filling Machine Operators and Tenders (*Advanced Manufacturing) (7,303 jobs)
Farmworkers and Laborers, Crop, Nursery, and Greenhouse (5,895 jobs)
First-Line Supervisors of Landscaping, Lawn Service, and Groundskeeping Workers (5,366 jobs)
Bakers (*Advanced Manufacturing) (4,753 jobs)
Veterinary Assistants and Laboratory Animal Caretakers (4,224 jobs)
Veterinarians (3,308 jobs)
Food Batchmakers (*Advanced Manufacturing) (3,192 jobs)

Greatest Number of Annual Job Openings, Virginia, 2023-2028 (500+)

Landscaping and Groundskeeping Workers (4,746 jobs)
Animal Caretakers (2,598 jobs)
Farmworkers and Laborers, Crop, Nursery, and Greenhouse (1,094 jobs)
Packaging and Filling Machine Operators and Tenders (*Advanced Manufacturing) (1,011 jobs)
Farmers, Ranchers, and Other Agricultural Managers (983 jobs)
Veterinary Assistants and Laboratory Animal Caretakers (943 jobs)
Bakers (*Advanced Manufacturing) (812 jobs)
First-Line Supervisors of Landscaping, Lawn Service, and Groundskeeping Workers (620 jobs)
Food Batchmakers (*Advanced Manufacturing) (543 jobs)

Greatest Number of New Jobs Created, Virginia, 2023-2028 (300+)

Animal Caretakers (1,725 jobs)
Landscaping and Groundskeeping Workers (1,579 jobs)
Packaging and Filling Machine Operators and Tenders (*Advanced Manufacturing) (576 jobs)
Bakers (*Advanced Manufacturing) (466 jobs)
Farmworkers and Laborers, Crop, Nursery, and Greenhouse (452 jobs) Veterinary Assistants and Laboratory Animal Caretakers (404 jobs)
Veterinary Technologists and Technicians (350 jobs)
Food Batchmakers (*Advanced Manufacturing) (344 jobs) Veterinarians (313 jobs)

Highest Job Growth Rates, Virginia, 2023-2028 (at least 10% job growth and 35 new jobs)

Slaughterers and Meat Packers (*Advanced Manufacturing) (+17%; 133 new jobs) Animal Caretakers (+15%; 1,725 new jobs)
Animal Trainers (+12%; 111 new jobs)
Veterinary Technologists and Technicians (+11%; 350 new jobs)
Food Batchmakers (*Advanced Manufacturing) (+11%; 344 new jobs)
Bakers (*Advanced Manufacturing) (+10%; 466 new jobs)
Veterinary Assistants and Laboratory Animal Caretakers (+10%; 404 new jobs) Agricultural Equipment Operators (+10%; 87 new jobs)

Highest Location Quotients, Virginia, 2024 (2.00 or greater)

Fallers (3.12)

Projected Job Decline, Virginia, 2023-2028

Fallers (39 fewer jobs; -8%)
Food and Tobacco Roasting, Baking, and Drying Machine Operators and Tenders (*Advanced Manufacturing) (36 fewer jobs; -5%)
Logging Equipment Operators (11 fewer jobs; -1%) Logging Workers, All Other (1 fewer job; -1%)

Occupational Employment Outlook by Agriculture Subcluster, Virginia, 2023-2028

(Each Table Sorted in Descending Order of Projected Job Growth)

Agribusiness

SOC Code	Occupation	Predominant Education Level	VOEE High-Demand	VOEE High-Value	Number of Jobs 2023	Annual Job Openings 2023-28	Job Change 2023-28 (#)	Job Change 2023-28 (%)	Location Quotient 2024
119013	Farmers, Ranchers, and Other Agricultural Managers	High School			8,240	983	171	2%	0.92
451011	First-Line Supervisors of Farming, Fishing, and Forestry Workers	High School	Yes	Yes	1,131	186	71	6%	0.39
131074	Farm Labor Contractors	Bachelor's			3	0	0	0%	NA
131021	Buyers and Purchasing Agents, Farm Products	Bachelor's			NA	NA	NA	NA	NA

Agricultural Technology & Automation

SOC Code	Occupation	Predominant Education Level	VOEE High-Demand	VOEE High-Value	Number of Jobs 2023	Annual Job Openings 2023-28	Job Change 2023-28 (#)	Job Change 2023-28 (%)	Location Quotient 2024
452091	Agricultural Equipment Operators	Less than High School	Yes		848	163	87	10%	0.25
452099	Agricultural Workers, All Other	Less than High School	Yes		841	156	59	7%	0.61
493041	Farm Equipment Mechanics and Service Technicians	High School			598	74	51	9%	NA
194012	Agricultural Technicians	Some College / Associate			341	56	27	8%	0.48
172021	Agricultural Engineers	Bachelor's			37	2	0	0%	NA
454022	Logging Equipment Operators	High School			1,061	183	-11	-1%	1.29

Animal Systems

SOC Code	Occupation	Predominant Education Level	VOEE High-Demand	VOEE High-Value	Number of Jobs 2023	Annual Job Openings 2023-28	Job Change 2023-28 (#)	Job Change 2023-28 (%)	Location Quotient 2024
392021	Animal Caretakers	Some College / Associate			11,384	2,598	1,725	15%	1.62
319096	Veterinary Assistants and Laboratory Animal Caretakers	Some College / Associate	Yes		4,224	943	404	10%	1.17
292056	Veterinary Technologists and Technicians	Some College / Associate	Yes	Yes	3,054	389	350	11%	1.11
291131	Veterinarians	Graduate			3,308	185	313	9%	NA
452093	Farmworkers, Farm, Ranch, and Aquacultural Animals	Less than High School			2,535	459	128	5%	NA
392011	Animal Trainers	Some College / Associate	Yes		917	171	111	12%	1.2
191011	Animal Scientists	Bachelor's			45	6	6	13%	0.81
452021	Animal Breeders	High School			25	5	4	17%	1.31
453031	Fishing and Hunting Workers	High School			523	82	-51	-10%	NA

Food Science and Processing (Agriculture Cluster)

SOC Code	Occupation	Predominant Education Level	VOEE High-Demand	VOEE High-Value	Number of Jobs 2023	Annual Job Openings 2023-28	Job Change 2023-28 (#)	Job Change 2023-28 (%)	Location Quotient 2024
513021	Butchers and Meat Cutters	High School	Yes		2,713	371	64	2%	0.57
191012	Food Scientists and Technologists	Bachelor's			241	29	19	8%	0.36
194013	Food Science Technicians	Some College / Associate			284	46	15	5%	0.64
452041	Graders and Sorters, Agricultural Products	Less than High School			522	88	9	2%	0.21

Food Processing / Production and Automation (Advanced Manufacturing Cluster)

SOC Code	Occupation	Predominant Education Level	VOEE High-Demand	VOEE High-Value	Number of Jobs 2023	Annual Job Openings 2023-28	Job Change 2023-28 (#)	Job Change 2023-28 (%)	Location Quotient 2024
519111	Packaging and Filling Machine Operators and Tenders	High School	Yes		7,303	1,011	576	8%	1.23
513011	Bakers	High School	Yes		4,753	812	466	10%	0.35
513092	Food Batchmakers	High School	Yes	Yes	3,192	543	344	11%	0.60

SOC Code	Occupation	Predominant Education Level	VOEE High-Demand	VOEE High-Value	Number of Jobs 2023	Annual Job Openings 2023-28	Job Change 2023-28 (#)	Job Change 2023-28 (%)	Location Quotient 2024
513023	Slaughterers and Meat Packers	High School	Yes		801	145	133	17%	0.68
513099	Food Processing Workers, All Other	High School	Yes		1,017	133	56	5%	0.38
519192	Cleaning, Washing, and Metal Pickling Equipment Operators and Tenders	High School			236	35	26	11%	0.93
513093	Food Cooking Machine Operators and Tenders	High School	Yes		702	143	15	2%	0.66
513022	Meat, Poultry, and Fish Cutters and Trimmers	High School			2,499	374	15	1%	0.82
519193	Cooling and Freezing Equipment Operators and Tenders	High School			126	18	5	4%	1.00
513091	Food and Tobacco Roasting, Baking, and Drying Machine Operators and Tenders	High School			700	97	-36	-5%	0.95

Plant Systems

SOC Code	Occupation	Predominant Education Level	VOEE High-Demand	VOEE High-Value	Number of Jobs 2023	Annual Job Openings 2023-28	Job Change 2023-28 (#)	Job Change 2023-28 (%)	Location Quotient 2024
373011	Landscaping and Groundskeeping Workers	High School	Yes		32,906	4,746	1,579	5%	0.5
452092	Farmworkers and Laborers, Crop, Nursery, and Greenhouse	Less than High School			5,895	1,094	452	8%	1.04
371012	First-Line Supervisors of Landscaping, Lawn Service, and Groundskeeping Workers	High School	Yes	Yes	5,366	620	193	4%	0.45
373013	Tree Trimmers and Pruners	High School	Yes		2,722	403	77	3%	0.38
191013	Soil and Plant Scientists	Bachelor's			510	61	38	7%	0.17
373012	Pesticide Handlers, Sprayers, and Applicators, Vegetation	High School			488	71	26	5%	0.68
373019	Grounds Maintenance Workers, All Other	High School			256	38	15	6%	1.02
454023	Log Graders and Scalers	High School			181	33	10	6%	1.03
454029	Logging Workers, All Other	High School			137	24	-1	-1%	NA
454021	Fallers	High School			501	80	-39	-8%	3.12

Water Systems

SOC Code	Occupation	Predominant Education Level	VOEE High-Demand	VOEE High-Value	Number of Jobs 2023	Annual Job Openings 2023-28	Job Change 2023-28 (#)	Job Change 2023-28 (%)	Location Quotient 2024
192043	Hydrologists	Graduate			578	66	7	1%	0.52
194044	Hydrologic Technicians	Bachelor's			270	26	4	1%	0.25

Occupational Employment Outlook, All Agriculture Occupations, Virginia, 2023-2028

(Table Sorted by Descending Number of Annual Job Openings)

All Agriculture Occupations (including Advanced Manufacturing food processing occupations)

SOC Code	Occupation	Predominant Education Level	VOEE High-Demand	VOEE High-Value	Number of Jobs 2023	Annual Job Openings 2023-28	Job Change 2023-28 (#)	Job Change 2023-28 (%)	Location Quotient 2024
373011	Landscaping and Groundskeeping Workers	High School	Yes		32,906	4,746	1,579	5%	1.04
392021	Animal Caretakers	Some College / Associate			11,384	2,598	1,725	15%	1.62
452092	Farmworkers and Laborers, Crop, Nursery, and Greenhouse	Less than High School			5,895	1,094	452	8%	0.17
519111	Packaging and Filling Machine Operators and Tenders	High School	Yes		7,303	1,011	576	8%	0.68
119013	Farmers, Ranchers, and Other Agricultural Managers	High School			8,240	983	171	2%	0.92
319096	Veterinary Assistants and Laboratory Animal Caretakers	Some College / Associate	Yes		4,224	943	404	10%	1.17

SOC Code	Occupation	Predominant Education Level	VOEE High-Demand	VOEE High-Value	Number of Jobs 2023	Annual Job Openings 2023-28	Job Change 2023-28 (#)	Job Change 2023-28 (%)	Location Quotient 2024
513011	Bakers	High School	Yes		4,753	812	466	10%	0.93
371012	First-Line Supervisors of Landscaping, Lawn Service, and Groundskeeping Workers	High School	Yes	Yes	5,366	620	193	4%	1.02
513092	Food Batchmakers	High School	Yes	Yes	3,192	543	344	11%	0.60
452093	Farmworkers, Farm, Ranch, and Aquacultural Animals	Less than High School			2,535	459	128	5%	NA
373013	Tree Trimmers and Pruners	High School	Yes		2,722	403	77	3%	0.68
292056	Veterinary Technologists and Technicians	Some College / Associate	Yes	Yes	3,054	389	350	11%	1.11
513022	Meat, Poultry, and Fish Cutters and Trimmers	High School			2,499	374	15	1%	0.66
513021	Butchers and Meat Cutters	High School	Yes		2,713	371	64	2%	0.57
451011	First-Line Supervisors of Farming, Fishing, and Forestry Workers	High School	Yes	Yes	1,131	186	71	6%	0.39
291131	Veterinarians	Graduate			3,308	185	313	9%	NA

SOC Code	Occupation	Predominant Education Level	VOEE High-Demand	VOEE High-Value	Number of Jobs 2023	Annual Job Openings 2023-28	Job Change 2023-28 (#)	Job Change 2023-28 (%)	Location Quotient 2024
454022	Logging Equipment Operators	High School			1,061	183	-11	-1%	1.29
392011	Animal Trainers	Some College / Associate	Yes		917	171	111	12%	1.20
452091	Agricultural Equipment Operators	Less than High School	Yes		848	163	87	10%	0.25
452099	Agricultural Workers, All Other	Less than High School	Yes		841	156	59	7%	0.61
513023	Slaughterers and Meat Packers	High School	Yes		801	145	133	17%	0.35
513093	Food Cooking Machine Operators and Tenders	High School	Yes		702	143	15	2%	1.00
513099	Food Processing Workers, All Other	High School	Yes		1,017	133	56	5%	1.23
513091	Food and Tobacco Roasting, Baking, and Drying Machine Operators and Tenders	High School			700	97	-36	-5%	0.95
452041	Graders and Sorters, Agricultural Products	Less than High School			522	88	9	2%	0.36
453031	Fishing and Hunting Workers	High School			523	82	-51	-10%	NA
454021	Fallers	High School			501	80	-39	-8%	3.12

SOC Code	Occupation	Predominant Education Level	VOEE High-Demand	VOEE High-Value	Number of Jobs 2023	Annual Job Openings 2023-28	Job Change 2023-28 (#)	Job Change 2023-28 (%)	Location Quotient 2024
493041	Farm Equipment Mechanics and Service Technicians	High School			598	74	51	9%	NA
373012	Pesticide Handlers, Sprayers, and Applicators, Vegetation	High School			488	71	26	5%	0.45
192043	Hydrologists	Graduate			578	66	7	1%	0.25
191013	Soil and Plant Scientists	Bachelor's			510	61	38	7%	0.50
194012	Agricultural Technicians	Some College / Associate			341	56	27	8%	0.48
194013	Food Science Technicians	Some College / Associate			284	46	15	5%	0.64
373019	Grounds Maintenance Workers, All Other	High School			256	38	15	6%	0.38
519192	Cleaning, Washing, and Metal Pickling Equipment Operators and Tenders	High School			236	35	26	11%	0.38
454023	Log Graders and Scalers	High School			181	33	10	6%	1.03
191012	Food Scientists and Technologists	Bachelor's			241	29	19	8%	0.21
194044	Hydrologic Technicians	Bachelor's			270	26	4	1%	0.52

SOC Code	Occupation	Predominant Education Level	VOEE High-Demand	VOEE High-Value	Number of Jobs 2023	Annual Job Openings 2023-28	Job Change 2023-28 (#)	Job Change 2023-28 (%)	Location Quotient 2024
454029	Logging Workers, All Other	High School			137	24	-1	-1%	NA
519193	Cooling and Freezing Equipment Operators and Tenders	High School			126	18	5	4%	0.82
191011	Animal Scientists	Bachelor's			45	6	6	13%	0.81
452021	Animal Breeders	High School			25	5	4	17%	1.31
172021	Agricultural Engineers	Bachelor's			37	2	0	0%	NA
131074	Farm Labor Contractors	Bachelor's			3	0	0	0%	NA
131021	Buyers and Purchasing Agents, Farm Products	Bachelor's			NA	NA	NA	NA	NA

VIRGINIA'S OCCUPATIONAL OUTLOOK – ENERGY AND NATURAL RESOURCES

Trends

Northern Virginia has the highest concentration of data centers in the world. Data centers require massive amounts of electricity and specialized infrastructure to operate reliably, which will require the skills of a range of tradespeople and technicians.

The Virginia Clean Economy Act of 2020, which mandates that Virginia transition to 100% carbon-free electricity by 2050, has set into motion efforts to shore up Virginia's electrical grid infrastructure and renewable energy workforce.

Utility-scale solar permitting in Virginia experienced rapid growth over the last several years, with 348 utility-scale solar projects approved by local governments since 2014 (Weldon Cooper Center for Public Service, 2025). Current political headwinds may slow the development of projects that have been approved but not yet built and impact the future of new solar development; however, public support remains for rooftop and brownfields solar (American Farmland Trust, n.d.).

The expansion of electric vehicle (EV) charging infrastructure to close the gap in EV charging deserts has recently received significant state funding (Virginia Energy, 2025).

Battery storage development is expanding in the Commonwealth. Since 2022, 17 battery storage projects have submitted notices of intent to the Virginia Department of Environmental Quality for small renewable energy permit-by-rule applications, with eight having received their state permits (Virginia Department of Environmental Quality, n.d.).

The global transition from fossil fuels to renewable and cleaner energy sources will likely be reflected in the types of worker skills that are in demand in the labor market. Emerging technology jobs will encompass roles focused on generation, transmission, and distribution of renewable energy; advanced statistical and machine learning modeling; and advances in utility metering (Center for Energy Workforce Development, 2023).

Coal production in Virginia declined by 33% between 2012 and 2023, with many surface coal mines across Southwest Virginia functionally abandoned (Virginia Conservation Network, 2024) and the focus at Virginia Energy and beyond shifting towards mine land reclamation (Virginia Energy, 2025). That being said, there has been a recent uptick in coal mine production in the last year (Virginia Energy, 2025).

Cuts by the federal government to workers who steward public lands and natural resources leaves the future of public jobs in natural resource work across the country uncertain.

OCCUPATIONAL OUTLOOK STATISTICS FOR VIRGINIA

VOEE High-Value Occupations

Biological Scientists, All Other
Biological Technicians
Control and Valve Installers and Repairers, Except Mechanical Door
Electrical and Electronics Repairers, Powerhouse, Substation, and Relay
Electrical Power-Line Installers and Repairers
Environmental Engineers
Environmental Science and Protection Technicians, Including Health
Environmental Scientists and Specialists, Including Health
Forest and Conservation Technicians
Life, Physical, and Social Science Technicians, All Other
Natural Sciences Managers
Physical Scientists, All Other
Septic Tank Servicers and Sewer Pipe Cleaners
Telecommunications Equipment Installers and Repairers, Except Line Installers
Telecommunications Line Installers and Repairers
Water and Wastewater Treatment Plant and System Operators

VOEE High-Demand (But Not High-Value) Occupations

Hazardous Materials Removal Workers
Refuse and Recyclable Material Collectors

Largest Occupations, Virginia, 2023 (Top 10)

Telecommunications Equipment Installers and Repairers, Except Line Installers (4,776 jobs)
Telecommunications Line Installers and Repairers (3,962 jobs)
Electrical Power-Line Installers and Repairers (3,552 jobs)
Environmental Scientists and Specialists, Including Health (3,227 jobs)
Water and Wastewater Treatment Plant and System Operators (3,206 jobs)
Refuse and Recyclable Material Collectors (2,849 jobs)
Biological Technicians (1,920 jobs)
Hazardous Materials Removal Workers (1,764 jobs)
Natural Sciences Managers (1,723 jobs)
Nuclear Engineers (1,685 jobs)

Greatest Number of Annual Job Openings, Virginia, 2023-2028 (500+)

Telecommunications Equipment Installers and Repairers, Except Line Installers (637 jobs)

Greatest Number of New Jobs Created, Virginia, 2023-2028 (300+)

[No occupations with at least 300 new jobs created]

Highest Job Growth Rates, Virginia, 2023-2028 (at least 10% job growth and 35 new jobs)

Roustabouts, Oil and Gas (+34%; 35 new jobs)
Petroleum Pump System Operators, Refinery Operators, and Gaugers (+17%; 38 new jobs)
Solar Photovoltaic Installers (+16%; 42 new jobs)
Forest and Conservation Workers (+11%; 51 new jobs)
Life, Physical, and Social Science Technicians, All Other (+10%; 156 new jobs)

Highest Location Quotients, Virginia, 2024 (2.00 or greater)

Nuclear Engineers (3.35)
Roof Bolters, Mining (2.81)
Physical Scientists, All Other (2.63)
Radio, Cellular, and Tower Equipment Installers and Repairers (2.53)
Life Scientists, All Other (2.40)
Physicists (2.24)
Nuclear Technicians (2.06)

Projected Job Decline, Virginia, 2023-2028

Gas Plant Operators (50 fewer jobs; -7%)
Nuclear Technicians (48 fewer jobs; -14%)
Nuclear Power Reactor Operators (25 fewer jobs; -11%)
Pipelayers (21 fewer jobs; -2%)
Nuclear Engineers (19 fewer jobs; -1%)
Meter Readers, Utilities (8 fewer jobs; -2%)
Power Distributors and Dispatchers (7 fewer jobs; -2%)
Mining and Geological Engineers, Including Mining Safety Engineers (4 fewer jobs; -2%)
Underground Mining Machine Operators, All Other (2 fewer jobs; -2%)

Occupational Employment Outlook by Energy & Natural Resources Subcluster, Virginia, 2023-2028

(Each Table Sorted in Descending Order of Projected Job Growth

Clean and Alternative Energy

SOC Code	Occupation	Predominant Education Level	VOEE High-Demand	VOEE High-Value	Number of Jobs 2023	Annual Job Openings 2023-28	Job Change 2023-28 (#)	Job Change 2023-28 (%)	Location Quotient 2024
472231	Solar Photovoltaic Installers	Some College / Associate			264	40	42	16%	1.49
499081	Wind Turbine Service Technicians	Some College / Associate			148	22	24	16%	NA
172161	Nuclear Engineers	Bachelor's			1,685	118	-19	-1%	3.35
518011	Nuclear Power Reactor Operators	Some College / Associate			221	22	-25	-11%	NA
194051	Nuclear Technicians	Bachelor's			349	37	-48	-14%	2.06

Conservation and Land Management

SOC Code	Occupation	Predominant Education Level	VOEE High-Demand	VOEE High-Value	Number of Jobs 2023	Annual Job Openings 2023-28	Job Change 2023-28 (#)	Job Change 2023-28 (%)	Location Quotient 2024
454011	Forest and Conservation Workers	High School			455	99	51	11%	NA
191031	Conservation Scientists	Bachelor's			737	80	49	7%	1.07
194071	Forest and Conservation Technicians	Bachelor's	Yes	Yes	771	106	25	3%	0.42
191032	Foresters	Bachelor's			411	43	23	6%	1.38
333031	Fish and Game Wardens	Bachelor's			198	24	0	0%	1.25

Ecological [Natural Science] Research and Development

SOC Code	Occupation	Predominant Education Level	VOEE High-Demand	VOEE High-Value	Number of Jobs 2023	Annual Job Openings 2023-28	Job Change 2023-28 (#)	Job Change 2023-28 (%)	Location Quotient 2024
194021	Biological Technicians	Bachelor's	Yes	Yes	1,920	294	157	8%	0.97
194099	Life, Physical, and Social Science Technicians, All Other	Bachelor's	Yes	Yes	1,634	244	156	10%	1.56
119121	Natural Sciences Managers	Graduate	Yes	Yes	1,723	167	114	7%	0.54

SOC Code	Occupation	Predominant Education Level	VOEE High-Demand	VOEE High-Value	Number of Jobs 2023	Annual Job Openings 2023-28	Job Change 2023-28 (#)	Job Change 2023-28 (%)	Location Quotient 2024
191021	Biochemists and Biophysicists	Graduate			1,485	155	112	8%	0.15
191029	Biological Scientists, All Other	Graduate	Yes	Yes	1,313	134	70	5%	1.24
192099	Physical Scientists, All Other	Graduate	Yes	Yes	1,621	140	46	3%	2.63
192012	Physicists	Graduate			910	78	45	5%	2.24
192042	Geoscientists, Except Hydrologists and Geographers	Graduate			720	73	32	4%	0.52
192021	Atmospheric and Space Scientists	Bachelor's			550	53	31	6%	0.66
191022	Microbiologists	Graduate			258	29	28	11%	0.30
191023	Zoologists and Wildlife Biologists	Graduate			429	43	19	5%	0.82
191099	Life Scientists, All Other	Graduate			378	28	13	4%	2.40
192011	Astronomers	Graduate			144	13	9	6%	NA
194043	Geological Technicians, Except Hydrologic Technicians	Bachelor's			112	14	6	6%	NA

Environmental Protection

SOC Code	Occupation	Predominant Education Level	VOEE High-Demand	VOEE High-Value	Number of Jobs 2023	Annual Job Openings 2023-28	Job Change 2023-28 (#)	Job Change 2023-28 (%)	Location Quotient 2024
192041	Environmental Scientists and Specialists, Including Health	Bachelor's	Yes	Yes	3,227	334	132	4%	1.20
194042	Environmental Science and Protection Technicians, Including Health	Bachelor's	Yes	Yes	1,155	136	45	4%	1.11
172081	Environmental Engineers	Bachelor's	Yes	Yes	1,312	107	40	3%	1.24
173025	Environmental Engineering Technologists and Technicians	Some College / Associate			290	33	14	5%	NA

Resource Extraction

SOC Code	Occupation	Predominant Education Level	VOEE High-Demand	VOEE High-Value	Number of Jobs 2023	Annual Job Openings 2023-28	Job Change 2023-28 (#)	Job Change 2023-28 (%)	Location Quotient 2024
518093	Petroleum Pump System Operators, Refinery Operators, and Gaugers	Some College / Associate			218	34	38	17%	0.11
475071	Roustabouts, Oil and Gas	High School			103	21	35	34%	NA

SOC Code	Occupation	Predominant Education Level	VOEE High-Demand	VOEE High-Value	Number of Jobs 2023	Annual Job Openings 2023-28	Job Change 2023-28 (#)	Job Change 2023-28 (%)	Location Quotient 2024
475013	Service Unit Operators, Oil and Gas	High School			72	15	26	36%	0.05
475012	Rotary Drill Operators, Oil and Gas	High School			116	17	16	14%	NA
537073	Wellhead Pumpers	High School			62	11	11	18%	NA
475041	Continuous Mining Machine Operators	High School			227	32	8	4%	0.58
172171	Petroleum Engineers	Bachelor's			374	28	5	1%	NA
475044	Loading and Moving Machine Operators, Underground Mining	High School			33	6	5	15%	1.06
475099	Extraction Workers, All Other	High School			53	8	5	9%	NA
537072	Pump Operators, Except Wellhead Pumpers	High School			344	46	5	1%	0.64
475011	Derrick Operators, Oil and Gas	High School			17	3	4	25%	NA
475051	Rock Splitters, Quarry	High School			51	7	4	9%	NA
537031	Dredge Operators	High School			39	6	3	9%	NA
475043	Roof Bolters, Mining	High School			21	3	1	5%	2.81
475081	Helpers--Extraction Workers	High School			135	17	1	1%	0.82

SOC Code	Occupation	Predominant Education Level	VOEE High-Demand	VOEE High-Value	Number of Jobs 2023	Annual Job Openings 2023-28	Job Change 2023-28 (#)	Job Change 2023-28 (%)	Location Quotient 2024
475022	Excavating and Loading Machine and Dragline Operators, Surface Mining	High School			1,238	142	0	0%	1.64
475049	Underground Mining Machine Operators, All Other	High School			81	11	-2	-2%	NA
172151	Mining and Geological Engineers, Including Mining Safety Engineers	Bachelor's			169	13	-4	-2%	0.71

Utilities

SOC Code	Occupation	Predominant Education Level	VOEE High-Demand	VOEE High-Value	Number of Jobs 2023	Annual Job Openings 2023-28	Job Change 2023-28 (#)	Job Change 2023-28 (%)	Location Quotient 2024
499051	Electrical Power-Line Installers and Repairers	Some College / Associate	Yes	Yes	3,552	362	218	6%	0.87
537081	Refuse and Recyclable Material Collectors	High School	Yes		2,849	465	185	6%	1.01
492022	Telecommunications Equipment Installers and Repairers, Except Line Installers	Some College / Associate	Yes	Yes	4,776	637	171	4%	0.78

SOC Code	Occupation	Predominant Education Level	VOEE High-Demand	VOEE High-Value	Number of Jobs 2023	Annual Job Openings 2023-28	Job Change 2023-28 (#)	Job Change 2023-28 (%)	Location Quotient 2024
499052	Telecommunications Line Installers and Repairers	Some College / Associate	Yes	Yes	3,962	490	85	2%	1.62
474041	Hazardous Materials Removal Workers	High School	Yes		1,764	255	78	4%	0.97
518031	Water and Wastewater Treatment Plant and System Operators	Some College / Associate	Yes	Yes	3,206	355	65	2%	1.02
499012	Control and Valve Installers and Repairers, Except Mechanical Door	Some College / Associate	Yes	Yes	1,081	102	45	4%	0.77
474071	Septic Tank Servicers and Sewer Pipe Cleaners	High School	Yes	Yes	1,037	132	41	4%	1.29
492095	Electrical and Electronics Repairers, Powerhouse, Substation, and Relay	Some College / Associate	Yes	Yes	1,081	114	18	2%	1.44
518013	Power Plant Operators	Some College / Associate			588	67	7	1%	0.91
492021	Radio, Cellular, and Tower Equipment Installers and Repairers	Some College / Associate			769	97	6	1%	2.53
475023	Earth Drillers, Except Oil and Gas	High School			600	68	3	0%	0.93

SOC Code	Occupation	Predominant Education Level	VOEE High-Demand	VOEE High-Value	Number of Jobs 2023	Annual Job Openings 2023-28	Job Change 2023-28 (#)	Job Change 2023-28 (%)	Location Quotient 2024
537071	Gas Compressor and Gas Pumping Station Operators	High School			65	9	2	3%	NA
518012	Power Distributors and Dispatchers	Some College / Associate			360	38	-7	-2%	0.88
435041	Meter Readers, Utilities	High School			508	46	-8	-2%	0.83
472151	Pipelayers	High School			1,086	110	-21	-2%	1.36
518092	Gas Plant Operators	Some College / Associate			765	86	-50	-7%	NA

Related Occupations in Other Clusters

SOC Code	Occupation	Predominant Education Level	VOEE High-Demand	VOEE High-Value	Number of Jobs 2023	Annual Job Openings 2023-28	Job Change 2023-28 (#)	Job Change 2023-28 (%)	Location Quotient 2024
252032	Career/Technical Education Teachers, Secondary School	Graduate	Yes	Yes	3,510	282	82	2%	1.31
173031	Surveying and Mapping Technicians	Some College / Associate	Yes	Yes	2,343	312	41	2%	1.45
172031	Bioengineers and Biomedical Engineers	Bachelor's			388	30	32	8%	0.87

SOC Code	Occupation	Predominant Education Level	VOEE High-Demand	VOEE High-Value	Number of Jobs 2023	Annual Job Openings 2023-28	Job Change 2023-28 (#)	Job Change 2023-28 (%)	Location Quotient 2024
259021	Farm and Home Management Educators	Graduate			766	81	21	3%	2.21
452011	Agricultural Inspectors	Bachelor's			311	62	16	5%	0.79
339011	Animal Control Workers	Some College / Associate			444	42	9	2%	1.16
171021	Cartographers and Photogrammetrists	Bachelor's			823	67	7	1%	2.23
332022	Forest Fire Inspectors and Prevention Specialists	Some College / Associate			37	5	4	10%	NA
193092	Geographers	Graduate			120	12	0	0%	NA
252023	Career/Technical Education Teachers, Middle School	Graduate			810	65	-5	-1%	1.51
271023	Floral Designers	High School			1,102	139	-36	-3%	0.92
251041	Agricultural Sciences Teachers, Postsecondary	Graduate			NA	NA	NA	NA	1.09
251042	Biological Science Teachers, Postsecondary	Graduate			NA	NA	NA	NA	1.34
251043	Forestry and Conservation Science Teachers, Postsecondary	Graduate			NA	NA	NA	NA	1.94

SOC Code	Occupation	Predominant Education Level	VOEE High-Demand	VOEE High-Value	Number of Jobs 2023	Annual Job Openings 2023-28	Job Change 2023-28 (#)	Job Change 2023-28 (%)	Location Quotient 2024
251051	Atmospheric, Earth, Marine, and Space Sciences Teachers, Postsecondary	Graduate			NA	NA	NA	NA	0.81
251052	Chemistry Teachers, Postsecondary	Graduate			NA	NA	NA	NA	1.23
251053	Environmental Science Teachers, Postsecondary	Graduate			NA	NA	NA	NA	1.89
251054	Physics Teachers, Postsecondary	Graduate			NA	NA	NA	NA	1.69
251064	Geography Teachers, Postsecondary	Graduate			NA	NA	NA	NA	0.83
251194	Career/Technical Education Teachers, Postsecondary	Graduate			NA	NA	NA	NA	0.88
251199	Postsecondary Teachers, All Other	Graduate			NA	NA	NA	NA	0.40

Occupational Employment Outlook, All Energy and Natural Resources Occupations, Virginia, 2023-2028

(Table Sorted by Descending Number of Annual Job Openings)

All Energy and Natural Resources Occupations

SOC Code	Occupation	Predominant Education Level	VOEE High-Demand	VOEE High-Value	Number of Jobs 2023	Annual Job Openings 2023-28	Job Change 2023-28 (#)	Job Change 2023-28 (%)	Location Quotient 2024
492022	Telecommunications Equipment Installers and Repairers, Except Line Installers	Some College / Associate	Yes	Yes	4,776	637	171	4%	0.78
499052	Telecommunications Line Installers and Repairers	Some College / Associate	Yes	Yes	3,962	490	85	2%	1.62
537081	Refuse and Recyclable Material Collectors	High School	Yes		2,849	465	185	6%	1.01
499051	Electrical Power-Line Installers and Repairers	Some College / Associate	Yes	Yes	3,552	362	218	6%	0.87
518031	Water and Wastewater Treatment Plant and System Operators	Some College / Associate	Yes	Yes	3,206	355	65	2%	1.02
192041	Environmental Scientists and Specialists, Including Health	Bachelor's	Yes	Yes	3,227	334	132	4%	1.20

SOC Code	Occupation	Predominant Education Level	VOEE High-Demand	VOEE High-Value	Number of Jobs 2023	Annual Job Openings 2023-28	Job Change 2023-28 (#)	Job Change 2023-28 (%)	Location Quotient 2024
194021	Biological Technicians	Bachelor's	Yes	Yes	1,920	294	157	8%	0.97
474041	Hazardous Materials Removal Workers	High School	Yes		1,764	255	78	4%	0.97
194099	Life, Physical, and Social Science Technicians, All Other	Bachelor's	Yes	Yes	1,634	244	156	10%	1.56
119121	Natural Sciences Managers	Graduate	Yes	Yes	1,723	167	114	7%	0.54
191021	Biochemists and Biophysicists	Graduate			1,485	155	112	8%	0.15
475022	Excavating and Loading Machine and Dragline Operators, Surface Mining	High School			1,238	142	0	0%	1.64
192099	Physical Scientists, All Other	Graduate	Yes	Yes	1,621	140	46	3%	2.63
194042	Environmental Science and Protection Technicians, Including Health	Bachelor's	Yes	Yes	1,155	136	45	4%	1.11
191029	Biological Scientists, All Other	Graduate	Yes	Yes	1,313	134	70	5%	1.24
474071	Septic Tank Servicers and Sewer Pipe Cleaners	High School	Yes	Yes	1,037	132	41	4%	1.29
172161	Nuclear Engineers	Bachelor's			1,685	118	-19	-1%	3.35

SOC Code	Occupation	Predominant Education Level	VOEE High-Demand	VOEE High-Value	Number of Jobs 2023	Annual Job Openings 2023-28	Job Change 2023-28 (#)	Job Change 2023-28 (%)	Location Quotient 2024
492095	Electrical and Electronics Repairers, Powerhouse, Substation, and Relay	Some College / Associate	Yes	Yes	1,081	114	18	2%	1.44
472151	Pipelayers	High School			1,086	110	-21	-2%	1.36
172081	Environmental Engineers	Bachelor's	Yes	Yes	1,312	107	40	3%	1.24
194071	Forest and Conservation Technicians	Bachelor's	Yes	Yes	771	106	25	3%	0.42
499012	Control and Valve Installers and Repairers, Except Mechanical Door	Some College / Associate	Yes	Yes	1,081	102	45	4%	0.77
454011	Forest and Conservation Workers	High School			455	99	51	11%	NA
492021	Radio, Cellular, and Tower Equipment Installers and Repairers	Some College / Associate			769	97	6	1%	2.53
518092	Gas Plant Operators	Some College /Associate			765	86	-50	-7%	NA
191031	Conservation Scientists	Bachelor's			737	80	49	7%	1.07
192012	Physicists	Graduate			910	78	45	5%	2.24
192042	Geoscientists, Except Hydrologists and Geographers	Graduate			720	73	32	4%	0.52
SOC Code	Occupation	Predominant Education Level	VOEE High-Demand	VOEE High-Value	Number of Jobs 2023	Annual Job Openings 2023-28	Job Change 2023-28 (#)	Job Change 2023-28 (%)	Location Quotient 2024
475023	Earth Drillers, Except Oil and Gas	High School			600	68	3	0%	0.93

SOC Code	Occupation	Predominant Education Level	VOEE High-Demand	VOEE High-Value	Number of Jobs 2023	Annual Job Openings 2023-28	Job Change 2023-28 (#)	Job Change 2023-28 (%)	Location Quotient 2024
518013	Power Plant Operators	Some College / Associate			588	67	7	1%	0.91
192021	Atmospheric and Space Scientists	Bachelor's			550	53	31	6%	0.66
537072	Pump Operators, Except Wellhead Pumpers	High School			344	46	5	1%	0.64
435041	Meter Readers, Utilities	High School			508	46	-8	-2%	0.83
191032	Foresters	Bachelor's			411	43	23	6%	1.38
191023	Zoologists and Wildlife Biologists	Graduate			429	43	19	5%	0.82
472231	Solar Photovoltaic Installers	Some College / Associate			264	40	42	16%	1.49
518012	Power Distributors and Dispatchers	Some College / Associate			360	38	-7	-2%	0.88
194051	Nuclear Technicians	Bachelor's			349	37	-48	-14%	2.06
518093	Petroleum Pump System Operators, Refinery Operators, and Gaugers	Some College / Associate			218	34	38	17%	0.11
SOC Code	Occupation	Predominant Education Level	VOEE High-Demand	VOEE High-Value	Number of Jobs 2023	Annual Job Openings 2023-28	Job Change 2023-28 (#)	Job Change 2023-28 (%)	Location Quotient 2024
173025	Environmental Engineering Technologists and Technicians	Some College / Associate			290	33	14	5%	NA
475041	Continuous Mining Machine Operators	High School			227	32	8	4%	0.58

SOC Code	Occupation	Predominant Education Level	VOEE High-Demand	VOEE High-Value	Number of Jobs 2023	Annual Job Openings 2023-28	Job Change 2023-28 (#)	Job Change 2023-28 (%)	Location Quotient 2024
191022	Microbiologists	Graduate			258	29	28	11%	0.30
191099	Life Scientists, All Other	Graduate			378	28	13	4%	2.40
172171	Petroleum Engineers	Bachelor's			374	28	5	1%	NA
333031	Fish and Game Wardens	Bachelor's			198	24	0	0%	1.25
499081	Wind Turbine Service Technicians	Some College / Associate			148	22	24	16%	NA
518011	Nuclear Power Reactor Operators	Some College / Associate			221	22	-25	-11%	NA
475071	Roustabouts, Oil and Gas	High School			103	21	35	34%	NA
475012	Rotary Drill Operators, Oil and Gas	High School			116	17	16	14%	NA
475081	Helpers--Extraction Workers	High School			135	17	1	1%	0.82
475013	Service Unit Operators, Oil and Gas	High School			72	15	26	36%	0.05
SOC Code	Occupation	Predominant Education Level	VOEE High-Demand	VOEE High-Value	Number of Jobs 2023	Annual Job Openings 2023-28	Job Change 2023-28 (#)	Job Change 2023-28 (%)	Location Quotient 2024
194043	Geological Technicians, Except Hydrologic Technicians	Bachelor's			112	14	6	6%	NA
192011	Astronomers	Graduate			144	13	9	6%	NA
172151	Mining and Geological Engineers, Including Mining Safety Engineers	Bachelor's			169	13	-4	-2%	0.71

SOC Code	Occupation	Predominant Education Level	VOEE High-Demand	VOEE High-Value	Number of Jobs 2023	Annual Job Openings 2023-28	Job Change 2023-28 (#)	Job Change 2023-28 (%)	Location Quotient 2024
537073	Wellhead Pumpers	High School			62	11	11	18%	NA
475049	Underground Mining Machine Operators, All Other	High School			81	11	-2	-2%	NA
537071	Gas Compressor and Gas Pumping Station Operators	High School			65	9	2	3%	NA
475099	Extraction Workers, All Other	High School			53	8	5	9%	NA
475051	Rock Splitters, Quarry	High School			51	7	4	9%	NA
475044	Loading and Moving Machine Operators, Underground Mining	High School			33	6	5	15%	1.06
537031	Dredge Operators	High School			39	6	3	9%	NA
475011	Derrick Operators, Oil and Gas	High School			17	3	4	25%	NA
475043	Roof Bolters, Mining	High School			21	3	1	5%	2.81

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APPENDICES

APPENDIX A

Current Agricultural Education Courses

Offered by the VDOE Office of Career and Technical Education.

Courses have been aligned to subclusters within several career clusters (see Appendix B: *Career Clusters*).

Agriculture	Agribusiness	Agricultural Technology & Automation	Animal Systems	Food Science & Processing	Plant Systems	Water Systems
MIDDLE SCHOOL COURSES						
Agriscience Exploration					•	
Agriscience & Technology		•				
Introduction to Agriscience	•					
HIGH SCHOOL COURSES						
Agricultural Business Fundamentals I	•					
Agricultural Business Management III	•					
Agricultural Business Operations II	•					
Agricultural Education-Development					•	
Agricultural Education-Preparation					•	
Agricultural Fabrication & Emerging Technologies		•				
Agricultural Power Systems		•				
Agricultural Power Systems, Advanced		•				
Agricultural Production Technology		•				
Applied Agricultural Concepts	•					
Biological Applications in Agriculture				•		
Biotechnology Applications in Agriculture				•		
Community Forestry and Tree Management					•	

Agriculture	Agribusiness	Agricultural Technology & Automation	Animal Systems	Food Science & Processing	Plant Systems	Water Systems
Equine Science			•			
Equine Science, Advanced			•			
Floriculture					•	
Foundations of Agriculture, Food, & Natural Resources		•				
Greenhouse Plant Production & Management					•	
Horticulture Science					•	
Introduction to Animal Systems			•			
Introduction to Plant Systems					•	
Introduction to Power, Structural, and Technical Systems		•				
Landscaping I					•	
Landscaping II					•	
Livestock Production Management			•			
Operating the Farm Business	•					
Small Animal Care I			•			
Small Animal Care II			•			
Turfgrass Management					•	
Turfgrass Management, Advanced					•	
Veterinary Science I			•			
Veterinary Science II			•			

Arts, Entertainment, & Design	Design & Digital Arts	Fashion & Interiors	Fine Arts	Lighting & Sound Technology	Media Production & Broadcasting	Performing Arts
HIGH SCHOOL COURSES						
Floral Design I		•				
Floral Design II		•				

Construction	Architecture & Civil Engineering	Construction Planning & Development	Equipment Operation & Maintenance	Skilled Trades
HIGH SCHOOL COURSES				
Agricultural Structural Systems				•

Digital Technology	Data Science & Artificial Intelligence	Information Technology (IT) Support & Services	Network Systems & Cybersecurity	Software Solutions	Unmanned Vehicle Technology	Web & Cloud
HIGH SCHOOL COURSES						
Cybersecurity in Food and Agriculture			•			
Cybersecurity in Food and Agriculture, Advanced			•			

Energy & Natural Resources	Clean & Alternative Energy	Conservation & Land Management	Ecological Research & Development	Environmental Protection	Resource Extraction	Utilities
HIGH SCHOOL COURSES						
Ecology and Environmental Management		•				
Fisheries and Wildlife Management		•				
Forestry Management		•				
Forestry Management, Advanced		•				
Introduction to Natural Resources and Ecology Systems		•				

Healthcare & Human Services	Behavioral & Mental Health	Biotechnology Research & Development	Community & Social Services	Health Data & Administration	Personal Care Services	Physical Health
HIGH SCHOOL COURSES						
Biotechnology Foundations in Agricultural and Environmental Science		•				

Hospitality, Events, and Tourism	Accommodations	Conferences & Events	Culinary & Food Services	Travel & Leisure
HIGH SCHOOL COURSES				
Outdoor Recreation, Parks, and Tourism Systems Management				•

Supply Chain & Transportation	Air & Space Transportation	Ground & Rail Transportation	Maintenance & Repair	Marine Transportation	Planning & Logistics	Purchasing & Warehousing
HIGH SCHOOL COURSES						
Small Engine Repair			•			

APPENDIX B

Career Clusters

APPENDIX C

The Three-Component Model, FFA