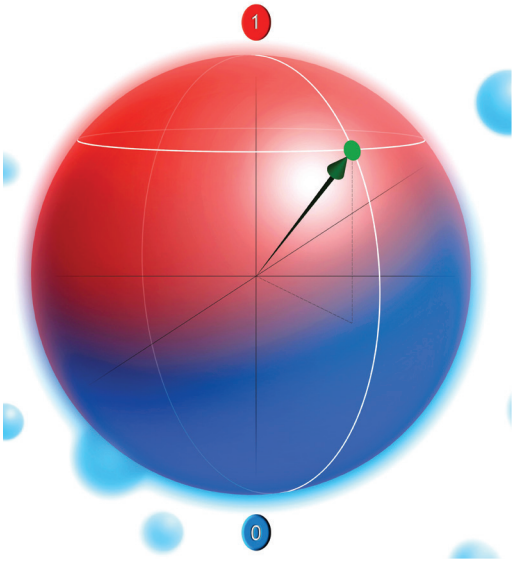
STRATEGIC ROADMAPS

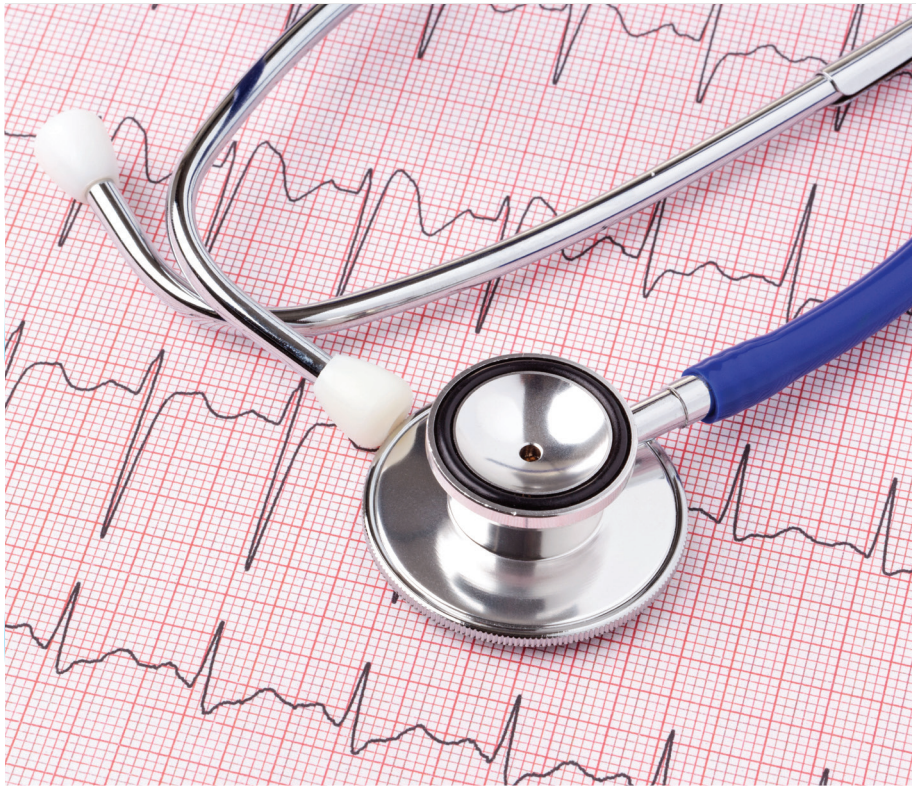
for the Commonwealth's Future

Pressing Challenges. Strategic Opportunities.

DEVELOPED BY VASEM

SEPTEMBER 2025





Virginia Academy of Science, Engineering, and Medicine

The Virginia Academy of Science, Engineering, and Medicine is a nonprofit organization consisting of members of the National Academies of Science, Engineering, and Medicine who reside or work in Virginia as well as Virginians who are leaders in these fields. Through its nonpartisan network of experts, the Virginia Academy provides rigorous analytical, technical, and scientific support to inform policy on issues critical to the Commonwealth.

The Virginia Academy also promotes research, fosters interchange among individuals and organizations, and recognizes and honors Virginians who have made major contributions to science, engineering, and medicine.

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Introduction

An old adage says that every challenge presents an opportunity. While this may be true, realizing the opportunity embedded in a challenge—especially given the scale of the challenges the Commonwealth faces today—requires careful planning and coordinated action. The goal of *Strategic Roadmaps*, a follow-up to VASEM's *Key Strategies* report of four years ago, is to highlight four of the most pressing challenges facing the Commonwealth, underscore the resident strengths Virginia can tap to address these issues, and provide guidance on constructing roadmaps to attack them in ways that create opportunities for Virginia and its citizens. The goal of *Strategic Roadmaps* is to encourage informed, timely action.

Preparing for Artificial General Intelligence

In the last few years, the changes wrought by large language models like ChatGPT and Gemini have infiltrated every aspect of modern life, from simple Google searches to more sophisticated tasks such as diagnosing medical conditions, writing software, and detecting financial fraud. But as powerful as AI is today, it will be vastly more powerful in five years as developers approach **artificial general intelligence (AGI)**. In many respects, AGI will be indistinguishable from human intelligence and, in some cases, will exceed it. It is imperative that the Commonwealth begin now to develop a roadmap to prepare for what promises to be an extremely disruptive technological transformation, differing from previous revolutions like the advent of electricity, in its speed and scope.

Meeting Virginia's Fast-Growing Energy Demand

The AGI revolution will place tremendous strain on the nation's electrical generation, transmission, and distribution systems. AI data centers are already raising concerns about their energy consumption (see the Virginia Academy's recent white paper on the topic),[1] and the move toward AGI will intensify this demand many times over. This challenge is particularly acute in Virginia, the home of the largest concentration of data centers in the world. If Virginia is to retain its preeminence, it must prepare a roadmap for developing interim and long-term solutions to **meeting Virginia's fast-growing energy demand.** If current strengths are cultivated properly, meeting data center demand could position the Commonwealth as a leader in small modular reactors and, in the next decade, cold fusion technology, while lessening our reliance on carbon-based fuels.

Improving Virginia's Health Outcomes

Funding cuts to programs like Medicaid and the Supplemental Nutrition Assistance Program and growing financial strains on the state's hospital system pose challenges for Virginia if it is to continue to improve health outcomes. For the public health community, AI, advanced data analytics, and access to large state and federal datasets may provide an opportunity to develop a neutral, granular understanding of health issues and pinpoint appropriate cost-effective interventions. Creating a roadmap based

[1] https://vasem.org/wp-content/uploads/2025/07/E_VASEM-WhitePaper.pdf

on this vision would require detailing the implications of new federal policies on local health outcomes, exploring methods to mobilize and focus the Commonwealth's considerable public health expertise, and considering how to accelerate access to public and private datasets.

Positioning Virginia for the Quantum Revolution

A last challenge is preparing for the next wave of sweeping transformation, driven by the **advent of quantum devices.** The responsiveness of quantum sensors now entering the market far surpasses those based on current technologies, and the quantum computers arriving in the next decade will be able to solve unimaginably complex problems in fields like drug discovery, financial modeling, and cybersecurity. Quantum computing also has the potential to help reduce global energy demand by facilitating the development of more efficient materials and processes. Although Virginia does not have the depth of research expertise and dedicated funding of leaders like Illinois or Colorado, it does have the lead time to take lessons learned from their initiatives and build centers of excellence in select quantum technologies. By acting now, Virginia will have the opportunity to secure the many benefits of the quantum revolution for its citizens.

Our Experts

In preparing the *Strategic Roadmaps* report, the Virginia Academy consulted with eminent scientists and engineers from universities and businesses across the state. We would like to thank them for their willingness to contribute their time and expertise to this project with the recognition that any errors found in it are those of the Virginia Academy. We would like to thank the following individuals:

- **Beth Bortz, MPP.** President and CEO, Virginia Center for Health Innovation.
- **L.D. Britt, MD, MPH.** Past Chair of the Board of Regents and Past President, American College of Surgeons. Vice Dean Clinical Affairs, Eastern Virginia Medical School. *Member, National Academy of Medicine.*
- **Jeffrey Colombe, PhD.** Principal Scientist: Neuroscience, AI/ML, Data Science, The MITRE Corporation.
- **Don E. Detmer, MD, MA.** Professor Emeritus and Professor of Medical Education, University of Virginia. Past Vice President for Health Sciences, University of Virginia and University of Utah.
- **Sophia Economou, PhD.** Director of the Center for Quantum Information Science and Engineering, Virginia Tech.
- **Matthew Gurka, PhD.** Evelyn Troup Hobson Professor and Chair of the Department of Public Health Sciences, University of Virginia.
- **X. J. Meng, PhD, MD.** University Distinguished Professor of Molecular Virology, Virginia Tech. *Member, National Academy of Sciences.*
- **Olivier Pfister, PhD.** Professor of Experimental Atomic, Molecular, and Optical Physics, University of Virginia.
- **Robert L. Phillips, Jr., MD, MSPH.** Executive Director, Center for Professionalism and Value in Health Care, American Board of Family Medicine. *Member, National Academy of Medicine.*
- **David Roop.** Past Director of Electric Transmission, Dominion Energy. *Member, National Academy of Engineering.*
- **Amarda Shehu, PhD.** Vice President and Chief AI Officer, George Mason University.
- **Yaakov Weinstein, PhD.** Chief Scientist of Quantum Technologies, The MITRE Corporation.

Following Up on Our 2021 Key Strategy Report

In 2021, the Virginia Academy published the *Key Strategies* report, which had a slightly different focus from *Strategic Roadmaps*. The goal was to identify five strategic domains in which Virginia had the resources, expertise, and infrastructure to lead the way in addressing critical national challenges. We identified five challenges which we reformulated as aspirational goals. In the intervening years, progress has been made in each area, but more can still be done:

1. **Position Virginia as a National Model for Reliable Sustainable Energy.** Virginia is among the nation's leaders in small modular reactors (SMRs) and has attracted significant federal funding for SMR projects. Dominion Energy has issued a request for proposals for a possible SMR at its North Anna Power Station, and it entered into an agreement with Amazon to advance SMR development in Virginia.

2. **Make Virginia a National Leader in Supply Chain System Security.** The Commonwealth Center for Advanced Logistics Systems has a major initiative on ensuring the security of embedded cyberphysical hardware in logistics systems. The Commonwealth Cyber Initiative, which leads the state's cybersecurity efforts, continues to produce research that supports critical infrastructure, with a recent focus on the integration of cybersecurity in AI and the use of AI to increase the power of cybersecurity systems.

3. **Chart a Path for Virginia Leadership in Semiconductors.** The CHIPS and Science Act of 2022 has prompted and supported several investments in the Commonwealth in the past three years. They include funding for the expansion of Micron's memory storage fabrication facility in Manassas and construction of Northrop Grumman's $200 million advanced electronics manufacturing and testing facility in Waynesboro.

4. **Maximize Healthcare Resources for All Citizens of the Commonwealth.** A sampling of the many initiatives under way to bolster the life sciences and improve healthcare includes the designation of the Advanced Pharmaceutical Manufacturing Tech Hub in Disputanta, Virginia, as a U.S. Department of Commerce Tech Hub, a bill establishing pregnancy as a qualifying event for enrolling in the Virginia Health Benefits Exchange, and the Virginia Rural Health Plan, which outlines strategies to improve healthcare access in rural communities.

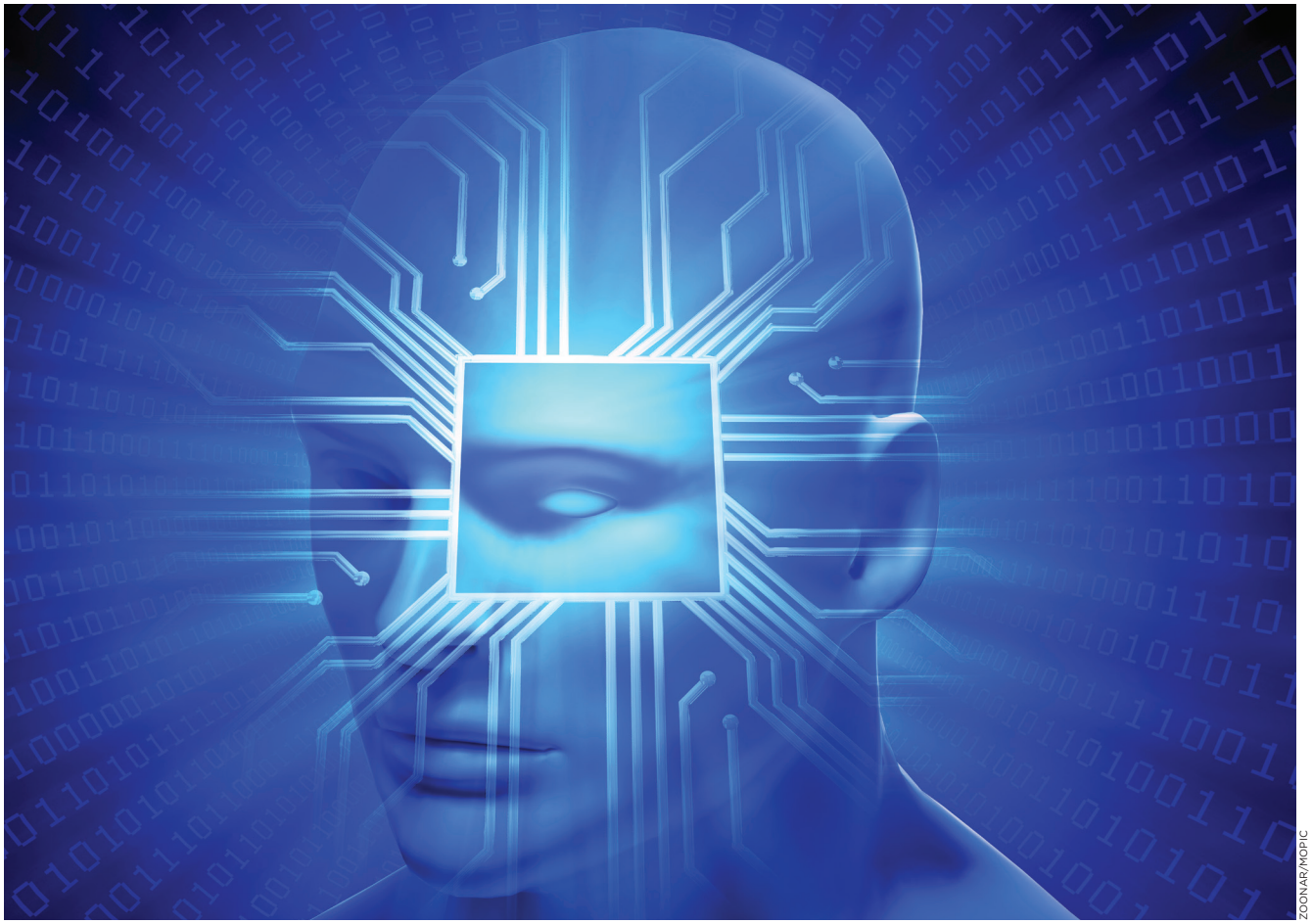
5. **Enable Virginia to Create Smarter, More Resilient Communities.** The Virginia Innovation Partnership Corporation continues to spearhead smart community progress in the Commonwealth, for instance, by promoting the development of new sensors, platforms, and control systems through its Smart City IoT Innovation lab. The Virginia Growth and Opportunity Board has also awarded grants for smart region initiatives, such as a $1.9 million grant to Smart City works for the Northern Virginia Smart Region Initiative.

Going Forward

The goal of the Virginia Academy is to provide rigorous analytical, technical, and scientific support to inform policy on issues critical to the Commonwealth. This *Strategic Roadmaps* report is part of that mission. It is meant to provoke discussion, planning, and action.

In a time of rapid technological change and evolving national priorities, Virginia must proactively address the challenges posed by substandard health outcomes, the advent of artificial general intelligence, sharply rising energy demand, and the quantum revolution. In the process, it must also create opportunities that will benefit the Commonwealth and its citizens. But to do so, it is imperative that Virginia act quickly. Our hope is that *Strategic Roadmaps* will help drive that action.

The Virginia Academy stands ready to support the Commonwealth's policymakers in navigating complex challenges like these and identifying opportunities grounded in emerging science and technology. By leveraging the expertise of its distinguished members, the Academy offers informed guidance to help Virginia realize its ambitions—advancing priority industries, accelerating workforce development, preparing infrastructure-ready sites, improving affordability, and fostering innovation through entrepreneurship.



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1.0
Preparing for Artificial General Intelligence

Artificial intelligence (AI) has reached an inflection point. Thanks to rapid advances over the last decade in computing hardware and software, artificial intelligence is in the process of transforming virtually every field of human endeavor, from medical research and healthcare to manufacturing and marketing—and it is spreading exponentially. More than 80 percent of companies claim it is a top priority in their business plans. They are turning to it for such competitive advantages as improved profitability, increased productivity, faster time to market, improved customer experience, and innovation in products and services. The global artificial intelligence market was valued at $279 billion in 2024 and is projected to reach $1.81 trillion by 2030, growing at a compound annual growth rate of 35.9% from 2025 to 2030.

The reason for this explosive growth is clear: the advent of artificial general intelligence (AGI). AI is about to become vastly more powerful than it is today. Although definitions vary, AGI refers to the idea of creating a form of AI that is at least as capable as human beings across a wide variety of cognitive tasks. AI developers are creating AI models called "reasoners" that are capable of solving problems across a broad range of topics at the human-expert level. The next step is to transform chatbots into agents capable of independently performing long chains of individual tasks to achieve a goal. These agents will be able to help create new ideas and new processes, including even more powerful AI.

In the next few years, according to one expert,[2] we should expect AI systems with the following skills and characteristics:

- Possess expert-level knowledge of every field
- Answer math and science questions as well as many professional researchers
- Code better than humans
- Reason better than almost all humans

Readying Virginia for this seismic shift in AI power will require careful planning, but the adjustment is essential if the Commonwealth is to continue to reap the benefits of an AI-enabled economy. Given the tremendous power of next-generation AI, those who are unprepared for this transition may fall irretrievably behind. Fortunately, the Commonwealth has many of the attributes required for success. They include extensive academic research programs, a range of efforts to grow a skilled AI workforce, and an array of companies exploring the application of AI to fields like healthcare, national security, and financial services. In addition, Virginia boasts the leading data center complex in the world. But action now is essential to maximize the potential for the fast-approaching era of AGI.

1.1 Virginia's AI Readiness

According to the 2025 AI Readiness Index from the marketing agency portal DesignRush, Virginia ranks as the third-best state in the U.S. for AI readiness, an indicator of how prepared it is to integrate AI into its economy.[3] Virginia blends solid AI adoption with one of the highest levels of public interest in the United States and an above-average proportion of digital jobs.

However, Virginia has a distance to go to become a leading AI state. The Commonwealth was not ranked in the top 10 of Chadix's 2025 comprehensive rankings of U.S. states driving AI innovation.[4] The top 10 are California, Colorado, Florida, Illinois, Massachusetts, New York, North Carolina, Pennsylvania, Texas, and Washington.

Virginia can move to the top 10 if it successfully manages the transition to an AGI-driven economy. There is currently no statewide organization that supports and coordinates the development of artificial intelligence in Virginia like the Commonwealth Cyber Initiative (CCI) does for cybersecurity. The General Assembly established CCI in 2018 as a statewide network connecting higher education, industry, and government to foster collaboration and drive economic diversification in cybersecurity. CCI participants include 46 institutions of higher education across Virginia, industry partners including AWS, CACI, Leidos, and Verizon, and government entities like the

[2] Todd, B. (2025c, April 6). The case for AGI by 2030. *Benjamin Todd*. https://benjamintodd.substack.com/p/the-case-for-agi-by-2030

[3] This ranking uses data on the percentage of firms adopting AI technologies from the U.S. Census Business Trends and Outlook Survey, digital job openings from the Bureau of Labor Statistics Job Openings and Labor Turnover report, Google search volume per 1,000 people for AI-related keywords, and legislation from the AI legislation tracker maintained by the law firm of Bryan Cave Leighton Paisner.

[4] The rankings were derived from data across five metrics: AI education, tech hubs, tech jobs, businesses using AI, and AI investment. Data was sourced from platforms like *U.S. News & World Report* (education), Crunchbase (tech hubs), Bureau of Labor Statistics (tech jobs), McKinsey and Deloitte (AI adoption), and National Science Foundation and Department of Education reports (AI investment).

Virginia Economic Development Partnership. Virginia could use the lessons learned from CCI to create a collaborative that would help it marshal its resources and navigate the transition.

1.2 Policy Framework

Virginia lacks an overall policy framework for AI, although it does have regulations and laws that govern the use of AI in specific circumstances. The Virginia Consumer Data Protection Act, which went into effect on January 1, 2023, is the second of its kind to be passed in the nation. Widely emulated by other states, it aims to protect consumers' personal data and prevent algorithmic discrimination by requiring transparency, accountability, and risk mitigation measures by businesses using AI-based systems to make decisions on employment, lending, housing, and insurance. Consumers can also opt out of having their personal data used to train AI models.

Virginia also has policies governing the use of AI by the state government. Executive Order No. 30, signed by Gov. Glenn Youngkin in January 2024, directed the Virginia Information Technologies Agency (VITA) to publish AI policy standards for all executive branch agencies, which it did in June 2024. These standards draw on widely accepted AI ethical principles (for instance, requiring guardrails against bias and privacy harms in AI systems used by government agencies). The order also requires that any AI technologies used by state agencies—including those provided by outside vendors—comply with the new AI standards for procurement and use. Thus, Executive Order No. 30 indirectly extends some AI governance expectations to companies operating in Virginia. The order also created the Artificial Intelligence Task Force, composed of tech experts from universities, nonprofits, and corporations, to develop further guardrails for the responsible use of AI and to provide ongoing recommendations.

In July 2025, Gov. Youngkin launched a pilot program that harnesses the growing competence of AI agents. As part of the initiative, a generative AI agent will scan all state regulations and guidance documents and flag any areas in which the regulation contradicts the statute, identify redundancies, and highlight areas in which regulatory language could be streamlined.

As AI adoption accelerates, the importance of governance and statutory frameworks cannot be overstated. Establishing clear and balanced policies will help mitigate risks related to bias, privacy, and security. Given the power of next-generation AI, it is imperative that Virginia find common ground on an AI regulatory framework that will ensure ethical AI deployment in both public and private sectors.

1.3.1 Strengths: Broad University Research in AI and Machine Learning

Virginia's universities have made AI research and education a top priority, creating administrative positions at the highest levels to help shape their efforts. George Mason University recently appointed its inaugural vice president and chief AI officer, the University of Virginia (UVA) has appointed two special advisors to the provost on AI, and Virginia Tech has formed an AI working group at the request of its executive vice president and provost.

Many of the Commonwealth's universities have created specialized centers to foster breakthroughs in AI, both in the technology itself and the application of AI to specific fields. The following is just a sampling of these activities.

Virginia Tech's Sanghani Center for Artificial Intelligence and Data Analytics, part of the university's AI for Impact program, is mobilizing cross-disciplinary work on such topics as explainable AI, natural language processing, adversarial AI, human-AI collaboration, and the ethical and social aspects of AI. Headquartered at Virginia Tech's new Alexandria campus, the center connects universities with 37 government and industry partners including multiple Department of Defense agencies, the Department of Homeland Security, the Department of Transportation,

and the Department of Energy, as well as Google, Microsoft, Meta, and IBM.

In 2024, UVA launched its National Security Data and Policy Institute in partnership with the Office of the Director of National Intelligence. The institute focuses on leveraging AI and data science to identify threats hidden in open-source data that might escape more traditional, time-consuming analysis. UVA also has number of other initiatives focusing on specialized AI applications, including the AI-Powered Astronomy Institute and the Visual Image and Video Analysis Lab. The University is also exploring ethical issues raised by AI, recently launching the LaCross Institute for Ethical Artificial Intelligence in Business.

In March 2025, George Mason University rolled out a new model for universities to responsibly harness AI and drive societal impact. George Mason's approach, called AI2Nexus, is building a series of collaborative relationship on campus, throughout the region, and across the state. Among other activities, it has created the AI-in-Governance Council, a partnership among academia, tech providers to the public sector, and government. The council provides guidance on government adoption of AI-based technologies as well as on governance frameworks and guardrails for AI development and deployment.

Virginia Commonwealth University also has a number of AI initiatives. They include the Human-AI Collab, housed in the School of Business, which supports an array of courses, and research on the interaction between humans and AI in various applications, including healthcare, national security, business, and ethics.

1.3.2 Strengths: Efforts Underway to Expand Its AI Workforce

Although Virginia ranks sixth among the 50 states in net tech employment and is well regarded for the quality of its tech labor pool, it has had difficulty meeting the growing need for a skilled AI workforce. In 2023, Virginia ranked third among U.S. states in the number of open jobs in artificial intelligence—and on a per capita basis, AI-related job openings were higher than in any other state. In June 2025, Glassdoor had almost 3,000 postings for artificial intelligence jobs in Virginia.

At the same time, Virginia has a number of advantages and initiatives underway that could help bridge this gap. The first is that the state is already attractive to tech workers. The Commonwealth ranked second in the nation for tech professionals in 2024. It is distinguished by its competitive salaries and relatively low cost of living.

Virginia has also prioritized AI training, supporting programs ranging from secondary to adult education. The Commonwealth has a number of highly regarded computer science and data science programs at its major universities—and they are rapidly growing. George Mason University, for instance, is the first university in the nation to offer a standalone Master of Science in Artificial Intelligence. In collaboration with Amazon, Virginia Tech has launched its Initiative for Efficient and Robust Machine Learning, which includes fellowships for doctoral students. In addition to computer science programs at the Commonwealth's major research institutions, universities like Old Dominion, Marymount, and Hampton offer bachelor's degree programs in data science with a specialization in AI, a bachelor's in AI, or a master's in computer science with concentrations in AI.

Virginia has a number of initiatives to bridge gaps in AI education. Virginia universities offer bootcamps to help workers make the switch to careers in artificial intelligence. Virginia Tech offers an AI & Machine Learning Bootcamp while Virginia Commonwealth University offers one in Data Science & AI. The Virginia Talent Accelerator Program, an initiative created by the Virginia Economic Development Partnership in collaboration with the Virginia Community College System, can also be used to meet business' needs for AI workers. This program helps companies opening new facilities by offering recruiting and training services customized to a company's unique products, processes, equipment, standards, and culture.

The strategic plan of the State Council on Higher Education for Virginia (SCHEV), "Pathways to Opportunity: The Virginia Plan for Higher Education," includes a focus on integrating AI in education. In 2025, SCHEV provided $250,000 to fund an initiative at Virginia State University, Northern Virginia Community College, and Brightpoint Community College to improve AI instruction and create AI-oriented microcredential programs. The purpose of the grant is to establish an AI-focused pathway for computer science majors between two-year and four-year institutions.

There also have been a number of efforts to encourage high school students to pursue AI-related careers. As part of Executive Order 30, Gov. Youngkin directed the Virginia Department of Education to support AI integration in schools. As a result, the department has launched a number of initiatives to integrate AI into K-12 education, bolstering teacher training, updating instructional resources, and focusing on ethical AI use. In 2024, SCHEV awarded a total of $225,000 to George Mason University, Old Dominion University, and Virginia Commonwealth University to boost integration of Artificial Intelligence (AI) into classrooms and build AI curricular pathways between secondary and postsecondary education.

1.3.3 Strengths: A Well-Articulated AI-Industry Ecosystem

Virginia has a well-developed ecosystem consisting of hundreds of companies offering AI-based services and solutions. These include defense giants Northrop Grumman and Boeing, large and mid-sized companies like Amazon, Microsoft Federal, CACI International, and Booz Allen Hamilton, and an array of start-ups including Vannevar Labs and MORSE Corp. Virginia also has important offices of AI leaders like Maxar Technologies, PwC, C3 AI, and Shield AI. Other companies like Shift Engineering and BigBear.ai offer customized solutions across various industries.

A sampling of their projects provides a sense of the diverse AI applications being developed by Virginia-based companies of all sizes:

- Radiant Solutions (Herndon) develops AI solutions for analyzing multisource geospatial data to provide insights for national security and commercial organizations' uses.
- Zephyr AI (McLean) develops AI-enabled software that can enhance the clinical utility, expand indication coverage, and unlock new commercialization opportunities of a drug candidate.
- Huntington Ingalls Industries (Newport News) is using computer vision and recognition technologies in its REMUS autonomous underwater vehicles, which are used for mine countermeasures, search and rescue, and scientific research.
- Kinis.ai (Richmond) develops smart insoles that use AI to analyze athletic performance and provide insights for wellness.
- Leidos (McLean) provides airport screening machines that use AI to quickly identify prohibited items that human scanners might miss.

1.3.4 Strengths: The Global Leader in Data Centers

According to the 2024 Joint Legislative Audit and Review Commission report on data centers, Northern Virginia is the largest data center market in the world, constituting 13 percent of data center operational capacity globally and 25 percent of capacity in the United States. Seventy percent of the world's Internet traffic flows through its data centers.

Multiple factors contribute to Northern Virginia's market prominence. They include an exceptionally dense intersection of fiber networks, reliable supply of energy, available land, proximity to major national customers (especially the United States government), a skilled work-

force, and state and local data-center tax incentives. More than 47 companies have data centers in Northern Virginia. Those with the biggest presence include AWS, Digital Realty, CloudHQ, STACK Infrastructure, Equinox, and NTT Global Data Centers.

Data centers that train, deploy, and run AI models and applications have special requirements. They must be able to handle the heavy computational demands of artificial intelligence workloads. They also require specialized hardware, higher power and cooling capacity, and optimized networking infrastructure.

There is no information about how many existing data centers are used for AI. Nonetheless, a number of companies are capitalizing on the infrastructure supporting Virginia's data centers to propose or develop new AI data centers in the Commonwealth. This includes the Prince William Digital Gateway project, whose 22 million square feet of data-center space make it the largest data-center campus ever conceived. A number of data-center developers have ambitious projects outside Northern Virginia. Large data-center complexes are proposed for Caroline, Culpeper, King George, Mecklenburg, Orange, Spotsylvania, Stafford, and Surry counties.

1.4 The Next Step: Create a Roadmap

By 2030, it is likely that AI researchers will have attained their long-held goal of creating AGI, which will be vastly more powerful than the generative AI behind such large language models as ChatGPT. Given the magnitude of this change, Virginia needs to begin immediately to develop plans to manage this transition.

Such a roadmap for change would entail gaining a better understanding of the Commonwealth's assets. This might mean conducting a census of AI-enabled projects at its universities as well as the products and services offered by its AI-centric businesses. The goal would be to identify application areas where Virginia has the critical mass to exert AI leadership, for instance, in fields like healthcare, national security, financial services, or governance. This knowledge would be useful in directing investment, supporting business growth, and developing incentives and funding for AI startups and entrepreneurs. It might also identify mechanisms that would assist university researchers in capitalizing on advances in AI to accelerate discovery and to build connections among universities, businesses, and government agencies, using organizations like the Commonwealth Cyber Initiative as a model.

This roadmap might also include an overview of the Commonwealth's growing data center sector, not only in Northern Virginia's Data Center Alley but in the rest of the state. It would look at existing and planned AI data centers to gain insight into the scale required to train and operate the models supporting AGI and the challenges to be overcome in building them.

Finally, it might take a deep dive into the foundational elements needed to support an AGI-fueled economy. This would include detailing the elements of a regulatory framework that would promote transparency, accountability, and fairness, providing insight about how to expand and accelerate the Commonwealth's AI educational initiatives to address talent shortages, investigate the feasibility of creating a sandbox and testing facility to assess risks associated with new, next-generation AI offerings, and outline ways to enhance the public and private cybersecurity infrastructure to meet a dramatically higher level of threats associated with AGI.

Planning now for the future of AI will not only help Virginia manage the transition to AGI, building on its advantages while mitigating risks, but it also has the potential to position Virginia as a national leader in AI-driven advances across multiple sectors. An AI roadmap would be of immense benefit to citizens of the Commonwealth as we approach the dawn of AGI.

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2.0
Meeting Virginia's Fast-Growing Energy Demand

The demand for electric power in the United States is on the rise, thanks to transportation and electrification, population growth, new manufacturing, and the advent of artificial intelligence (AI) data centers. As the foremost data center hub in the world, the Commonwealth epitomizes the challenges of increasing consumption. Fortunately, it has many of the prerequisites required to meet these challenges, including a diversified energy portfolio incorporating intermittent and dispatchable options, a skilled workforce, and close cooperation between universities and industry. The steps it takes over the next five years to build on those strengths and add generation, transmission, and distribution capacity to meet increasing demand will be critical to its future.

2.1 Virginia's Energy Demand and Infrastructure

Virginia has more data centers than any other state in the country, and Northern Virginia has more data centers than any other place in the world. During the last two years, Dominion Energy, Virginia's biggest utility, has connected 30 data centers, and that number is rising. The size of the individual data centers the utility supplies is also growing, from an average of 10 megawatts in 2013 to nearly 100 megawatts currently. In July 2025, Dominion Energy reported that its total data center power capacity under contract reached 40 gigawatts, almost double the contracted amount in July 2024. This rapid expansion has placed significant strain on the state's energy infrastructure, necessitating substantial investments in generation, transmission, and distribution capacity.

According to the most recent data (2023) from the U.S. Energy Information Administration, natural gas accounted for 59 percent of electricity generation in Virginia, nuclear power for 28 percent, a combination of solar, biomass, and pumped storage for 9 percent, coal for 3 percent, and petroleum for less than 1 percent. Dominion Energy's generation sources include several highly efficient gas-fired plants in Greensville, Brunswick, Warren, and Buckingham counties that it has built over the past decade. Dominion's two nuclear power plants in Virginia, North Anna and Surry, have a combined capacity of 3.4 gigawatts and have extended 80-year licenses. The utility's Bath County Pumped Storage Station is the largest pumped-storage hydroelectric plant in the nation. Dominion Energy also maintains a 6,800-mile network of regulated electric transmission lines in Virginia and North Carolina and 58,510 miles of distribution lines across this footprint.

In response to electricity demand, Dominion Energy is undertaking significant grid and generation upgrades in Virginia, focusing on expanding transmission infrastructure, improving distribution grid reliability, and increasing renewable energy generation. In the first half of 2024, Dominion Energy completed 123 new transmission projects, including nearly 90 miles of new and rebuilt transmission lines and 13 new substations. The company is also making significant investments in the distribution grid to reduce storm-related outages and shorten power restoration times.

Finally, it is adding substantial renewable generation. Its Coastal Virginia Offshore Wind project, scheduled to come online in 2026, has a capacity of 2.6 gigawatts. This is larger than the output of its North Anna Nuclear Generating Station, which produces slightly less than 1.9 gigawatts.

Because data centers require 24 hour/day base load generation, relying on additional renewable energy alone is not sufficient. The Commonwealth can modify its load profile by supplementing renewable generation with energy storage, but current storage cannot meet this ever-increasing load demand. In the near term, gas generation can be rapidly dispatched to lessen any load profile shortfall, but the Commonwealth does not have the gas transmission facilities to support longer-term generation requirements. This will require the use of nuclear generation.

2.2 Policy Framework

The Virginia Clean Economy Act (VCEA), passed in 2020, set ambitious goals for renewable energy and carbon reduction. It requires 100 percent clean energy by 2045 for Dominion Energy and by 2050 for Appalachian Power Company, with a benchmark of 45 percent renewable energy by 2030. However, when it was enacted, energy growth in Virginia was projected to be just 1 to 2 percent annually, far below the current estimate of 6 to 7 percent annually. Gov. Youngkin considers the VCEA to be based on "failing policy" and has supported legislative efforts to weaken or repeal it.

To address growing energy demand, ensure that energy remains reliable and affordable, and meet sustainability goals, the Youngkin administration developed an all-of-the-above energy plan. This includes reliance on natural gas as a bridging source as well as investments in wind, solar, nuclear, geothermal, battery storage, hydrogen, and carbon capture.

To promote innovation in these areas, Virginia has provided $10 million to fund the Virginia Clean Energy Innovation Bank. The first project funded under this initiative is a commercial cold fusion power plant to be built in Chesterfield County. The Commonwealth has also established the Virginia Power Innovation program, designed to support Virginia companies conducting research and development of such technologies as nuclear, hydrogen, carbon capture and utilization, and energy storage.

2.3.1 Strengths: Small Modular Reactors

Small modular reactors (SMRs) offer a promising solution to Virginia's energy challenges thanks to their scalability, safety, short lead times, and ability to provide consistent power. These advanced nuclear reactors can enhance the resilience of the state's energy infrastructure. They are not expected to go online until the early to mid-2030s, necessitating interim solutions such as adding natural gas generation coupled with renewable generation to meet growing energy needs.

The climate for nuclear energy has changed dramatically over the past decade. In May 2025, President Donald Trump signed a series of executive orders instructing Secretary of Energy Chris Wright "to significantly expedite the review, approval, and deployment of advanced reactors under the Department's jurisdiction… [and to] ensure that the Department's expedited procedures enable qualified test reactors to be safely operational at Department-owned or Department-controlled facilities within two years following the submission of a substantially complete application."

Virginia is well positioned to benefit from this order. The Commonwealth has a well-established nuclear industry and a well-trained nuclear workforce. Currently, nuclear power provides 28 percent of the state's electricity, making Virginia the eighth most nuclear-dependent state in the U.S. The state is also home to global leaders in nuclear energy and SMRs, including BWX Technologies, which has partnered with NuScale Power to advance SMR design. The federal government has allocated $3.2 billion to support advanced nuclear technologies, with a significant portion designated for Virginia-based projects.

In July 2024, Gov. Youngkin signed legislation to accelerate the development, testing, and deployment of SMRs. At the same time, Dominion Energy has begun to explore the siting of SMRs at its nuclear facilities. In July 2024, Dominion Energy issued a request for proposals for a possible SMR at its North Anna Power Station. In October, the utility and Amazon entered into an agreement to explore innovative development and financial structures that would help advance SMR development in Virginia.

In June 2025, Dominion Energy and Naval Weapons Station Yorktown signed an agreement to work together to build energy resilience at the station. This could include SMRs, gas generation, or other alternate energy options such as solar farms.

2.3.2 Strengths: University Research and Workforce Development

Many of the Commonwealth's colleges and universities are taking an active role in creating the workforce needed to bridge the gap between its current capacity and projected demand and to help guide Virginia through its energy transition. For instance, Virginia Tech's Power and Energy Center is among the foremost centers of its kind in the country. It is dedicated to developing a next-generation power grid that is highly efficient, resilient, and flexible. Faculty researchers are also involved in the education of power engineers and have recently added courses in such areas as distribution systems, alternative energy systems, and microgrids. George Mason University, Virginia Commonwealth University, Virginia State University, and the University of Virginia have similar initiatives in various stages of development.

The Virginia Community College System is also training students for the energy workforce through its FastForward program. This short affordable training program is

designed to provide Virginians with the secure competency-based, third-party credentials, including licenses and certifications, that are valued by employers. In addition, Danville Community College has developed an Electrical Electronic Engineering Program to train students in industrial electrical, electronics, and power systems, preparing them for electrical / electronic troubleshooting, automation and control, power utilities, and industrial maintenance. Businesses across the Commonwealth have supported this program with equipment and guest speakers.

In 2020, Dominion Energy pledged to give $35 million to 11 historically Black colleges and universities (HBCUs) in Virginia, Ohio, North Carolina, and South Carolina over the following six years as part of its HBCU Promise program. Of that sum, $25 million was allocated to the institutions themselves for endowments, capital projects, operating expenses, and educational programs in clean energy. The remainder was used for scholarships for African American and underrepresented students throughout the company's service areas.

One outcome of this commitment is Virginia State University's (VSU's) Power and Energy Concentration. The courses in the program combine academic instruction from VSU faculty with real-world insights from experienced Dominion industry professionals. A significant number of the classes for the Power and Energy Concentration are conducted at Dominion Energy's Chester Training Center, providing students with hands-on experience using industry-grade resources and facilities.

2.3.3 Strengths: Renewables

Dominion Energy has invested $10.6 billon in the CVOW project, the largest offshore wind farm in the United States. It remains on-time and on-budget. When the project is operational in 2026, it will generate enough energy to power up to 660,000 homes and will support 1,100 jobs.

Dominion Energy has several solar projects either under way or planned for 2025 in Virginia. These include the Bellflower Solar project in Brunswick County and the Merry Point Solar and Storage project in Lancaster County, which is expected to begin construction in spring 2027 and be online in 2029.

A limitation of wind and solar sources is that they produce energy only under specific meteorological conditions. One way to address this drawback is to store excess renewable energy in long-duration energy storage systems. Dominion Energy has several pilot battery storage projects under way to support grid stability. Its 12-megawatt battery pilot project at the Scott Solar generation facility—the first utility-scale project of its kind in Virginia—is operational, as are pilot projects in New Kent and Hanover counties. In addition to these three pilot projects, Dominion Energy has received regulatory approval from the State Corporation Commission for the 20-megawatt Dry Bridge storage project in Chesterfield County and 50 megawatts of storage at Dulles International Airport in Loudoun County.

2.3.4 Strengths: Nuclear Fusion

Virginia is emerging as a key player in commercial nuclear fusion. Commonwealth Fusion Systems (CFS), the world's largest fusion company, has chosen Chesterfield County for its planned 400-net-megawatt fusion energy plant, citing Virginia's high energy demand, strong partnerships with state and local stakeholders, and skilled workforce. The state's regulatory structure ensures a clear framework for fusion development, providing a stable environment for investment and innovation.

CFS stands out in the competitive fusion industry for its high-temperature superconducting magnets, a key differentiator in the race to harness commercial fusion energy. While the company has received federal funding through initiatives like the Department of Energy's public-private Innovation for Fusion Energy (INFUSE) Program and Milestone-Based Fusion Development Program, CFS is

backed primarily by private investment, a demonstration of confidence in Virginia's fusion potential.

The Youngkin administration has been actively supporting CFS through workforce development initiatives, incentives, and partnerships with the state's universities. Additionally, the Virginia Clean Energy Innovation Bank is expected to provide funding support, further strengthening the state's commitment to advancing fusion energy.

Recently, Google has signed an agreement to offtake 200 megawatts of fusion energy from the Chesterfield County plant.

2.4 Current Plan

In its Integrated Resource Plan filed with the Virginia State Corporation Commission in October 2024, Dominion Energy laid out its strategy for the following 15 years. Dominion is taking an all-of-the-above approach. Nearly 80 percent of the plan's incremental power generation over the next 15 years is carbon-free, including the following:

- 3,400 megawatts of new offshore wind in addition to the 2,600-megawatt CVOW project
- 12,000 megawatts of new solar, a more than 150 percent increase from the 4,750 megawatts of solar the company currently has in operation or under development
- 4,500 megawatts of new battery storage
- Small modular nuclear reactors coming on line in the mid-2030s.

The remaining 20 percent of additional power generation will come from natural gas.

The wide-scale adoption of renewable energy sources will also require a series of technical advances including the following:

- Improvements in power electronics, data communications, and system-control algorithms
- New system modeling techniques
- Increased data management and data visualization capability
- Next-generation system monitoring and protection equipment to prevent wide-scale outages and cascading failures
- Heightened cybersecurity defenses to protect the grid
- New electric utility black start capability to enable systems with dispersed generation to recover quickly from extreme events.

Increased investment in the transmission and distribution system will also be needed to ensure reliability and resilience from extreme events and the significant external threats from terrorism that could affect critical government facilities served within the Commonwealth such as the Pentagon, the CIA, and the Norfolk Naval Station.

Furthermore, as more dispersed generation comes online in the next decade, robust communications, situational awareness, and secure digital systems will be required to effectively manage and improve the value of this distributed resource to the grid. The combination of dispersed generation and new generation resources should improve the resilience of the electric grid and reduce the risk of a significant voltage surge cascading across the network and producing widespread power outages, as happened in Spain and Portugal in 2025.

2.5 The Changing Landscape

The ability to take action in all these areas will be affected by policies enacted by the new administration in Washington, which depreciates the impact of climate change. It has pursued a number of initiatives that prioritize fossil fuel production:

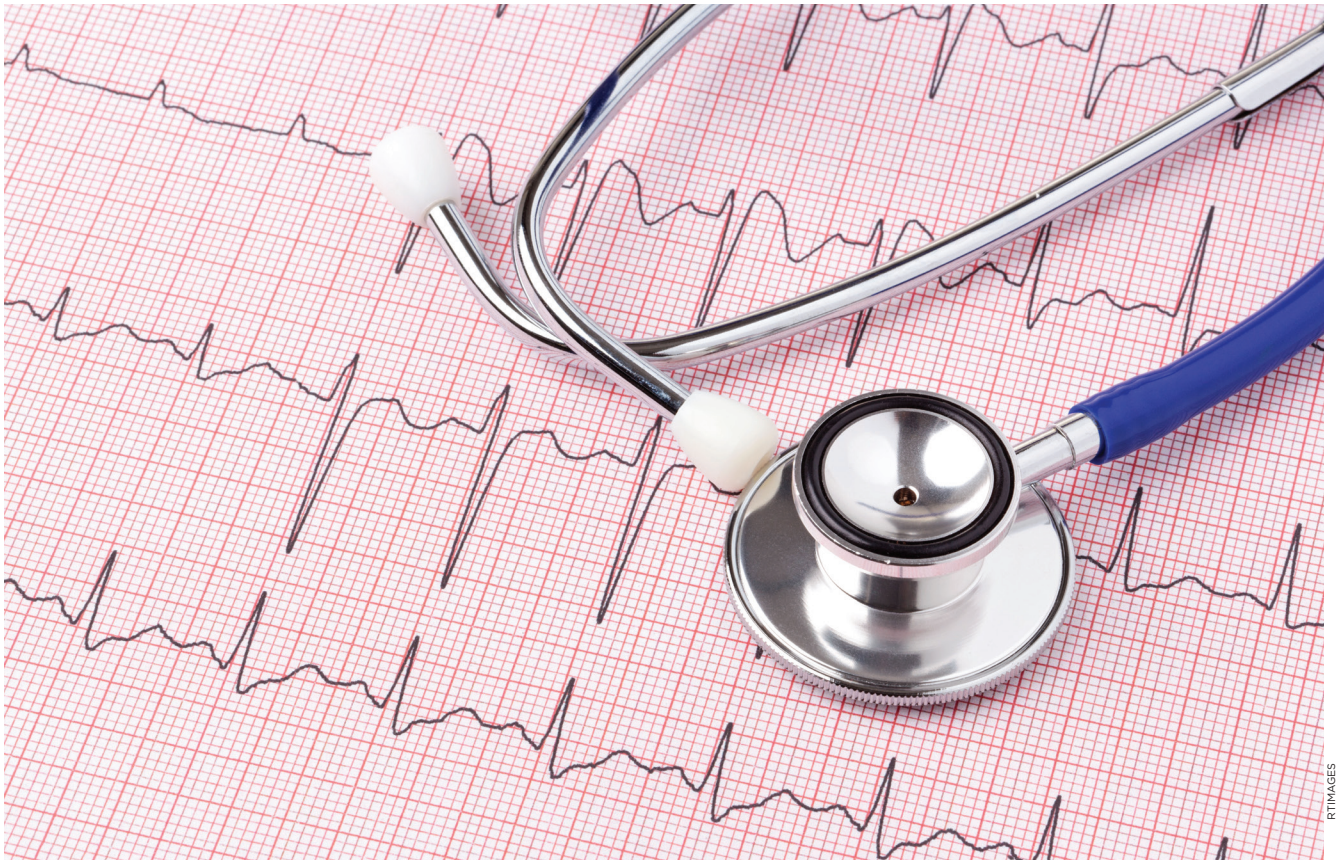
- On his first day in office, President Donald Trump issued an executive order aimed at halting approvals for new onshore wind projects on federal land and new leases for offshore wind farms.

- In March, the EPA administrator announced his intention to reconsider the Clean Power Plan 2.0, which had set limits on greenhouse gas emissions from power plants.
- In April, the president issued an executive order directing Attorney General Pam Bondi "to identify all [state laws] burdening the identification, development, siting, production, or use of domestic energy resources that are or may be unconstitutional, preempted by Federal law, or otherwise unenforceable." It also orders her to take actions to stop the enforcement of those state laws and file a report within 60 days. The order may pertain to the Virginia Clean Economy Act, which requires a gradual transition to carbon-free energy production in the Commonwealth.
- The budget bill passed by the House of Representatives would shorten by three years to 2028 an end-date for the use of clean electricity tax credits for wind, solar, and battery storage projects and require projects to begin construction within 60 days of the bill's passage.

2.6 The Next Step

Clearly, the new administration's policies require that Virginia rethink the way it plans to meet the growing demand for energy within the Commonwealth. It would be productive for the administration or General Assembly to commission an in-depth roadmap to review this new landscape and develop strategies to determine how Virginia can meet energy demand while meeting its clean energy goals.

This roadmap, for instance, might demonstrate ways to give precedence to meeting increasing demand while ensuring affordability, reliability, resilience, and reduced environmental impact. It might also highlight the role that technical innovation could play in facilitating the introduction of a wide range of affordable power sources and in helping to modernize the grid. In addition, the roadmap might examine the use of public-private partnerships to fund new energy supplies. In 2024, CNBC ranked Virginia the Top State for Business. Developing a path forward for Virginia's energy sector is a way to make sure that it remains among the most attractive states and has the energy necessary to power a flourishing economy far into the future.



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3.0
Improving Virginia's Health Outcomes

Virginia is one of the most prosperous states in the country, ranking 11th in 2023 for median household income,[5] but this prosperity does not always translate into commensurate health outcomes. While Virginia ranked second in the nation for hospital safety according to the 2024 Leapfrog rankings,[6] the Commonwealth ranks 30th in the nation for adult obesity, 33rd for adults with chronic conditions, and 34th for adults reporting mental stress.[7] Citizens with poor health can be found in both urban and rural areas, and disparities remain in maternal health, insurance coverage, and access to care.

[5] American Community Survey, U.S. Census Bureau, 2023.
[6] Leapfroghospitalsafetygrade.org, 2024
[7] UnitedHealth Foundation, 2023.

These outcomes are shaped by differences in access to medical services, socioeconomic status, and geographic location. Better health outcomes are correlated with regions that have a higher concentration of medical services. Loudoun County and Falls Church are among the healthiest in Virginia, while medically underserved[8] counties like Buchanan, Henry, and Brunswick are in the ranks of the least healthy.[9] But even in well-served areas, there are places in which health outcomes are far below state averages.[10] Limitations in coordination, funding, and data sharing inhibit the Commonwealth's ability to respond to local health challenges and capitalize fully on the state's healthcare resources.

This suggests that an effective way to improve state-wide health outcomes is to focus on the local and regional level. While we have measurements of specific indices of poor health like obesity and addiction in particular areas of the state, we could gain more insight into specific local targets for intervention that would most improve health outcomes.

Currently, the challenge for Virginia is to preserve and even promote gains in health outcomes in the face of cuts to Medicaid funding. Systemic solutions such as a bill passed in March 2025 establishing pregnancy as a qualifying event for a woman to enroll in the Virginia Health Benefits Exchange are vital, but the state's ability to fund similar initiatives going forward may be a challenge. The Commonwealth will also be challenged by the reorganization of the U.S. Department of Health and Human Services (HHS) and the need to restructure and start new programs—for instance, those focused on public health—under the Make America Healthy Again (MAHA) agenda. This transition may provide an opportunity to move funding to new and novel approaches to addressing population health needs, as well as ensuring that current resources are being dedicated to those areas that are able to achieve the best return on investment.

Given the current situation, the Commonwealth must be inventive and creative. Gaining a more granular understanding of the most pressing health challenges in each local jurisdiction and being able to quickly identify and apply the most effective, proven interventions for these specific situations will be invaluable. This will require better mobilizing and coordinating of Virginia's extensive public health expertise, streamlining access to relevant state health data and other data sets, and marshaling the latest advances in AI and data analytics to pinpoint issues and identify and implement responses that will improve health outcomes.

3.1 Virginia's Healthcare Infrastructure

Virginia's healthcare infrastructure is a complex mix of health districts and departments, large integrated health systems, community hospitals, and medical and nursing schools. Despite concerted good faith efforts, competing interests and priorities, regulation, and the size and complexity of this sprawling infrastructure impede the broad exchange of information.

The Virginia Department of Health (VDH) oversees public health services through a network of 35 health districts and 118 local health departments. The VDH has initiated a series of planning initiatives aimed at improving the health of Virginians: among them are Virginia's Plan for Well-Being and the Virginia Rural Health Plan. It also oversees efforts to modernize its public health practices through cross-sector collaboration and data-driven approaches such as the Right Help, Right Now behavioral health transformation plan and the Safe Kids, Strong Families child welfare initiative.

Virginia is served by many health systems; some of them are the best in the nation. They have been recognized

[8] Health Resources and Services Administration, n.d.

[9] County Health Rankings & Roadmaps, 2025.

[10] Olivia Trani, Dying too soon: New report reveals deep and persistent health disparities in Northern Virginia, Virginia Commonwealth University, June 28, 2023.

for excellence by the Centers for Medicare & Medicaid Services, *U.S. News & World Report's* Best Hospitals, and Leapfrog Hospital Safety Grades. For instance, according to the 2024 Leapfrog rankings, Virginia's hospitals are second in the nation for patient safety, with 56.3% of its hospitals receiving an A grade. These systems include Ballard Health, Bon Secours Mercy Health, Carilion Clinic, Centra Health, HCA Capital Division, Inova Health System, LifePoint Health, Riverside Healthcare Association, Sentara Health System, University of Virginia (UVA) Health System, Valley Health System, and Virginia Commonwealth University (VCU) Health System. Many of the Commonwealth's small community hospitals are part of these larger health systems, but a handful, such as Buchanan General Hospital and Bath Community Hospital, are independent.

Four medical schools in Virginia offer an MD degree. They are the Eastern Virginia Medical School (EVMS), University of Virginia School of Medicine, Virginia Commonwealth University School of Medicine, and Virginia Tech Carilion School of Medicine. The Edward Via College of Osteopathic Medicine and Liberty University College of Osteopathic Medicine offer DO programs. Collectively, these schools are at the cutting-edge of research in scores of fields of immediate relevance to community health outcomes including public health sciences, biomaterials and body-device interfaces, data acquisition and analysis, immunology and cancer biology, and diabetes, metabolism, and obesity.

Finally, there are 10 schools of nursing, at research institutions like George Mason University (GMU), James Madison University, Old Dominion University (ODU), Sentara College of Health Sciences, UVA, and VCU as well as at such smaller schools as Hampton, Marymount, Radford, and Eastern Mennonite universities. They are conducting community-related research in geriatric nursing, mental health nursing, and nursing analytics.

Virginia has a rich and varied healthcare infrastructure, but coordination is limited. There have been several proposals to improve cooperation and the exchange of information among these entities to support community-level health initiatives. These include using the Virginia Cooperative Extension's existing network of offices to increase the flow of patient-centered behavioral health outcomes research into routine care and developing a detailed statewide dashboard of factors that lead to poor health outcomes. There is currently no funding available for these proposals.

3.2.1 Strengths: Public and Population Health Expertise

The Commonwealth has the public and population health expertise needed to continue developing focused solutions to improve local health outcomes in the face of decreased funding. This expertise is distributed across public agencies, academic institutions, and nonprofits. VDH partners with local stakeholders to conduct community health assessments and develop community health improvement plans. It also conducts its own research. For instance, its Division of Social Epidemiology studies preventive care access and gaps in preventive care, as well as the factors influencing preventive care and health system capacity.

Two Virginia universities have a school or college of public health while several have departments and centers devoted to the field. The School of Public Health at VCU brings together the departments of Biostatistics, Epidemiology, Health Policy, and Social and Behavioral Sciences around a unified focus on public health. It emphasizes translational research and addresses public health issues that disproportionately affect low-income and underserved populations.

VCU also hosts several centers. They include the Center on Society and Health (CSH), the Virginia Ambulatory Care Outcomes Research Network (ACORN), and the C. Kenneth and Dianne Wright Center for Clinical and Translational Science (CCTS):

- Located in the School of Public Health, CSH studies the preventable causes of illness and delivery of the latest insight and information in formats and venues that are useful to decision-makers and change agents.

- Located in the Department of Family Medicine and Pediatrics, ACORN is a collaborative partnership between primary care practices and a multidisciplinary team of researchers devoted to evaluating and improving the quality of primary health care.
- Among its many activities, the Wright CCTS works to understand and address the complex interplay of community-level barriers to prevention and wellness in vulnerable populations. Its initiatives go beyond clinical interventions, concentrating on factors like access to healthy food, clothing, and social support networks to improve overall well-being and health outcomes.

In 2022, GMU created its College of Public Health, focusing on community engagement, workforce development, research, and education to meet public health infrastructure, research, and workforce needs. The college includes the School of Nursing and the departments of Global and Community Health, Health Administration and Policy, Nutrition and Food Studies, and Social Work.

A third school of health in Virginia is in the formative phase. In 2024, the State Council on Higher Education in Virginia approved the creation of a Joint School of Public Health, an academic partnership between ODU and Norfolk State University (NSU).

Virginia also benefits from a number of department-level resources. The Department of Population Health Sciences at Virginia Tech houses the Center for Public Health Practice and Research (CPHPR), which focuses on enhancing public health practice and research in the region through collaboration with community partners. The department facilitates the Public Health Network, an interdisciplinary group of faculty and staff at Virginia Tech who collaborate on public health initiatives.

At UVA, the School of Medicine is home to the Department of Public Health Sciences. Among its many research programs is the Center for Community-Based Health Equity. It includes behavioral and implementation scientists and staff who focus on the development, implementation, and sustainability of evidence-based behavioral interventions targeting cancer control priorities for rural communities. Similar entities at other institutions include the EVMS Division of Community Health and Research in its Department of Pediatrics and NSU's Center of Excellence in Health Disparities.

Several nonprofits also focus on bringing the latest research on health to the community. The Virginia Center for Health Innovation (VCHI) is a public-private partnership established in 2012 through the Governor's Virginia Health Reform Initiative. VCHI is a trusted health care convener with a mission to facilitate innovation by engaging key stakeholders and securing the resources to accelerate value-driven models of wellness and health care throughout Virginia. Another nonprofit, the Virginia Hospital & Healthcare Foundation, in partnership with state agencies, administers grants and awards to improve the healthcare system and the overall health of Virginia's communities.

The public health and population health expertise resident in the state is impressive, and virtually every one of these entities is, in some way, seeking to work with local communities to identify pressing health issues and to find and implement appropriate responses. As proposals to increase collaboration have shown, there is a recognition that closer cooperation among members of Virginia's public health community would have a substantial beneficial impact on health outcomes.

3.2.2 Strengths: Healthcare Records and Datasets

A wealth of data is being continually collected in Virginia by public institutions and health systems that potentially would prove invaluable in gaining a detailed understanding of health issues at the local level and helping to identify effective interventions. They include the following resources:

- The Virginia All Payer Claims Database (APCD) is administered by Virginia Health Information (VHI). It collects paid medical and pharmacy claims for roughly 6.5 million Virginia residents with commercial,

Medicaid, and Medicare coverage across all types of healthcare services. Each claim and corresponding enrollment record submitted to the Virginia APCD includes information such as patient demographics, location of care across all settings, the identity of the caregiver, any diagnoses presented by the patient, and the allowed amount for a particular service.

- HealthLandscape Virginia (HLVA) is a collaboration between HealthLandscape (a division of the American Academy of Family Physicians) and the VCU College of Health Professions. HLVA is a geospatial and analytic platform that catalogues characteristics of Virginia residents by zip code, census tract, county, and congressional district. This data is aggregated from a range of sources such as the American Community Survey, the 500 Cities Project, the Behavioral Risk Factor Surveillance System, and the National Health and Nutrition Examination Survey.
- Virginia Vital Certificate Data is maintained by the Department of Health Office of Vital Records. This contains community-level birth and mortality information. It can be linked with other datasets, such as Medicaid claims, and used to analyze the impact of programs on health outcomes.
- The Epic Electronic Health Record (EHR) system has been adopted by most Virginia health systems, including UVA, VCU, Inova, and Sentara, to record patient treatment. Each health system customizes its Epic EHR to reflect its specific workflow and needs.

While Virginia has an abundance of data that could be used to improve local health outcomes, it takes a concerted effort on the part of public health researchers to access this data. Establishing clear and flexible data-sharing agreements between different entities can be time-consuming and complex. Researchers must comply with HIPAA regulations, which can impose strict requirements on data access and use. In the case of Epic data, health systems may be reluctant to share data for competitive reasons.

If researchers gain access, they face another set of challenges. They must have the tools and expertise to work with enormous datasets, find ways to align disparate data with their research goals, and, if they wish to combine data from different sources, to reconcile different formats.

Despite these difficulties, several public health researchers and research organizations have secured access to some of these databases and have used them to gain insight into community health. Most notably, the Wright Regional CCTS at VCU has been approved by VHI to store and use the APCD and Virginia Mortality Statistics.

Federal data from demographic, socioeconomic, housing, and neighborhood datasets would also be useful in understanding local health outcomes. However, Virginia is one of 17 states that have not established a Federal Statistical Research Data Center, complicating efforts to use restricted-access data from federal agencies.

3.2.3 Strengths: AI and Data Analytic Expertise in Healthcare

Advances in AI and data analytics now provide researchers the ability to find patterns and nuances in massive datasets that would have been impossible just five years ago. A multitude of complex technical issues complicates the process of deploying this data. Fortunately, the Commonwealth already has expertise in this area, including the following:

- The Wright Regional CCTS. In addition to maintaining VCU's extract of the APCD, the Wright Regional CCTS has expertise in data and analytics and informatics and assists healthcare researchers with such issues as data architecture design for specific queries and analyses. The Wright Regional CCTS is supported by the VCU High Performance Research Computing Core, which maintains four supercomputing clusters, each specialized for different computing environments. For instance, the fenn.vcu.edu cluster is optimized to support research data that must comply with federal security and privacy requirements.
- The Center for Discovery Science and Health Informatics (CDSHI). Located at GMU, CDSHI researches computational methods to improve healthcare cost, quality, safety, and effectiveness. The

center collaborates with GMU's Machine Learning and Inference Laboratory (whose focus is on development of computation methods), the Center for Health Information Technology (which specializes in the development and use of technology in healthcare), and the Center for Health Policy Research & Ethics (which conducts research on health policy).
- The Healthcare Analytics and Delivery Science Institute (HADSI): HADSI is a collaboration between EVMS and Sentara Healthcare. HADSI leverages their combined resources to design, implement, and evaluate clinical research, healthcare delivery systems, and health economic analyses.

Ultimately, the use of AI and advanced data analytics could move Virginia toward the ideal of a Learning Health System but applied to public health. This would be a system where new knowledge is generated from patient care and other forms of data and then analyzed and translated into improved practices and better outcomes. Such a system would seamlessly embed best practices, capture new knowledge as a byproduct of care, and use data to drive continuous improvement and innovation.

3.2.4 Strengths: An Expanding Biotechnology and Pharmaceutical Sector

Virginia is home to a thriving and rapidly expanding biotechnology and pharmaceutical sector. Major players like AstraZeneca, Indivior, and AMPAC Fine Chemicals anchor the state's biopharmaceutical ecosystem. Recent years have seen significant investment in advanced therapeutic manufacturing, including cell and gene therapy, which signal the Commonwealth's potential to lead in biomedical innovation. At the center of this innovation is the VA Bio+Tech Park, a dedicated hub for bioscience companies, startups, and research institutions. Located in Richmond, this park provides vital infrastructure and collaborative space for commercialization efforts. Complementing this is the Fralin Biomedical Research Institute in Roanoke, which is conducting groundbreaking work in neuroscience, cancer research, and cardiovascular sciences, helping to position Virginia at the forefront of translational research. To further encourage growth, Virginia offers a range of tax incentives, grants, and funding programs designed to attract and retain biotech and pharmaceutical companies. These programs reduce financial barriers for new ventures and support long-term investments in research and development.

The Virginia Biosciences Health Research Corporation (VBHRC) is a key facilitator of research collaborations across the state. Initially formed as a consortium of leading universities—UVA, VCU, Virginia Tech, GMU, and EVMC—VBHRC has received $3.75 million in state funding over two years. It contracts with private companies, foundations, and government agencies to conduct bioscience research and promote infrastructure development to support expanded research capacity.

Northern Virginia plays a vital role as a health IT and federal health research hub. The region supports major federal health agencies including the National Institutes of Health (NIH), Food and Drug Administration (FDA), and Department of Health and Human Services (HHS), offering a rich environment for public-private partnerships and digital health innovation.

3.3 The Federal Landscape

The landscape for healthcare has changed dramatically under the Trump administration. Many states have leaned forward and passed their own MAHA laws, initially focused on food additives, but these efforts could easily be applied to other areas such as health-related data sharing. The One Big Beautiful Bill Act (OBBBA) will necessitate that states address significant cuts to the federal health agencies, Medicaid, the Supplemental Nutrition Assistance Program, and Affordable Care Act (ACA) marketplaces. The Congressional Budget Office estimates that the OBBBA will lead to 17 million additional uninsured individuals nationwide by 2034, with 13.8 million losing Medicaid, 4.2 million losing exchange funding, and 1 million affected by other provisions.

Among other difficult challenges, Virginia must find resources to mitigate cuts in Federal funding, implement new work-reporting requirements for Medicaid enrollees, and address the financial strain on hospital systems. While the $50 billion Rural Health Transformation Fund established under OBBBA for states with approved rural health transformation plans could benefit rural healthcare providers, it may be insufficient in terms of current debt being carried by the rural healthcare providers and the increasing healthcare needs of an aging population. All hospitals regardless of rural setting will need to ensure that their services are targeting their patient population's health needs in the face of increased costs.

3.4 The Next Step: Create a Roadmap

For more than a decade, the public health community has been motivated by evidence that poor health outcomes were a fundamental product of systemic factors. The factors influencing access to preventive care encompass various aspects of daily life, including work hours, race or ethnicity, economic stability, education, infrastructure, and other aspects of the environment. The challenge for the public health community is to find ways to act on insights already gained and operate in a severely resource-limited environment to improve health outcomes. AI and advanced data analytics and access to large, varied datasets may provide a way forward.

Healthcare data, encompassing electronic health records (EHRs), wearables, medical devices, claims, and social determinants of health (SDOH), hold immense potential to transform patient care and operational efficiency. Research suggests that effectively leveraging this data can lead to improved health outcomes through personalized care, predictive analytics, and enhanced decision-making. However, challenges such as data privacy, interoperability, and workforce readiness must be addressed to realize these benefits.

Virginia needs a roadmap for moving forward if it is to continue to improve the health of all its citizens. Creating such a roadmap would mean detailing the implications of the new federal environment on local health outcomes and exploring methods to promote the development of consortia and collaborations to help bring together and focus the Commonwealth's considerable public health expertise and university health students and researchers.

It might also include consideration of how to accelerate access to public and private datasets. And, finally, it might take a closer look at the potential for the ongoing revolution in AI and advanced data analytics to identify current and emerging issues at the microcommunity level and to comb the literature and suggest solutions—some of them low-tech and low-cost—with a high likelihood of success.

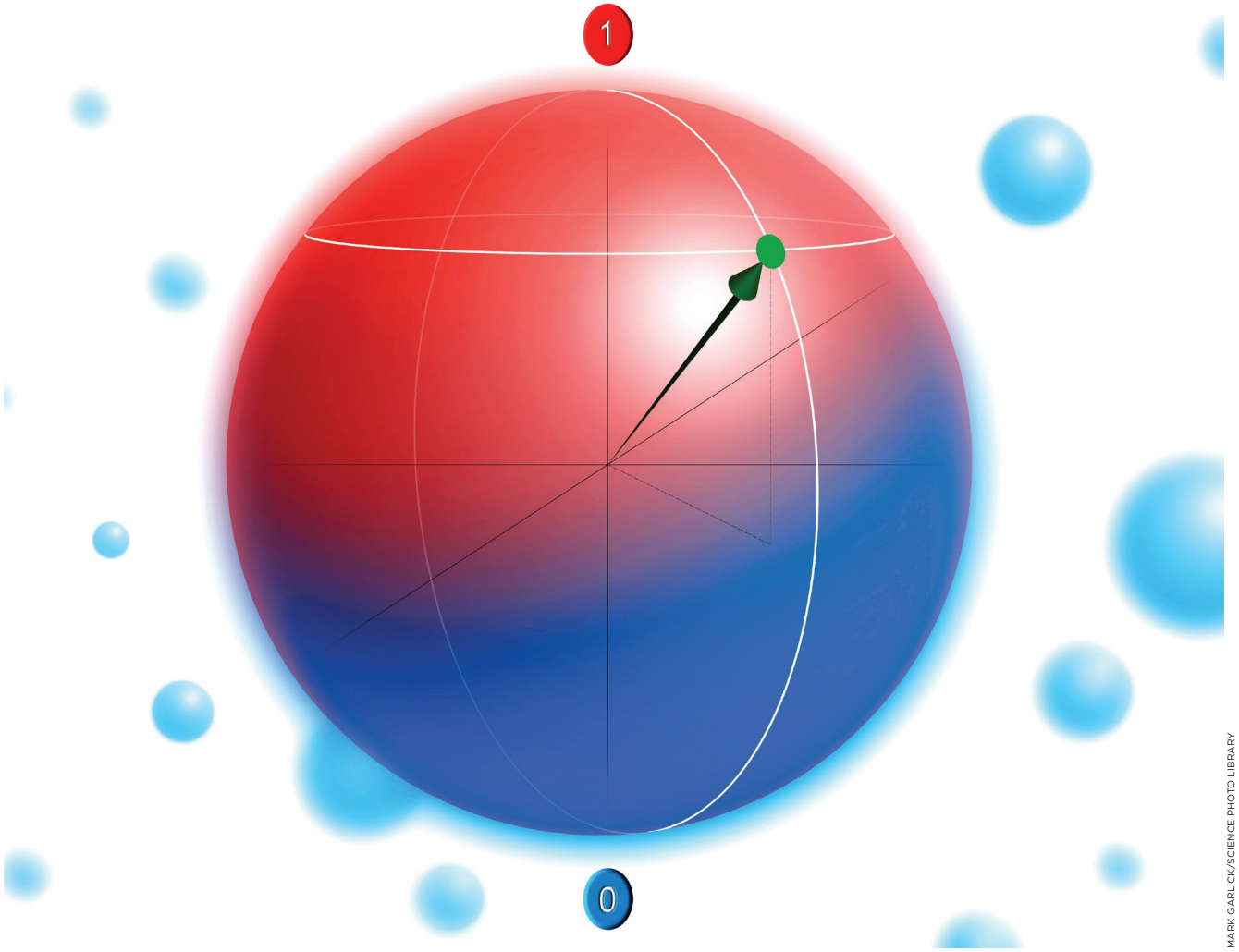
Other elements of the roadmap might include the following:

1. Investigating the possibility of creating a Federal Statistical Research Data Center
2. Establishing a state-wide coordinated plan to secure funding from the Rural Health Transformation Fund
3. Establishing a Virginia Health Research and Data Coordination Portal bringing together health care providers, public health professionals, and university researchers
4. Reviewing nontraditional data related to environment, consumption, and socioeconomics that would indicate pending negative health trends
5. Developing a framework and formal structure for data management, addressing usage, sources, formats, access, sharing, privacy, security, and technology specifications to ensure data is accurate, secure, and actionable
6. Developing and cataloguing tools and methods leveraging AI and advanced analytics to predict patient risk, to identify trends such as disease prevalence or treatment efficacy across populations, to guide preventive care programs, and to advance precision medicine
7. Developing methods to provide real-time decision support, especially to underserved localities through remote monitoring and telehealth

8. Engaging and empowering patients through education, patient portals, and targeted lifestyle interventions
9. Considering Virginia as a MAHA pilot site for initiatives on preventing chronic disease, creating new HHS patient portals, and data analyses.

The roadmap must address such significant challenges in achieving desired health outcomes as lack of data coverage, persistent sourcing, data standards, interoperability, privacy and security, inequitable technology access, unconscious bias, and available workforce and skills.

Virginia must adapt to the Trump administration's new healthcare funding model and policies. The challenge for the Commonwealth is how to respond in ways that protect its citizens. Developing a roadmap describing how the state could use its resident expertise in public health and artificial intelligence and the vast amount of data it collects could enable it to continue improving local health outcomes.



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4.0
Positioning Virginia for the Quantum Revolution

The promise of quantum information science and technology (QIST) is vast. Quantum computers, for instance, will perform computations far beyond the capabilities of classical computers. This includes solving complex problems in medicine, materials science, finance, and artificial intelligence (AI)—leading to breakthroughs in drug discovery, new materials, optimized financial strategies, and more sophisticated AI systems. QIST represents the next wave of technological innovation after AI.

The first signs of the QIST revolution are already evident. Quantum sensing is now being used for applications such as electromagnetic field detection, where sensitivity is critical, and navigation, where it will lessen our dependence on GPS. Technologies like quantum key distribution and quantum encryption for secure digital transmission are moving beyond the research stage and are now commercially available for limited uses.

However, widespread adoption of most applications of quantum technologies, while growing rapidly in sophistication, is a decade away. The Technology Readiness Level (TRL) scale, devised by NASA in the 1970s and later adopted by the Department of Defense, measures the maturity of a technology. The scale has nine levels ranging from TRL 1, the formulation of basic principles and concepts, to TRL 9, a fully operational system. The TRL for quantum computing is currently estimated to be TRL 3-4, which means that it has achieved lab-scale proof of concept and is approaching the sweet spot for technology investment, TRL 5-7.

This gives Virginia a window of opportunity. If Virginia can mount a concerted effort to begin building a QIST ecosystem over the next two years, it has the potential to emerge as a dominant player in select quantum applications—and to reap the benefits for the Commonwealth of this transformative technology.

4.1 The Quantum Opportunity

To understand QIST's potential, it is helpful to understand its underlying principles. Quantum technology is based on the principles of quantum mechanics, which describes the behavior of matter and energy at the atomic and subatomic levels. At these levels, they exhibit particle-like behavior and can exist in multiple states simultaneously, a property called "superposition." Quantum particles can also be linked together, a state called "entanglement." Researchers are taking advantage of these principles to create quantum devices that are dramatically more powerful than traditional computers or sensors.

For instance, the most basic unit of information in a computer is the bit. In a traditional computer, these bits are either one or zero, on or off. Bits can be strung together in long sequences to represent unique values, characters, or instructions. Simply put, programming languages automate the process of converting instructions into the one or zero states that a computer chip can interpret and execute.

Quantum bits, which are known as "qubits," can exist in a superposition of both states. In other words, they can represent one and zero simultaneously or any combination in between. This enables quantum computers to perform many computations concurrently, making them ideal for problems involving extremely large datasets or intricate calculations. Two or more qubits can also be entangled. This means they share the same fate, regardless of the distance between them. Measuring the state of one entangled qubit instantly reveals the state of the other, a property crucial for quantum computing and communications.

In early computers, ones and zeros were represented by the solid spaces and holes in punch cards. In modern computers, they are indicated by the presence or absence of an electrical charge or pulse. When voltage is applied to a gate in one of the billions of transistors on a computer chip, it opens, and current flows through it, representing a one. When voltage is adjusted, the gate closes, blocking current flow, representing a zero.

Qubits are much harder to represent—and researchers are experimenting with different quantum systems, each with its advantages and disadvantages. These often involve quantum materials. Qubits made from superconducting materials work well but have to be cooled to extreme temperatures. Other candidates include trapped ions, photons, quantum dots, and neutral atoms.

QIST has many applications, however, in addition to computing. These are just four examples:

- Quantum cryptography leverages the properties of quantum particles to detect eavesdropping. Any attempt to break into a quantum encryption system would alter its quantum state immediately, giving the hacker away.
- Quantum sensing leverages phenomena like superposition, entanglement, and quantum coherence to achieve greater sensitivity to weak signals or to enhance spatial or spectral resolution in imaging. In addition to electromagnetic field detection and navigation, its applications include timekeeping, diagnostics, and medicine.
- Quantum simulations differ fundamentally from computer-based simulations, which are descriptions of physical processes. Quantum simulations are controllable quantum systems that mimic the quantum mechanics of the system being studied. They could be used to identify drug candidates and for highly accurate climate modeling.
- Quantum networks can allow the secure transmission of information, ameliorating the challenge posed by an adversary in possession of a quantum computer.

4.2 Virginia's Quantum Readiness

Virginia has several efforts already in place that could provide a starting point for Virginia's emergence as a quantum leader. It has solid quantum programs at Virginia Tech, George Mason University, and the University of Virginia. These universities also offer minors and concentrations in quantum computing and are helping to introduce quantum courses and curricula to the state's school districts. In addition, the Virginia Economic Development Partnership is actively promoting Virginia's potential to become a center of quantum development. Through its publications, it has highlighted the state's research strengths and focused on the application of quantum computing in sectors like the life sciences, energy, finance, and defense.

Two states—Colorado and Illinois—have launched major quantum initiatives that could serve as templates for Virginia's future efforts.

4.2.1 Elevate Quantum

In 2023, Colorado's Elevate Quantum was named a Designated Tech Hub by the Department of Commerce's Economic Development Administration. Elevate Quantum is a consortium of 120 organizations in Colorado and the Mountain West, including 17 universities employing four Nobel laureates in quantum physics, three national labs, and 30 leading quantum companies. It initially received $40.5 million in federal funding, which activated $77 million in matching funds from Colorado and $10 million from New Mexico. This helped attract over $1 billion in private capital, supporting the growth of more than 30 start-up companies. In June 2024, Elevate Quantum received an additional $127 million in new federal and state funding.

Elevate Quantum is building a quantum campus in suburban Denver with a 10,000-square-foot open-access quantum fabrication laboratory and cleanroom as well as a 13,000-square-foot incubator in Boulder. It has also launched a number of workforce development programs—including the Quantum Workforce Collaborative and the Quantum Technician Bootcamp—and is coordinating the efforts of its members to solidify the region's global leadership in quantum information technology.

Colorado has its own programs to support the development of quantum technologies. They include the Colorado Quantum Fund for Innovative Lending, which encourages lenders to make favorable loans to companies by registering up to 15% of the loan in a pooled loan loss reserve. The reserve is accessible with a 100% refundable tax credit should the lender incur losses associated with those loans.

Currently, Colorado has the largest cluster of quantum businesses in the nation, employing 3,000 highly skilled workers. These companies include five of the top 20 venture capital-backed quantum companies, more than any other state.

4.2.2 Chicago Quantum Exchange and Other Initiatives

Illinois has benefited from a variety of quantum initiatives, thanks to its concentration of top-tier research centers, including the University of Chicago, the University of Illinois Urbana-Champaign, the Argonne National Laboratory, and the Fermi National Accelerator Laboratory.

Based at the University of Chicago's Pritzker School of Molecular Engineering, the Chicago Quantum Exchange (CQE) brings together more than 200 researchers from those four institutions plus the University of Wisconsin-Madison, Northwestern University, and Purdue University. Its goal is to advance the science and engineering of quantum information, train the future quantum workforce, and foster the growth of the quantum economy. The CQE has over 40 partners from industry, including major global companies like IBM, CISCO, and Toshiba, as well as such quantum specialists as Xanadu and PsiQuantum.

CQE has played a key role in the development of the multibillion-dollar Illinois Quantum and Microelectronics Park (IQMP) and leads the Economic Development Administration's Bloch Quantum Tech Hub. In addition, it has played a major role in establishing Duality, the nation's first quantum startup accelerator, and funds the Open Quantum Initiative Fellowship for undergraduate students.

Illinois is also the home of two of the five National Quantum Information Science Research Centers funded by the Department of Energy: Q-NEXT at Argonne National Laboratory and the Superconducting Quantum Materials and Systems Center at Fermilab. These consortia have a national reach, tapping experts from national laboratories, industry, and academia across the country.

The state of Illinois itself has made a substantial investment in QIST. It has allocated $500 million for a quantum campus and invested $200 million to support the CQE. It has also provided $140 million to the DARPA-Illinois Quantum Proving Ground, which will be located at IQMP. Through its Economic Development for a Growing Economy program and Innovation Venture Fund, it also provides funding and support to quantum startups.

4.3.1 Strengths: University Research Programs

Several of Virginia's major research institutions have programs in QIST. Virginia Tech established the Center for Quantum Information Science and Engineering (VTQ) in 2022. VTQ has more than 15 faculty members from such fields as physics, computer science, chemistry, electrical and computer engineering, and math. Together, they have attracted more than $25 million in federal funding. VTQ's focus is theoretical, concentrating on such aspects of quantum computing as the quantum algorithms used to program quantum computers. The Office of Research and Innovation at Virginia Tech has named quantum as one of its four key strategic priorities. Recent quantum investments from the university include a dedicated space for VTQ and a new electron-beam lithography machine. With support from industry, Virginia Tech opened a Center for Quantum Architecture and Software Development in 2025 at its Northern Virginia Innovation Campus.

Virginia Tech quantum researchers are also involved in the National Quantum Initiative Co-design Center for Quantum Advantage, which is supported by the Department of Energy. In addition, they collaborate with the Department of Energy Quantum Testbed facilities at Sandia and Lawrence Berkeley national labs.

By and large, University of Virgina (UVA) researchers focus on hardware. They are pursuing advances in on-chip photonic computing and photodetection. Photonic quantum devices have the advantage of being able to operate at room temperature and are easily scalable. In 2022, the research group at UVA formed a startup, QC82, to commercialize their technology. Unable to find funding in Virginia, they located in Maryland and secured a Maryland Industrial Partnerships grant.

George Mason University launched its Quantum Science & Engineering Center (QSEC) in 2018. Researchers at Mason's QSEC are working to identify problems that might be solvable with existing rudimentary quantum computers as well as those that are theoretically possible on an ideal quantum computer. They have also made ad-

vances in quantum sensing, producing one of the world's most sensitive quantum magnetometers. Devices like this can sense the signature magnetic fields of varied materials with potential applications in biomedicine, security, and geological surveys, and in navigation as an alternative to GPS.

4.3.2 Strengths: Workforce Development

A number of schools and universities in Virginia have anticipated the need to develop a workforce ready for the age of quantum technology. George Mason's QSEC is updating course curricula, adding a quantum concentration for the master's degree in physics, and broadening outreach programs. As part of the K12 Quantum Workforce Development Project organized by the Potomac Quantum Innovation Center, QSEC is helping school systems in Loudoun and Fairfax counties train educators and develop curricula that will lay the foundation for tomorrow's quantum workforce. In addition, backed by a U.S. Department of Education grant, QSEC runs several quantum education programs, including "Pathways to Quantum Summer Immersion," which helps high schoolers learn about quantum technology and careers, and "Quantum in Your Classroom," aimed at helping K–12 teachers incorporate quantum topics in their classrooms.

Virginia Tech has established a Quantum Information Science and Engineering (QISE) minor degree for undergraduate students, one of the first of its kind in the country. Indeed, Virginia Tech faculty have advised universities in other states about setting up similar degree programs. Doctoral students and postdoctoral researchers with quantum expertise from Virginia Tech have been hired at government labs, quantum computing startup companies, established tech and defense companies, and as faculty at universities in the United States and worldwide.

4.4 The Federal Landscape

In 2018, President Donald Trump signed into law a bill establishing the National Quantum Initiative (NQI) "to accelerate quantum research and development for the economic and national security of the United States." The NQI Act authorizes U.S. Federal departments and agencies to establish quantum centers and consortia and carry out new programs to foster quantum information systems (QIS) research and development (R&D). The NQI Act calls for the coordination of QIS R&D efforts across the federal government, as well as with industry and the academic community. In addition, the National Defense Authorization Act for fiscal years 2019, 2020, and 2022, as well as the CHIPS and Science Act of 2022, all contain legislation relevant to the promotion of quantum information science.

Since its founding, NQI agencies have increased budget expenditures for quantum information science. These have averaged approximately $1 billion over the past four years. In January 2025, the Department of Energy announced that is providing $625 million to create five new National Quantum Information Science Research Centers, two of which, as we have seen, are in Illinois.

As part of the NQI, the National Institute of Standards and Technology created the Quantum Economic Development Consortium (QED-C). George Mason University, Boeing, and MITRE Corporation, a federally funded R&D center located in Northern Virginia, are among its founding members.

4.5 The Next Step: Create a Roadmap

Virginia is in a much weaker starting position than states like Colorado and Illinois, but it also has the opportunity to take advantage of the programs and strategies they have pioneered to build a flourishing quantum ecosystem. A carefully focused Commonwealth Quantum Initiative that builds on Virginia's strengths could place the state solidly in the midst of the quantum revolution.

Before launching such an effort, Virginia should identify its areas of quantum expertise and develop a roadmap to establish innovation hubs and research centers that foster collaboration within and across state universities and among academia, industry, and government to build expertise in these areas. It should also identify sources of funding, suggest methods to attract quantum companies and nurture quantum startups, while recommending ways higher education can help create a well-articulated quantum workforce. By working now to stake Virginia's place in the quantum future, Virginia will be well positioned to profit as the quantum revolution begins to accelerate.

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