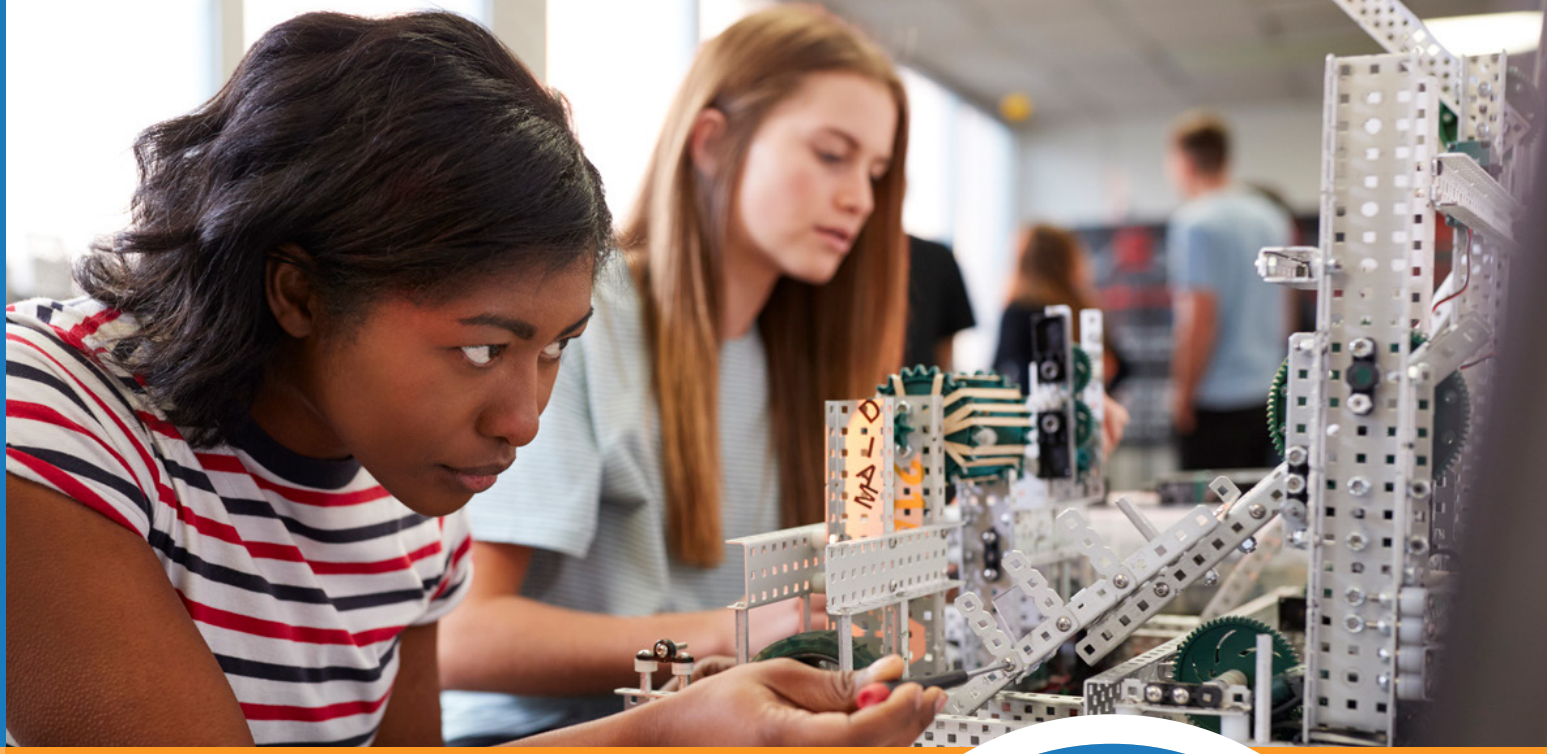


Vision 2030:

South Carolina Science & Technology Plan

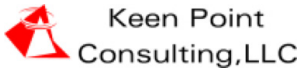
June 2022

SC EPSCoR

SCRA South Carolina Research Authority

Keen Point Consulting, LLC

RTI INTERNATIONAL



The development of the South Carolina Science & Technology Plan: Vision 2030 was led by Jennifer Ozawa at RTI International and Anthony Gillespie at Keen Point Consulting in collaboration with the South Carolina EPSCoR State Committee. David Friedrich, Alison Bean de Hernandez, Michael Hogan, and Rizwaan Lakhani of RTI supported research, data collection, and analysis. Lisa Gardner created the report design. The Plan was adopted by the South Carolina EPSCoR State Committee on July 11, 2022.

SC EPSCoR

June 15, 2022

The National Science Foundation (NSF), through its Established Program to Stimulate Competitive Research (EPSCoR), aims to advance excellence in science and engineering research and education, thereby supporting economic development and prosperity throughout the country, including South Carolina (SC). SC EPSCoR programs catalyze and enhance research capability, establish novel educational and professional development programs leading to diverse career pathways, and broaden participation from the state's diverse talent base.

The South Carolina Research Authority (SCRA) manages the SC EPSCoR program on behalf of the state. SCRA fuels South Carolina's innovation economy by accelerating the technology-enabled growth of academia, industry, and entrepreneurship.

SC EPSCoR is governed by a State Committee comprised of representatives from academia, government, and industry. The State Committee and SCRA, with support from RTI International and Keen Point Consulting, have prepared the *South Carolina Science & Technology Plan: Vision 2030* to serve as the foundational roadmap for science-and technology-based strategies and investments in the state over the next five to seven years. This Plan incorporates the insightful input of stakeholders from industry, state government, federal facilities, economic development organizations, and academia.

As stated in the Executive Summary, this Plan describes "… the role that science and technology education, research, innovation, and business can play in advancing the well-being and livelihoods of all South Carolinians regardless of race, gender, and geographic location." The Plan's four categories for action (High-Tech Industry Growth; Innovation & Entrepreneurship; Research Competitiveness; and STEM Education) promise to be transformative in their impact. The Target Industry Sectors (Advanced Manufacturing; Human Health Life Sciences; Information Technology; and Clean Tech, Sustainability, and Resiliency) build upon the state's existing areas of strength while positioning the state to meet the future needs of industry.

On behalf of the SC EPSCoR State Committee, SCRA, and the many contributors, we are pleased to present *Vision 2030* to policy makers, industry leaders, economic developers, university administrators, researchers, and all others who are working toward the shared goal of elevating the prosperity and fortunes of our citizens and our economy.

Sincerely,

Michael A Matthews
Chair, SC EPSCoR State Committee

Bob Quinn
Executive Director, South Carolina Research Authority

Henry McMaster
Governor

SOUTH CAROLINA
DEPARTMENT OF COMMERCE

Harry M. Lightsey III
Secretary

June 3, 2022

Bob Quinn
Executive Director
South Carolina Research Authority
315 Sigma Drive
Summerville, SC 29486

Michael Matthews, PhD
Chair, SC EPSCoR State Committee
University of South Carolina
1600 Hampton St
Columbia, SC 29208

Dear Dr. Matthews and Mr. Quinn,

On behalf of the South Carolina Department of Commerce (Commerce), I am pleased to extend our support for the Science and Technology Plan that is being commissioned by the South Carolina Research Authority (SCRA) and SC EPSCoR State Committee.

The mission of Commerce is to create economic opportunities to increase choices for all South Carolinians. We do this by looking to the future, recognizing the increasing prevalence of science and technology in today's economic landscape.

This plan brings together a cross-section of science and technology stakeholders and representatives spanning higher education, industry, nonprofit, economic development and government landscapes. And, the final product will be reflective of the state's diverse voices, grounded in an understanding of how South Carolina can harness existing resources, leverage opportunities and amplify partnerships to grow our economy.

Through strategic and allied partnerships, such an effort will help build a foundation for South Carolina to realize long-term economic competitiveness through STEM-related growth. Investing in our intellectual capital and the advancement of our science and technology sectors will create enduring pathways to lasting socioeconomic growth.

We appreciate SCRA and the SC EPSCoR State Committee's shared innovative vision and shared dedication to South Carolina's continued success, and we look forward to bringing this plan to fruition.

Sincerely,

Ashely Teasdel
Deputy Secretary

1201 Main Street, Suite 1600, Columbia, SC 29201 USA
tel: (803)737-0400 · fax: (803)737-0418 · www.sccommerce.com

South Carolina Established Program to Stimulate Competitive Research State Committee Members

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Susie Shannon
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John Wheeler, PhD
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Ken Deans, Jr.
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Lori McMahon, PhD
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Bob Quinn
Executive Director
South Carolina Research Authority

Kelly Steinhelper
Vice President of Communications
South Carolina Technical College System

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Executive Summary

S&T Plan Vision

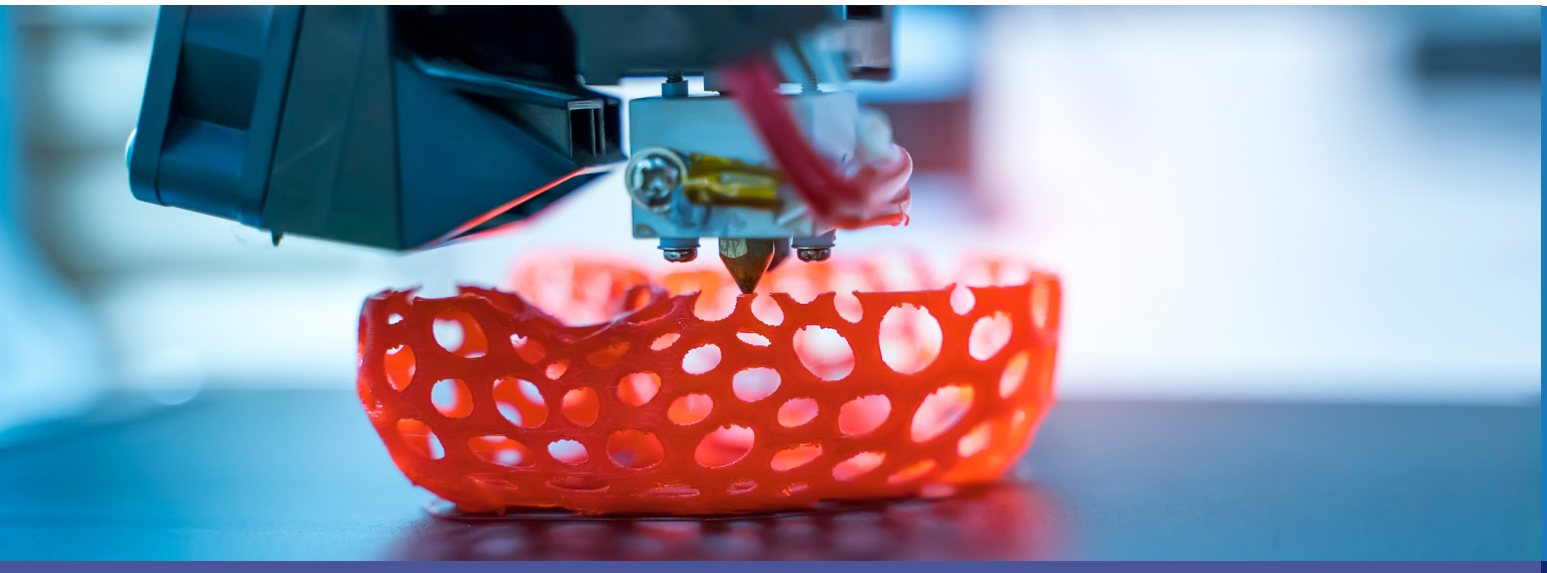
The *South Carolina Science & Technology Plan: Vision 2030* presents a stakeholder-driven plan for the role that science and technology education, research, innovation, and business can play in advancing the well-being and livelihoods of all South Carolinians regardless of race, gender, and geographic location. The Plan includes four areas for action, with a vision for each as presented below.

High-Tech Industry Growth:
South Carolina recruits and retains science- and technology-intensive companies through targeted business development and supports the growth of new ventures through strategic investments in the entrepreneurial and innovation ecosystem. The growth of South Carolina's high-tech sector spurs more innovation, business research and development (R&D), and high-tech sector employment.

Innovation & Entrepreneurship:
Entrepreneurs, companies, and investors look to South Carolina as a vibrant ecosystem for startups at the forefront of technology, ranging from materials and medtech to software and robotics. This thriving ecosystem spurs more private investment and attracts Fortune 1000 companies through mergers and acquisition (M&A) activity.

Research Competitiveness:
South Carolina's academic research competitiveness and stature grows in high-priority research fields, from artificial intelligence (AI) and machine learning to precision biology, by investing in top talent and research infrastructure and winning major federal research center awards. Strong university-industry research collaboration supports greater business R&D and innovation.

Science, Technology, Engineering, and Mathematics (STEM) Education:
South Carolina investments establish the Palmetto State as a leader in K-20 STEM education and increase the diversity and representation of graduates in STEM fields. South Carolina students are inspired and prepared to make an impact in the world by pursuing STEM majors and acquiring the technical and critical thinking skills needed by companies.



Target Industry Sectors and High-Priority Research Areas

The Plan focuses attention on four science- and technology-intensive industry sectors that are high-wage, high-growth, and represent a mix of both large existing industries and smaller emerging industries measured by employment. These industries are: Advanced Manufacturing; Human Health Life Sciences; Information Technology; and Clean Tech, Sustainability, and Resiliency.

The plan also identifies four high-priority research fields that will support these industry sectors: AI, machine learning, and data science; advanced materials; precision biology; and systems engineering. Table 1 presents examples of technologies arising from these research fields and their alignment with the target industry sectors.

Table 1. Examples of High-Priority Research Field Applications Within the Target Industry Sectors

	ADVANCED MANUFACTURING	HUMAN HEALTH LIFE SCIENCES	INFORMATION TECHNOLOGY	CLEAN TECH, SUSTAINABILITY, AND RESILIENCY
AI, Maching Learning, Data Science	Autonomous vehicles	AI-assisted robotic surgery	Website chatbot	Power grid management
Advanced Materials	Composites and coatings	Orthopedic biomaterials	Semiconductors	Electric-vehicle batteries
Precision Biology	Synthetic biology	Immunotherapy	Wearable devices	Precision agriculture
Systems Engineering	Digital twins	Health care delivery	Network security	Connected transportation systems

Goals and Baseline

To improve South Carolina's economic competitiveness and growth over the next 5-7 years, the plan recommends the following goals relative to the current representative baseline information.

GOAL	BASELINE
High-Tech Industry Growth	
1. Stakeholders work with state, regional, and local economic development offices (EDOs) in ongoing efforts to recruit and retain high-tech companies (aiming for parity with the high-tech sector's share of total employment nationally)	• SC high-tech share of total employment is 10.6% vs. 12.1% nationally
2. Stakeholders regularly and consistently serve as a resource to the South Carolina Department of Commerce (SC Commerce) providing ideas and input into potential new programming or initiatives	• Good collaboration from stakeholders on requests for input, information, and participation in recruitment efforts
Innovation & Entrepreneurship	
1. Increase 3-year rolling average of SC venture capital (VC) deals to 50/year and achieve 25 successful exits	• 3-year rolling avg of 42.0 deals (2017-19), 39.7 deals/year (2019-21) • 5-year total of 12 exits (2017-2021), 7-year total of 20 exits (2015-2021)
2. Increase the 3-year rolling average of SC VC investment (seed, early-stage VC, later-stage VC) to $200M/year	• SC ranks 39th in VC investment relative to the size of its economy • 3-year rolling avg of $120.4M in VC investment (2017-19), $170.4M (2019-21) • 9 VC firms with SC offices, 2 angel groups
3. Continue to develop vibrant, inclusive, engaged entrepreneurial ecosystems (local, regional, state) connected to national and international markets	• SC Commerce has engaged in formal innovation planning since 2013 and runs the Relentless Challenge grant program • South Carolina Research Authority (SCRA) Programs and Grants • Multiple local efforts (e.g., NEXT, MIT Venture Mentor, Harbor Entrepreneurial Center, Growco, Gravity Center, Minority Business Accelerators, etc.)
Research Competitiveness	
1. Invest in research facilities and infrastructure to support faculty recruitment and retention and expand STEM enrollment (e.g., $200M/year for 5 years)	• Georgia, North Carolina, Tennessee, Virginia, Texas, Indiana, etc., use bonds to finance capital projects for higher education institutions • Competitor states have significantly more research space and infrastructure
2. Increase the number of nationally recognized faculty	• SmartState program and others aimed at investing in research programs
3. Increase the growth rate of science and engineering (S&E) R&D expenditures in high-priority research areas at a rate closer to the U.S. growth rate (4.6% compound annual growth rate [CAGR]) over the next 5-7 years	• SC S&E R&D grew 2.7% CAGR vs. U.S. 4.6% from 2015-2020
K-20 STEM Education	
1. Improve the quality of K-12 STEM education (increase ranking on Math and Science National Assessment of Educational Progress [NAEP]) 2. Raise average Math and Science teacher salaries to national average 3. Reduce number of SC low-income students taught by out-of-field Math and Science teachers to well below 10%	• SC ranks 39th on 8th grade Math NAEP • The starting average salary for new teachers is $36,000 and for all teachers is $53,000 • 1 in 5 low-income students is taught by an inexperienced teacher in English, Math, or Science; 1 in 10 low-income students taught by an out-of-field teacher • No current state-supported math and science instructional coaches program
4. Inspire and attract a large and diverse number of K-12 students to STEM by increasing the share of Title 1 school participating in the South Carolina Junior Academy of Sciences (SCJAS) to 10%	• Title 1 schools currently account for 5% of total participating schools in SCJAS
5. Increase the number and share of women and people of color graduating with postsecondary STEM degrees	• Women: 51.6% of SC population, but 22% of engineering bachelor's degrees and 29% of math and computer science bachelor's degrees • African Americans: 27% of SC population, but 6% of engineering bachelor's degrees and 15.5% of math and computer science bachelor's degrees
6. Increase the number of partnerships between major research universities and primarily undergraduate institutions, especially historically black colleges and universities (HBCUs), to pursue federal grants that strengthen research experiences and alignment of STEM curricula with graduate programs	• MUSC, Clemson, and USC have at least one major research partnership with HBCUs currently, but there is an opportunity to scale up

About This Plan

Purpose

The *South Carolina Science & Technology Plan*: *Vision 2030* (hereafter, the S&T Plan) presents a stakeholder-driven plan for the role that science and technology education, research, innovation, and business can play in advancing the continued economic development, well-being, and livelihoods of all South Carolinians regardless of race, gender, and geographic location.

The Plan serves as a vehicle for determining South Carolina's strategic direction and for coordinating and guiding university-industry-government collaboration on high-priority goals and initiatives. It is informed by South Carolina's economic development priorities and includes four areas for action: High-Tech Industry Growth, Innovation & Entrepreneurship, Research Competitiveness, and STEM Education.

Another impetus for this five- to seven-year plan is South Carolina's upcoming submission of a research capacity-building proposal to the National Science Foundation's (NSF)'s Established Program to Stimulate Competitive Research (EPSCoR). The development of a state S&T plan is a requirement of the proposal. This S&T Plan updates the previous plan, Vision 2025, which was drafted in 2012.[1]

Approach

The South Carolina EPSCoR State Committee, working through the South Carolina Research Authority (which manages the state's EPSCoR program), led the S&T Plan development. The State Committee engaged RTI International and Keen Point Consulting (hereafter, RTI-Keen Point) to facilitate the development and preparation of the revised S&T Plan.

Over the course of this six-month project, RTI-Keen Point collected and analyzed a variety of economic, science and engineering, innovation and entrepreneurship, and education data from state and national sources. They benchmarked South Carolina's competitive positioning against other states and the national average. RTI-Keen Point interviewed more than 40 stakeholders representing university, industry, government, and nonprofit and trade organizations to understand South Carolina's strengths and weaknesses for pursuing science- and technology-based growth. They also surveyed more than 150 stakeholders to solicit ideas on S&T Plan goals and actions that can make South Carolina more competitive over the next five to seven years.

Report Organization

The first section of the report presents the case for why South Carolina needs an S&T plan and stakeholders' vision for the role that science and technology can play in advancing South Carolina's economy and job opportunities available to its citizens. The second section identifies key science- and technology-intensive industry sectors and high-priority research fields upon which the recommended actions are focused. The third section presents five- to seven-year goals and metrics for each of the four areas for action relative to current representative baseline information. Finally, the Appendix includes the full list of stakeholders who contributed to this S&T Plan, as well as indicators and analysis of data that RTI-Keen Point used to benchmark South Carolina.

1 South Carolina Science and Technology Task Force (2012). *Vision 2025: Advancing South Carolina's Capacity and Expertise in Science and Technology.* https://scepscor.org/documents/Vision2025.pdf

Why South Carolina Needs an S&T Plan

Recent Economic Performance

During the five-year period, 2014-2019 (the last half of the pre-COVID economic expansion), South Carolina's real gross domestic product (GDP) growth, population growth, and new business starts exceeded the national average. South Carolina ranked 11th for real GDP growth and among the top 10 states in the country for population and new business growth.

At the same time, public and private sector leaders in South Carolina are aware that the state needs continued growth in higher-wage, higher-value added industries and investment in K-20 STEM Education to create the technical workforce that can fuel the growth of new and existing companies in these industries.

Figure 1. South Carolina Performance on Key Economic Indicators, 2014-2019

U.S.	South Carolina
$19,032.7BN Real GDP Growth Rate 2014-19 **2.4%**	**$213.5BN** Real GDP Growth Rate 2014-19 **3.1%** State Rank **11**
328.2M Population Growth Rate 2014-19 **0.6%**	**5,148,714** Population Growth Rate 2014-19 **1.3%** State Rank **9**
9.9M New Businesses Growth Rate 2014-19 **1.8%**	**139,449** New Businesses Growth Rate 2014-19 **3.4%** State Rank **3**

Note: Blue is the U.S. compound average growth rate (CAGR); orange indicates > 2% CAGR; gray indicates a 0-2% CAGR; and red would indicate a negative CAGR for South Carolina.

Source: U.S. Bureau of Economic Analysis, U.S. Bureau of Labor Statistics, U.S. Census Bureau

Industry Structure and Average Wages

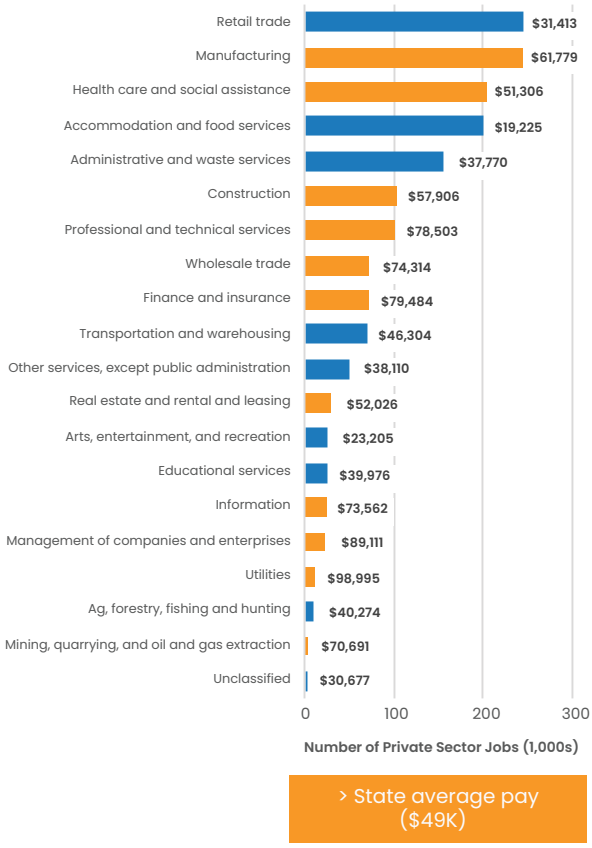
What industry sectors are driving South Carolina's economy in terms of contribution to GDP and employment?

- Measured by contribution to GDP: manufacturing (from food and beverage to automobiles), real estate, retail trade, health care and social assistance, and wholesale trade.
- Measured by employment: retail trade, manufacturing, health care and social assistance, accommodation and food service, and administrative and waste services.[2]

What are the wage profiles of these industry sectors?

- Only two of the five largest industries (measured by both GDP and employment), manufacturing ($61,779) and health care and social assistance ($51,306), exceed the average private sector salary in South Carolina of $49,000.
- Stronger employment growth in smaller science- and technology-driven industries, such as professional and technical services ($78,503), information ($73,562), and management of companies ($89,111), would raise South Carolina average private sector salary.[3]

Figure 2. South Carolina Employment and Average Salary by Industry, 2020

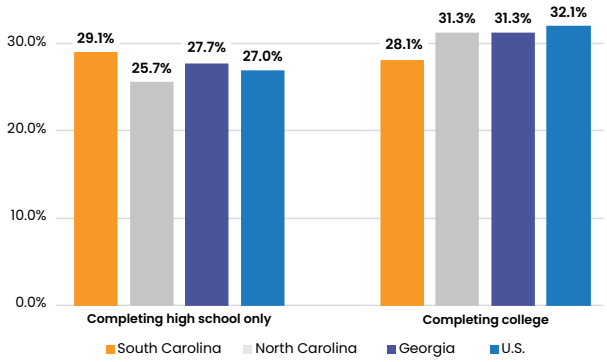


Source: U.S. Bureau of Economic Analysis

Educational Attainment and Workforce

The educational attainment of South Carolina's workforce lags that of neighboring states and the nation. South Carolina's "high school-only" population is higher than the U.S. average and neighboring states, while South Carolina's college-educated population is lower. Higher-paying jobs (jobs that pay salaries higher than the private sector average) often require an associate's or higher-level degree.

Figure 3. Share of Adult Population (25+ years) Completing High School Only and Completing 4-Year College, 2015-2019 Average



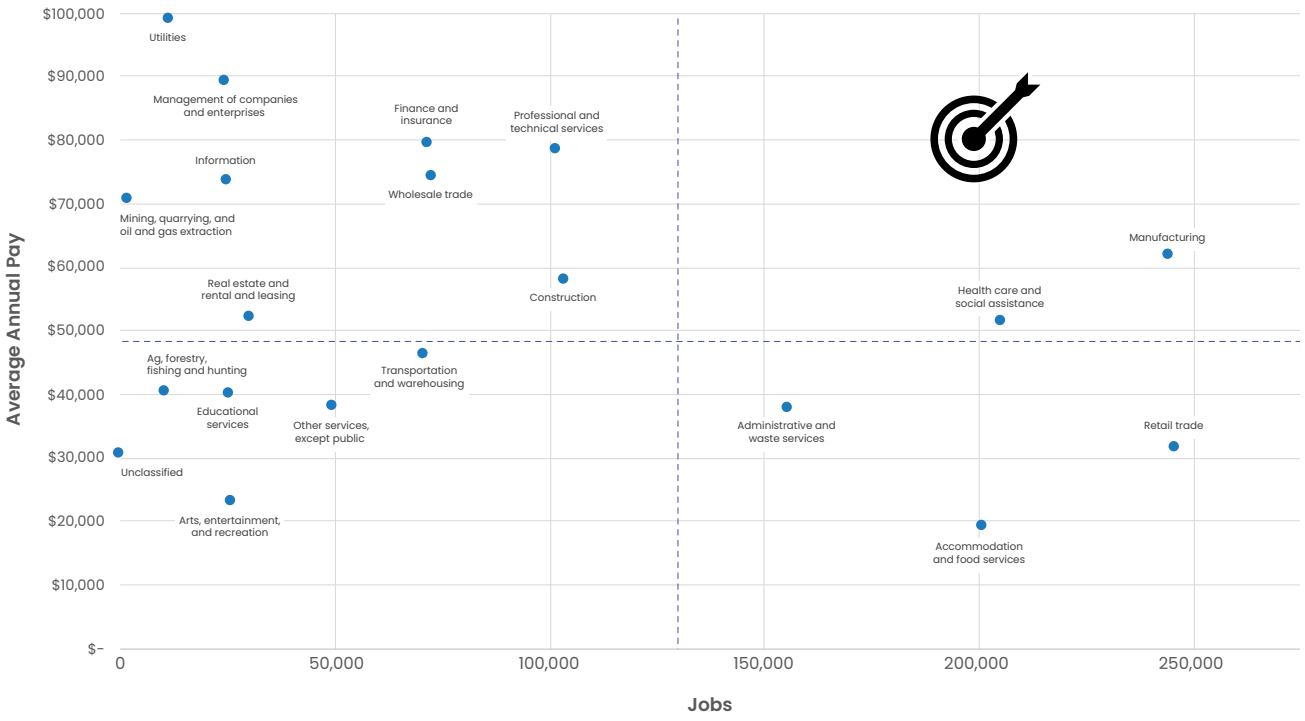
2 In 2019, the top five industries were the same but ranked slightly differently: manufacturing, retail trade, accommodation and food service, health care and social assistance, and administrative and waste services. Manufacturing and accommodation and food service ranked higher pre-COVID.

3 The 54 industry code in the North American Industrial Classification System (NAICS) includes engineering services, environmental and technical consulting, computer programming, computer systems design, and scientific R&D services. The 55 industry code in NAICS includes headquarters, subsidiary, and corporate offices of companies. The 51 NAICS includes software publishing, data processing and hosting, and telecommunications.

Case for More Knowledge- and Technology-Intensive Growth

A key question for South Carolina is how to increase the number of companies and employment with salaries that exceed the state average—that is, how to move more industries to the top right quadrant in the figure, below. The S&T Plan identifies goals and actions to move more of these industries to the top right quadrant.

Figure 4. South Carolina Industry by Total Employment and Average Salary, 2020



Source: U.S. Bureau of Labor Statistics

Today, most science-and technology-intensive companies and industries, which pay higher-than-average salaries, represent 100,000 or fewer employees. They are mainly located in the top left quadrant of Figure 4 and are categorized as Management of Companies (i.e., the headquarters industry code, $89,111), Information ($73,562), Utilities ($98,995), and Professional and Technical Services ($78,503) based on the North American Industrial Classification System. There are also science- and technology-intensive companies and industries within Manufacturing in the top right quadrant. The top right quadrant is where more of South Carolina's industry base needs to move.

SC S&T Plan Vision

The S&T Plan is anchored by an ambitious, but achievable vision for each of the four key areas for action in the Plan.

High-Tech Industry Growth:
South Carolina recruits and retains science- and technology-intensive companies through targeted business development and supports the growth of new ventures through strategic investments in the entrepreneurial and innovation ecosystem. The growth of South Carolina's high-tech sector spurs more innovation, business R&D, and high-tech sector employment.

Innovation & Entrepreneurship:
Entrepreneurs, companies, and investors look to South Carolina as a vibrant ecosystem for startups at the forefront of technology, ranging from materials and medtech to software and robotics. This thriving ecosystem spurs more private investment and attracts Fortune 1000 companies through M&A activity.

Research Competitiveness:
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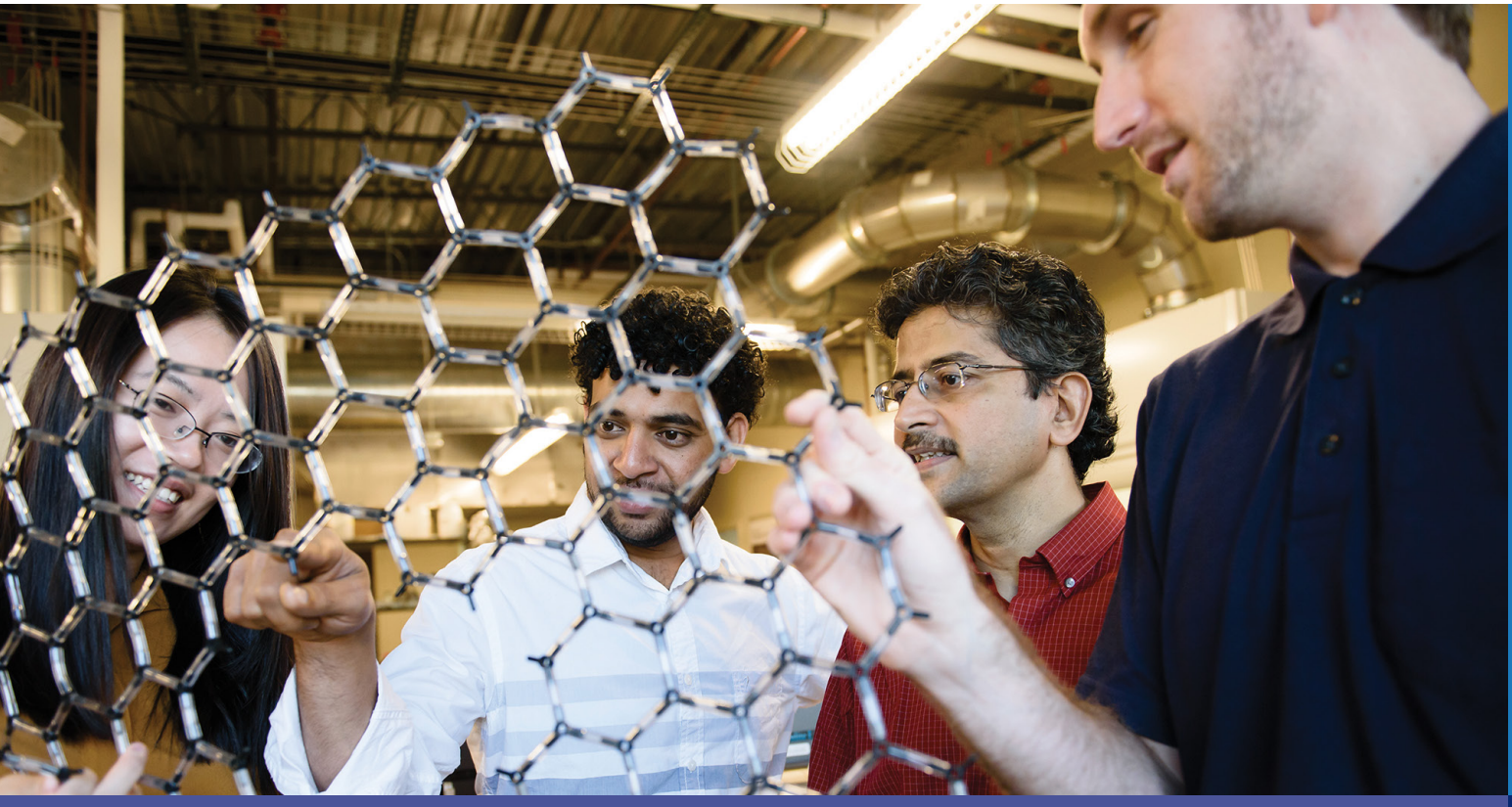
STEM Education:
South Carolina investments establish the Palmetto State as a leader in K-20 STEM education and increase the diversity and representation of graduates in STEM fields. South Carolina students are inspired and prepared to make an impact in the world by pursuing STEM majors and acquiring the technical and critical thinking skills needed by companies.



Target Industry Sectors and High-Priority Research Fields

Target Industry Sectors

To help frame the S&T Plan and its activities, RTI-Keen Point identified four major science- and technology-intensive industry sectors that are high-wage, high-growth, and include a mix of existing and emerging industries measured by employment.

Figure 5. South Carolina S&T Plan Target High-Tech Industry Sectors

Definition and Case for Selection

The case for the selection of each high-tech industry sector is summarized below.

Advanced Manufacturing: As noted earlier in this report, manufacturing is South Carolina's largest industry sector with approximately 250,000 employees and spans food and beverage to automobile production.[4] "Advanced" manufacturing refers to those industry segments with high- and medium-high R&D intensity. High-R&D intensity manufacturing segments include computer, electronics, and optics; aerospace; and pharmaceutical manufacturing (e.g., Boeing [aerospace], Kyocera AVX [electronic components], AFL [fiber optics], Nephron [pharmaceuticals]). Medium-high R&D intensity industry segments include automotive and chemical manufacturing (e.g., BMW [automotive], ZF Group [vehicle transmissions], Proterra, [electric vehicles], and Milliken [specialty chemicals]).[5]

Human Health Life Science: Human health life sciences spans drugs, pharmaceuticals, and biologics (i.e., contract development and manufacturing organizations, as well as therapeutic startups), medtech, testing and medical labs, and healthtech. This sector leverages biomedical research and clinical care provided by medical schools and the healthcare sector, but the focus is on bringing products to national and international markets. Examples of South Carolina life sciences companies include Nephron Pharmaceuticals, Lonza Biotech, Cardinal Health, AmbioPharm, Patheon (Thermo Fisher Scientific), and Ritedose (recently acquired by Novo Holdings). While this is an emerging industry sector of 15,000 employees (only Greenville-Anderson, SC has a higher-than-average employment concentration of 2.0), the state continues to add jobs through company recruitments and expansions.

Information Technology: Information Technology includes computer, semiconductor, and related electronics manufacturing and software development, computer systems design, enterprise solutions, and network security. There is a great variety of companies and growth in this sector as IT enterprise solutions, network security, and data analytics are increasingly applied across other industry sectors. Examples of South Carolina companies

4 U.S. Bureau of Labor Statistics
5 Galindo-Rueda, Fernando and Fabien Verger (2016). "Table 1. Proposed classification of economic activity into five major groups," OECD Science, Technology, and Industry Working Papers: OECD Taxonomy of Economic Activities Based on R&D Intensity, p.10.

active in this sector include Blackbaud (cloud software), Siemens Healthineers (healthcare IT and medtech), Diesel Laptops (truck diagnostics), Adapt Forward (cybersecurity), and Clear Touch (interactive panels). The Naval Information Warfare Center Atlantic in Charleston is a node in this ecosystem driving demand for IT services through its contracting and supporting IT innovation through its tech transfer activity.[6]

Clean Tech, Sustainability & Resiliency: Clean Tech, Sustainability, and Resiliency span products and services that reduce emissions, improve energy efficiency, generate clean and renewable energy, improve management of water and waste by farms, homes, offices, and industry, and engineer more resilient and environmentally friendly buildings, transportation, and agricultural systems. In South Carolina, companies in this sector include environmental engineering and consulting firms, like Weston & Sampson, AECOM, Rogers and Callcott Environmental, Palmetto Clean Technology, Trane Technologies (energy-efficient HVAC systems), Westinghouse Electric (nuclear energy services and technology; 55% of South Carolina's power comes from nuclear energy), and agtech firms, like venture-backed AmplifiedAg. The Savannah River National Laboratory, a U.S. Department of Energy laboratory in Aiken, drives demand for R&D in environmental management and nuclear infrastructure security.

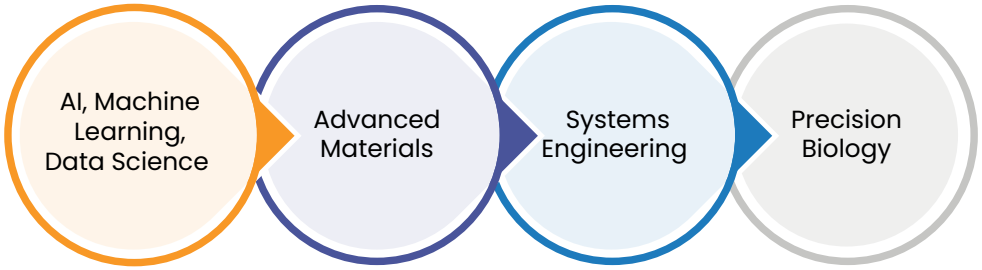
Use in the S&T Plan

While South Carolina welcomes all expanding or relocating companies, the purpose of identifying strategic industry sectors for the S&T Plan is to provide focus for stakeholder collaboration and effort. Relative to other major industry employers in South Carolina (e.g., retail trade, hospitality and tourism, finance and insurance, etc.), companies in the Advanced Manufacturing, Human Health Life Sciences, Information Technology, and CleanTech, Sustainability and Resiliency sectors are more R&D-intensive, require more STEM workers, and are higher-growth and higher-wage. These target sectors represent the next step for where South Carolina's economy needs to go in terms of number of companies and employment to stay competitive with regional neighbors and nationally.

One data challenge is that each of the four industry sectors include a mix of manufacturing and service companies. Because the U.S. Bureaus of Labor Statistics uses the North American Industrial Classification System, it is more difficult to see new emerging industry verticals that span both manufacturing and services.

6 For example, Reston, VA-based TIAG® was awarded a $39 million, five-year contract to provide data analytics, business intelligence, and other enterprise health information technology for NIWC Atlantic. TIAG expanded into Charleston and now has an office with approximately 75 software engineers, quality assurance analysts, and cybersecurity leads.

Figure 6. High-Priority Research Fields for SC S&T Plan



High-Priority Research Fields

In the same way that target industry sectors were identified, RTI-Keen Point identified high-priority research areas for the S&T Plan. The four fields build on existing competitive advantages or will hold other research areas back if not further developed, align with federal agency funding priorities, and align with global technology trends. They represent new opportunities or a competitiveness threat depending upon how quickly South Carolina companies adopt them.

Definition and Case for Selection

Artificial Intelligence (AI), Machine Learning, and Data Science: Data science is the collection, preparation, and analysis of data for visualization, decision making, and prediction. Different statistical techniques are applied to large data sets (e.g., healthcare and biomedical data, online user data, manufacturing production data, etc.) AI is a field that combines computer science and data science to interpret historical data, recognize patterns, and make predictions the way humans do. Machine learning is a subset of AI that draws on statistics and algorithms to provide models for learning and processing data autonomously without human intervention (e.g., supply chain inventory management).[7] Although AI, machine learning, and data science R&D expenditures cannot be seen in existing taxonomies (e.g., the NSF Higher Education R&D Survey), computer science R&D represents less than 2% of South Carolina's R&D portfolio versus 4% nationally. Because ample test beds and use cases abound in South Carolina's manufacturing industry base and healthcare system, this is a high-priority research area.

Advanced Materials: Advanced Materials are materials that are specifically engineered to exhibit novel or enhanced properties that confer superior performance relative to conventional materials. Like AI and data science, advanced materials research supports technological advances in nearly all other S&E fields, be it better batteries, solar cells, drug delivery systems, or medical devices. South Carolina's current EPSCOR award—Materials Assembly and Design Excellence in South Carolina (MADE in SC)—is focused on advanced materials research. The University of South Carolina has a SmartState Center for Multifunctional Materials and Structures, and Clemson University has a National Science Foundation Industry-University Cooperative Research Center with Rutgers University—the Ceramic, Composite, and Optic Materials Center.[8] There is also a Clemson Bioengineering Program at the Medical University of South Carolina, among other assets across the state in the advanced materials research area.

Precision Biology: On the human health side, precision biology is focused on tailoring disease prevention, diagnosis, and treatment to differences in genes, environment,

7 See Braincube (2022). "AI vs. Machine Learning vs. Data Science for Industry: Key Definitions, Differences, and How They Work Together," Resources.
8 The Ceramics, Composite and Optical Materials Center was established in 2010 and completed its I/UCRC Phase II funding in 2021.

and lifestyle. On the agricultural and environmental side, precision biology is focused on collecting and analyzing data about the soil, water, air, and microorganisms to inform decisions about crop, forestry, and water management. South Carolina has four medical schools[9], and Life Sciences R&D (including Health Sciences) represents 69% of South Carolina academic R&D compared to 61% nationally. All medical schools are leveraging genomics for precision medicine. In 2021, the Medical University of South Carolina and the genomics company, Helix, launched a first-of-its-kind population genomics program to generate actionable data on patient risk for certain forms of cancer and cardiovascular disease for 100,000 patients.

Systems Engineering: Systems Engineering is an interdisciplinary field of research which takes a holistic view in the design, integration, and management of complex systems. Systems Engineering spans several domains and has applications across all industries, e.g., healthcare, manufacturing, air traffic and road traffic management, energy. An example is Clemson University's $1.4 million U.S. Department of Transportation Center for Connected Multimodal Mobility with researchers from Benedict College, The Citadel, South Carolina State University, and University of South Carolina. The center explores the development of safe, efficient, cost-effective, and connected transportation systems through sensors, cameras, computer systems, and communication devices.[10]

Use in the S&T Plan

The goal of the high-priority research areas is not to limit faculty-driven research activity in other fields, but rather to identify areas for growth that both support South Carolina's high-tech industries and align with significant federal funding opportunities across federal agencies. They build on existing strengths and address strategic weaknesses in terms of research competitiveness. Examples of the ways in which the high-priority research areas can be applied to meet industry needs and opportunities are provided below. This is not an exhaustive list and is meant for illustrative purposes only.

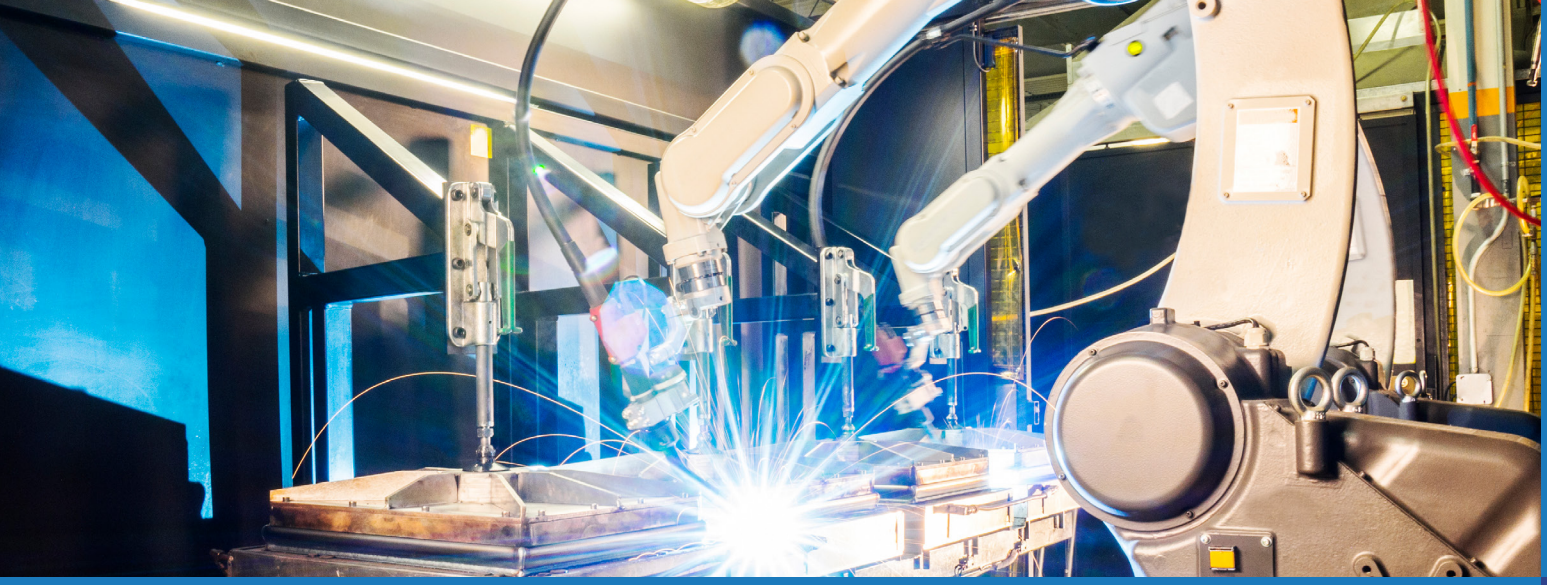
Table 2. Examples of High-Priority Research Field Applications Within the Target Industry Sectors

	ADVANCED MANUFACTURING	HUMAN HEALTH LIFE SCIENCES	INFORMATION TECHNOLOGY	CLEAN TECH, SUSTAINABILITY, AND RESILIENCY
AI, Machine Learning, Data Science	Autonomous vehicles	AI-assisted robotic surgery	Website chatbot	Power grid management
Advanced Materials	Composites and coatings	Orthopedic biomaterials	Semiconductors	Electric-vehicle batteries
Precision Biology	Synthetic biology	Immunotherapy	Wearable devices	Precision agriculture
Systems Engineering	Digital twins	Health care delivery	Network security	Connected transportation systems

9 South Carolina's four medical schools are the Medical University of South Carolina, the University of South Carolina School of Medicine (Columbia), the University of South Carolina School of Medicine (Greenville), and the Edward Via College of Osteopathic Medicine.
10 See the Center for Connected Multimodal Mobility website: https://cecas.clemson.edu/C2M2/

SC S&T Plan Goals and Actions

The S&T Plan identifies four areas for action in which public-private collaboration is critical to advancing South Carolina's science- and technology-based economic development and competitiveness. This section presents five- to seven-year goals and actions which, if implemented, will improve South Carolina's national ranking and stature. Each of the four components begin with observations expressed by stakeholders and restatements of component visions and why they are important to the Plan. Summaries of opportunities and challenges faced in each component are presented next. Finally, the overall goals and specific actions to achieve them are presented for each Plan component.



Vision: South Carolina recruits and retains science- and technology-intensive companies through targeted business development and supports the growth of new ventures through strategic investments in the entrepreneurial and innovation ecosystem. The growth of South Carolina's high-tech sector spurs more innovation, business R&D, and high-tech sector employment.

High-Tech Industry Growth

Stakeholder Observations:

- "Over my lifetime, I have seen South Carolina transition from textiles to automotive manufacturing. We need to figure out what comes next."
- "South Carolina has the same opportunity on the East Coast (Columbia-Charlotte-Greenville-Atlanta) to create a thriving tech-based regional economy that the "golden triangle" of Texas (Dallas-Austin-San Antonio-Houston) has in the South-Central region."
- "Robotics and predictive analytics are the future of manufacturing, and South Carolina needs to shift towards more manufacturing innovation."
- "Our mission should be to have the world's best companies, talent, and entrepreneurs."

Why It Is Important to the S&T Plan: Science- and technology-intensive companies (high-tech companies, for short) are those characterized by higher R&D intensities and higher concentrations of STEM workers.[11] (See Appendix Table 2) They span software, computer systems design, data processing, scientific R&D services, chemicals, biotech and pharmaceuticals, medical devices, computer and electrical equipment, aerospace, and other advanced manufacturing. These industries are important to South Carolina's economy because they leverage national and international markets, tend to be higher-growth and more resilient to economic downturns, and pay higher average salaries compared to non-high-tech industries. They are the industry sectors fueling global economic growth today and into the foreseeable future.

11 High-tech or science- and technology-intensive industries include computers and electronics; chemicals and materials; pharmaceuticals and medical devices; machinery; automotive vehicles; and aerospace on the manufacturing side, and IT and information services; software publishing; and scientific R&D on the services side.

Challenges and Opportunities Addressed:

1. Strategic investment and growth in South Carolina's advanced manufacturing sector has transformed portions of the state's economy and raised incomes. Today, **manufacturing (which ranges from food and beverage to automotive) is South Carolina's largest private-industry sector** (measured by employment and output) and is the only one of the top two industries whose average salary ($61,000) exceeds the state average private sector salary of $49,000.[12]

2. **South Carolina ranks 28th nationally with employment in high-tech companies accounting for 10.6% of total employment compared to 12.1% nationally.**[13] Increasing the number of companies and share employment in science- and technology-intensive industries over the next five to seven years will raise per capita incomes.

3. In 2020 and 2021, **SC Commerce successfully supported recruitment and expansion of several high-tech companies**, such as Telus International (technology), T-Mobile, Techtronic Industries (power electronics manufacturer of AEG and Ryobi), Pall Corporation (filtration and purification solutions), Nephron Pharmaceuticals, and Arthrex (orthopedics).[14]

4. **South Carolina is a small state of 5.2 million people.** Ensuring the availability of technical workforce and trained scientists and engineers is paramount to future tech-based economic growth.

Goals and Actions

As South Carolina's economic development agency, SC Commerce sets the strategic direction for company recruitment and retention efforts regarding target industries in the state. Because SC Commerce is currently engaged in its own strategic planning process, the goals in this section will be expanded or will become more defined when this process is complete.

Goal 1: Stakeholders work with state, regional, and local EDOs in ongoing efforts to recruit and retain high-tech companies (aiming for parity with high-tech sector's share of total employment nationally).

- Action 1.1 Stakeholders (spanning industry, higher education, and local EDOs) contribute their respective industry and domain expertise, as requested, to SC Commerce-led recruitment and retention efforts.
- Action 1.2: Local and regional stakeholders complement the recruitment of companies by parallel efforts to support new high-growth startups.

Goal 2: Stakeholders regularly and consistently serve as a resource to SC Commerce providing ideas and input into potential new programming or initiatives.

- Action 2.1 Stakeholders build on existing initiatives to connect corporate leaders, entrepreneurs, and faculty with a track record of working with companies around technology development opportunities and needs. This network can be tapped as a resource by SC Commerce.

12 The annual salary for manufacturing is $61,779 compared to $31,413 for retail trade.
13 https://ncses.nsf.gov/indicators/states/indicator/high-set-employment-to-total-employment
14 South Carolina Department of Commerce. 2020 and 2021 Recruitment Overview.
https://www.sccommerce.com/sites/default/files/2022-01/2021RecruitmentOverview_FINAL_0.pdf
https://www.sccommerce.com/sites/default/files/2021-01/2020_Year_End_Report_FINAL.pdf

Vision: Entrepreneurs, companies, and investors look to South Carolina as a vibrant ecosystem for startups at the forefront of technology, ranging from materials and medtech to software and robotics. This thriving ecosystem spurs more private investment and attracts Fortune 1000 companies through M&A activity.

Innovation and Entrepreneurship

Stakeholder Observations:

- "As a state, we are good at recruiting manufacturing companies. Now we need to create more incentives and infrastructure for small, tech-based companies—e.g., Series A and B-stage companies."
- "We are seeing significant growth in deal flow, particularly in cyber security, real estate, fintech, and insuretech, as well as the life science sectors (therapeutics, medtech, and care management)."
- "South Carolina needs more risk capital and a larger number of venture capital (VC) firms with relevant industry expertise. For example, because of the lack of an existing industry base, South Carolina has fewer VC firms that focus on the life science, although there are VC firms, like Good Growth Capital and Cultivation Capital, that invest in healthcare and life sciences companies as part of their overall portfolio."
- "South Carolina is a small state. A single sponsored-research/intellectual property template that works across academic institutions would encourage more industry-university collaboration and tech transfer."
- "South Carolina is working to support more biotech startup activity, but there is very limited wet lab space for growth-stage biotech companies. This is different from incubator space."

Why It Is Important to the S&T Plan: Innovation—the introduction of new or improved products and processes to the market—drives corporate revenue growth and industry competitiveness. New companies are launched to commercialize new products, and existing companies invest in innovation internally (through business R&D expenditures) and externally (through M&A activity, open innovation, and licensing). In dynamic innovation and startup ecosystems, existing companies and industries benefit from working with startups to test and experiment with new technologies and business processes without internal disruption to ongoing operations.

Challenges and Opportunities Addressed:

1. Nationally, businesses account for 75% of total R&D activity, and business R&D intensity is highly correlated with innovation activity. **South Carolina's business R&D expenditures as a percentage of private-industry sector output (0.85%) is significantly below the national average (2.12%).**[15] South Carolina has a smaller number of companies that perform R&D relative to the total size of its industry base.

2. Industries in the U.S. that report the highest levels of R&D and highest R&D intensity are concentrated in manufacturing (e.g., pharmaceuticals, computers and electronics, and transportation equipment) and knowledge-intensive services (software publishing, scientific R&D services, and computer systems design).[16] **South Carolina ranks 26th in its number of patent assignees with the highest concentration of patenting companies in electrical engineering and energy, medical technology, and handling technologies.**[17]

3. **Pre-COVID, South Carolina ranked 39th in venture capital investment relative to the size of its economy**, although the value of this indicator varies significantly with the addition or subtraction of a few large deals. Information Technology (IT, 31%), Business-to-Consumer (B2C, 26%), and Healthcare (25%) are the largest technology sectors in terms of total number of deals representing 82% of all deals from 2016-2020. South Carolina **needs more venture-backed companies and later-stage investments** to increase its ranking, although Pitchbook data indicates that 2021 was South Carolina's strongest year yet.[18]

4. South Carolina needs more mentors and connectors in its ecosystem, since it has many **first-time entrepreneurs, a small number of existing companies that perform R&D, and a small number of local VC firms** (which bring industry-specific knowledge, networks, and capital).

5. **South Carolina companies doubled their federal Small Business Innovation Research/Small Business Technology Transfer (SBIR/STTR) Phase 1 awards over the past five years (growing from 14 to 30 awards from 2015-2020).** Increasing the number of Phase 2 awards will advance South Carolina's national ranking, since Phase 2 awards are much larger. Phase 2 awards require a strong commercialization plan.

15 National Science Board (2021). "Business-Performed R&D as a Percentage of Private-Industry Output." Science and Engineering Indicators: State Indicators. https://ncses.nsf.gov/indicators/states/indicator/business-performed-rd-to-private-industry-output

16 National Science Board (2020). "Industries that perform the most U.S. Business R&D," U.S. Business R&D: Key Characteristics of Domestic Business R&D Performance, Science & Engineering Indicators. https://ncses.nsf.gov/pubs/nsb20203/u-s-business-r-d

17 Examples of leading South Carolina patent assignees in these categories include Sensor Electronic Technology, Milliken, AFL Telecommunications, Sonoco Development, AVX Corporation, KEMET Electronics, Poly-Med, DeGen Medical, in addition to universities and Savannah River National Lab.

18 South Carolina is likely to move up in the National Science Foundation State Indicators on the Venture Capital per Million Dollars of GDP indicator.

Goals and Actions

Goal 1: Increase the 3-year rolling average of South Carolina VC deals (i.e., seed-stage, early-stage, and later-stage VC investment rounds in South Carolina companies) by 50 VC deals/year over the next five to seven years and achieve 25 successful exits.

- Action 1.1 Recruit serial entrepreneurs by leveraging South Carolina's reputation as a great place to live and work.
- Action 1.2 Expand startup mentoring by increasing the network of retirees who have startup and industry experience.
- Action 1.3 Invest in pre-seed, seed-stage, and growth-stage incubators and accelerators including local, regional, national, and global organizations.[19]
- Action 1.4 Support programming to connect inventors/technologists, entrepreneurs, and investors through tech fairs, business-to-business (B2B) matchmaking, and investor forums and facilitate productive interactions.

Goal 2: Increase the three-year rolling average of SC VC investment to $200 million/year over the next five to seven years.

- Action 2.1 Successfully implement the U.S. Treasury State Small Business Credit Initiative to create new VC funds and expand existing funds.
- Action 2.2 Improve policies and incentives for angel and other investments.
- Action 2.3 Actively and strategically promote South Carolina startup successes to generate more "buzz" and attract more private investors.
- Action 2.4 Actively engage with corporate venture capital funds and large VC funds.

Goal 3: Continue to develop vibrant, inclusive, and engaged entrepreneurial ecosystems (local, regional, and state) that is connected to national and international markets.

- Action 3.1 Create a task force comprised of entrepreneurs, angel investors, venture development organizations, VC investors, and corporate technology scouts/corporate VC investors of companies with a manufacturing presence in South Carolina (even if the individuals are located elsewhere) to advise the South Carolina Department of Commerce, SCRA, and others on startup ecosystem development and capital strategy.
- Action 3.2 Invest in entrepreneurial ecosystem infrastructure, such as buildings for growth-stage companies near universities and broadband in rural and non-served urban areas.
- Action 3.3 Engage diverse cohorts of students across different institutions for pitch competitions, entrepreneurial education, internships/co-ops at startups, and connections to existing startups in the community.
- Action 3.4 Hold industry challenges and innovation think tank events, such as hackathons and codeathons. These events can be designed for many kinds of industries to promote innovation and larger-scale problem solving.

19 Examples include the Minority Business Accelerators being run by the Chambers of Commerce in Charleston, Columbia, and Greenville and a recent Techstars Startup Weekend in Beaufort. SCRA has provided financial and other support to NEXT in Greenville, Harbor Accelerator in Charleston, Growco in Columbia, Gravity Center in Rock Hill, and the Minority Business Accelerators.

Vision: South Carolina's academic research competitiveness and stature grows in high-priority research fields, from AI and machine learning to precision biology, by investing in top talent and research infrastructure and winning major federal research center awards. Strong university-industry research collaboration supports greater business R&D and innovation.

Research Competitiveness

Stakeholder Observations:

- "South Carolina needs to pursue and win a major federal research center award (e.g., Science & Technology Center, Engineering Research Center, etc.)."
- "We need to continue to expand our STEM research programs, but a key bottleneck is the deferred maintenance, renovation, and construction of new STEM buildings at South Carolina universities to accommodate growth."
- "From a national competitiveness perspective, South Carolina is behind in AI applications to health research. Grants like EPSCoR can help us advance."
- "For HBCUs and primarily undergraduate institutions (PUIs), we need significant investments in faculty hires and research labs to prepare undergraduate students for STEM graduate programs."
- "The Savannah River National Lab award to Battelle, USC, Clemson, and South Carolina State University (SCSU) is a big opportunity for the state. It will bring new researchers with joint appointments in higher education institutions, similar to University of Tennessee, Knoxville and Oak Ridge National Lab."

Why It Is Important to the S&T Plan: Advances in science and technology create opportunities and challenges for companies, industries, and workers. As everything from cars to medical devices become more computer than machine, South Carolina needs to expand research capacity in fields that are currently underrepresented in its R&D portfolio, such as computer science, and apply these new digital and computational tools to areas where South Carolina has research strengths, such as engineering and life sciences.[20]

20 The industrial internet of things company, BrainCube, provides a good discussion of "AI vs. Machine Learning vs. Data Science for Industry," https://braincube.com/resource/manufacturing-ai-vs-machine-learning-vs-data-science/.

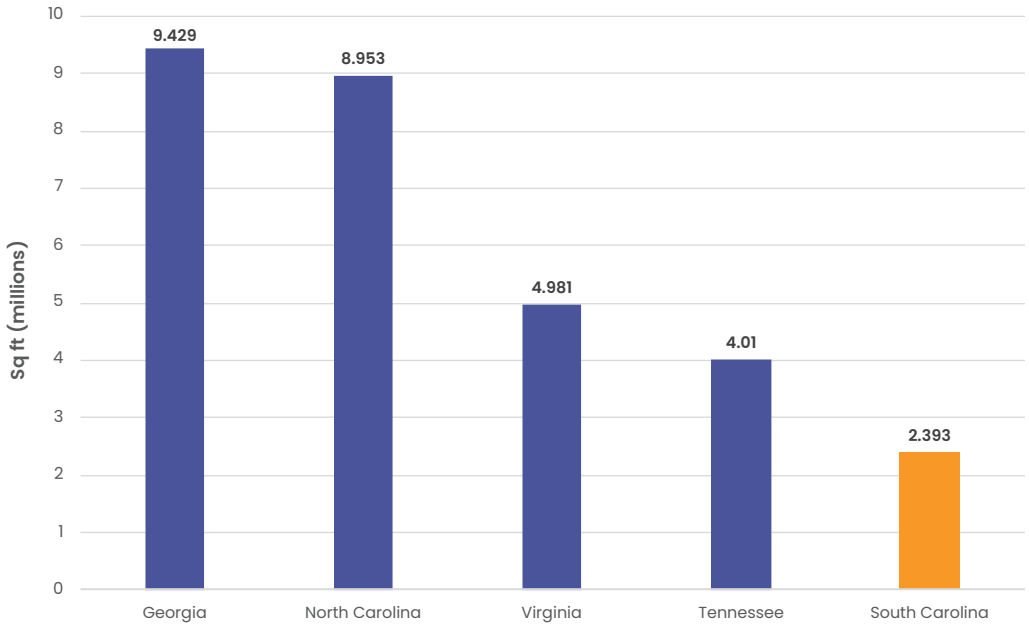
Challenges and Opportunities Addressed:

1. **South Carolina ranks 36th for higher education S&E R&D expenditures relative to the size of its economy. South Carolina S&E R&D expenditures grew more slowly than the U.S. average** over the last five years (2.7% CAGR vs 4.6% CAGR from 2015-2020).[21]

2. Looking across science and engineering (S&E) fields, South Carolina's **higher education R&D is most concentrated in Life Sciences R&D** (69% in South Carolina vs 61% nationally) **and Engineering R&D** (19% in South Carolina vs 17% nationally). **Computer Science R&D is underrepresented** at 2% of SC S&E R&D compared to 4% nationally.

3. **South Carolina ranks 31st nationally in academic research space** measured in millions of square feet. Georgia and North Carolina rank in the top 10 in this metric, and Virginia and Tennessee rank in the top 20. This metric does not capture the quality of the space and equipment, which is also important for research. The four benchmark states, as well as many other states with leading public research universities, use bonds to finance higher education capital projects. South Carolina is an outlier in not having passed a bond bill.

Figure 7. Total Academic Research Space, 2019



Source: National Center for Science and Engineering Statistics, Survey of Science and Engineering Research Facilities

21 South Carolina S&E R&D expenditures have also grown more slowly than other EPSCOR states, such as Alabama (5.0% CAGR from 2015-2020), Nebraska (4.6%), Kentucky (4.2%), Louisiana (3.9%).

Goals and Actions

Goal 1: Invest in research facilities and infrastructure (e.g., $200 million/year for five years) to support faculty recruitment and retention and growth in STEM enrollment.

- Action 2.1 Assess and make a list of high-priority capital projects needed to support faculty recruitment and retention and growth in STEM research activities and enrollment.
- Action 2.2 Benchmark levels of investment that neighboring states are making in STEM academic buildings and research infrastructure and financing mechanism, e.g., state bonds.
- Action 2.3 Develop a financing model (e.g., higher education capital projects bond bill) for investing in research infrastructure and facilities as part of the state's tech-based economic development strategy.

Goal 2: Increase the number of nationally recognized faculty in high-priority research areas who have a track record for bringing in research dollars, working with industry, and developing new technologies.

- Action 2.1 Develop and recruit faculty who are at the top of their fields in research aligned to target industries
- Action 2.2 Assess the strengths and weaknesses of past state programs (e.g., the 2002 SmartState Program, the 2004 Research University Infrastructure Act, etc.) and identify criteria needed to incentivize and reward success in bringing in major federal grants or center awards, building strong R&D collaborations with industry, and commercializing new technologies
- Action 2.3 Assess other models for supporting high-performing faculty (future National Academies members) who can pursue and win major federal research awards aligned to target industries. Examples of other states who have developed these models include Georgia, North Carolina, Texas, and Utah.

Goal 3: Increase the growth rate of S&E R&D expenditures in high-priority research fields at a rate closer to the U.S. growth rate over the next five to seven years.

- Action 3.1 Invest in and empower university leaders who know how to compete and win research funding on a national and international level. Successful implementation will likely require action on Goals 2 and 3.
- Action 3.2 Increase the number of graduate students and post docs by 25% to support research activity.
- Action 3.3 Develop streamlined teams to effectively compete for major center grants from the National Science Foundation, Department of Energy, Department of Defense, and National Institutes of Health.

Vision: South Carolina investments establish the Palmetto State as a leader in K-20 STEM education and increase the diversity and representation of graduates in STEM fields. South Carolina students are inspired and prepared to make an impact in the world by pursuing STEM majors and acquiring the technical and critical thinking skills needed by companies.

K-20 STEM Education

Stakeholder Observations:

- "Our laboratory goals and commitments to our customers require that we have the best people applying their skills across a range of technical competencies, operations, and business support areas. Recruiting and retaining high-quality talent is a priority as we pursue excellence in meeting our evolving mission and focus areas."
- "High school preparation is not where it needs to be for students to pursue S&E majors. Math preparation is weak, and Calculus is a stumbling block."
- "Middle school and high school education is too technical without providing applied problem solving. Students need to create muscle memory by solving problems—not just reading how to solve a problem."
- "In South Carolina, teachers are underpaid, and many K-12 science teachers are teaching out of field."
- "We need to make sure short-term credentials (e.g., certificates, associate degrees) do not supplant the option for a higher educational trajectory."
- "You can recruit the best 10% in any underrepresented population, but you can't move the needle without reaching the middle 50-60%."

Why It Is Important to the S&T Plan: Future growth of science- and technology-intensive companies and industries in South Carolina requires workers with S&E degrees (associate through doctoral level), especially computer science, engineering, and data science, in addition to physical and life sciences degrees. This requires strong K-20 STEM education, including applied experiences, for all South Carolinians to ensure a robust workforce talent pipeline.

Challenges and Opportunities Addressed:

1. **Nontraditional students, including "adult learners," "near completers," and "career changers," present a good opportunity to increase STEM degree attainment in South Carolina.**

2. **The CAGR of South Carolina engineering degrees conferred (all levels, associates through PhDs) exceeded U.S. growth over the past 10 years.** This likely reflects the strong demand from South Carolina manufacturing companies and expansion of programs by South Carolina higher education institutions.

3. **Women and people of color are underrepresented in STEM majors and degrees awarded in South Carolina relative to demographic representation in the state.**
   - Women represent 51.6% of South Carolina's population, but only 22% of engineering bachelor's degrees and 29% of math and computer science bachelor's degrees.[22]
   - African Americans represent 27% of South Carolina's population, but only 6% of engineering bachelor's degrees and 15.5% of math and computer science bachelor's degrees.[23]
   - Retention of underrepresented populations in STEM majors and matriculation of STEM undergraduates to graduate programs is a key challenge noted in interviews.

4. **South Carolina has six HBCUs, the largest number per capita in the country.** They include a mix of public and private institutions and require investment in STEM programs.

5. **South Carolina ranks 39th nationally on 8th grade Math NAEP test scores.** Math proficiency is a strong predictor of the pursuit and retention of undergraduate STEM majors.

6. **South Carolina needs more highly qualified math and science teachers.**
   - Math and science teacher vacancies represent 21.5% of 938 vacant teaching positions in 2021-2022.[24]
   - One in 10 low-income students in Title I schools are taught by an out-of-field teacher in Mathematics, English, and Science, and one in five students is taught by an inexperienced teacher.[25] The same approximate ratios hold for students of color in Title 1 schools.

Table 4. Engineering Degrees Conferred by SC Higher Education Institutions by Level, 2008-19

ENGINEERING DEGREES	SOUTH CAROLINA			U.S.
	2008	2019	CAGR (%)	CAGR (%)
Associates in Engineering Technologies	340	518	3.9%	-1.1%
Bachelors	726	1,106	7.8%	5.7%
Masters	229	455	6.4%	4.3%
PhD	92	131	3.3%	3.1%

Source: National Center for Education Statistics, IPEDS Completions Survey

22 National Center for Education Statistics, Integrated Postsecondary Education Data System Completions (IPEDS) Survey.
23 Ibid
24 117 teaching vacancies in Mathematics (grades 6-12) and 85 is Science (grades 6-12) in 2021-22. See 2021-22_supply_demand_report__1_.pdf (cerra.org)
25 South Carolina Department of Education. "Access to Educators Report," December 21, 2018. https://ed.sc.gov/sites/scdoe/assets/File/policy/federal-education-programs/Title%20II/IOIReport-Final.pdf

Goals and Actions

Goal 1. Improve the quality of K-12 STEM education (improve South Carolina's score and ranking on Math NAEP).

- Action 1.1 Increase teacher salaries (currently, the minimum starting salary for new teachers is $36,000 and the average teacher salary is $53,000 overall), to be more competitive with other professions and other states.[26] The South Carolina legislature is currently considering raising the minimum starting salary to $40,000.[27] Increasing salaries for math and science teachers specifically should also be considered. Alabama recently enacted legislation to pay well-trained and educated math and science teachers up to $15,000 in additional pay each year.[28]
- Action 1.2 Provide tuition reimbursement for newly certified math and science teachers who agree to teach in Title 1 schools and provide salary support for those completing Master's degree programs in STEM-related subjects (e.g., Noyce Scholars Tracks 1-2)
- Action 1.3 Improve South Carolina early childhood math instruction and student math scores through the provision of comprehensive and sustained professional learning support by reconstituting a state program to provide instructional coaches in mathematics and science and measuring outcomes.

Goal 2. Inspire and attract a large and diverse number of K-12 students to STEM by increasing the share of Title 1 school participants in the South Carolina Junior Academy of Sciences (SCJAS) to 10% .

- Action 2.1 Support outreach and support for Title 1 school participation in the SCJAS through coaching, subsidized transportation costs, and hybrid formats
- Action 2.2 Support public-private partnerships among state agencies, not-for-profits, universities, and K-12 school districts to develop a more systematic approach to offer hands-on research and technology experiences and internships for students and faculty.
- Action 2.3 Request regional or state South Carolina industry council efforts to increase employee visits to South Carolina classrooms and participation in events to raise awareness about STEM jobs and careers

Goal 3. Increase the number and share of women and people of color graduating with postsecondary STEM degrees.

- Action 3.1 Increase the diversity of science and engineering faculty at South Carolina's comprehensive research universities in computer science, engineering, data science, etc.
- Action 3.2 Increase investment in STEM programs at HBCUs which represent a mix of public and private institutions.
- Action 3.3 Continue to pursue federal funding aimed at increasing diversity in S&E degree postsecondary programs, e.g., NSF Inclusion across the Nation of Communities of Learners of Underrepresented Discoverers in Engineering and Science (NSF INCLUDES), Louis Stokes South Carolina Alliance for Minority Participation (LS-SCAMP), and NSF Bridge to the Doctorate grants.
- Action 3.4 Host events that connect high school and college students to industry executives and academic leaders that celebrate and elevate the need for women and people of color in STEM careers, e.g., Men of Color National Summit and the Ernest E. Just Symposium.
- Action 3.5 Increase support for preparatory programs for students entering associates and bachelors-level institutions who are focused on STEM degrees. (These should not be framed as remedial or bridge programs, rather preparatory programs designed to bring all entering students to a common level of preparation).

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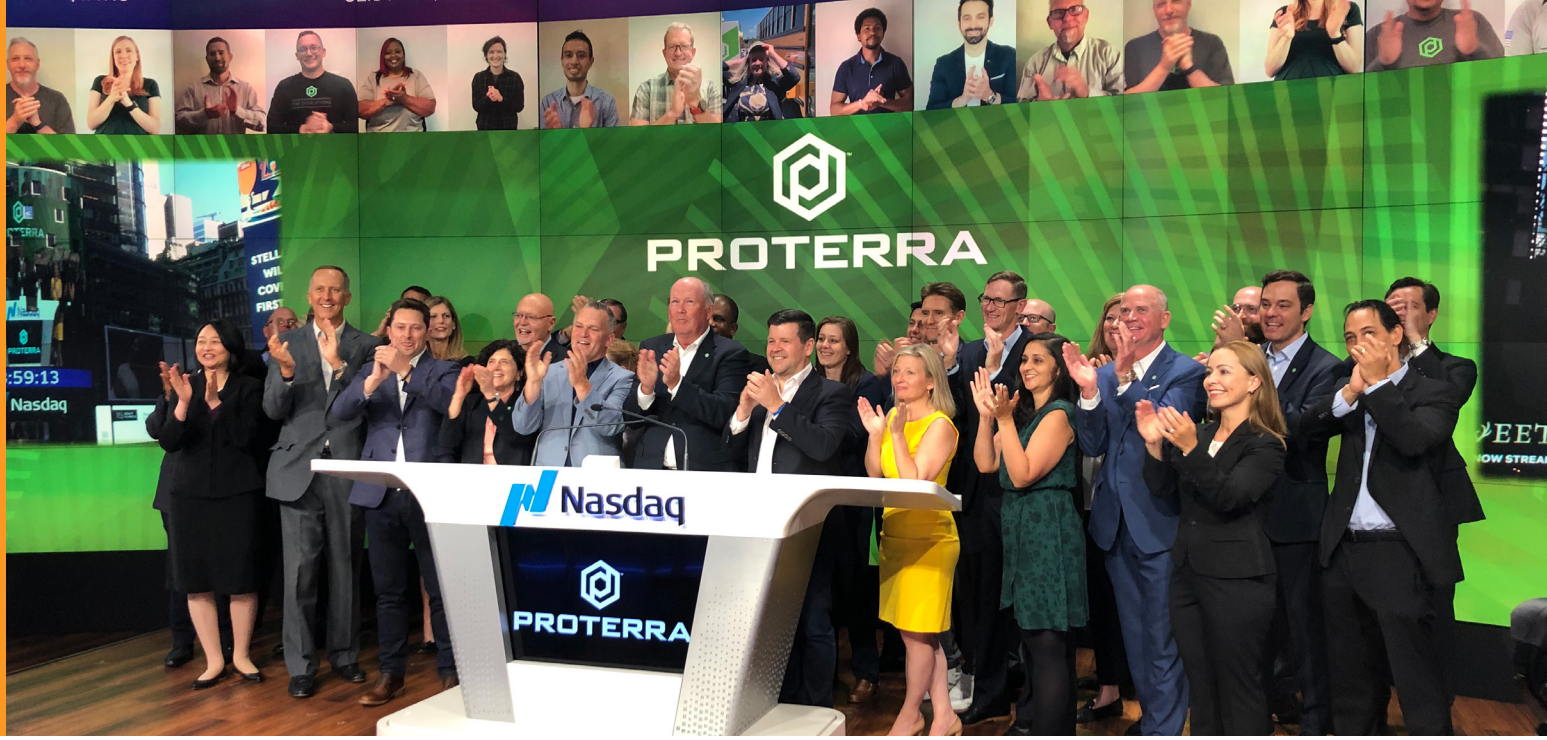
26 Bustos, Joseph (2022). "SC teachers should earn at least $40K a year, state superintendent says," The State, 26 January 2022. https://www.thestate.com/news/politics-government/article257733538.html

27 Bustos, Joseph (2022). "Will new SC teachers get $38K or $40K? Competing plans face off as teachers push for more," The State, 2 May 2022. https://www.thestate.com/news/politics-government/article260765052.html

28 https://governor.alabama.gov/newsroom/2021/05/governor-kay-ivey-signs-teacher-excellence-and-accountability-for-mathematics-and-sciences-teams-salary-schedule-program/



Goal 4. Increase the number of partnerships between major research universities and PUIs, especially HBCUs, to pursue federal grants and strengthen research experiences and alignment of STEM curricula with that of graduate programs.

- Action 4.1 Host a one-day working meeting to bring together diversity, equity, and inclusion champions at the three major research universities and faculty at HBCUs to share current and past models that have been successful in improving 3+2 curriculum alignment and research experiences for STEM undergraduates at HBCUs. Provide time for faculty to meet 1:1 (by similar research interest/ domain expertise or by type of federal funding program) to discuss collaboration opportunities.
- Action 4.2 At a second half-day meeting, finalize faculty teams that will partner to pursue funding opportunities to support collaboration activities.
- Action 4.3 Set outcome metrics for this goal such as number of teams and proposals submitted, projects awarded, and student outcomes in terms of retention in STEM majors and continuation to graduate programs.
- Action 4.4 Establish STEM student and faculty exchange programs and partnerships between comprehensive research universities and HBCUs in South Carolina.

Goals, Metrics, and Baseline

This section presents the S&T Plan goals and metrics against a representative baseline to track South Carolina's performance over the next five to seven years. Moving the needle on many of these goals will require continued public-private attention, coordinated efforts, and investment, because South Carolina is a $215 billion economy with 5 million people. Effecting change at the macro level will require scaling up effective programs and practices that may have originated at the institutional or community level.

GOALS	METRICS	BASELINE
High-Tech Industry Growth		
1. Stakeholders work with state, regional, and local EDOs in on-going efforts to recruit and retain high-tech companies (aiming for parity with the high-tech sector's share of total employment nationally)	• # of high-tech companies recruited and retained (# of expansion projects) in SC • High-tech sector share of private sector employment	• SC high-tech share of total employment is 10.6% vs. 12.1% nationally, via NSF definition
2. Stakeholders regularly and consistently serve as a resource to SC Commerce providing ideas and input into potential new programming or initiatives	• Participation in meetings and advisory panels, as requested by SC Commerce	• Good collaboration from stakeholders on requests for input, information, and participation in recruitment efforts
Innovation & Entrepreneurship		
3. Increase 3-year rolling average of SC VC deals to 50/year and achieve 25 successful exits	• # of venture-backed companies • # of exits (M&A, IPO, etc.)	• 3-year rolling avg of 42.0 deals (2017-19), 39.7 deals/year (2019-21) • 5-year total of 12 exits (2017-2021), 7-year total of 20 exits (2015-2021)
4. Increase the 3-year rolling average of SC VC investment (seed, early-stage VC, later-stage VC) to $200M/year	• Amount of SSBCI funds awarded for equity investment • # and size of new and expanded VC funds capitalized	• SC ranks 39th in VC investment relative to size of its economy • 3-year rolling avg of $120.4M in VC investment (2017-19), $170.4M (2019-21) • 9 VC firms with SC offices, 2 angel groups

5. Continue to develop vibrant, inclusive, engaged entrepreneurial ecosystems (local, regional, state) connected to national and international markets	• Creation of advisory panel to suggest ideas and test potential new program or initiative concepts:
	  • Startup and VC policies and incentives
	  • Physical infrastructure
	  • Innovation and entrepreneurship in K-20
	  • Etc.
	• Launch of national accelerator program (e.g., gener8tor) in SC
		• SC Commerce has engaged in formal innovation planning since 2013 and runs the Relentless Challenge grant program
		• SCRA Programs and Grants
		• Multiple local efforts (e.g., NEXT, MIT Venture Mentor, Harbor Entrepreneurial Center, Growco, Gravity Center, Minority Business Accelerators)

Research Competitiveness		
1. Invest in research facilities and infrastructure to support faculty recruitment and retention and expand STEM enrollment (e.g., $200M/year for 5 years)	• Develop list of high-priority capital projects to determine investment required • Pass Bond Bill to provide a financing mechanism (or an alternative solutions)	• Georgia, North Carolina, Tennessee, Virginia, Texas, Indiana, etc., use bonds to finance capital projects for higher education institutions • Competitor states have significantly more research space (sq ft)
2. Increase the number of nationally recognized faculty • Develop and recruit faculty who are at the top of their fields in research aligned to target industries	• # of faculty winning major federal research grants and center awards, working with industry, licensing technology (future National Academy members) • Amount of federal research funding generated	• SC has invested in the SmartState program and others, in the past, aimed at increasing R&D stature

3. Increase growth rate of S&E R&D expenditures in high-priority research areas at a rate closer to the U.S. growth rate (4.6% CAGR) over the next 5-7 years
• Increase # of graduate students and post-docs by 25%
• Win one major federal research center award (e.g., NSF Engineering Research Center)
	• S&E R&D expenditures (NSF Higher Education R&D Survey)
	  • # of graduate students and post-docs
	  • # of major federal research center awards
		• SC S&E R&D grew 2.7% CAGR vs. U.S. 4.6% CAGR from 2015-2020

GOALS	METRICS	BASELINE
K-20 STEM Education		
1. Improve the quality of K-12 STEM education (increase ranking on Math and Science NAEP) • Reconstitute math and science instructional coaches with goal of 150 coaches by year 5 2. Raise SC average Math and Science teacher salaries to national average 3. Reduce SC number of low-income students taught by out-of-field Math and Science teachers to well below 10%	• SC scores on math and science NAEP • Entry-level and average salary for SC teachers vis-à-vis other states • Number of out-of-field math and science teachers • # of math and science instructional coaches/year and # of Title 1 schools served	• SC ranks 39th on 8th grade Math NAEP • The starting average salary for new teachers is $36,00 and for all teachers is $53,000 overall • 1 in 5 low-income students taught by an inexperienced teach in English, Math or Science; 1 in 10 low-income students taught by an out-of-field teacher • No math and science instructional coaches program currently
4. Inspire and attract a large and diverse number of K-12 students to STEM by increasing share of Title 1 schools participating in SCJAS to 10%	• # of Title 1 schools and students participating in SCJAS	• Title 1 schools currently account for 5% of total participating schools in the SCJAS
5. Increase the number and share of women and people of color graduating with postsecondary STEM degrees	• # of women and people of color in STEM, especially engineering, computer science, physical sciences	• Women: 51.6% of SC population, but 22% of engineering bachelor's degrees and 29% of math and computer science bachelor's degrees • African Americans: 27% of SC population, but 6% of engineering bachelor's degrees and 15.5% of math and computer science bachelor's degrees
6. Increase the number of partnerships between major research universities and PUIs, especially HBCUs, to pursue federal grants that strengthen research experiences and alignment of STEM curricula with graduate programs	• # of faculty, # of institutions participating • # and value of proposals submitted and won, awarding federal agency, STEM field	• MUSC, Clemson, and USC have at least one major research partnership with HBCUs currently, but there is an opportunity to scale up

Appendix

List of Contributing Stakeholders

South Carolina EPSCoR State Committee

Mark Barnes, PhD, Deputy Associate Laboratory Director, Science, Engineering and Energy, Savannah River National Laboratory

Ken Deans, Jr., President and CEO, Health Sciences South Carolina

James J. Doolittle, PhD, Director, South Carolina Established Program to Stimulate Competitive Research, South Carolina Research Authority

Tanju Karanfil, PhD, Vice President for Research, Clemson University

Elbert Malone, PhD, Associate Provost for Sponsored Programs and Research, South Carolina State University

Michael Matthews, PhD, State Committee Chair, Associate Vice President for Research, and Senior Associate Dean for Research & Graduate Programs in the College of Engineering & Computing, University of South Carolina

Godwin Mbamalu, PhD, FAIC, Associate Vice President for Research, Distinguished Professor of Chemistry, Benedict College

Lori McMahon, PhD, Vice President for Research, Medical University of South Carolina

Prakash Nagarkatti, PhD, Senior Research Advisor to the President, Vice President for Research Emeritus, University of South Carolina

Bob Quinn, Executive Director, South Carolina Research Authority

Susie Shannon, President and CEO, South Carolina Council on Competitiveness

Kelly Steinhilper, Vice President of Communications, South Carolina Technical College System

John Wheeler, PhD, Associate Provost for Integrative Science, Professor of Chemistry, Furman University

Federal Facilities

Liz Hoffman, PhD, Director, Office of Innovation and University Engagement, Savannah River National Laboratory

Michael Merriken, Manager, Technology Transfer Office, Naval Warfare Information Center

Higher Education Administrators

Chad Hardaway, Director, Technology Commercialization Office, University of South Carolina

Lee Gill, JD, Chief Diversity Officer and Special Assistant to the President for Inclusive Excellence, Clemson University

Jesse Goodwin, PhD, Chief Innovation Officer, Medical University of South Carolina

William Kirkland, Executive Director, Office of Economic Engagement, University of South Carolina

Angela Leidinger, Vice President for External Affairs and Senior Advisor to the Board of Trustees, Clemson University

Susan Anderson Rivaleau, PhD, Assistant Vice President for Research, Director, Office of Research & Grants Administration, College of Charleston

Regine Rucker, Program Manager, Academic Affairs, South Carolina Commission on Higher Education

Higher Education Faculty

Caitlin Allen, PhD, MPH, Assistant Professor of Public Health Sciences, Medical University of South Carolina

Marc Birtwistle, PhD, Associate Professor of Chemical and Biomolecular Engineering and Bioengineering, Clemson University

Raj Bordia, PhD, Chair and Professor of Ceramics and Materials Engineering, Clemson University

Frank Chen, PhD, Associate Chair and Undergraduate Director, Professor of Mechanical Engineering, University of South Carolina

Mashrur "Ronnie" Chowdhury, Professor of Automotive Engineering, Civil Engineering, Computer Science, Director, USDOT, Co-Director Complex Systems, Analytics, and Visualization Institute, Clemson University

Brian Dean, PhD, Professor and Chair, Computer Science Division, Biomedical Data Science Masters and PhD Coordinator, Clemson University

Bert Ely, PhD, Professor and Director for Science Education, University of South Carolina

Stephen Foulger, PhD, Endowed Chair and Professor of Materials Science and Engineering, Clemson University

Bruce Gao, PhD, Professor and Endowed Chair of Biofabrication Engineering, Clemson University

Herb Ginn, PhD, Professor of Electrical Engineering, University of South Carolina

Ramy Harik, PhD, Associate Professor of Mechanical Engineering, University of South Carolina

Dan Judge, MD, Professor of Cardiology, Medical University of South Carolina

Katie Kathrein, PhD, Assistant Professor of Biological Sciences, University of South Carolina

Polinho Freeman Katina, PhD, Assistant Professor of Informatics and Engineering Systems, University of South Carolina Upstate

John Kaup, PhD, Director of Science Education, Furman University

Martine LaBerge, PhD, Professor and Chair of Bioengineering, Clemson University

Jessica Larsen, PhD, Dean's Assistant Professor of Chemical and Biomolecular Engineering, Clemson University

Jochen Lauterbach, PhD, Professor of Chemical Engineering, Endowed Chair, Center for Strategic Approaches to the Generation of Electricity, University of South Carolina

Christine Lotter, PhD, Professor of Science Education, PhD, University of South Carolina

Karina Liles, PhD, Interim Chair and Professor of Mathematics and Computer Science, Claflin University

Chang Liu, PhD, Assistant Professor of Chemical Engineering and Biomedical Engineering, University of South Carolina

Renee Lyons, PhD, Director of Science Education Outreach, Clemson University

Lane Mears, PhD, Assistant Professor of Automotive Engineering, Clemson University

Jihad Obeid, MD, Co-Director of the Biomedical Informatics Center and Endowed Chair in Biomedical Informatics Center, Medical University of South Carolina

Cassandra Runyon, PhD, Director, SC NASA EPSCoR and Associate Professor of Planetary Geology, College of Charleston

Amit Sheth, PhD, Founding Director, Artificial Intelligence Institute, Professor of Computer Science and Engineering, University of South Carolina

Natalia Shustova, PhD, Professor of Chemistry, University of South Carolina

Linda Sinclair, PhD, Supervisor of Science Student Teachers, University of South Carolina

Varghese Vaidyan, PhD, Assistant Professor of Computer Science and Engineering, Benedict College

Homayoun Valafar, PhD, Professor; Associate Chair of Research, Associate Infrastructure Director, University of South Carolina

Kuang-Ching Wang, PhD, Professor of Electrical and Computer Engineering, Endowed Chair, Clemson University

Qi Wang, PhD, Professor of Mathematics, University of South Carolina

Yi Wang, PhD, Associate Professor of Mechanical Engineering, University of South Carolina

Michael Yost, PhD, Professor of Surgery and Bioengineering, Vice Chair for Research, Department of Surgery, Medical University of South Carolina

Industry

Gore Bolton, CEO and Founder, Land Intelligence

Benjamin David, PhD, Founder and CEO, ASSET

Jeff DiMaio, PhD, CEO, Tetramer

Peter Dunphy, Director, Finance and Distribution, Michelin Commercial Service Network

Tyrone Ellis, Aftermarket Engineering Leader, Americas, Trane Technologies

Clifford Holecamp, Co-Founder, Managing Director, and General Partner, Cultivation Capital

Ashley Holbrook, Chief of Staff, Government Operations, Boeing

Rick Johnson, Vice President of Corporate Development, CFO, Kyocera-AVX

Austin McCombs, Co-Founder and CEO, Gnosis Freight

Bryan Murdaugh, Co-Founder, Fivable

Scott Pancoast, CEO and Founder, Zylo Therapeutics

Shelly Waite Bey, Founder, Waite Secured Line Technology Solutions

Industry Development/Economic Development/Venture Development Organizations

Marc Drews, Vice President of Community and Governmental Relations, EdVenture Children's Museum

Cole Dudley, Director, Industry Solutions, South Carolina Research Authority

Erin Ford, Executive Vice President and Chief Operating Office, SC Bio

David Ginn, President and CEO, Charleston Regional Development Alliance

John Lummus, President and CEO, Upstate SC Alliance

Thomas Peters, Ed.D., Executive Director, South Carolina Coalition for Mathematics & Science

Michael Weeks, Director, Roper Mountain Science Center

Will Williams, President and CEO, Economic Development Partnership

State Government

Ben Kessler, former Clean Transportation Coordinator, Energy Office, South Carolina Office of Regulatory Staff

Julie Kunkle, Deputy Director, Business Services, South Carolina Department of Commerce

Laura McIntosh, former Managing Director, Office of Innovation, South Carolina Department of Commerce

Tia Nelson, former Business Intelligence Manager, Office of Innovation, South Carolina Department of Commerce

Catherine Reed, Deputy Director, Energy Office, South Carolina Office of Regulatory Staff

Ashely Teasdel, Deputy Secretary, South Carolina Department of Commerce

Definition of High-Tech Industries

Table 5. High Science, Engineering and Technology Industries

NAICS CODE	INDUSTRY
1131	Timber track operations
1132	Forest nurseries and gathering of forest products
2111	Oil and gas extraction
2211	Electric power generation, transmission, and distribution
3241	Petroleum and coal products manufacturing
3251	Basic chemical manufacturing
3252	Resin, synthetic rubber, and artificial synthetic fibers and filaments manufacturing
3253	Pesticide, fertilizer, and other agricultural chemical manufacturing
3254	Pharmaceutical and medicine manufacturing
3255	Paint, coating, and adhesive manufacturing
3259	Other chemical product and preparation manufacturing
3332	Industrial machinery manufacturing
3333	Commercial and service industry machinery manufacturing
3336	Engine, turbine, and power transmission equipment manufacturing
3339	Other general purpose machinery manufacturing
3341	Computer and peripheral equipment manufacturing
3342	Communications equipment manufacturing
3343	Audio and video equipment manufacturing
3344	Semiconductor and other electronic component manufacturing
3345	Navigational, measuring, electromedical, and control instruments manufacturing
3346	Manufacturing and reproducing magnetic and optical media
3353	Electrical equipment manufacturing
3364	Aerospace product and parts manufacturing
3369	Other transportation equipment manufacturing
4234	Professional and commercial equipment and supplies, merchant wholesalers
4861	Pipeline transportation of crude oil
4862	Pipeline transportation of natural gas
4869	Other pipeline transportation
5112	Software publishers
519130	Internet publishing and broadcasting and Web search portals
5171	Wired telecommunications carriers
5172	Wireless telecommunications carriers (except satellite)
5174	Satellite telecommunications

NAICS CODE	INDUSTRY
5179	Other telecommunications
na	Internet service providers and Web search portals
5182	Data processing, hosting, and related services
5211	Monetary authorities, central bank
5232	Securities and commodity exchanges
5413	Architectural, engineering, and related services
5415	Computer systems design and related services
5416	Management, scientific, and technical consulting services
5417	Scientific research and development services
5511	Management of companies and enterprises
5612	Facilities support services
561312	Executive search services
8112	Electronic and precision equipment repair and maintenance

Source: The NSF S&E Indicators use a modification of the approach employed by the Bureau of Labor Statistics (BLS; Hecker 2005), which identifies high-tech or science, engineering, and technology (SET) industries as those industries whose SET employment is double the average for all industries.

Data and Benchmarking

Figure A-1

South Carolina is a small, but rapidly growing state economy measured by real gross domestic product (GDP) and new business growth. This is reflected in the state's rankings moving in the right direction on most Milken Institute Index categories.

South Carolina Performance on Key Economic Indicators, 2014-2019

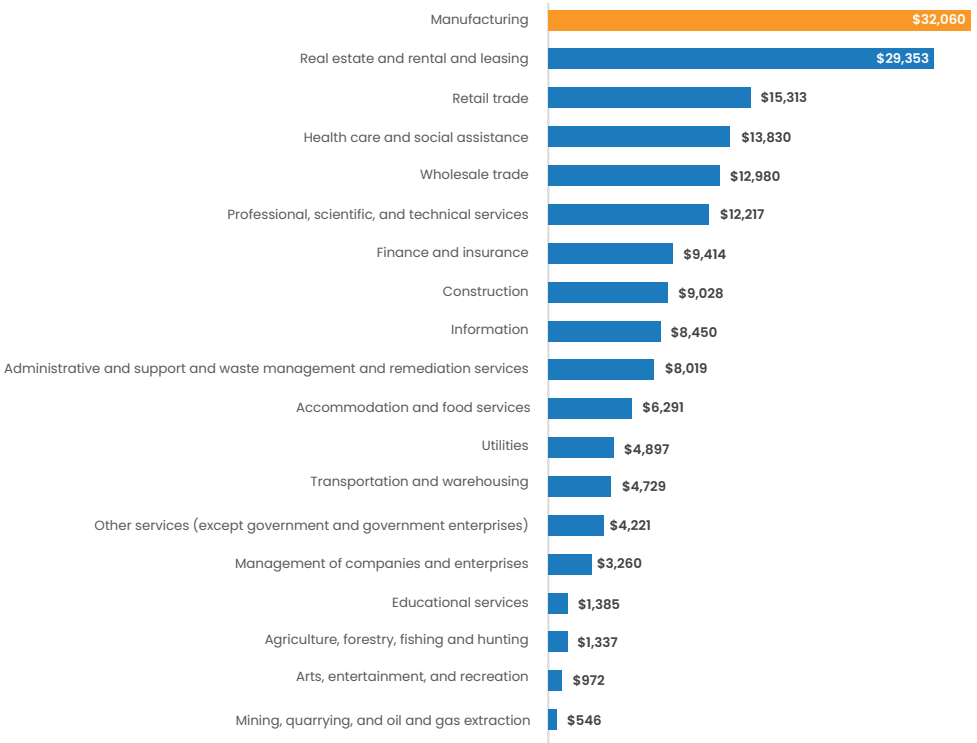
	2014	2016	2018	2020	TREND
R&D Inputs	43	40	40	40	+
Risk Capital and Entrepreneurial Infrastructure	28	42	26	31	Mixed
Human Capital Investment	47	48	47	44	+
STEM Workforce	41	39	36	34	++
Technology Concentration & Dynamism	29	32	32	20	++

Source: Milken Institute, State Technology and Science Index

Figure A-2

Manufacturing, real estate, retail trade, and health care are major contributors to South Carolina's economy measured by GDP.

Industry Sector Contribution to South Carolina GDP ($M), 2020

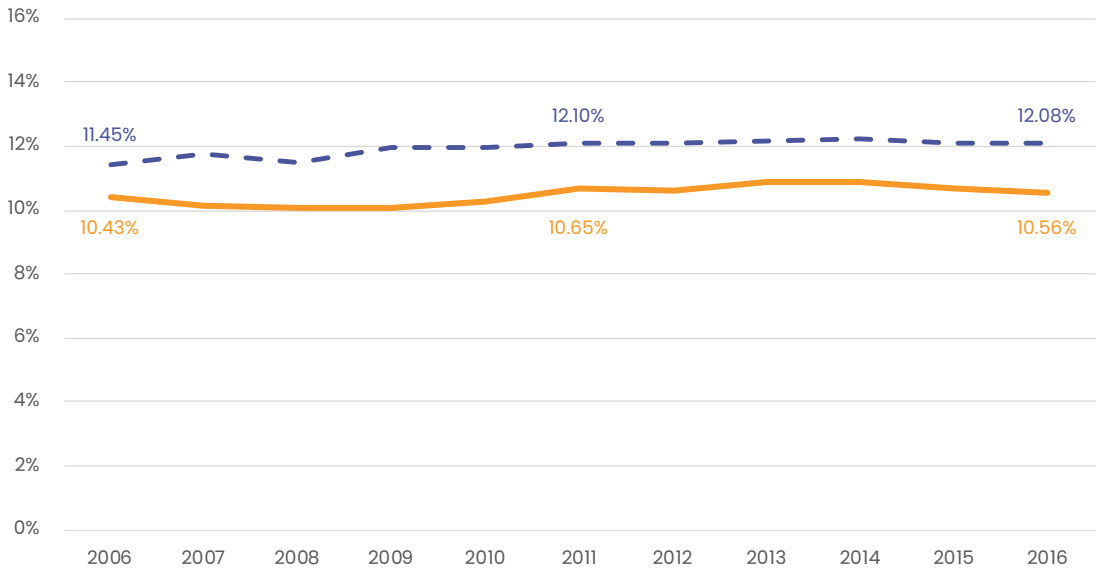


Source: U.S. Bureau of Economic Analysis

Figure A-3

South Carolina's high-tech sector employment has fallen further behind the national average rather than converging with the national average over the past 10 years. More rapid growth non-science- and technology-intensive industries could be one factor.

South Carolina and U.S. Employment in High-Tech Companies as a Percentage of Total Private Sector Employment, 2006–2016



Source: U.S. Census Bureau, special tabulations of the Business Information Tracking Services (various years).

Figure A-4

The South Carolina high-tech industry segments that added the most jobs over the last 5 years (in spite of COVID) were computer systems design, technical consulting, pharma, and data processing.

South Carolina High-Tech Industries with the Largest Employment Gains and Losses, 2015–2020

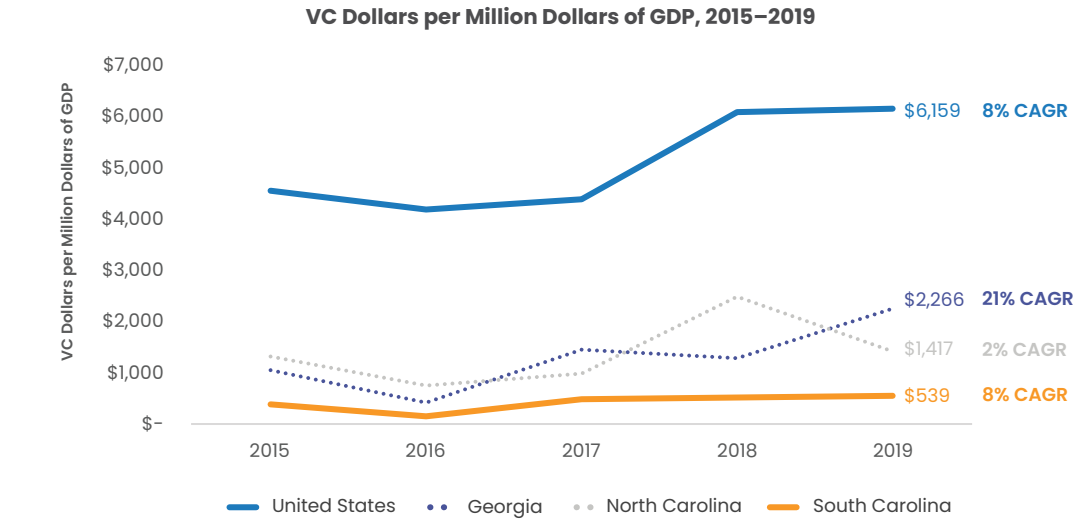
NAICS	INDUSTRY TITLE	TOTAL JOBS (2020)	CHANGE (2015-20)	CAGR (2015-20)
55	Management of companies and enterprises	24,292	7,609	7.80%
5415	Computer systems design and related services	18,399	5,078	6.70%
5416	Management and technical consulting services	17,938	3,957	5.10%
3254	Pharmaceutical and medicine manufacturing	4,993	2,663	16.50%
518	Data processing, hosting and related services	3,799	1,246	8.30%
5173	Wired and wireless telecommunications carriers	10,131	-2,052	-3.60%
2211	Power generation and supply	9,759	-1,439	-2.70%
5413	Architectural and engineering services	20,328	-1,250	-1.20%
3364	Aerospace product and parts manufacturing	6,751	-589	-1.70%
3343	Audio and video equipment manufacturing	246	-346	-16.10%
	High Tech	**142,400**	**17,547**	**2.70%**

Note: Note that 2020 was the start of COVID and a U.S. recession from March–April 2020.

Source: U.S Bureau of Labor Statistics

Figure A-5

VC investment in South Carolina companies is low relative to the U.S. average and to neighboring states in absolute terms and relative to the size of its economy. Growth will need to be faster for South Carolina to move up.

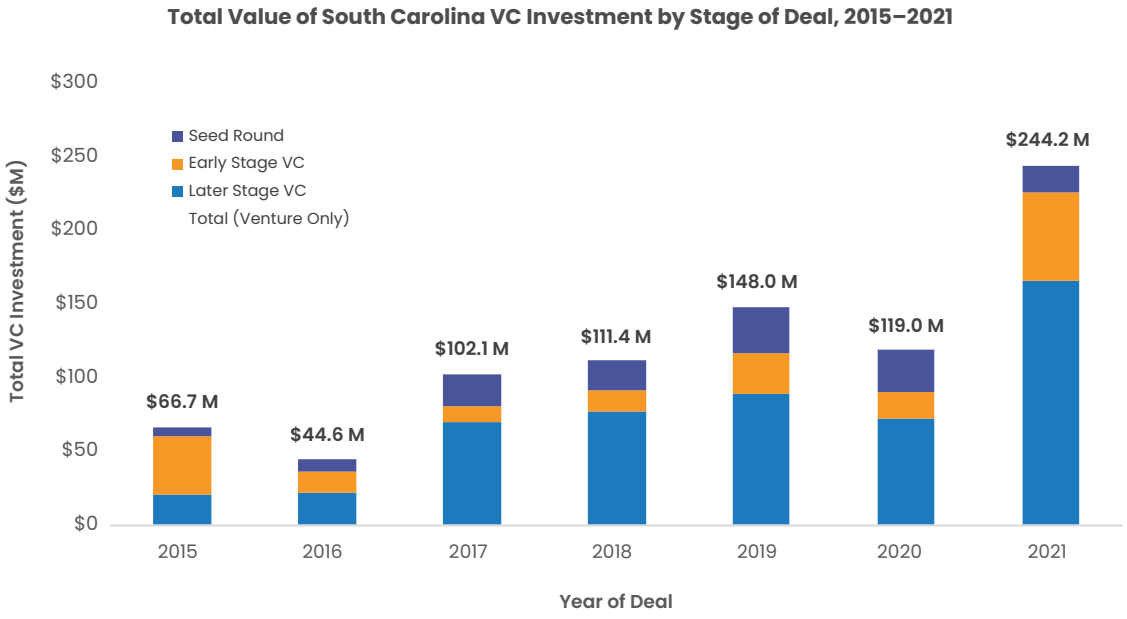


Note: The Science and Engineering Indicators use Pitchbook data, but the most recent data published are 2019.

Source: National Science Board. Science and Engineering Indicators.

Figure A-6

South Carolina raised record VC investment in 2021 driven by several large later-stage deals.

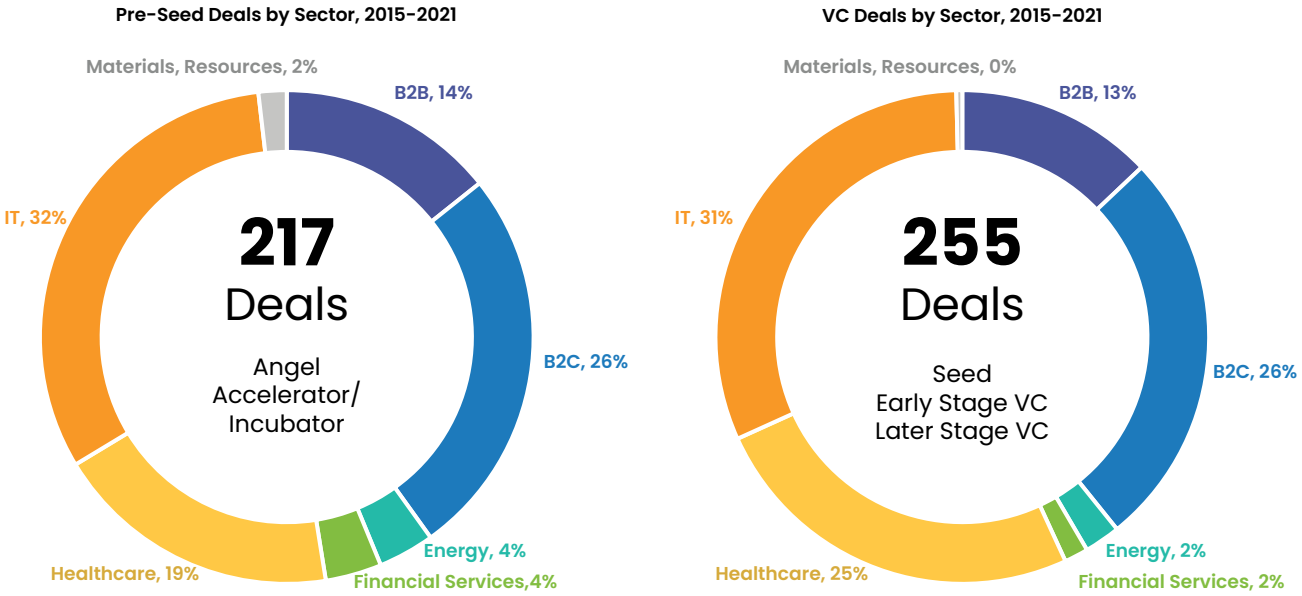


Source: Pitchbook Venture Capital and Private Equity Database

Figure A-7

Information Technology, B2C, and Healthcare account for 77% of pre-seed deals and 82% of VC deals.

Total Value of South Carolina VC Investment by Stage of Deal, 2015–2021



Source: Pitchbook Venture Capital and Private Equity Database

Figure A-8

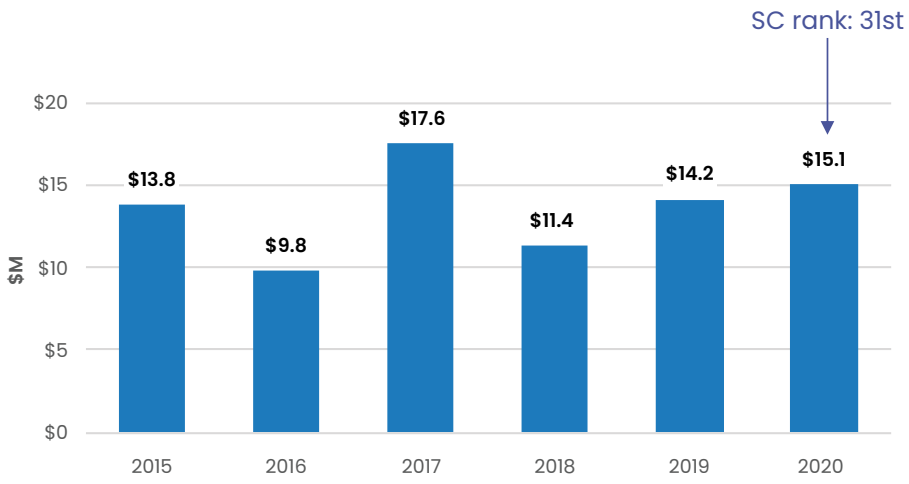
South Carolina increased its SBIR/STTR Phase 1 awards from 14 to 30 from 2015-2020, but Phase 2 performance has been mixed. South Carolina needs to increase its number of Phase 2 awards to improve its ranking

South Carolina SBIR/STTR Award Count, 2015–2020

PHASE	2015	2016	2017	2018	2019	2020	TOTAL
Phase 1	14	17	16	19	26	30	122
Phase 2	8	5	10	5	7	10	45
Total Count	22	22	26	24	33	40	167

Source: SBIR/STTR Award Database

South Carolina SBIR/STTR Award Value and Rank, 2015–2020



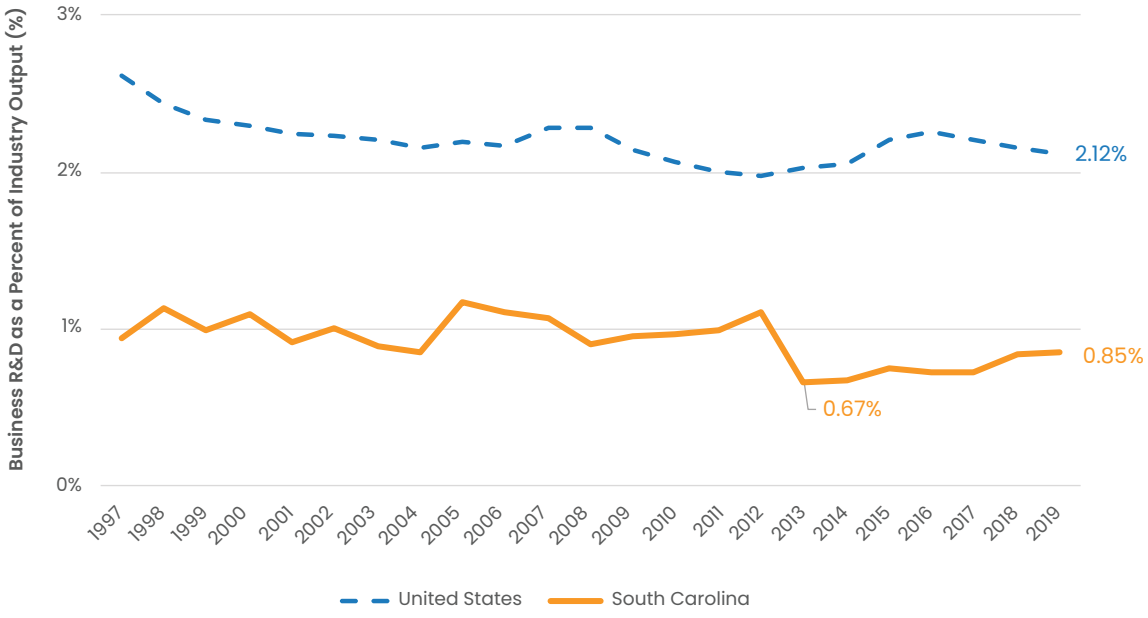
Source: SBIR/STTR Award Database

Figure A-9

South Carolina business R&D expenditures as a share of industry output (0.85%) is lower than U.S. (2.12%) but reflects growth since a low in 2013 (0.67%).

South Carolina and U.S. Business R&D Expenditures as a Share of Industry Output, 1999, 2009, and 2019

	1999	2009	2019
BERD ($M)	922	1,254	1,784
BERD/industry output	0.99%	0.95%	0.85%
Rank	32	33	32



Source: National Science Board, Science and Engineering Indicators

Figure A-10

Although manufacturing facilities in South Carolina participate in the parent companies R&D activities, South Carolina needs more R&D-based companies headquartered in the state to increase its total number of patent assignees.

Patents Granted to South Carolina Inventors by Patent Assignee: Out-of-State vs. In-State Assignees, 2015–2021

OUT-OF-STATE HEADQUARTERS	TOTAL PATENTS
General Electric	1,914
Boeing	368
American Standard	319
Michelin	305
Hubbell Incorporated	186
TTI Power Equipment	102
Electrolux Home Products	91
Schaeffler Technologies	89
IBM	88
InVue Security Products	59
Berkshire Grey, Inc.	59

IN-STATE HEADQUARTERS	TOTAL PATENTS
Sensor Electronic Technology	226
University of South Carolina	208
Milliken & Company	122
AFL Telecommunications	107
Sonoco Development	96
The Urban Electric Company	91
Clemson University	83
AVX Corporation	72
Savannah River Nuclear	72
KEMET Electronics Corporation	59
Medical University of South Carolina	57

Source: National Science Board, Science and Engineering Indicators

Figure A-11

South Carolina's academic science and engineering (S&E) R&D expenditures are growing more slowly than the U.S. and other EPSCoR states.

Total Academic S&E R&D Expenditures and Compound Average Annual Growth Rate for the U.S., South Carolina, and Select EPSCoR States, 2015–2020

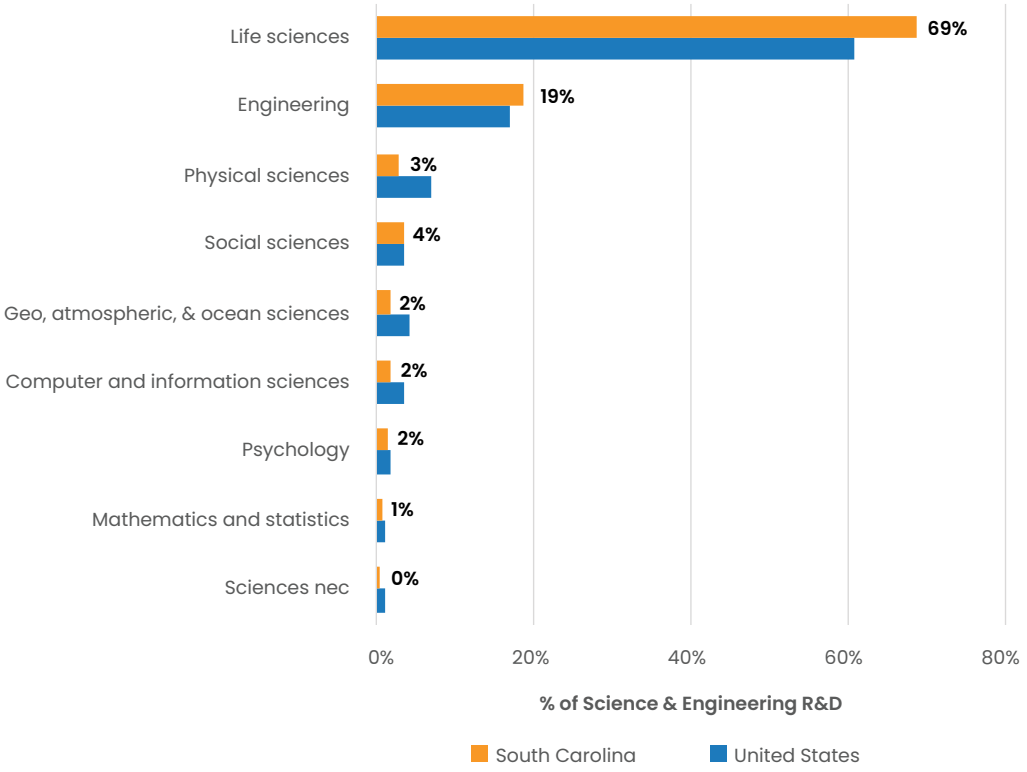
STATE	2015	2020	CAGR (2015-2020)
Alabama	$868.16	$1,110.64	5.05%
Nebraska	$435.77	$545.37	4.59%
United States	**$64,935.60**	**$81,260.56**	**4.59%**
Kentucky	$499.96	$614.16	4.20%
Louisiana	$609.10	$737.20	3.89%
North Dakota	$212.52	$251.91	3.46%
South Carolina	**$571.75**	**$653.03**	**2.69%**
Iowa	$726.23	$829.22	2.69%
Idaho	$142.95	$162.34	2.58%

Source: National Science Foundation, Higher Education R&D Survey

Figure A-12

South Carolina's R&D expenditures are most concentrated in the life sciences and engineering and lower than U.S. average share in the physical sciences; geographic, atmospheric, and ocean sciences; and computer science.

Share of Academic S&E R&D Expenditures by S&E Field in the U.S., South Carolina, 2020

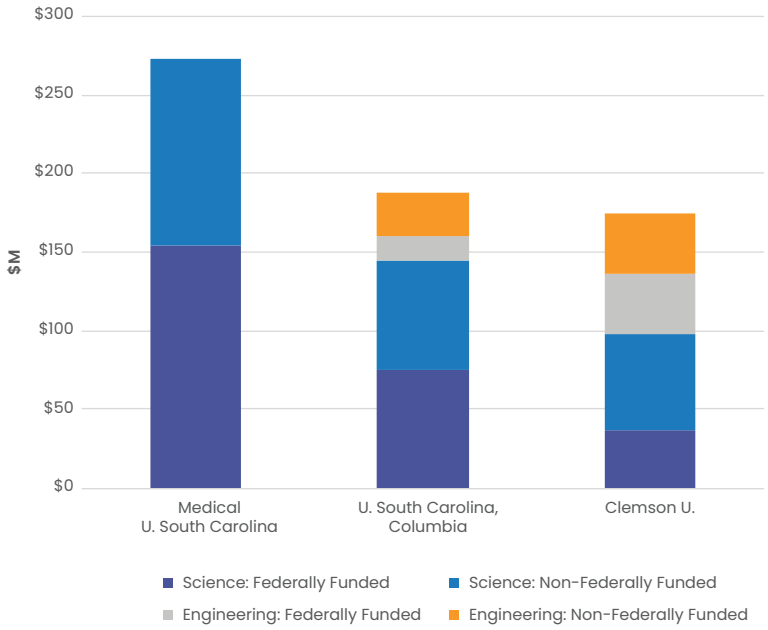


Source: National Science Foundation, Higher Education R&D Survey

Figure A-13

Federal funds account for a third to a half of S&E R&D expenditures at South Carolina's R1 research institutions.

Share of Federally Funded S&E R&D Expenditures at South Carolina R1 Research Institutions, FY2020

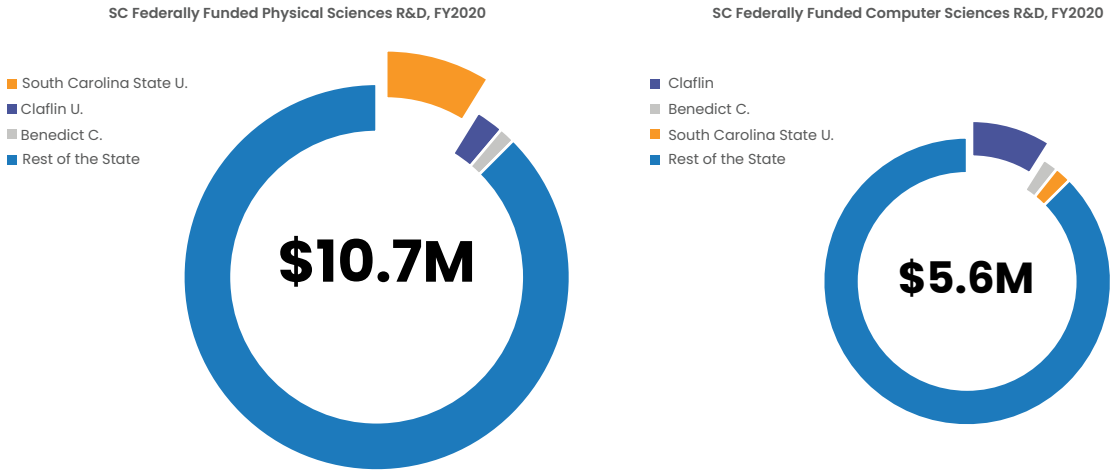


	ACADEMIC S&E R&D (% FEDERALLY FUNDED)	
	SCIENCE	ENGINEERING
MUSC	56%	N/A
USC	52%	35%
Clemson	37%	50%

Source: National Science Foundation, Higher Education R&D Survey

Figure A-14

Among South Carolina's HBCUs, South Carolina State University accounts for 9% of federally funded Physical Sciences R&D, and Claflin University accounts for 9% of Computer Science R&D.

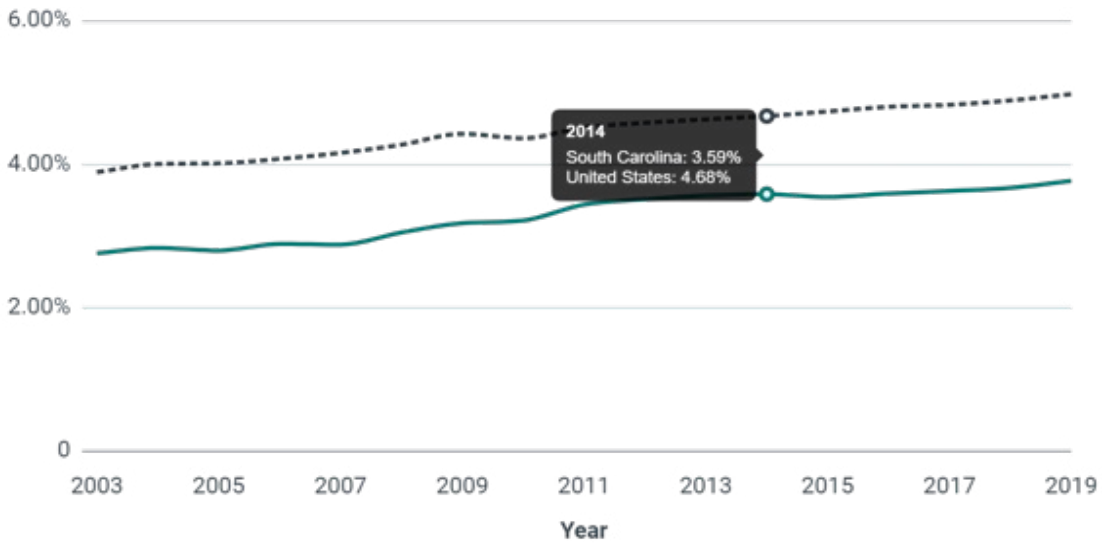


Source: National Science Foundation, Higher Education R&D Survey

Figure A-15

South Carolina's S&E workforce accounts for 3.77% of all occupations (up from 3.59% in 2014). This is below the current U.S. average of 4.98%.

Individuals in S&E Occupations as Percent of All Occupations, 2003–2019



Source: National Science Board. Science & Engineering Indicators.

Figure A-16

South Carolina's S&E workforce accounts for 3.77% of all occupations (up from 3.59% in 2014). This is below the current U.S. average of 4.98%.

South Carolina and U.S. Population by Race and by Gender, 2020

	SC	U.S.
White	63.7%	60.1%
Black or African-American	27.0%	12.5%
Hispanic or Latino	6.0%	18.5%
More than one race	2.0%	2.2%
Asian	1.8%	5.8%
American Indian, Alaska Native	0.5%	0.7%
Native Hawaiian, Pacific Islander	0.1%	0.2%
Total–All Races	**101.1%**	**100.0%**
Female	51.6%	50.8%
Male	48.4%	49.3%

Note: The Hispanic or Latino population estimate for South Carolina is a preliminary estimate, which is why the breakdown of population by race and ethnicity does not sum.

Source: U.S. Census Bureau

Figure A-17

Women represent 62% of Bachelors, 54% of Masters, and 44% of Associates and PhDs in science conferred in South Carolina.

Science Degrees Conferred to Women by South Carolina Higher Education Institutions by Level and by Percent of Total Degrees, 2019

FIELD OF SCIENCE	ASSOCIATES	BACHELORS	MASTERS	PHDS
Life Sciences	4	1,871	168	40
Psychology		1,247	96	12
Social Sciences	186	1,004	71	18
Math & Computer Sciences	83	304	68	16
Physical Sciences		155	5	17
Geosciences		39	8	0
Women %	**44%**	**62%**	**54%**	**44%**
Total: Women	**273**	**4,620**	**416**	**103**
Total: All SC Graduates	**624**	**7,498**	**775**	**234**

Source: National Center for Education Statistics, IPEDS Completion Survey

Figure A-18

African-Americans represent 27% of Associates, 17% of Bachelors, 13% of Masters, and 3% of PhDs in science conferred in South Carolina.

Science Degrees Conferred to African-Americans by South Carolina Higher Education Institutions by Level and by Percent of Total Degrees, 2019

FIELD OF SCIENCE	ASSOCIATES	BACHELORS	MASTERS	PHDS
Life Sciences		391	27	2
Psychology		329	27	
Social Sciences	106	362	34	3
Math & Computer Sciences	76	165	11	
Physical Sciences		30		2
Geosciences		6	2	
African-American %	**29%**	**17%**	**13%**	**3%**
Total: African-American	**182**	**1,283**	**101**	**7**
Total: All SC Graduates	**624**	**7,498**	**775**	**234**

Source: National Center for Education Statistics, IPEDS Completion Survey

Figure A-19

Men account for 74%+ of engineering degrees conferred in South Carolina, while women account for 26% or less.

Engineering Degrees Conferred to Men by South Carolina Higher Education Institutions by Level and by Percent of Total Degrees, 2019

FIELD OF ENGINEERING	ASSOCIATES	BACHELORS	MASTERS	PHDS
Engineering Technology				
Mechanical Engineering		447	60	18
Electrical Engineering		249	59	22
Civil Engineering		222	48	17
Industrial Engineering		131	77	3
Other Engineering		113	82	23
Aerospace Engineering		-	7	-
Chemical Engineering		99	4	8
Materials Engineering		27	1	8
Male %	**89%**	**78%**	**74%**	**76%**
Total: Men	**462**	**1,288**	**338**	**99**
Total: All SC Graduates	**518**	**1,654**	**455**	**131**

Source: National Center for Education Statistics, IPEDS Completion Survey

Figure A-20

African-Americans represent 14% of Engineering Tech Associates, 6% of Bachelors, 3% of Masters, and no PhDs in Engineering conferred in South Carolina.

Engineering Degrees Conferred to African-Americans by South Carolina Higher Education Institutions by Level and by Percent of Total Degrees, 2019

FIELD OF SCIENCE	ASSOCIATES	BACHELORS	MASTERS	PHDS
Engineering Technology	74			
Electrical Engineering		31	2	
Civil Engineering		22	2	
Mechanical Engineering		13		
Industrial Engineering		11	8	
Chemical Engineering		8		
Other Engineering		6	2	
Materials Engineering		1		
African-American %	**14%**	**6%**	**3%**	**–**
Total: African-American	**74**	**92**	**14**	**0**
Total: All SC Graduates	**518**	**1,654**	**455**	**131**

Source: National Center for Education Statistics, IPEDS Completion Survey

Figure A-21

African-Americans and women are underrepresented in Math and Computer Science degrees conferred, but are more highly represented than in engineering.

Math and Computer Science Degrees Conferred to African-Americans and Women by South Carolina Higher Education Institutions by Number and by Percent of Total Degrees, 2019

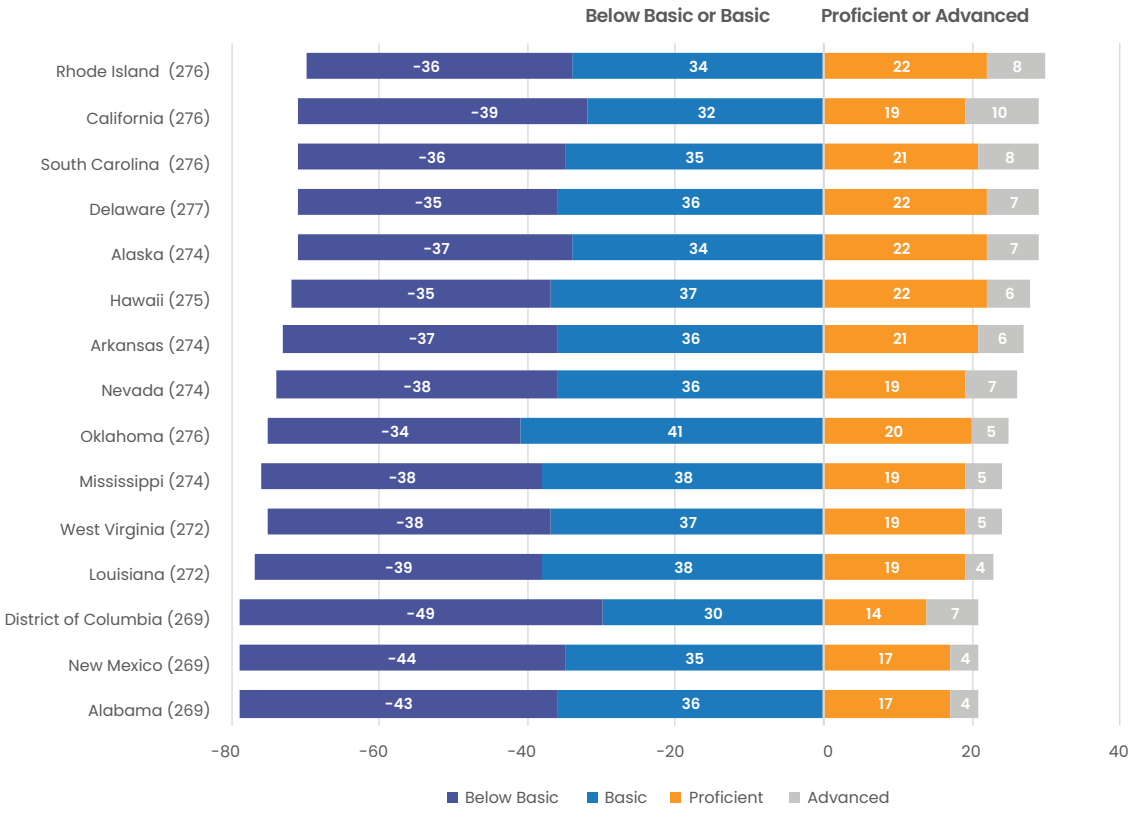
	AFRICAN-AMERICAN		WOMEN		TOTAL
	% OF TOTAL	DEGREES CONFERRED	% OF TOTAL	DEGREES CONFERRED	DEGREES CONFERRED
Associates	**18.5%**	76	**20%**	83	411
Bachelors	**15.5%**	165	**29%**	304	1,063
Masters	**6%**	11	**38%**	68	181
PhD	**-**	0	**42%**	16	38

Source: National Center for Education Statistics, IPEDS Completion Survey

Figure A-22

South Carolina ranks 39th on the 8th grade math National Assessment of Educational Progress. Basic or below proficiency scores on 8th grade math are a major impediment to higher level high school math and science classes and preparedness for STEM postsecondary degrees.

8th Grade Mathematics NAEP Proficiency Levels Based on Score for the Bottom 15 States and the District of Columbia, 2019



Source: National Center for Education Statistics, National Assessment of Educational Progress