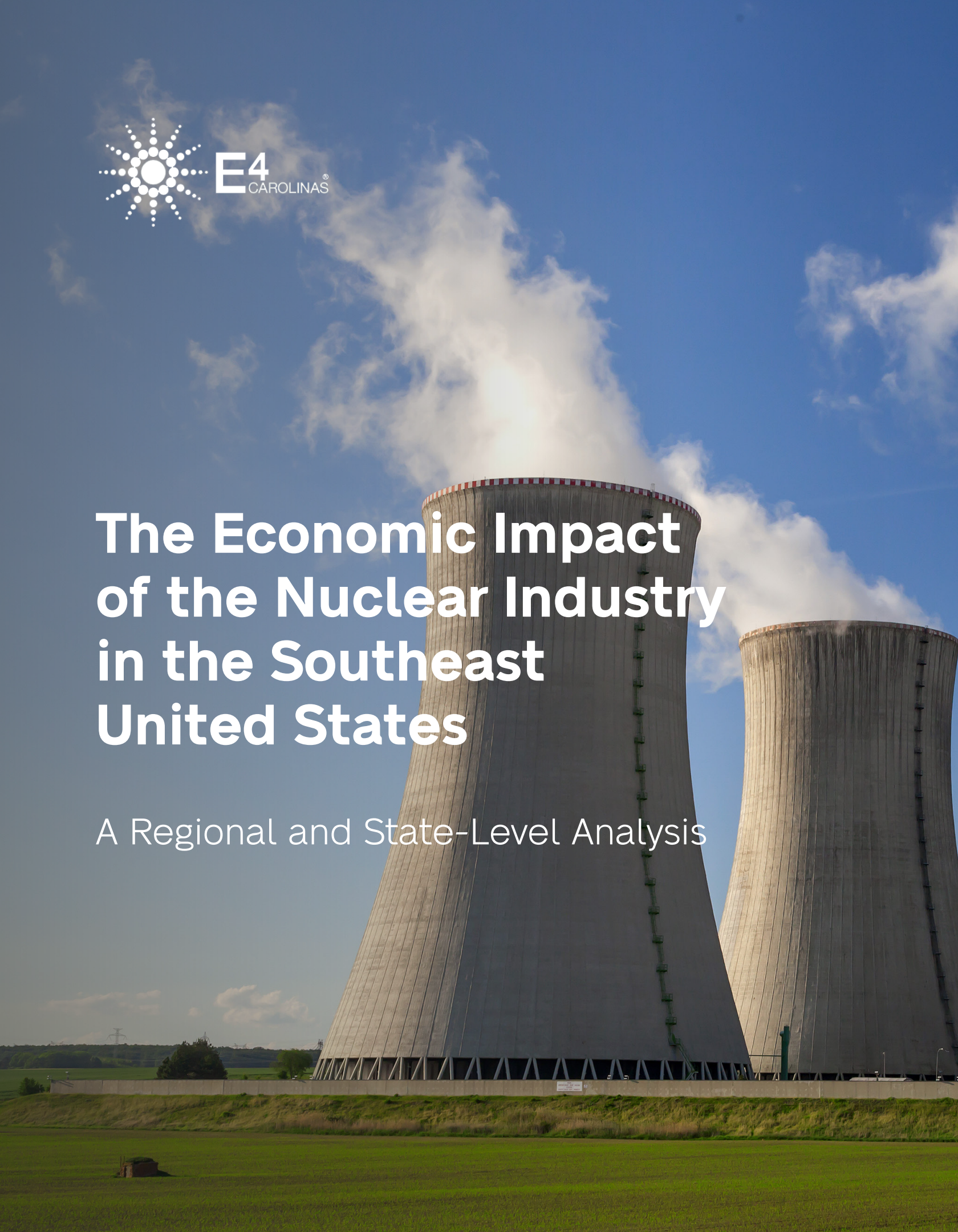


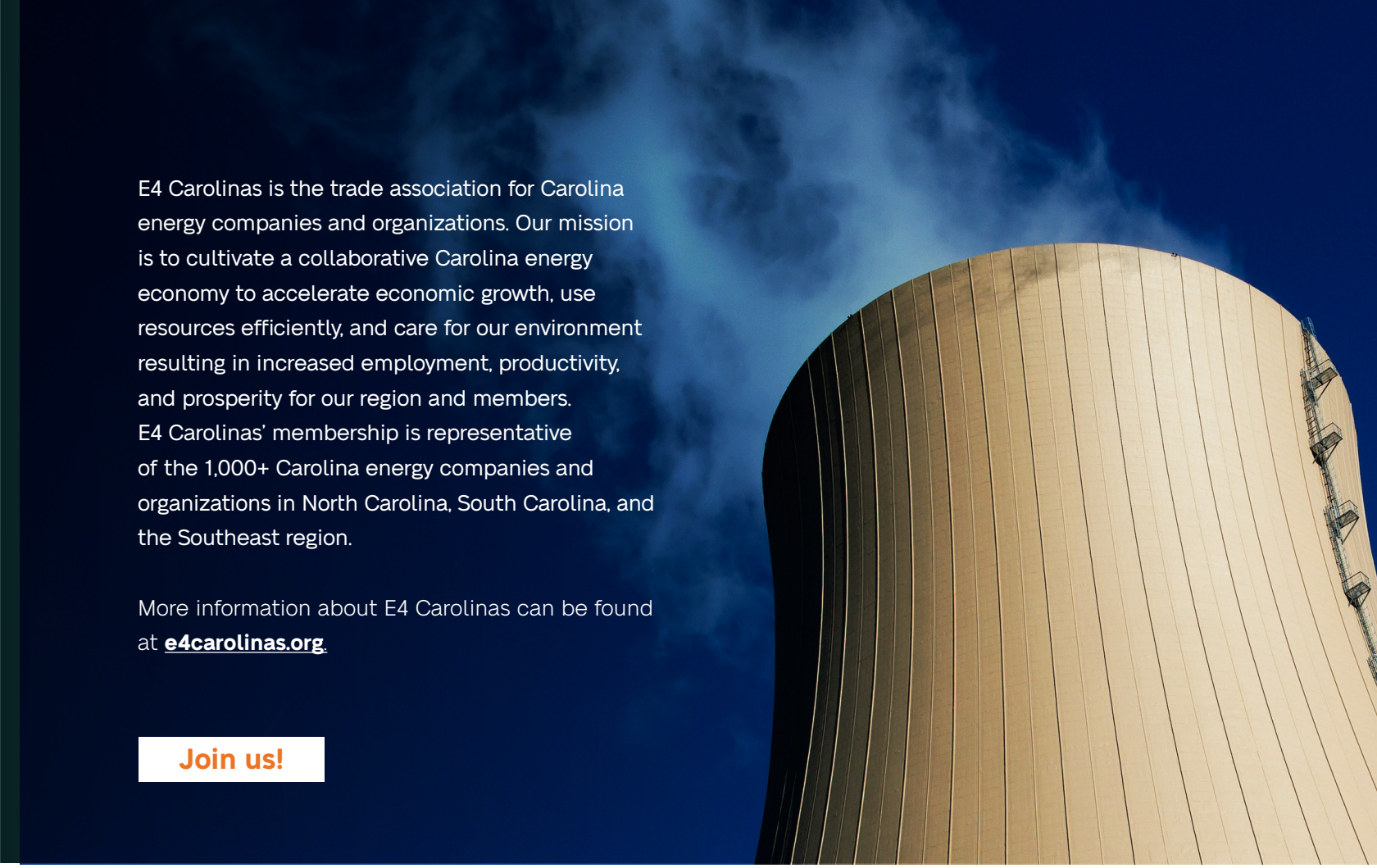
E4 CAROLINAS®

The Economic Impact of the Nuclear Industry in the Southeast United States

A Regional and State-Level Analysis

TABLE OF

CONTENTS



E4 Carolinas is the trade association for Carolina energy companies and organizations. Our mission is to cultivate a collaborative Carolina energy economy to accelerate economic growth, use resources efficiently, and care for our environment resulting in increased employment, productivity, and prosperity for our region and members. E4 Carolinas' membership is representative of the 1,000+ Carolina energy companies and organizations in North Carolina, South Carolina, and the Southeast region.

More information about E4 Carolinas can be found at **e4carolinas.org**.

Join us!

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NOTICE

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Letters from the Advisory Board Chairs

JEFF MERRIFIELD
Co-chair, Southeast Nuclear Advisory Council
Chair, E4 Carolinas
Partner, Pillsbury Law

Dear Readers:

On behalf of the Southeast Nuclear Advisory Council and E4 Carolinas, we proudly present *The Economic Impact of the Nuclear Power Industry in the Southeast.* This report provides the most comprehensive assessment of the economic benefits of the nuclear industry to our region to date. It is the result of a two-year collaboration with industry, higher education, and energy nonprofit organizations supported by a grant from the U.S. Economic Development Administration.

As our region looks forward to deploying additional nuclear plants and extending the life of its current fleet, the impacts reported in this document will serve as a baseline for understanding the benefits of nuclear power to our communities. But the economic benefits reported here are only part of the picture, as nuclear energy also provides a pathway to meeting the anticipated increased demand for power and reduced carbon emissions, while maintaining the low-cost energy and reliability goals important to the region. We think this report contributes to the ongoing conversation about how nuclear energy is vital to our clean energy future, enhanced quality of life, and economic competitiveness in the Southeast.

JIM LITTLE
Co-chair, Southeast Nuclear Advisory Council
Industry Representative, South Carolina Governor's Nuclear Advisory Council

Dear Readers:

The Southeastern United States is a leader in domestic nuclear energy production. Approximately 37 percent of net electricity production in Georgia, North Carolina, South Carolina, Tennessee, and Virginia comes from nuclear power, compared to the U.S. average of approximately 19 percent. In addition, nuclear power represents the largest source of clean energy in the United States, and will be a growing component of many economic development strategies targeting an increased use of clean energy.

The analysis contained in this report estimates the total economic impact of the nuclear industry in the Southeastern United States. And it is impressive. The total annual economic impact of the five-state region is estimated to be $42.9 billion, supporting 152,598 jobs, $13.7 billion in labor income, and $3.7 billion in annual state and local tax revenues to host communities that would not exist otherwise.

I am pleased to present this report on behalf of E4 Carolinas and the Southeast Nuclear Advisory Council and look forward to the ongoing conversation about how nuclear is an essential part of our regional economy and clean energy future.

EXECUTIVE SUMMARY

The Southeastern United States is a leader in domestic nuclear energy production. Approximately 37 percent of net electricity production in Georgia, North Carolina, South Carolina, Tennessee, and Virginia comes from nuclear power, which is higher than in virtually all other U.S. states and is also higher than the U.S. average of approximately 19 percent. In addition, nuclear power represents the largest source of clean energy in the United States, and the expectation is that the nuclear industry will grow in demand in the coming years as a required component of many economic development strategies targeting an increased use of clean energy. Nuclear power already generates nearly 800 billion kilowatt hours of electricity each year and produces more than half of the nation's emissions-free electricity.

The economic impact of the nuclear industry extends beyond the fence line of nuclear power plants. Nuclear power plants rely on an extensive supplier network of firms throughout the local regions in which they are located. In addition, there are also many private and federal facilities engaged in various forms of high-tech nuclear-related research & development, waste remediation, and other support activities. The purpose of this analysis is to estimate the total economic impact of the nuclear industry in the Southeastern United States, with a specific focus on the five-state region of Georgia, North Carolina, South Carolina, Tennessee, and Virginia.

The key findings of this analysis are as follows:

- There is a 'fertile crescent' of the nuclear industry located in the Southeastern United States which includes Georgia, North Carolina, South Carolina, Tennessee, and Virginia. The total annual economic impact of the nuclear industry in the five-state region is estimated to be $42.9 billion. The figure represents the dollar value of all the final goods and services produced in the five-state region that can be attributed (either directly or indirectly) to the nuclear industry. This impact corresponds to 152,598 jobs and $13.7 billion in labor income that would not exist otherwise.

- This $42.9 billion impact can be broken down at the state level, with the largest impacts occurring in South Carolina ($11.1 billion & 41,949 jobs), followed by Tennessee ($9.8 billion & 40,286 jobs), Virginia ($7.1 billion & 24,704 jobs), Georgia ($5.3 billion & 16,241 jobs) and North Carolina ($4.8 billion & 15,494 jobs).

- The nuclear industry contributes $3.7 billion in annual state and local tax revenues to host communities in the Southeast. South Carolina receives $1.1 billion, Tennessee $1 billion, Virginia $842 million, Georgia $336 million, and North Carolina $368 million in annual tax revenues from the industry.

- Nuclear power plants purchase a relatively high percentage of their raw materials from local vendors relative to other firms because of the need to minimize lead times, reduce transportation costs, and access localized knowledge. This local purchasing behavior, in turn, dramatically increases the economic impact of nuclear power plants relative to other firms of similar size by generating additional rounds of local spending activity.

- The employment multiplier effect associated with the activities of the nuclear industry is estimated to be approximately 2.8 across the five-state region. In other words, for every 10 jobs created directly by the nuclear industry, another 18 jobs, on average, are created elsewhere in the region. This multiplier effect of 2.8 is significantly higher than that of the average industry in the five-state region, which is 1.9. When examining nuclear power plants exclusively, this employment multiplier increases further to 4.5. This means that future growth in the nuclear industry may generate higher employment returns relative to the average industry in the five-state region

- The nuclear industry also contributes to a high-quality workforce as measured by wage levels. The 152,598 jobs that are currently supported by the nuclear industry (which include all direct and secondary job creation) pay an average wage of $89,972. This represents a wage premium of 65.5 percent over the average job in the five-state Southeastern region.

- Due to the multiplier effects resulting from the large, local supply chains that nuclear power plants draw from, future investments in new nuclear power plants have the potential to generate significant impacts for the local region. This study estimates that for every $100 in revenue generated by a new nuclear power plant in the five-state region, approximately $200 in total economic output would be created, representing a 2:1 ratio.

1. INTRODUCTION

The Southeast United States is a hub of the global nuclear industry. With its impressive set of companies and long-standing experience in nuclear power generation, the region plays a significant part in the development and production of nuclear technologies worldwide. Furthermore, new nuclear technologies just on the horizon offer the Southeast a generational opportunity to help develop a clean energy system reducing the carbon footprint of power production and consumption, while maintaining the low-cost energy and reliability goals important to the region's utilities, independent power producers, industrial, commercial, and residential users.

The region is poised to capture additional benefits due to its unique position in the nuclear industry. The growing demand for clean energy, an increasing population, existing nuclear power plants, federal labs, and demonstration sites in the region offer the nuclear industry in the Southeast extraordinary opportunities. In particular, two market forces offer renewed prospects for increased deployment of nuclear technologies: the demand for clean energy and changes in nuclear technologies. As governments and other economic participants seek to implement carbon neutrality goals by 2050, its attractiveness for reaching these goals is compelling as some of the core benefits of nuclear energy are high energy density, flexibility to be used in multiple end markets, and zero-carbon emissions. Nuclear power in the existing energy system provides baseload power along with coal and natural gas, supplemented by intermittent renewable energy sources. As demand for zero-carbon energy increases, nuclear power provides a compelling pathway to achieve this goal by providing baseload power to support increasing renewable power. In a near future hybrid energy system, nuclear power can also generate non-carbon hydrogen, which can then be blended with natural gas, fired directly into turbines, or stored for future use. In a world where countries seek to reduce carbon emissions while satisfying the demand for more electric power, nuclear energy makes sense for a host of applications currently powered by fossil fuels.

New nuclear technologies are also emerging. These technologies, which are in the advanced development and demonstration phase, promise lower construction costs, enhanced safety, reduced land use and environmental footprint. Known as "Generation IV" technologies, these new nuclear reactors differ from current light-water reactor technologies.[1] Generation IV technologies can be divided into two general categories: thermal reactors and fast reactors, which vary by the type of coolant used.[2] Thermal reactors "moderate" (that is, slow) the speed of neutrons created by nuclear fission using gas, graphite, molten salt, or water as moderators. Fast reactors do not moderate the speed of the neutrons created by the nuclear reaction and include gas, sodium, and lead coolant subtypes.[3]

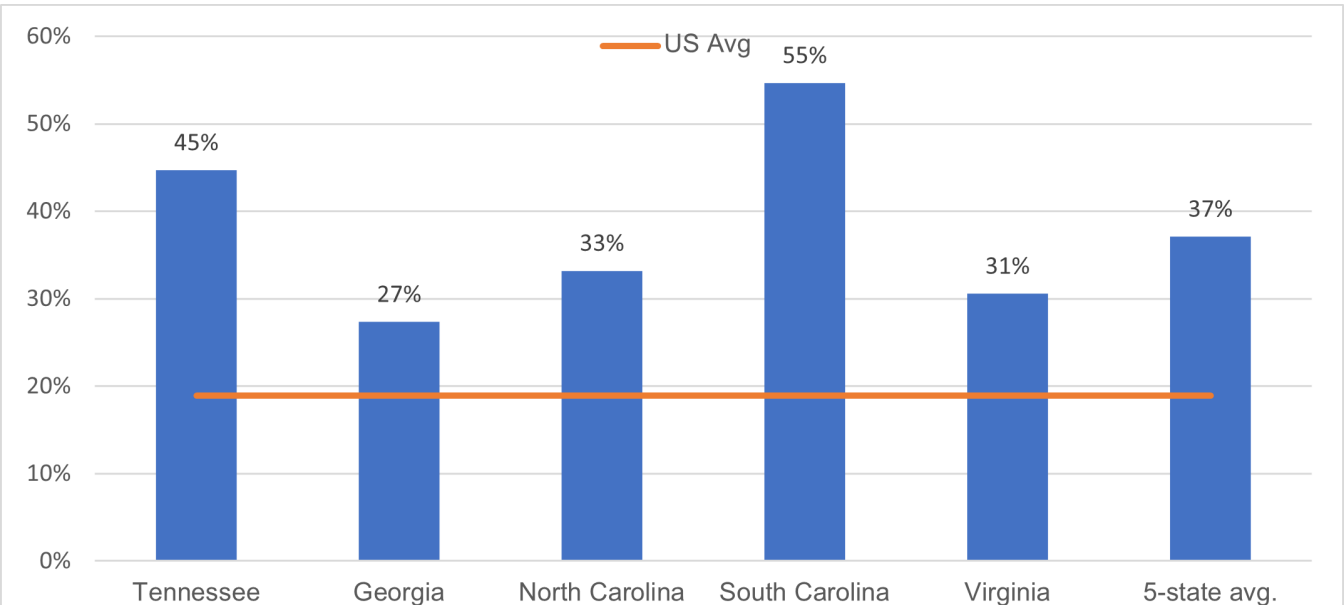
Both thermal and fast Generation IV reactors can range in operating temperatures (500 – 1,000 C) and sizes (30 MW – 2,000 MW). Small reactors (20-300 MW) can be built modularly and transported to the site, reducing the construction cost, and are called Small Modular Reactors (SMRs). Micro-reactors (1-20MW) are currently used in niche areas such as university research reactors, medical isotope production, or transportation applications where weight and remote power production are overriding considerations, for example, in surface and subsurface military marine propulsion (i.e., nuclear submarines and aircraft carriers) or space satellites.[4] However, in the near future, small and microreactors can be used by industrial customers for required process heat and power applications at plant facilities.[5]

The commitment by national governments and subnational stakeholders[6] - specifically state and local governments, investor-owned utilities, and commercial and industrial energy consumers - to become carbon neutral by 2050, and technological changes in reactor technology and construction techniques allow for smaller and more affordable nuclear power plants. The commitments appear enduring and are made by market participants in both advanced industrial and emerging market economies. As a result, the investments in the energy transition, estimated to require $50-100 trillion[7] over the next three decades, are more likely to be realized than during earlier discussions about a nuclear revival. Nuclear power production credits, demonstration sites of advanced reactors, and NRC regulatory action on SMRs are positive steps toward realizing the promise of nuclear power in our region.

The purpose of this report is to examine the economic impact of the nuclear industry in the Southeast United States. We do so in two parts. The first part summarizes the regional nuclear market by providing an overview of existing nuclear power plants, the contribution of nuclear power to the region's energy mix, and the companies in the nuclear value chain with locations in the region. The second part models the economic impact of the regional and state-level nuclear industry using IMPLAN, a software program widely used to assess the impact of an industry in a market region[8].

1.1 SOUTHEAST NUCLEAR MARKET OVERVIEW

Figure 1: Nuclear as Percent Net Electricity Generation, By SE State and U.S. Average



Source: calculated from EIA 2022 Electric Power Annual, Tables 3.7 and 3.13.

The region hosts 25 of the 93 operational nuclear reactors in the U.S. and 13 of the 55 operating nuclear power plants. The 26,287 MW of generation capacity located in Virginia, North Carolina, South Carolina, Tennessee, and Georgia, makes up 37% of utility-scale net electricity generation in the region compared with 19% in the U.S. overall (Figure 1).

Nuclear power plants are located throughout the Southeast. Tennessee has four reactors at two plants operated by the Tennessee Valley Authority (TVA); two reactors are at the Sequoya Nuclear Power Plant in Soddy-Daisy (outside Chattanooga), and two reactors are located at the Watts Bar Nuclear Power Plant in Spring City (outside of Knoxville). Georgia has five reactors at two nuclear plants operated by the Southern Company; two reactors at the Hatch Nuclear Power Plant in Baxley (outside of Vidalia) and three reactors (a fourth will soon begin operation) at the Vogtle Nuclear Power Plant in Waynesboro (outside of Augusta). North Carolina has five reactors at three nuclear plants operated by Duke Energy; two reactors at the Brunswick Nuclear Power Plant in Southport (outside of Wilmington), one reactor at the Harris Nuclear Power Plant in New Hill (outside of the Raleigh-Durham metro area), and two reactors at the McGuire Nuclear Power Plant in Huntersville (outside of Charlotte). South Carolina has seven reactors at four plants operated by Duke Energy and Dominion Energy; two reactors at the Catawba Nuclear Power Plant in York, SC (outside of Charlotte), three reactors at the Oconee Nuclear Power Plant in Seneca, SC (outside of Greenville), one reactor at the Robinson Nuclear Power Plant in Hartsville (outside of Florence) and one reactor at the Summer Nuclear Power Plant in Jenkinsville (outside of Columbia) operated by Dominion Energy. Virginia has four reactors at two nuclear power plants operated by Dominion Energy: two reactors are at the North Anna Nuclear Power Plant (outside of Richmond), and two reactors are at the Surry Nuclear Power Plant (outside of Newport News). Please see Table 1.

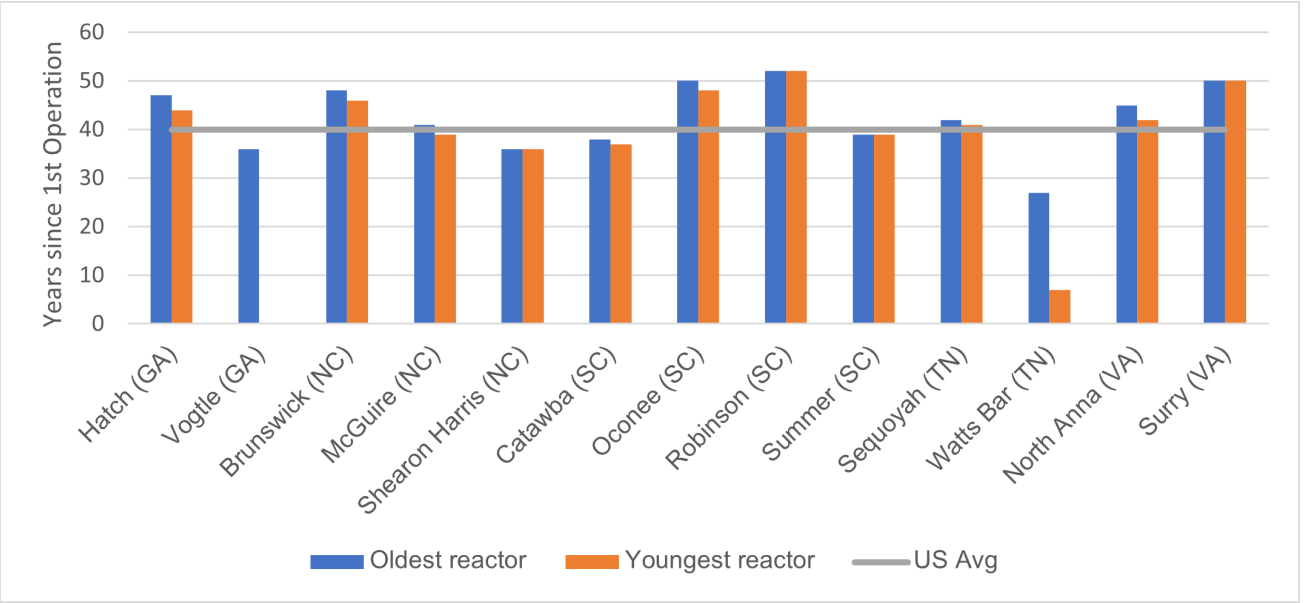
Table 1: Nuclear Power Plants in the SE United States

Plant Name	Reactors (#)	Type	Capacity (MWe)	Owner/Operator	Location	First In-Service	Last In-Service
Hatch	2	BWR	1,848	Southern (SNOC)	Baxley, GA	1975-12	1979-9
Vogtle	3	PWR	3,530	Southern (SNOC)	Waynesboro, GA	1987-6	2023-7*
Brunswick	2	BWR	2,004	Duke Progress	Southport, NC	1975-11	1977-3
McGuire	2	PWR	2,440	Duke Energy	Huntersville, NC	1981-12	1984-3
Shearon Harris	1	PWR	951	Duke Progress	New Hill, NC	1987-5	1987-5
Catawba	2	PWR	2,410	Duke Energy	York, SC	1985-6	1986-8
Oconee	3	PWR	2,667	Duke Energy	Seneca, SC	1973-7	1974-12
Robinson	1	PWR	769	Duke Progress	Hartsville, SC	1971-3	1971-3
Summer	1	PWR	1,030	Dominion Energy SC	Jenkinsville, SC	1984-1	1984-1
Sequoyah	2	PWR	2,442	TVA	Soddy-Daisy, TN	1981-7	1982-6
Watts Bar	2	PWR	2,540	TVA	Spring City, TN	1996-5	2016-10
North Anna	2	PWR	1,960	Dominion	Mineral, VA	1978-6	1980-12
Surry	2	PWR	1,696	Dominion	Surry, VA	1972-12	1973-5

NOTE: ***Vogtle-4 is scheduled to enter into service in 2024. Capacity is nameplate capacity, as reported by U.S. EIA. BWR = Boiling Water Reactor; PWR = Pressurized Water Reactor. Source: Summarized from IAEA 2021 Reactor Database, Table 14, except as noted.***

Almost all nuclear power plants in the region are pressurized water reactors (PWR), with the exception of the boiling water reactors (BWR) at Hatch (operated by Southern Company) and Brunswick (operated by Duke Energy Progress, LLC). The majority of reactors operating in the SE U.S were built in the 1970s and 1980s. Only two reactors, TVA's Watts Bar-2 and Southern Company's Vogtle-3 were built and entered into service in this century.[9]

Figure 2: Average Age of SE Nuclear Power Reactors



NOTE: ***Vogtle-3 in-service date is July 31, 2023. Source: Calculated from IAEA 2021 Reactor Database, Table 14***

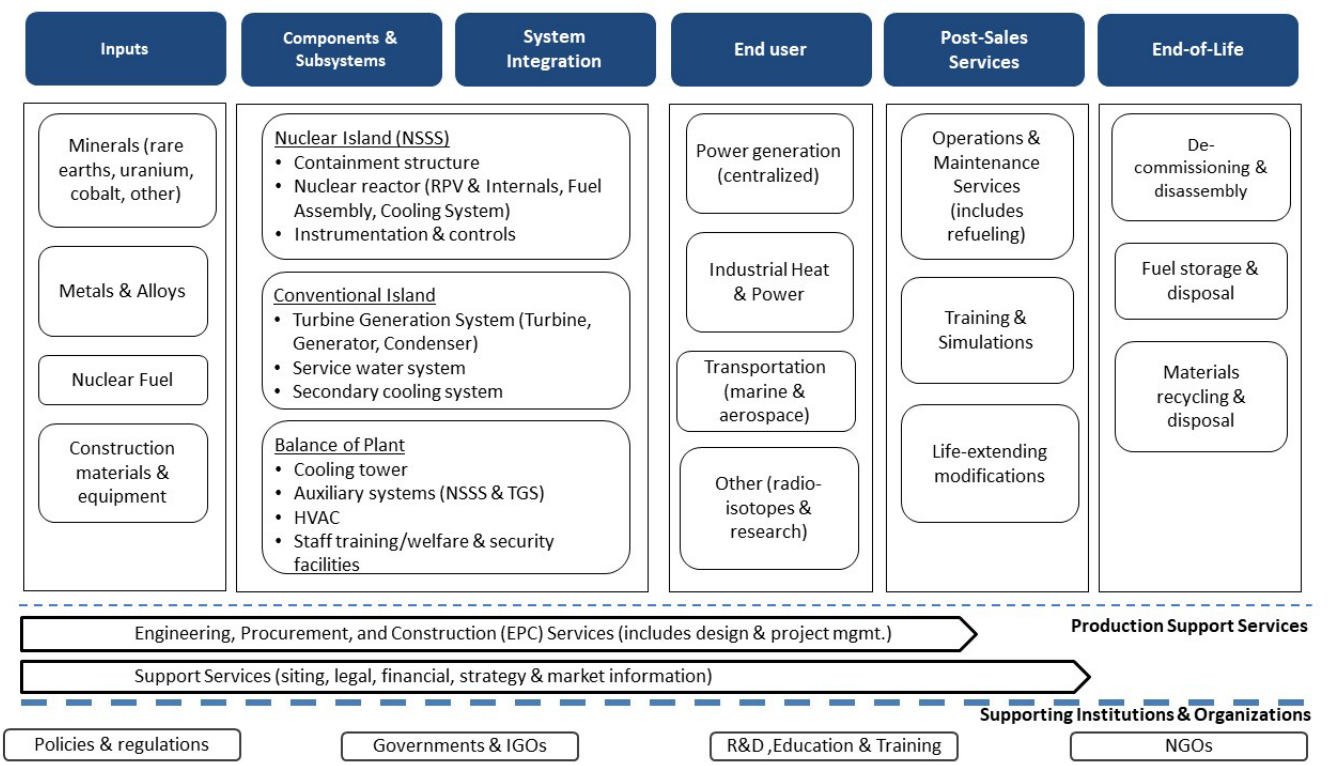
If nuclear power is to help achieve zero-carbon energy goals, new reactor construction must exceed reactor decommissioning.[10] However, as the fleet gets older, the risk is that new reactors will at best only supplant retiring reactors, leaving a gap in the energy system that must be filled by other, perhaps even higher carbon-emitting, sources to maintain the availability of baseload power in our region. To mitigate this gap in the Southeast, Dominion Energy announced plans to deploy small modular nuclear reactors in Virginia by 2032, notably in the southwestern portion of the state.[11] Duke Energy plans to add 600 MW of new nuclear power generation capacity by 2035, partially replacing coal retirements at two existing coal generation sites.[12] The TVA plans to begin building its first SMR at Clinch River by 2027.[13]

Having provided an overview of the nuclear market and technology dynamics in our region, we now turn to examining the regional footprint of companies in the Southeast nuclear industry before discussing the economic impact of the nuclear industry in Section 2 of this report.

1.2 SOUTHEAST NUCLEAR COMPANIES

We sought to understand better the Southeast's footprint in the nuclear industry. To do so, we created a nuclear industry value chain comprised of inputs, components & subsystems, systems integration, end-users, post-sales services, and end-of-life activities (Figure 3) to organize our collection of company information[14]

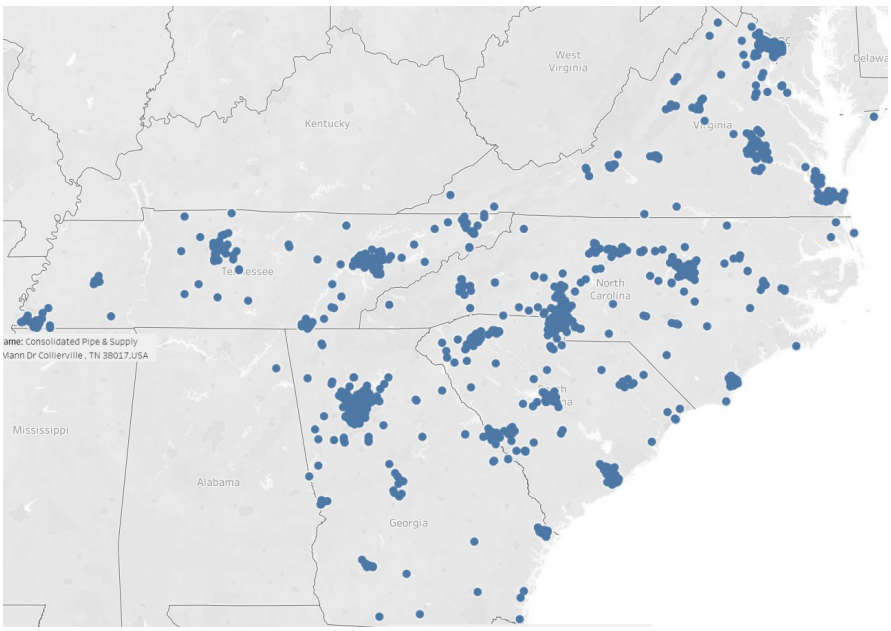
Figure 3: The Nuclear Value Chain



Source: Authors

We then created a business inventory of firms active in each segment of the nuclear industry value chain within the five southeastern U.S. states Virginia, Tennessee, North Carolina, South Carolina, and Georgia covered in this report. The companies selected for inclusion in the inventory offered products or services relevant to the nuclear value chain and maintained at least one location in the Southeast. We identified companies by searching globally for companies active in the nuclear industry, described their products and services in the nuclear value chain, and found their headquarters and branch locations. This "top-down" process was complemented by a "bottom-up" search for additional, more localized, companies in the Southeast. We reviewed regional business organizations, industry news sources, the Reference USA company database, and LinkedIn to ensure that we captured as many companies as possible that are known to have products and services relevant to the nuclear value chain in the Southeast U.S. We found 494 firms active in the nuclear industry with 1,632 unique locations in the Southeast (see Figure 4).

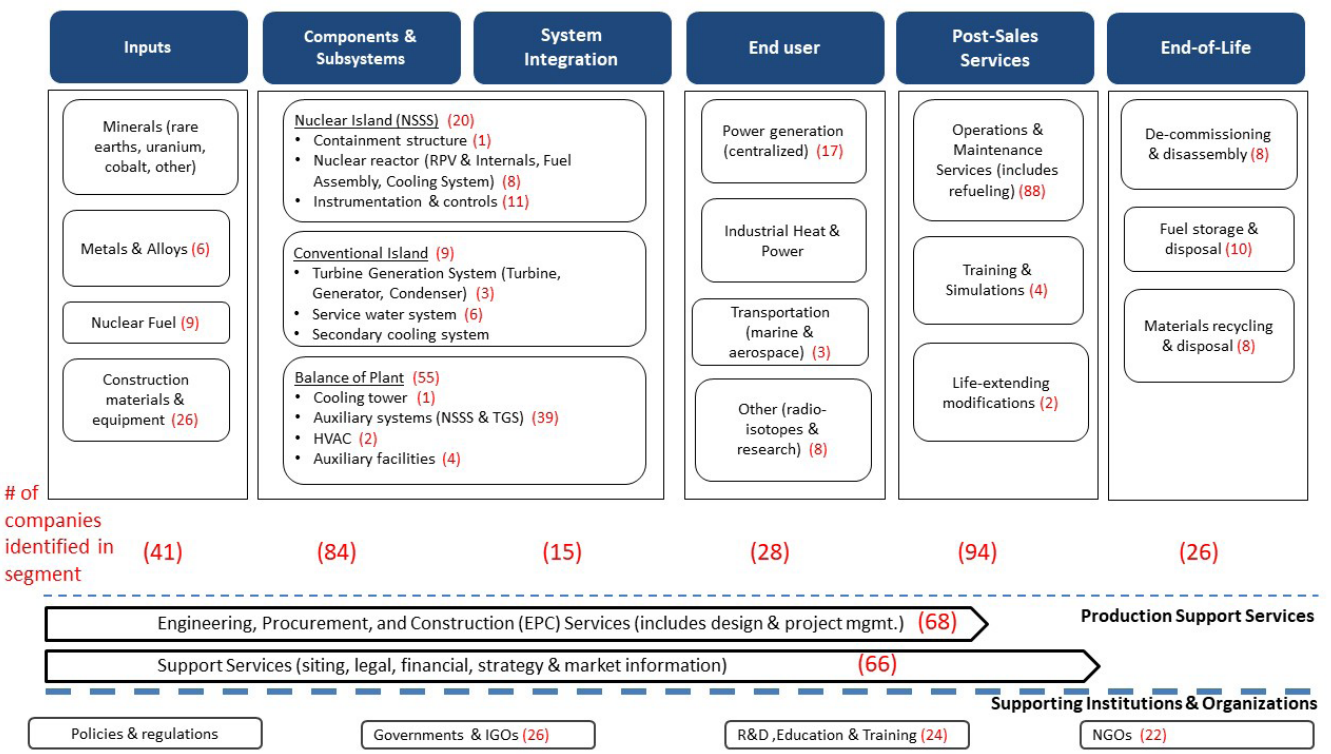
Figure 4: Southeast Nuclear Companies



Source: Authors

The review of the region's footprint in the nuclear value chain found that the Southeast has a capable base of companies across the nuclear industry. We found that the Southeast is particularly well-endowed with components & subsystem manufacturers, post-sales service companies, and production support service providers. A summary of the number of companies in each portion of the value chain by primary activity is provided in Figure 5 below.

Figure 5: Number of SE Companies Across the Nuclear Value Chain



Source: Authors

Table 2 summarizes the number of firms in each value chain segment and provides examples of companies located in the Southeast for each segment. Please note that the companies listed in the table are representative but not exhaustive of those whose primary activity is in the value chain segment. Additional companies in each segment are available at www.senuclear.org.

Table 2: SE Nuclear Company Examples By Value Chain Segment

Segment	# Co	Southeast Company Examples
Inputs	41	
Metals & Alloys	6	ATI Specialty Materials, 3M, Carolina Metals
Nuclear fuel	9	GE-H, Centrus Energy, Westinghouse
Construction materials	26	Graybar Electric Co, Gerdau SA, Barnhart Crane & Rigging
Components & Subsystems	84	
Nuclear Island	20	
Containment structure	1	Primetals Technologies USA LLC
Nuclear reactor	8	ThyssenKrupp, TE Connectivity, Mitsubishi Power (MHI)
Instrumentation & Controls	11	Lockheed Martin Corp, Schneider Electric, Mirion Technologies
Conventional Island	9	
Turbine Generation System	3	GE; Siemens Energy; Control Southern
Service water system	6	Consolidated Pipe & Supply, Bristol Metals; Hoffer Flow Controls
Balance of Plant	55	
Cooling tower	1	Tower Engineering Professionals
Auxiliary systems	39	FlowServe Corp, Emerson/ASCO, Sulzer
HVAC	2	Bahson (EMCOR), SPX Technologies Inc
Auxiliary facilities	4	Woven Electronics LLC, Keller's Inc , Barrier 1 Systems Inc
Systems Integration	15	Hitachi Ltd, BWX Technologies Inc, Mitsubishi Electric
End-user	28	
Power generation	17	Georgia Power (So. Company), Dominion Energy, Duke Energy, TVA
Transportation	3	Maxar Technologies, NASA, HII/Newport News
Other	8	Woodburn Nuclear Medicine, Southeast Nuclear, RbM Services
Post-sales services	94	
O&M	88	Allied Universal, Securitas AB, DEKRA
Life-extending modifications	2	Structural Integrity Associates, Advanced Nuclear (Irex), (See also EPC services)
Training & Simulations	4	Dade Moeller (NV5), Mastering Business Development, Operations Support Services
End-of-Life	26	
De-commissioning & disassembly	8	Environmental Alternatives Inc. (EAI), BHI Energy, River Technologies
Fuel storage & disposal	10	Orano USA, Columbiana High Tech, AVANTech, LLC
Materials recycling & disposal	8	Energy *Solutions*, WAI (VNS Federal Services), Perma-FIX Environmental Services Inc, United Cleanup Oak Ridge, LLC (UCOR)
Production Support Services	134	
EPC Services	68	Jacobs, Parsons, Kiewit Corporation, Bechtel Power
Support services	66	
Legal	5	Baker Donelson; Pillsbury Law; Bradley, Arant, LLC.

Segment	# Co	Southeast Company Examples
Financial	6	Aon; Deloitte LLP; Ernst & Young LLP
Siting	5	Geosyntec Consultants; Merrick & Company; Haley & Aldrich
Strategy & Market Info	13	Booz Allen Hamilton; Accenture; Moody's
Other	37	Capgemini; Applied Technical Services; ABZ, Inc.
Supporting I&O	72	
Education & training	24	NC State; VCU; Aiken Technical College
Governments & IGOs	26	Tennessee Department of Environment & Conservation (TDEC); U.S. Department of Energy; Nuclear Waste Technical Review Board
NGOs	22	E4 Carolinas; East Tennessee Economic Council; World Association of Nuclear Operators (WANO)

Note: Firms listed are examples of companies active in each value chain segment. Additional firms identified in each segment are available at https://www.senuclear.org

Source: Authors

Several firms in the company inventory stand out due to the number of segments and subsegments in which they are active. The list includes large nuclear power plant technology vendors Westinghouse and GE-Hitachi, SMR technology vendors Rolls-Royce and Kairos Power, and commercial nuclear fuel and component producer BWX Technologies. Also on the list are major international industrial equipment manufacturing and service companies Mitsubishi Power, Toshiba Energy Systems, and Siemens Energy, as well as the full-service EPC Burns & McDonnell. A list of the top ten companies in the SE Nuclear Value chain in terms of breadth of activity across the nuclear value chain is provided in Table 3 below.[15]

Table 3: Top 10 Firms In The SE Nuclear Value Chain, By Breadth of Activity

Company Name	HQ	U.S. HQ	Southeast Locations
Mitsubishi Power	Yokohama, Japan	Lake Mary, FL	Charlotte (NC), Pooler (GA)
Rolls-Royce SMR	London (UK)	Reston, VA	Reston (VA), Prince George (VA), Graniteville (SC), Savannah (GA)
Westinghouse Electric	Pittsburg, PA	Pittsburg, PA	Chattanooga (TN), Hopkins (SC), Manning (SC), Rock Hill (SC), Memphis (TN)
Ultra Safe Nuclear Corp	Seattle, WA	Seattle, WA	Oak Ridge (TN)
General Electric	Boston, MA	Boston, MA	Greenville (SC), Alpharetta (GA), Atlanta (GA), Durham (NC), Flatrock (SC), Wilmington (NC)
Burns & McDonnell	Kansas City, MO	Kansas City, MO	Aiken (SC), Greenville (SC); Atlanta (GA), Charlotte (NC), Chattanooga (TN), Raleigh (NC), Chesapeake (VA), Richmond (VA), Roanoke (VA)
Toshiba Energy Systems	Kanagawa, Japan	Milwaukee, WI	Chattanooga (TN)
Siemens Energy	Munich, Germany	Orlando, FL	Charlotte (NC), Raleigh(NC), Alpharetta (GA)
Kairos Power	Alameda, CA	Alameda, CA	Charlotte (NC); Oak Ridge (TN)
BWX Technologies	Lynchburg, VA	Lynchburg, VA	Aiken (SC); Charlotte (NC); Erwin (TN), Lynchburg (VA); Oak Rigge (TN)

Note: the table lists selected companies by the number of segments and subsegments in which they are active in the nuclear value chain. For a full list, please visit https://www.senuclear.org

Source: Authors

Notable also are companies with multiple branch locations across the Southeast (Table 4). The companies stand out due to the number of sites in the region and their importance to job and sales revenue in the regional economy. The top three in the list are production support and O&M companies. Allied Universal and Securitas provide facility services, while Marsh & McLennan is a major insurance provider for nuclear power plants. Component suppliers Graybar Electric and Consolidated Pipe & Supply are leading global suppliers of electrical components and pipes, valves, and fittings (respectively) used in nuclear plants. Jacobs is a full-service EPC, design, and D&D company with deep experience in the nuclear industry; it specializes in program management, decommissioning, demolition, site closure, nuclear radioactive waste management, and site remediation and revitalization. ABB provides wiring, electrical components, computer & software systems, integration & controls used in nuclear power plants. Hitachi provides electronics, power industrial equipment, and digital services (IoT) to the nuclear industry. Tetra Tech provides consulting, engineering, and technical services related to nuclear cleanup and environmental remediation. DEKRA provides worker safety and inspection services to the nuclear industry. Honeywell International provides electronic components and services to the nuclear industry including HVAC contracting and supply, software, industrial automation, business alarm systems, HVAC wholesale supplier, micro switches, safety products, and telecommunication. Their activities in the nuclear industry also include uranium hexafluoride (UF6) conversion for nuclear fuel production and operating nuclear security sites as part of their Federal Manufacturing & Technologies (Honeywell FM&T) division.

Table 4: Top 10 Firms In The SE Nuclear Value Chain, By Number of Locations

Company Name	HQ	U.S. HQ	SE Locations	States (# of locations)
Allied Universal	Santa Ana, CA	Santa Ana, CA	46	VA(6), NC(13), SC(11), GA(10), TN (6)
Securitas AB	Stockholm, Sweden	Boston, MA	41	VA(8), NC(6), SC(8), GA(12), TN(7)
Marsh & McLennan	New York, NY	New York, NY	29	VA(6), NC(8), SC(3), GA(9), TN(3)
Graybar Electric Co	Clayton, MO	Clayton, MO	28	VA(7), NC(6), SC(5), GA(4), TN(6)
Jacobs	Dallas, TX	Dallas, TX	25	VA(10), NC(3), SC(3), GA(4), TN(5)
ABB Ltd	Zurich, Switzerland	Cary, NC	25	VA(1), NC(17), SC(1), GA(1), TN(5)
Hitachi Ltd	Tokyo, Japan	Santa Clara, CA	23	VA(0), NC(6), SC(5), GA(7), TN(5)
Tetra Tech	Pasadena, CA	Pasadena, CA	23	VA(13), NC(2), SC(2), GA(3), TN(3)
DEKRA	Stuttgart, Germany	Atlanta, GA	22	VA(1), NC(3), SC(0), GA(18), TN(0)
Consolidated Pipe & Supply	Birmingham, AL	Birmingham, AL	22	VA(2), NC(3), SC(4), GA(8), TN(5)
Honeywell International	Charlotte, NC	Charlotte, NC	22	VA(6), NC(4), SC(4), GA(6), TN(2)

Note: the table lists firms by the number of branch locations in the Southeast U.S. Additional companies are available at https://www.senuclear.org

Source: Authors

The Southeast hosts important supporting organizations, including research universities and national labs conducting primary research on a variety of nuclear topics and associated nuclear-related construction and engineering. Major universities with significant nuclear research and technology development labs are provided in Table 5. The region also boasts three national labs: Savannah River National Laboratory (Aiken, SC), Oak Ridge National Laboratory (Oak Ridge, TN), Jefferson ("JLab") National Accelerator Facility (Newport News, VA). Supporting organizations with active nuclear interests include the Electric Power Research Institute (EPRI) and E4 Carolinas, based in Charlotte, NC.

Table 5: Southeast Universities with Nuclear-Relevant Programs and Laboratories

Institution	Location	Relevant Programs and Laboratories
George Mason University	Fairfax, VA	Systems Engineering (B.S.), Applied and Engineering Physics (M.S.)
Georgia Institute of Technology	Atlanta, GA	Nuclear and Radiological Engineering and Medical Physics Programs (B.S., M.S., Ph.D.); Fusion Research Center, Radiological Science and Engineering Laboratory
North Carolina State University	Raleigh, NC	Nuclear Engineering (B.S., M.S., Ph.D.); Nuclear Reactor Program (Pulstar Research Reactor); Simulation Hub; Center for Nuclear Energy Facilities and Structures (CNEFS).
University of North Carolina at Charlotte	Charlotte, NC	Energy Production & Infrastructure Center (EPIC)
University of South Carolina	Columbia, SC	Mechanical and Nuclear Engineering (M.S., Ph.D.) USC Nuclear Materials Laboratory, Thermal Hydraulics Laboratory, High Performance Computing, Used Fuel Drying and Disposition Laboratory
University of Tennessee, Knoxville	Knoxville, TN	Nuclear Engineering (B.S., M.S., Ph.D.)
University of Virginia	Charlottesville, VA	Physics (B.S., M.S., Ph.D.); Aerospace, Electrical, Materials Science, Mechanical, and Systems Engineering (B.S., M.Eng., M.S., Ph.D.)
South Carolina State University	Orangeburg, SC	Civil & Mechanical Engineering Technology and Nuclear Engineering (B.S.)
Virginia Commonwealth University	Richmond, VA	Nuclear Engineering Concentration (B.S), Nuclear Engineering (M.S., Ph.D.), Department of Radiation Sciences (B.S.)
Virginia Polytechnic (Virginia Tech)	Blacksburg, VA	Nuclear Engineering (Ph.D., M.S., M.E.)

Note: this list does not include civil, mechanical, and electrical engineering programs at listed institutions.
Source: summarized from Gilligan, John (2020) "Nuclear Science and Engineering Education Sourcebook" Version 8.20 U.S. DOE/ANS.

In addition to university degree-granting programs are community colleges that help develop a range of skilled positions important to nuclear planning & construction, power plant operations, and decommissioning phases of the nuclear value chain.[16] Programs may use the Institute of Nuclear Power Operations (INPO) Uniform Curriculum Program (UCP) Guide, a curriculum to standardize associate degree nuclear training across the nation. Associates Degree (A.A.S) programs and non-degree continuing education programs at community colleges located in the Southeast are listed in Table 6.[17]

Table 6: Nuclear Industry Community College Programs

Institution	Location	Relevant Programs(s)	Degree(s)
Aiken Technical College*	Aiken, SC	1. Nuclear Quality Systems; 2. Manufacturing & Technology Training Center (MTTC); 3. Construction and Industrial Training	1. Associates (A.A.S), Nuclear Quality Systems; 2. Associates (A.A.S.), Industrial Technology; 3. Construction and Industrial Training; Continuing education programs (non-degree)
Augusta Technical College	Augusta, GA	1. Nuclear Engineering Technology (NET) Program; 2. Construction and Industrial Updates	1. Associates (A.A.S), Applied Science; 2. Construction and Industrial Updates (non-degree)
Cape Fear Community College	Wilmington, NC	1.Nuclear Technology; 2.Nuclear Technology CCP Pathway (HS)	1.Associates (A.A.S), Nuclear Technology 2. qualified reactor field technicians (non-degree).
Chattanooga State Community College*	Chattanooga, TN	Nuclear Power Engineering Technology	Engineering Technology (A.A.S)
Wake Technical College	Raleigh, NC	Nuclear Engineering	Associates (A.A.S), Engineering
Midlands Technical College*	Midlands, SC	Nuclear Systems Technology	Certificate
Spartanburg Technical College*	Spartanburg, SC	Operational Technology; Process Control	Operational Technology (A.A.S); Process Control Technology (A.A.S., certificate)

**NEI Nuclear Uniform Curriculum Program (NUCP) partner*

Source: Authors

The Southeast United States possesses a remarkable set of strengths that positions the region to remain a global hub of the nuclear industry. Existing nuclear power plants, a strong group of nuclear technology vendors and value chain partners, national labs, and universities will help meet the demand for clean energy for the region's growing population while offering opportunities for companies and workers. In the next section of this report, we reveal just how strong the current contribution of the nuclear industry is to the region's economy.

2. THE ECONOMIC IMPACT OF THE SOUTHEAST NUCLEAR INDUSTRY

The nuclear industry makes sizeable and unique contributions to the region's economy. Nuclear power plants, in particular, currently employ a sizable workforce and support large, extensive supply chain networks throughout the local regions in which they are located. These supply chain networks, in turn, generate significant economic ripple effects across many industries that are far higher than in most other industry sectors. These ripple effects include additional indirect job creation that supports higher incomes for local residents and a substantial increase in overall economic activity.
This section of the report documents the economic impact of the nuclear industry in the Southeastern United States, with a specific focus on the states of Georgia, North Carolina, South Carolina, Tennessee, and Virginia – including all ongoing operations and associated business activities.

2.1 PREVIOUS STUDIES

There have been multiple previous impact studies that have examined the size and scope of the nuclear industry at both the regional and national level in recent years. At the national level, the most frequently published research comes from the United States Department of Energy's (DOE) annual release of its U.S. Energy & Employment Report, which estimates the direct employment base of the nuclear industry alongside a broader assessment of the economic impacts resulting from electric power generation. Additionally, the Nuclear Energy Institute, the World Nuclear Association, as well as many private research groups have all assessed the economic impact of the U.S. nuclear industry using a variety of overlapping methodologies as they seek to quantify and focus on different components of the industry.[i]

The economic impact of the nuclear industry in the Southeastern United States that is most closely associated with the approach taken in this study is the Carolinas' Nuclear Cluster CELDi Project Report 2012-2013 conducted by Clemson University in 2013, which focused exclusively on the states of North and South Carolina. The study was completed during a period in which there was active construction of new nuclear reactors in and around the Carolinas two-state region as well as before the cessation of all activities at the V.C. Summer nuclear station in Jenkinsville, South Carolina. As such, the composition of the nuclear industry has changed substantially in the years since, requiring an updated assessment of the economic impact of the region.

Finally, there have been various economic assessments that have examined the specific impacts of individual national lab sites along with related professional service, supplier, and research & development firms around the country that support the nuclear industry. The studies include the ongoing nuclear-related activities at the facility being examined, but are generally focused on examining the total impact of the facility, including non-nuclear activities. As a result, these studies tend to overestimate the contribution of these facilities to the nuclear industry alone.

2.2 PROJECT SCOPE

2.2.1 Geography

This report defines the study area as the states of Georgia, North Carolina, South Carolina, Tennessee, and Virginia – collectively referred to as the Southeastern United States. Six separate economic models were created to capture the economic impacts; one for the Southeastern United States and one for each of the five states in the study area.

2.2.2 Activities Modeled

In this study, the economic impact of the nuclear industry is categorized into three primary sets of economic activities.

ACTIVITY 1

The total impact of all current operations of nuclear power plants – including direct effects, secondary effects associated with supplier firms, and the increase in aggregate spending due to expenditures made by employees of both the nuclear power plants and their suppliers.

ACTIVITY 2

The total impact of all firms serving as suppliers for nuclear power plants and other nuclear facilities that are located outside of the Southeastern United States. Or put another way, Activity 2 represents the impacts of firms within the Southeastern United States that are contained within the supply chain of nuclear power plants and other nuclear facilities located outside of the Southeastern United States. This includes all impacts associated with the supplier firms themselves and additional secondary effects (e.g., vendors of the supplier firms and all accompanying household spending arising from employee expenditures).

ACTIVITY 3

The impact of non-Department of Defense (DOD) federal facilities engaged in nuclear-related research & development, waste remediation, and related activities – including direct and secondary effects.

2.2.3 Impacts Modeled

All organizations encompassing the nuclear industry as defined above collectively employ a large workforce and support an extensive supply chain network throughout the five-state region in order to facilitate their ongoing operations. The expenditures made by these organizations with local businesses and suppliers as well as through wages and salaries paid to employees introduce new spending activity at a statewide and regional level that would not exist otherwise. As a result, the presence of the nuclear industry in each state provides a stable base of activity that also helps contribute to long-run economic growth.

Economic impacts can be divided into direct, indirect, and induced impacts. Direct effects are based on the activity of the nuclear power plant itself, typically described in terms of employment at, or sales generated by, a facility. Indirect effects are based on the supply chain effects of a facility, in our example, a nuclear power plant. For example, when a nuclear power plant purchases goods and services from one of its vendors, this vendor experiences an increase in demand. To satisfy this demand, it must then hire more workers and increase purchases from its own suppliers. These suppliers then experience an increase in demand, and so on. Thus, the initial dollars that are spent by the nuclear power plant are re-spent over and over again through a supplier network, which is known as the indirect effect.

A similar effect – known as the induced effect – occurs with the employees of the nuclear power plant and its suppliers. These workers spend part of their incomes in the local economy, thereby increasing the demand for a variety of goods and services (such as dining, transportation, or recreation). Once again, the initial payroll dollars are re-spent multiple times in the region. Collectively, these subsequent rounds of spending are known as the economic multiplier effect. This effect makes the impact of local expenditures on the part of a nuclear facility far larger.

These successive rounds of indirect and induced spending do not go on forever, which is why a specific value can be calculated for each of them. In each round, money is "leaked out" for a variety of reasons. For example, firms may purchase some of their supplies from vendors located outside of the local area. In addition, employees will save part of their income or spend part of it with firms located outside of the area. In order to determine the total economic impact that will result from an initial direct impact, economic multipliers are used. An economic multiplier can be used to determine the total impact (direct, indirect, and induced) that results from an initial change in economic activity (the direct impact). Multipliers are different in each sector of the economy and are largely determined by the size of the local supplier network as well as the particular region being examined. In addition, economic multipliers are available to calculate not just the total impact, but also the total employment and income levels associated with the total impact.
In order to estimate the total impact (direct, indirect, and induced) from a given initial increase in expenditure activity (direct), economic input-output models are used. In each state being analyzed, an input-output model is tailored with specific parameters that represent that state, which is based on the estimated dynamic relationships of over 500 industry categories. Direct, indirect, and induced economic impacts will be reported for estimates of employment (job creation), labor income, and overall economic output (GDP). Once these impacts are estimated, specific employment, income, and output multipliers can be derived. These multipliers will highlight the total additional gains in economic activity that result from direct business activity associated with all nuclear facilities and firms engaged in nuclear-related activities in each state. Additionally, the business activities associated with the nuclear industry also generate both state- and regional-level tax revenue that will be quantified. The input-output modeling software IMPLAN is used to calculate all estimates.

Following the estimation of direct, indirect, and induced effects associated with the current economic impact of the nuclear industry, this study models the economic impact of a billion dollar investment in the construction and operation of a new nuclear power plant in the five-state study region and in each state. The purpose of modeling this hypothetical investment in the nuclear power sector is to estimate the economic impacts resulting from constructing and operating a plant at a fixed level of investment, and to better understand the impacts associated with nuclear power plant construction vs. ongoing operations among different states in the study area.

2.2.4 Data Sources and Methods

Activity 1

In this study, measuring the direct impacts resulting from the operations of all nuclear power plants (Activity 1) begins with the utilization of raw employment data from the U.S. Bureau of Labor Statistics' (BLS) North American Industry Classification System (NAICS), in which nuclear power plants are classified under six-digit NAICS code 221113: Nuclear Electric Power Generation. However, due to BLS data suppression requirements, South Carolina employment totals are the only ones publicly available for NAICS code 221113. In order to estimate direct employment totals in each of the four remaining states, the following two-step process was utilized: (1) First, using estimates from the Nuclear Energy Institute that track the total annual volume of nuclear power generation at the state level (as measured in MWh), the ratio of nuclear employment-to-nuclear power generation was calculated for South Carolina. This ratio represents an estimate of the number of employees working in nuclear electric power generation per nuclear MWh generated in South Carolina. (2) Second, this ratio was applied to the total number of MWh generated by nuclear power in each of the remaining states, which provides an estimate of the total number of employees working in nuclear electric power generation in each of these states. These results appear in Table 7. In sum, the nuclear power plants across the five-state region being examined are estimated to contain 10,680 employees.

Table 7: Total Direct Employment in Nuclear Electric Power Generation

State	Georgia	North Carolina	South Carolina	Tennessee	Virginia	**Five-State Total**
Employment	2,040	1,950	2,830	2,000	1,860	**10,680**

Source: *Author's Calculations based on U.S. BLS QCEW, 2021*

Activity 2

Activity 2 represents the impacts of firms within the Southeastern United States that are contained within the supply chain of nuclear power plants located outside of the Southeastern United States. This includes all impacts associated with the supplier firms themselves and additional secondary effects (e.g., vendors of the supplier firms and all accompanying household spending arising from employee expenditures).

The first step towards capturing the impacts of these additional firms is to specifically identify who they are. This identification process is not straightforward because many firms that supply nuclear power plants are not always "fully contained" within the nuclear industry. In other words, these are often firms that service both nuclear power plants as well as other non-nuclear businesses. For example, consider an engineering firm located in North Carolina that provides engineering services to both nuclear power plants and coal power plants outside of the five-state region. In such a case, only the percentage of the business activity of this engineering firm that is supported by its nuclear-related work should be included in Activity 2.

In order to identify the companies that belong in Activity 2, E4 Carolinas used a subscription database (ReferenceUSA) to derive employment counts for each branch location of companies in the nuclear industry. For those entirely engaged in the nuclear industry, their full employment count was included. For those engaged in a mix of industries, ten percent of the total reported employment count was included. The results are listed in Table 8.

Table 8: Total Direct Employment in Establishments Serving Nuclear Power Plants (or their Suppliers) Outside of the Southeast Region

State	Georgia	North Carolina	South Carolina	Tennessee	Virginia	**Five-State Total**
Employment	3,213	3,434	3,077	2,796	8,183	**20,703**

Source: *E4 Carolinas and ReferenceUSA*

Activity 3

Activity 3 consists of selected non-DOD federal facilities, chosen in consultation with E4 Carolinas, that are primarily engaged in nuclear-related research & development, waste remediation, and related activities. These facilities, along with their total direct employment levels, are listed in Table 9. Note that although the vast majority of the workforce at each of these facilities are highly likely to be primarily or fully engaged in nuclear-related activity, due to data limitations it is not possible to know the degree to which any non-nuclear activities may also be taking place. Also note that all economic activity generated by this employment base is modeled as using industry NAICS codes 541715 (Research and Development in the Physical, Engineering, and Life Sciences and 562910 (Remediation Services).

Table 9: Total Direct Employment of Selected Non-DOD Federal Facilities

Facility	Employment
SC – Savannah River Nuclear Solutions (SRNS)	6,041
SC – Savannah River Mission Completion (SRMC)	3,590
SC – Savannah River National Lab (SRNL)	1,112
TN - Oak Ridge National Lab	5,800
TN – Y-12 National Security Complex	6,000
VA – Thomas Jefferson National Accelerator Facility	766
Total	**23,309**

Source: *E4 Carolinas*

Total Direct Impact Estimates: Activities 1-3

The estimates in Tables 7-9 can be combined in order to estimate the total direct economic impact of the nuclear industry in the five-state region being analyzed. Table 10 highlights these totals as previously described. Across all five states, the annual direct impact of the nuclear industry is estimated to total 54,692 employees.

Table 10: Total Direct Impact of Nuclear Industry in the Southeast

State	Activity 1	Activity 2	Activity 3	Total
Georgia	2,040	3,213	0	5,253
North Carolina	1,950	3,434	0	5,384
South Carolina	2,830	3077	10,743	16,650
Tennessee	2,000	2,796	11,800	16,596
Virginia	1,860	8,183	766	10,809
Five-State Total	**10,680**	**20,703**	**23,309**	**54,692**

[i] *Specific citations of reports referenced in this section are displayed in the References Section at the end of this report document.*

2.3 TOTAL ECONOMIC IMPACT: FIVE-STATE REGION

As previously shown in Table 10, the annual direct impact of the nuclear industry on the five-state Southeastern U.S. region is estimated to total 54,692 employees. These direct economic impacts also lead to indirect and induced impacts through increases in demand for goods and services in other related industries and through increases in household spending activity – all of which are estimated using economic multipliers. Each of these impacts is reported in Table 11, along with the accompanying totals. These totals represent the overall impact of the nuclear industry on the five-state region[18]. Tables 11 - 50 report calculated values derived from the IMPLAN modeling software.

Table 11: Economic Impact of the Nuclear Industry on the Five-State Region

	Employment	Labor Income	Economic Output	Tax Revenue
Direct Impact	54,692	$6,629,810,338	$21,260,047,121	
Indirect Impact	47,803	$4,031,971,826	$12,629,515,435	
Induced Impact	50,104	$3,067,753,306	$9,042,871,485	
Total Impact	**152,598**	**$13,729,535,470**	**$42,932,434,041**	**$3,680,442,161**

Source: *IMPLAN, 2021*

The total direct employment base of the nuclear industry across the five-state region is estimated to be 54,692. This workforce (along with all associated non-labor expenditures) is estimated to generate approximately $21.2 billion in annual economic output. Additionally, this level of direct economic activity leads to indirect effects totaling approximately $12.6 billion in economic output and 47,803 jobs. These estimates reflect the increased demand for goods and services of local suppliers throughout the five-state region. The direct economic activity also leads to induced effects totaling $9.0 billion in economic output and 50,104 jobs. This is a reflection of economic activity in the five-state region generated across all industries that is the result of increased household spending. The combination of the direct, indirect, and induced effects leads to a total economic impact of approximately $42.9 billion, which is associated with 152,598 jobs in Georgia, North Carolina, South Carolina, Tennessee, and Virginia. This economic activity results in $3.6 billion in annual state and local tax revenues.

2.4 RESULTS BY MAJOR ACTIVITY: FIVE-STATE REGION

This section presents a breakdown of the overall economic impact of the nuclear industry on the five-state region by major activity.

2.4.1 Activity 1 – Nuclear Electric Power Generation

Activity 1 consists of the economic impact of all current operations of nuclear power plants within the five-state region – including both direct effects and all secondary effects associated with supplier firms as well as the demand generated through local household spending arising from expenditures made by employees of both the nuclear power plants and their suppliers. These results are displayed in Table 12.

Table 12: Economic Impact of Nuclear Electric Power Generation on the Five-State Region

	Employment	Labor Income	Economic Output
Direct Impact	10,680	$2,373,512,823	$10,445,780,341
Indirect Impact	17,428	$1,538,774,851	$6,577,086,362
Induced Impact	19,789	$1,126,701,271	$3,578,129,276
Total Impact	**47,897**	**$5,038,988,945**	**$20,600,995,979**

Source: *IMPLAN, 2021*

The total direct employment base within nuclear electric power generation across the five-state region is estimated to be 10,680. This workforce (along with all associated non-labor expenditures) is estimated to generate approximately $10.4 billion in annual economic output. Additionally, this level of direct economic activity leads to indirect effects totaling approximately $6.6 billion in economic output and 17,428 jobs. These estimates reflect the increased demand for goods and services of local suppliers throughout the five-state region. The direct economic activity also leads to induced effects totaling $3.6 billion in economic output and 19,789 jobs. This is a reflection of economic activity in the five-state region generated across all industries that is the result of increased household spending. The combination of the direct, indirect, and induced effects leads to a total economic impact of approximately $20.6 billion, which is associated with 47,897 jobs.

Note also from the results in Table 12 that nuclear power plants generally maintain an employment multiplier of 4.5 across the five-state region, meaning that for every 10 jobs created directly by nuclear power plants, another 35 jobs, on average, are created elsewhere in the five-state region. This additional secondary job creation arises from increases in total demand that results from nuclear-related businesses purchasing raw materials and supplies from their vendors and from workers at these businesses spending their wages in the local economy in a variety of industries (e.g., food, entertainment, health care). This multiplier effect of 4.5 is also significantly higher than that of the average industry in the five-state region, which is 1.9. This means that future growth in the nuclear industry may generate a higher employment return relative to the average industry in the five-state region.

The utilities industry sector (including nuclear) often has substantially higher multiplier effect within a local region than most others. The reason for this difference arises from at least two primary factors: (1) the necessity of minimizing lead times; (2) the necessity of local experience. In both cases, these necessities incentivize utility companies to purchase raw materials locally, thus creating a larger in-state supply chain. The larger in-state supply chain is what generates the higher multiplier effect.

2.4.2 Activity 2 – Establishments Serving Nuclear Power Plants (or their Suppliers) Outside of the Southeast Region

Activity 2 consists of the total impact of all firms serving as suppliers for nuclear power plants that are located outside of the Southeastern United States. In other words, Activity 2 represents the impacts of firms within the Southeastern United States that are contained within the supply chain of nuclear power plants located outside of the Southeastern United States. This includes all impacts associated with the supplier firms themselves and additional secondary effects (e.g., vendors of the supplier firms and all accompanying household spending arising from employee expenditures). These results are displayed in Table 13.

Table 13: Economic Impact of Establishments Serving Nuclear Power Plants (or their Suppliers) Outside of the Southeast Region

	Employment	Labor Income	Economic Output
Direct Impact	20,702	$1,981,377,242	$4,966,014,969
Indirect Impact	14,132	$1,158,331,392	$2,768,042,775
Induced Impact	14,068	$902,907,974	$2,535,729,676
Total Impact	**48,902**	**$4,042,616,608**	**$10,269,787,420**

Source: *IMPLAN, 2021*

The total direct employment base encompassing all of Activity 2 across the five-state region is estimated to be 20,702. This workforce (along with all associated non-labor expenditures) is estimated to generate approximately $5.0 billion in annual economic output. Additionally, this level of direct economic activity leads to indirect effects totaling approximately $2.8 billion in economic output and 14,132 jobs. These estimates reflect the increased demand for goods and services of local suppliers throughout the five-state region. The direct economic activity also leads to induced effects totaling $2.5 billion in economic output and 14,068 jobs. This is a reflection of economic activity in the five-state region generated across all industries that is the result of increased household spending. The combination of the direct, indirect, and induced effects leads to a total economic impact of approximately $10.3 billion, which is associated with 48,902 jobs.

242.3 Activity 3 – Selected Non-DOD Federal Facilities Engaged in Nuclear-Related Activities

Activity 3 consists of selected non-DOD federal facilities, chosen in consultation with E4 Carolinas, that are primarily engaged in nuclear-related research & development, waste remediation, and related activities. These results are displayed in Table 14.

Table 14: Economic Impact of Non-DOD Federal Facilities Engaged in Nuclear-Related Activities

	Employment	Labor Income	Economic Output
Direct Impact	23,309	$2,230,891,805	$5,591,384,548
Indirect Impact	15,912	$1,304,199,905	$3,116,622,021
Induced Impact	15,839	$1,016,611,049	$2,855,053,764
Total Impact	**55,060**	**$4,551,702,759**	**$11,563,060,333**

Source: *IMPLAN, 2021*

The total direct employment base encompassing all of Activity 3 across the five-state region is estimated to be 23,309. This workforce (along with all associated non-labor expenditures) is estimated to generate approximately $5.6 billion in annual economic output. Additionally, this level of direct economic activity leads to indirect effects totaling approximately $3.1 billion in economic output and 15,912 jobs. These estimates reflect the increased demand for goods and services of local suppliers throughout the five-state region. The direct economic activity also leads to induced effects totaling $2.8 billion in economic output and 15,839 jobs. This is a reflection of economic activity in the five-state region generated across all industries that is the result of increased household spending. The combination of the direct, indirect, and induced effects leads to a total economic impact of approximately $11.5 billion, which is associated with 55,060 jobs.

2.5 FISCAL IMPACTS: FIVE-STATE REGION

The ongoing activities of the nuclear industry, in addition to generating a sizable volume of jobs and incomes statewide, also generates tax benefits as denoted in Table 15. Specifically, the IMPLAN modeling tool reveals that the regional (five-state) tax revenue generated from the nuclear industry's $42.9 billion economic impact totals approximately $3.7 billion that would not exist otherwise.

Table 15: Regional (Five-State) Tax Revenue Generated by the Nuclear Industry

State	Georgia	North Carolina	South Carolina	Tennessee	Virginia	Five-State Total
Employment	335,743,694	367,501,403	1,107,005,447	1,027,741,331	842,450,286	**3,680,442,161**

Source: *IMPLAN, 2021*

2.6 CONSTRUCTION AND OPERATIONS SCENARIOS: FIVE-STATE REGION

In addition to the current economic impact of the nuclear industry, the economic impacts resulting from the construction and subsequent operations of a new nuclear power plant can also be modeled. This allows for a direct comparison of the differences between impacts associated with nuclear power plant construction vs. ongoing operations. Specifically, Table 16 illustrates the total economic impact that would result from a $1 billion investment towards the construction of a new nuclear power plant[18]. By contrast, Table 17 illustrates the total economic impact that would result from a nuclear power plant facilitating approximately $1 billion in annual operations.

Table 16: Hypothetical Economic Impact of Nuclear Power Plant Construction

	Employment	Labor Income	Economic Output
Direct Impact	7,790	$514,266,871	$1,000,000,000
Indirect Impact	2,177	$165,942,983	$450,767,007
Induced Impact	3,447	$196,369,933	$541,686,293
Total Impact	**13,414**	**$876,579,787**	**$1,992,453,300**

Source: *IMPLAN, 2021*

Table 17: Hypothetical Economic Impact of Nuclear Power Plant Operations

	Employment	Labor Income	Economic Output
Direct Impact	1,022	$227,222,165	$1,000,000,000
Indirect Impact	1,669	$147,310,665	$629,640,501
Induced Impact	1,894	$107,861,858	$342,543,033
Total Impact	**4,585**	**$482,394,688**	**$1,972,183,533**

Source: *IMPLAN, 2021*

There are several differences to note between the impacts of construction and ongoing operations. First, consider that the employment effects associated with $1 billion in new construction are far higher than for operations. A $1 billion investment in new construction is estimated to generate a total of 13,414 jobs, compared to just 4,585 jobs for ongoing operations. This is primarily due to the difference in the nature of the industries being supported – the construction of a nuclear power plant requires more labor than its operations. The wage differences in these positions that reflect differences in occupations can also be observed. Tables 16 and 17 imply that the average wage for all jobs associated with construction-related activities is $65,348, which can be compared to $105,211 for all nuclear-related jobs associated with plant operations. Finally, as previously described, note again the unusually high employment multiplier effect of 4.5 for plant operations. This means that, on average, for every 10 jobs created by a nuclear power plant in the five-state region, an additional 35 jobs are created elsewhere. This is far higher than the employment multiplier of 1.7 for new construction.

3. STATE-LEVEL ECONOMIC IMPACTS

3.1 GEORGIA

3.1.1 Total Economic Impact: Georgia

The annual direct impact of the nuclear industry on the state of Georgia is estimated to total 5,253 employees. These direct economic impacts also lead to indirect and induced impacts through increases in demand for goods and services in other related industries and through increases in household spending activity – all of which are estimated using economic multipliers. Each of these impacts is reported in Table 18, along with the accompanying totals. These totals represent the overall impact of the nuclear industry on the state of Georgia.

Table 18: Total Economic Impact of the Nuclear Industry in Georgia

	Employment	Labor Income	Economic Output
Direct Impact	5,253	$786,616,562	$2,788,073,399
Indirect Impact	5,175	$435,246,800	$1,494,925,332
Induced Impact	5,813	$341,818,439	$1,021,677,993
Total Impact	**16,241**	**$1,563,681,801**	**$5,304,676,724**

Source: *IMPLAN, 2021*

The total direct employment base of the nuclear industry in Georgia is estimated to be 5,253. This workforce (along with all associated non-labor expenditures) is estimated to generate approximately $2.8 billion in annual economic output. Additionally, this level of direct economic activity leads to indirect effects totaling approximately $1.5 billion in economic output and 5,175 jobs. These estimates reflect the increased demand for goods and services of local suppliers throughout the state of Georgia. Direct economic activity also leads to induced effects totaling $1 billion in economic output and 5,813 jobs. This is a reflection of economic activity in Georgia generated across all industries that is the result of increased household spending. The combination of the direct, indirect, and induced effects leads to a total economic impact of approximately $5.3 billion, which is associated with 16,241 jobs across all of Georgia.

3.1.2 Results by Major Activity: Georgia

This section presents a breakdown of the overall economic impact of the nuclear industry on the state of Georgia by major activity.

3.1.2.1 Activity 1 – Nuclear Electric Power Generation in Georgia

Activity 1 consists of the economic impact of all current operations of nuclear power plants within the state of Georgia – including both direct effects and all secondary effects associated with supplier firms as well as the demand generated through local household spending arising from expenditures made by employees of both the nuclear power plants and their suppliers. These results are displayed in Table 19.

Table 19: Economic Impact of Nuclear Electric Power Generation in Georgia

	Employment	Labor Income	Economic Output
Direct Impact	2,040	$506,265,743	$2,036,145,525
Indirect Impact	3,032	$261,095,010	$1,089,123,049
Induced Impact	3,862	$214,749,288	$678,651,791
Total Impact	**8,934**	**$982,110,041**	**$3,803,920,365**

Source: *IMPLAN, 2021*

The total direct employment base within nuclear electric power generation in Georgia is estimated to be 2,040. This workforce (along with all associated non-labor expenditures) is estimated to generate approximately $2.0 billion in annual economic output. Additionally, this level of direct economic activity leads to indirect effects totaling approximately $1.1 billion in economic output and 3,032 jobs. These estimates reflect the increased demand for goods and services of local suppliers throughout Georgia. The direct economic activity also leads to induced effects totaling $678.7 million in economic output and 3,862 jobs. This is a reflection of economic activity in Georgia generated across all industries that is the result of increased household spending. The combination of the direct, indirect, and induced effects leads to a total economic impact of approximately $3.8 billion, which is associated with 8,934 jobs.

3.1.2.2 Activity 2 – Georgia Establishments Serving Nuclear Power Plants (or their Suppliers) Outside of Georgia

Activity 2 consists of the total impact of all firms serving as suppliers for nuclear power plants that are located outside of the state of Georgia. In other words, Activity 2 represents the impacts of firms within Georgia that are contained within the supply chain of nuclear power plants located outside of Georgia. This includes all impacts associated with the supplier firms themselves and additional secondary effects (e.g., vendors of the supplier firms and all accompanying household spending arising from employee expenditures). These results are displayed in Table 20.

Table 20: Economic Impact of Georgia Establishments Serving Nuclear Power Plants (or their Suppliers) Outside of Georgia

	Employment	Labor Income	Economic Output
Direct Impact	3,213	$280,686,776	$753,523,127
Indirect Impact	2,146	$174,305,839	$406,653,236
Induced Impact	1,954	$127,206,364	$343,497,858
Total Impact	**7,313**	**$582,198,980**	**$1,503,674,279**

Source: *IMPLAN, 2021*

The total direct employment base encompassing all of Activity 2 in Georgia is estimated to be 3,213. This workforce (along with all associated non-labor expenditures) is estimated to generate approximately $753.5 million in annual economic output. Additionally, this level of direct economic activity leads to indirect effects totaling approximately $406.7 million in economic output and 2,146 jobs. These estimates reflect the increased demand for goods and services of local suppliers throughout the state of Georgia. The direct economic activity also leads to induced effects totaling $343.5 million in economic output and 1,954 jobs. This is a reflection of economic activity in the state of Georgia generated across all industries that is the result of increased household spending. The combination of the direct, indirect, and induced effects leads to a total economic impact of approximately $1.5 billion, which is associated with 7,313 jobs.

3.1.3 Fiscal Impacts: Georgia

The ongoing activities of the nuclear industry, in addition to generating a sizable volume of jobs and incomes statewide, also generates tax benefits as denoted in Table 21. Specifically, the IMPLAN modeling tool reveals that the tax revenue generated for the state of Georgia from the nuclear industry's $5.3 billion economic impact totals approximately $335.7 million that would not exist otherwise.

Table 21: Tax Revenue Generated by the Nuclear Industry in Georgia

Region	Tax Revenue
Georgia	$335,743,694

Source: *IMPLAN, 2021*

3.1.4 Construction and Operations Scenarios: Georgia

In addition to the current economic impact of the nuclear industry, the economic impacts resulting from the construction and subsequent operations of a new nuclear power plant in Georgia can also be modeled. This allows for a direct comparison of the differences between impacts associated with nuclear power plant construction vs. ongoing operations. Specifically, Table 22 illustrates the total economic impact that would result from a $1 billion investment towards the construction of a new nuclear power plant. By contrast, Table 23 illustrates the total economic impact that would result from a nuclear power plant facilitating approximately $1 billion in annual operations.

Table 22: Hypothetical Economic Impact of Nuclear Power Plant Construction in Georgia (per $1B)

	Employment	Labor Income	Economic Output
Direct Impact	7,591	$482,785,583	$1,000,000,000
Indirect Impact	2,014	$153,217,209	$400,399,167
Induced Impact	3,257	$178,131,138	$482,455,653
Total Impact	**12,862**	**$814,133,930**	**$1,882,854,820**

Source: *IMPLAN, 2021*

Table 23: Hypothetical Economic Impact of Nuclear Power Plant Operations in Georgia (per $1B)

	Employment	Labor Income	Economic Output
Direct Impact	1,002	$248,639,273	$1,000,000,000
Indirect Impact	1,489	$128,230,034	$534,894,503
Induced Impact	1,897	$105,468,535	$333,302,204
Total Impact	**4,388**	**$482,337,842**	**$1,868,196,707**

Source: *IMPLAN, 2021*

There are several differences to note between the impacts of construction and ongoing operations. First, consider that the employment effects associated with $1 billion in new construction are far higher than for operations. A $1 billion investment in new construction is estimated to generate a total of 12,862 jobs, compared to just 4,388 jobs for ongoing operations. This is primarily due to the difference in the nature of the industries being supported – the construction of a nuclear power plant requires more labor than its operations. The wage differences in these positions that reflect differences in occupations can also be observed. Tables 22 and 23 imply that the average wage for all jobs associated with construction-related activities is $63,298, which can be compared to $109,922 for all nuclear-related jobs associated with plant operations. Finally, as previously described, note again the unusually high employment multiplier effect of 4.4 for plant operations. This means that, on average, for every 10 jobs created by a nuclear power plant in the five-state region, an additional 34 jobs are created elsewhere. This is far higher than the employment multiplier of 1.7 for new construction.

3.2 NORTH CAROLINA

3.2.1 Total Economic Impact: North Carolina

The annual direct impact of the nuclear industry on the state of North Carolina is estimated to total 5,384 employees. These direct economic impacts also lead to indirect and induced impacts through increases in demand for goods and services in other related industries and through increases in household spending activity – all of which are estimated using economic multipliers. Each of these impacts is reported in Table 24, along with the accompanying totals. These totals represent the overall impact of the nuclear industry on the state of North Carolina.

Table 24: Total Economic Impact of the Nuclear Industry in North Carolina

	Employment	Labor Income	Economic Output
Direct Impact	5,384	$804,033,948	$2,557,939,810
Indirect Impact	4,824	$419,499,342	$1,378,847,412
Induced Impact	5,286	$316,720,461	$944,063,570
Total Impact	**15,494**	**$1,540,253,751**	**$4,880,850,792**

Source: *IMPLAN, 2021*

The total direct employment base of the nuclear industry in North Carolina is estimated to be 5,384. This workforce (along with all associated non-labor expenditures) is estimated to generate approximately $2.6 billion in annual economic output. Additionally, this level of direct economic activity leads to indirect effects totaling approximately $1.4 billion in economic output and 4,824 jobs. These estimates reflect the increased demand for goods and services of local suppliers throughout the state of North Carolina. Direct economic activity also leads to induced effects totaling $944 million in economic output and 5,286 jobs. This is a reflection of economic activity in North Carolina generated across all industries that is the result of increased household spending. The combination of the direct, indirect, and induced effects leads to a total economic impact of approximately $4.9 billion, which is associated with 15,494 jobs across all of North Carolina.

3.2.2 Results by Major Activity: North Carolina

This section presents a breakdown of the overall economic impact of the nuclear industry on the state of North Carolina by major activity.

3.2.2.1 Activity 1 – Nuclear Electric Power Generation in North Carolina

Activity 1 consists of the economic impact of all current operations of nuclear power plants within the state of North Carolina – including both direct effects and all secondary effects associated with supplier firms as well as the demand generated through local household spending arising from expenditures made by employees of both the nuclear power plants and their suppliers. These results are displayed in Table 25.

Table 25: Economic Impact of Nuclear Electric Power Generation in North Carolina

	Employment	Labor Income	Economic Output
Direct Impact	1,950	$531,145,337	$2,007,629,912
Indirect Impact	2,796	$248,977,164	$1,084,407,230
Induced Impact	3,698	$202,365,130	$649,265,762
Total Impact	**8,444**	**$982,487,631**	**$3,741,302,904**

Source: *IMPLAN, 2021*

The total direct employment base within nuclear electric power generation in North Carolina is estimated to be 1,950. This workforce (along with all associated non-labor expenditures) is estimated to generate approximately $2.0 billion in annual economic output. Additionally, this level of direct economic activity leads to indirect effects totaling approximately $1.1 billion in economic output and 2,796 jobs. These estimates reflect the increased demand for goods and services of local suppliers throughout North Carolina. The direct economic activity also leads to induced effects totaling $649.3 million in economic output and 3,698 jobs. This is a reflection of economic activity in North Carolina generated across all industries that is the result of increased household spending. The combination of the direct, indirect, and induced effects leads to a total economic impact of approximately $3.7 billion, which is associated with 8,444 jobs.

3.2.2.2 Activity 2 – North Carolina Establishments Serving Nuclear Power Plants (or their Suppliers) Outside of North Carolina

Activity 2 consists of the total impact of all firms serving as suppliers for nuclear power plants that are located outside of the state of North Carolina. In other words, Activity 2 represents the impacts of firms within North Carolina that are contained within the supply chain of nuclear power plants located outside of North Carolina. This includes all impacts associated with the supplier firms themselves and additional secondary effects (e.g., vendors of the supplier firms and all accompanying household spending arising from employee expenditures). These results are displayed in Table 26.

Table 26: Economic Impact of North Carolina Establishments Serving Nuclear Power Plants (or their Suppliers) Outside of North Carolina

	Employment	Labor Income	Economic Output
Direct Impact	3,434	$342,077,102	$862,081,517
Indirect Impact	2,330	$198,505,067	$463,134,481
Induced Impact	2,102	$139,631,334	$383,422,968
Total Impact	**7,866**	**$680,213,503**	**$1,708,638,966**

Source: *IMPLAN, 2021*

The total direct employment base encompassing all of Activity 2 in North Carolina is estimated to be 3,434. This workforce (along with all associated non-labor expenditures) is estimated to generate approximately $862 million in annual economic output. Additionally, this level of direct economic activity leads to indirect effects totaling approximately $463.1 million in economic output and 2,330 jobs. These estimates reflect the increased demand for goods and services of local suppliers throughout the state of North Carolina. The direct economic activity also leads to induced effects totaling $383.4 million in economic output and 2,102 jobs. This is a reflection of economic activity in the state of North Carolina generated across all industries that is the result of increased household spending. The combination of the direct, indirect, and induced effects leads to a total economic impact of approximately $1.7 billion, which is associated with 7,866 jobs.

3.2.3 Fiscal Impacts: North Carolina

The ongoing activities of the nuclear industry, in addition to generating a sizable volume of jobs and incomes statewide, also generates tax benefits as denoted in Table 27. Specifically, the IMPLAN modeling tool reveals that the tax revenue generated for the state of North Carolina from the nuclear industry's $4.9 billion economic impact totals approximately $367.5 million that would not exist otherwise.

Table 27: Tax Revenue Generated by the Nuclear Industry in North Carolina

Region	Tax Revenue
North Carolina	$367,501,403

Source: *IMPLAN, 2021*

3.2.4 Construction and Operations Scenarios: North Carolina

In addition to the current economic impact of the nuclear industry, the economic impacts resulting from the construction and subsequent operations of a new nuclear power plant in North Carolina can also be modeled. This allows for a direct comparison of the differences between impacts associated with nuclear power plant construction vs. ongoing operations. Specifically, Table 28 illustrates the total economic impact that would result from a $1 billion investment towards the construction of a new nuclear power plant. By contrast, Table 29 illustrates the total economic impact that would result from a nuclear power plant facilitating approximately $1 billion in annual operations.

Table 28: Hypothetical Economic Impact of Nuclear Power Plant Construction in North Carolina (per $1B)

	Employment	Labor Income	Economic Output
Direct Impact	7,724	$474,106,416	$1,000,000,000
Indirect Impact	1,998	$141,321,353	$402,748,487
Induced Impact	2,903	$159,482,865	$460,472,666
Total Impact	**12,625**	**$774,910,634**	**$1,863,221,153**

Source: *IMPLAN, 2021*

Table 29: Hypothetical Economic Impact of Nuclear Power Plant Operations in North Carolina (per $1B)

	Employment	Labor Income	Economic Output
Direct Impact	971	$264,563,371	$1,000,000,000
Indirect Impact	1,393	$124,015,468	$540,142,993
Induced Impact	1,842	$100,798,025	$323,399,127
Total Impact	**4,206**	**$489,376,864**	**$1,863,542,120**

Source: *IMPLAN, 2021*

There are several differences to note between the impacts of construction and ongoing operations. First, consider that the employment effects associated with $1 billion in new construction are far higher than for operations. A $1 billion investment in new construction is estimated to generate a total of 12,625 jobs, compared to just 4,206 jobs for ongoing operations. This is primarily due to the difference in the nature of the industries being supported – the construction of a nuclear power plant requires more labor than its operations. The wage differences in these positions that reflect differences in occupations can also be observed. Tables 28 and 29 imply that the average wage for all jobs associated with construction-related activities is $61,379, which can be compared to $116,352 for all nuclear-related jobs associated with plant operations. Finally, as previously described, note again the unusually high employment multiplier effect of 4.3 for plant operations. This means that, on average, for every 10 jobs created by a nuclear power plant in the five-state region, an additional 33 jobs are created elsewhere. This is far higher than the employment multiplier of 1.6 for new construction.

3.3 SOUTH CAROLINA

3.3.1 Total Economic Impact: South Carolina

The annual direct impact of the nuclear industry on the state of South Carolina is estimated to total 16,650 employees. These direct economic impacts also lead to indirect and induced impacts through increases in demand for goods and services in other related industries and through increases in household spending activity – all of which are estimated using economic multipliers. Each of these impacts is reported in Table 30, along with the accompanying totals. These totals represent the overall impact of the nuclear industry on the state of South Carolina.

Table 30: Total Economic Impact of the Nuclear Industry in South Carolina

	Employment	Labor Income	Economic Output
Direct Impact	16,650	$1,740,992,435	$6,219,650,869
Indirect Impact	13,750	$872,235,956	$3,039,033,989
Induced Impact	11,549	$556,640,942	$1,865,236,871
Total Impact	**41,949**	**$3,169,869,333**	**$11,123,921,729**

Source: *IMPLAN, 2021*

The total direct employment base of the nuclear industry in South Carolina is estimated to be 16,650. This workforce (along with all associated non-labor expenditures) is estimated to generate approximately $6.2 billion in annual economic output. Additionally, this level of direct economic activity leads to indirect effects totaling approximately $3.0 billion in economic output and 13,750 jobs. These estimates reflect the increased demand for goods and services of local suppliers throughout the state of South Carolina. The direct economic activity also leads to induced effects totaling $1.9 billion in economic output and 11,549 jobs. This is a reflection of economic activity in South Carolina generated across all industries that is the result of increased household spending. The combination of the direct, indirect, and induced effects leads to a total economic impact of approximately $11.1 billion, which is associated with 41,949 jobs across all of South Carolina.

3.3.2 Results by Major Activity: South Carolina

This section presents a breakdown of the overall economic impact of the nuclear industry on the state of South Carolina by major activity.

3.3.2.1 Activity 1 – Nuclear Electric Power Generation in South Carolina

Activity 1 consists of the economic impact of all current operations of nuclear power plants within the state of South Carolina – including both direct effects and all secondary effects associated with supplier firms as well as the demand generated through local household spending arising from expenditures made by employees of both the nuclear power plants and their suppliers. These results are displayed in Table 31.

Table 31: Economic Impact of Nuclear Electric Power Generation in South Carolina

	Employment	Labor Income	Economic Output
Direct Impact	2,830	$509,657,176	$2,568,236,599
Indirect Impact	4,204	$289,195,990	$1,291,059,904
Induced Impact	3,504	$169,990,653	$574,077,120
Total Impact	**10,538**	**$968,843,819**	**$4,433,373,623**

Source: *IMPLAN, 2021*

The total direct employment base within nuclear electric power generation in South Carolina is estimated to be 2,830. This workforce (along with all associated non-labor expenditures) is estimated to generate approximately $2.6 billion in annual economic output. Additionally, this level of direct economic activity leads to indirect effects totaling approximately $1.3 billion in economic output and 4,204 jobs. These estimates reflect the increased demand for goods and services of local suppliers throughout South Carolina. The direct economic activity also leads to induced effects totaling $574.1 million in economic output and 3,504 jobs. This is a reflection of economic activity in South Carolina generated across all industries that is the result of increased household spending. The combination of the direct, indirect, and induced effects leads to a total economic impact of approximately $4.4 billion, which is associated with 10,538 jobs.

3.3.2.2 Activity 2 – South Carolina Establishments Serving Nuclear Power Plants (or their Suppliers) Outside of South Carolina

Activity 2 consists of the total impact of all firms serving as suppliers for nuclear power plants that are located outside of the state of South Carolina. In other words, Activity 2 represents the impacts of firms within South Carolina that are contained within the supply chain of nuclear power plants located outside of South Carolina. This includes all impacts associated with the supplier firms themselves and additional secondary effects (e.g., vendors of the supplier firms and all accompanying household spending arising from employee expenditures). These results are displayed in Table 32.

Table 32: Economic Impact of Nuclear Electric Power Generation in South Carolina

	Employment	Labor Income	Economic Output
Direct Impact	3,077	$261,640,691	$724,510,696
Indirect Impact	2,017	$121,561,027	$343,837,321
Induced Impact	1,699	$81,673,799	$272,425,267
Total Impact	**6,793**	**$464,875,517**	**$1,340,773,284**

Source: *IMPLAN, 2021*

The total direct employment base encompassing all of Activity 2 in South Carolina is estimated to be 3,077. This workforce (along with all associated non-labor expenditures) is estimated to generate approximately $724.5 million in annual economic output. Additionally, this level of direct economic activity leads to indirect effects totaling approximately $343.8 million in economic output and 2,017 jobs. These estimates reflect the increased demand for goods and services of local suppliers throughout the state of South Carolina. Direct economic activity also leads to induced effects totaling $272.4 million in economic output and 1,699 jobs. This is a reflection of economic activity in the state of South Carolina generated across all industries that is the result of increased household spending. The combination of the direct, indirect, and induced effects leads to a total economic impact of approximately $1.3 million, which is associated with 6,793 jobs.

3.3.2.3 Activity 3 – Selected South Carolina Non-DOD Federal Facilities Engaged in Nuclear-Related Activities

Activity 3 consists of the selected non-DOD federal facilities previously identified in Table 9, chosen in consultation with E4 Carolinas, that are primarily engaged in nuclear-related research & development, waste remediation, and related activities throughout South Carolina. These results are displayed in Table 33.

Table 33: Economic Impact of Non-DOD Federal Facilities Located in South Carolina and Engaged in Nuclear-Related Activities

	Employment	Labor Income	Economic Output
Direct Impact	10,743	$913,489,087	$2,529,547,739
Indirect Impact	7,040	$424,416,672	$1,200,469,412
Induced Impact	5,938	$285,154,905	$951,142,233
Total Impact	**23,721**	**$1,623,060,664**	**$4,681,159,384**

Source: *IMPLAN, 2021*

The total direct employment base encompassing all of Activity 3 in South Carolina is estimated to be 10,743. This workforce (along with all associated non-labor expenditures) is estimated to generate approximately $2.5 billion in annual economic output. Additionally, this level of direct economic activity leads to indirect effects totaling approximately $1.2 billion in economic output and 7,040 jobs. These estimates reflect the increased demand for goods and services of local suppliers throughout South Carolina. The direct economic activity also leads to induced effects totaling $951.1 million in economic output and 5,938 jobs. This is a reflection of economic activity in South Carolina generated across all industries that is the result of increased household spending. The combination of the direct, indirect, and induced effects leads to a total economic impact of approximately $4.7 billion, which is associated with 23,721 jobs.

3.3.3 Fiscal Impacts: South Carolina

The ongoing activities of the nuclear industry, in addition to generating a sizable volume of jobs and incomes statewide, also generates tax benefits as denoted in Table 34. Specifically, the IMPLAN modeling tool reveals that the tax revenue generated for the state of South Carolina from the nuclear industry's $11.1 billion economic impact totals approximately $1.1 billion that would not exist otherwise.

Table 34: Tax Revenue Generated by the Nuclear Industry in South CarolinaCarolina

Region	Tax Revenue
South Carolina	$1,107,005,447

Source: *IMPLAN, 2021*

3.3.4 Construction and Operations Scenarios: South Carolina

In addition to the current economic impact of the nuclear industry, the economic impacts resulting from the construction and subsequent operations of a new nuclear power plant in South Carolina can also be modeled. This allows for a direct comparison of the differences between impacts associated with nuclear power plant construction vs. ongoing operations. Specifically, Table 35 illustrates the total economic impact that would result from a $1 billion investment towards the construction of a new nuclear power plant. By contrast, Table 36 illustrates the total economic impact that would result from a nuclear power plant facilitating approximately $1 billion in annual operations.

Table 35: Hypothetical Economic Impact of Nuclear Power Plant Construction in South Carolina (per $1B)

	Employment	Labor Income	Economic Output
Direct Impact	5,558	$380,411,166	$1,000,000,000
Indirect Impact	1,938	$122,318,713	$385,187,655
Induced Impact	2,207	$107,680,767	$364,152,973
Total Impact	**9,703**	**$610,410,646**	**$1,749,340,628**

Source: *IMPLAN, 2021*

Table 36: Hypothetical Economic Impact of Nuclear Power Plant Operations in South Carolina (per $1B)

	Employment	Labor Income	Economic Output
Direct Impact	1,102	$198,446,349	$1,000,000,000
Indirect Impact	1,636	$112,604,886	$502,702,868
Induced Impact	1,365	$66,189,639	$223,529,686
Total Impact	**4,103**	**$377,240,874**	**$1,726,232,554**

Source: *IMPLAN, 2021*

There are several differences to note between the impacts of construction and ongoing operations. First, consider that the employment effects associated with $1 billion in new construction are far higher than for operations. A $1 billion investment in new construction is estimated to generate a total of 9,703 jobs, compared to just 4,103 jobs for ongoing operations. This is primarily due to the difference in the nature of the industries being supported – the construction of a nuclear power plant requires more labor than its operations. The wage differences in these positions that reflect differences in occupations can also be observed. Tables 35 and 36 imply that the average wage for all jobs associated with construction-related activities is $62,909, which can be compared to $91,942 for all nuclear-related jobs associated with plant operations. Finally, as previously described, note again the unusually high employment multiplier effect of 3.7 for plant operations. This means that, on average, for every 10 jobs created by a nuclear power plant in South Carolina, an additional 27 jobs are created elsewhere. This is far higher than the employment multiplier of 1.7 for new construction.

3.4 TENNESSEE

3.4.1 Total Economic Impact: Tennessee

The annual direct impact of the nuclear industry on the state of Tennessee is estimated to total 16,596 employees. These direct economic impacts also lead to indirect and induced impacts through increases in demand for goods and services in other related industries and through increases in household spending activity – all of which are estimated using economic multipliers. Each of these impacts is reported in Table 37, along with the accompanying totals. These totals represent the overall impact of the nuclear industry on the state of Tennessee.

Table 37: Total Economic Impact of the Nuclear Industry in Tennessee

	Employment	Labor Income	Economic Output
Direct Impact	16,596	$1,604,914,166	$5,192,947,601
Indirect Impact	12,728	$936,692,168	$2,722,010,463
Induced Impact	10,962	$659,873,408	$1,871,409,824
Total Impact	**40,286**	**$3,201,479,742**	**$9,786,367,888**

Source: *IMPLAN, 2021*

The total direct employment base of the nuclear industry in Tennessee is estimated to be 16,596. This workforce (along with all associated non-labor expenditures) is estimated to generate approximately $5.2 billion in annual economic output. Additionally, this level of direct economic activity leads to indirect effects totaling approximately $2.7 billion in economic output and 12,728 jobs. These estimates reflect the increased demand for goods and services of local suppliers throughout the state of Tennessee. Direct economic activity also leads to induced effects totaling $1.9 billion in economic output and 10,962 jobs. This is a reflection of economic activity in Tennessee generated across all industries that is the result of increased household spending. The combination of the direct, indirect, and induced effects leads to a total economic impact of approximately $9.8 billion, which is associated with 40,286 jobs across all of Tennessee.

3.4.2 Results by Major Activity: Tennessee

This section presents a breakdown of the overall economic impact of the nuclear industry on the state of Tennessee by major activity.

3.4.2.1 Activity 1 – Nuclear Electric Power Generation in Tennessee

Activity 1 consists of the economic impact of all current operations of nuclear power plants within the state of Tennessee – including both direct effects and all secondary effects associated with supplier firms as well as the demand generated through local household spending arising from expenditures made by employees of both the nuclear power plants and their suppliers. These results are displayed in Table 38.

Table 38: Economic Impact of Nuclear Electric Power Generation in Tennessee

	Employment	Labor Income	Economic Output
Direct Impact	2,000	$360,181,750	$1,815,008,197
Indirect Impact	2,970	$204,378,791	$912,409,826
Induced Impact	2,477	$120,134,738	$405,708,212
Total Impact	**7,447**	**$684,695,279**	**$3,133,126,235**

Source: *IMPLAN, 2021*

The total direct employment base within nuclear electric power generation in Tennessee is estimated to be 2,000. This workforce (along with all associated non-labor expenditures) is estimated to generate approximately $1.8 billion in annual economic output. Additionally, this level of direct economic activity leads to indirect effects totaling approximately $912.4 million in economic output and 2,970 jobs. These estimates reflect the increased demand for goods and services of local suppliers throughout Tennessee. The direct economic activity also leads to induced effects totaling $405.7 million in economic output and 2,477 jobs. This is a reflection of economic activity in Tennessee generated across all industries that is the result of increased household spending. The combination of the direct, indirect, and induced effects leads to a total economic impact of approximately $3.1 billion, which is associated with 7,447 jobs.

3.4.2.2 Activity 2 – Tennessee Establishments Serving Nuclear Power Plants (or their Suppliers) Outside of Tennessee

Activity 2 consists of the total impact of all firms serving as suppliers for nuclear power plants that are located outside of the state of Tennessee. In other words, Activity 2 represents the impacts of firms within Tennessee that are contained within the supply chain of nuclear power plants located outside of Tennessee. This includes all impacts associated with the supplier firms themselves and additional secondary effects (e.g., vendors of the supplier firms and all accompanying household spending arising from employee expenditures). These results are displayed in Table 39.

Table 39: Economic Impact of Nuclear Electric Power Generation in Tennessee

	Employment	Labor Income	Economic Output
Direct Impact	2,796	$235,705,661	$627,577,292
Indirect Impact	1,846	$138,781,245	$337,064,243
Induced Impact	1,606	$102,726,079	$277,814,484
Total Impact	**6,248**	**$477,212,985**	**$1,242,456,019**

Source: *IMPLAN, 2021*

The total direct employment base encompassing all of Activity 2 in Tennessee is estimated to be 2,796. This workforce (along with all associated non-labor expenditures) is estimated to generate approximately $627.6 million in annual economic output. Additionally, this level of direct economic activity leads to indirect effects totaling approximately $337.1 million in economic output and 1,846 jobs. These estimates reflect the increased demand for goods and services of local suppliers throughout the state of Tennessee. The direct economic activity also leads to induced effects totaling $277.8 million in economic output and 1,606 jobs. This is a reflection of economic activity in the state of Tennessee generated across all industries that is the result of increased household spending. The combination of the direct, indirect, and induced effects leads to a total economic impact of approximately $1.2 billion, which is associated with 6,248 jobs.

3.4.2.3 Activity 3 – Selected Tennessee Non-DOD Federal Facilities Engaged in Nuclear-Related Activities

Activity 3 consists of the selected non-DOD federal facilities previously identified in Table 9, chosen in consultation with E4 Carolinas, that are primarily engaged in nuclear-related research & development, waste remediation, and related activities throughout Tennessee. These results are displayed in Table 40.

Table 40: Economic Impact of Non-DOD Federal Facilities Located in Tennessee and Engaged in Nuclear-Related Activities

	Employment	Labor Income	Economic Output
Direct Impact	11,800	$994,752,078	$2,648,573,689
Indirect Impact	7,789	$585,700,532	$1,422,517,192
Induced Impact	6,780	$433,536,386	$1,172,464,568
Total Impact	**26,369**	**$2,013,988,996**	**$5,243,555,449**

Source: *IMPLAN, 2021*

The total direct employment base encompassing all of Activity 3 in Tennessee is estimated to be 11,800. This workforce (along with all associated non-labor expenditures) is estimated to generate approximately $2.6 billion in annual economic output. Additionally, this level of direct economic activity leads to indirect effects totaling approximately $1.4 billion in economic output and 7,789 jobs. These estimates reflect the increased demand for goods and services of local suppliers throughout Tennessee. The direct economic activity also leads to induced effects totaling $1.2 billion in economic output and 6,780 jobs. This is a reflection of economic activity in Tennessee generated across all industries that is the result of increased household spending. The combination of the direct, indirect, and induced effects leads to a total economic impact of approximately $5.2 billion, which is associated with 26,369 jobs.

3.4.3 Fiscal Impacts: Tennessee

The ongoing activities of the nuclear industry, in addition to generating a sizable volume of jobs and incomes statewide, also generates tax benefits as denoted in Table 41. Specifically, the IMPLAN modeling tool reveals that the tax revenue generated for the state of Tennessee from the nuclear industry's $9.8 billion economic impact totals approximately $1.0 billion that would not exist otherwise.

Table 41: Tax Revenue Generated by the Nuclear Industry in Tennessee

Region	Tax Revenue
Tennessee	$1,027,741,331

Source: *IMPLAN, 2021*

3.4.4 Construction and Operations Scenarios: Tennessee

In addition to the current economic impact of the nuclear industry, the economic impacts resulting from the construction and subsequent operations of a new nuclear power plant in Tennessee can also be modeled. This allows for a direct comparison of the differences between impacts associated with nuclear power plant construction vs. ongoing operations. Specifically, Table 42 illustrates the total economic impact that would result from a $1 billion investment towards the construction of a new nuclear power plant. By contrast, Table 43 illustrates the total economic impact that would result from a nuclear power plant facilitating approximately $1 billion in annual operations.

Table 42: Hypothetical Economic Impact of Nuclear Power Plant Construction in Tennessee (per $1B)

	Employment	Labor Income	Economic Output
Direct Impact	9,647	$743,788,579	$1,000,000,000
Indirect Impact	2,292	$170,629,012	$434,556,097
Induced Impact	4,215	$253,803,429	$617,368,198
Total Impact	**16,154**	**$1,168,221,020**	**$2,051,924,295**

Source: *IMPLAN, 2021*

Table 43: Hypothetical Economic Impact of Nuclear Power Plant Operations in Tennessee (per $1B)

	Employment	Labor Income	Economic Output
Direct Impact	1,128	$203,121,745	$1,023,560,000
Indirect Impact	1,675	$115,257,857	$514,546,548
Induced Impact	1,397	$67,749,067	$228,796,045
Total Impact	**4,200**	**$386,128,669**	**$1,766,902,593**

Source: *IMPLAN, 2021*

There are several differences to note between the impacts of construction and ongoing operations. First, consider that the employment effects associated with $1 billion in new construction are far higher than for operations. A $1 billion investment in new construction is estimated to generate a total of 16,154 jobs, compared to just 4,200 jobs for ongoing operations. This is primarily due to the difference in the nature of the industries being supported – the construction of a nuclear power plant requires more labor than its operations. The wage differences in these positions that reflect differences in occupations can also be observed. Tables 42 and 43 imply that the average wage for all jobs associated with construction-related activities is $72,318, which can be compared to $91,937 for all nuclear-related jobs associated with plant operations. Finally, as previously described, note again the unusually high employment multiplier effect of 3.7 for plant operations. This means that, on average, for every 10 jobs created by a nuclear power plant in Tennessee, an additional 27 jobs are created elsewhere. This is far higher than the employment multiplier of 1.7 for new construction.

3.5 VIRGINIA

3.5.1 Total Economic Impact: Virginia

The annual direct impact of the nuclear industry on the state of Virginia is estimated to total 10,809 employees. These direct economic impacts also lead to indirect and induced impacts through increases in demand for goods and services in other related industries and through increases in household spending activity – all of which are estimated using economic multipliers. Each of these impacts is reported in Table 44, along with the accompanying totals. These totals represent the overall impact of the nuclear industry on the state of Virginia.

Table 44: Total Economic Impact of the Nuclear Industry in Virginia

	Employment	Labor Income	Economic Output
Direct Impact	10,809	$1,374,845,503	$3,940,005,307
Indirect Impact	6,865	$659,178,541	$1,873,751,801
Induced Impact	7,030	$443,901,922	$1,260,349,120
Total Impact	**24,704**	**$2,477,925,966**	**$7,074,106,228**

Source: *IMPLAN, 2021*

The total direct employment base of the nuclear industry in Virginia is estimated to be 10,809. This workforce (along with all associated non-labor expenditures) is estimated to generate approximately $3.9 billion in annual economic output. Additionally, this level of direct economic activity leads to indirect effects totaling approximately $1.9 billion in economic output and 6,865 jobs. These estimates reflect the increased demand for goods and services of local suppliers throughout the state of Virginia. Direct economic activity also leads to induced effects totaling $1.3 billion in economic output and 7,030 jobs. This is a reflection of economic activity in Virginia generated across all industries that is the result of increased household spending. The combination of the direct, indirect, and induced effects leads to a total economic impact of approximately $7.1 billion, which is associated with 24,704 jobs across all of Virginia.

3.5.2 Results by Major Activity: Virginia

This section presents a breakdown of the overall economic impact of the nuclear industry on the state of Virginia by major activity.

3.5.2.1 Activity 1 – Nuclear Electric Power Generation in Virginia

Activity 1 consists of the economic impact of all current operations of nuclear power plants within the state of Virginia – including both direct effects and all secondary effects associated with supplier firms as well as the demand generated through local household spending arising from expenditures made by employees of both the nuclear power plants and their suppliers. These results are displayed in Table 45.

Table 45: Economic Impact of Nuclear Electric Power Generation in Virginia

	Employment	Labor Income	Economic Output
Direct Impact	1,860	$418,246,415	$1,926,093,394
Indirect Impact	2,272	$223,984,708	$973,119,649
Induced Impact	2,499	$140,738,528	$449,835,733
Total Impact	**6,631**	**$782,969,6521**	**$33,490,487,776**

Source: *IMPLAN, 2021*

The total direct employment base within nuclear electric power generation in Virginia is estimated to be 1,860. This workforce (along with all associated non-labor expenditures) is estimated to generate approximately $1.9 billion in annual economic output. Additionally, this level of direct economic activity leads to indirect effects totaling approximately $973.1 million in economic output and 2,272 jobs. These estimates reflect the increased demand for goods and services of local suppliers throughout Virginia. The direct economic activity also leads to induced effects totaling $449.8 million in economic output and 2,499 jobs. This is a reflection of economic activity in Virginia generated across all industries that is the result of increased household spending. The combination of the direct, indirect, and induced effects leads to a total economic impact of approximately $3.3 billion, which is associated with 6,631 jobs.

3.5.2.2 Activity 2 – Virginia Establishments Serving Nuclear Power Plants (or their Suppliers) Outside of Virginia

Activity 2 consists of the total impact of all firms serving as suppliers for nuclear power plants that are located outside of the state of Virginia. In other words, Activity 2 represents the impacts of firms within Virginia that are contained within the supply chain of nuclear power plants located outside of Virginia. This includes all impacts associated with the supplier firms themselves and additional secondary effects (e.g., vendors of the supplier firms and all accompanying household spending arising from employee expenditures). These results are displayed in Table 46.

Table 46: Economic Impact of Virginia Establishments Serving Nuclear Power Plants (or their Suppliers) Outside of Virginia

	Employment	Labor Income	Economic Output
Direct Impact	8,138	$889,108,494	$1,963,318,761
Indirect Impact	4,292	$407,439,446	$887,786,367
Induced Impact	4,257	$282,490,981	$761,682,988
Total Impact	**16,687**	**$1,579,038,921**	**$3,612,788,116**

Source: *IMPLAN, 2021*

The total direct employment base encompassing all of Activity 2 in Virginia is estimated to be 8,138. This workforce (along with all associated non-labor expenditures) is estimated to generate approximately $2.0 billion in annual economic output. Additionally, this level of direct economic activity leads to indirect effects totaling approximately $887.8 million in economic output and 4,292 jobs. These estimates reflect the increased demand for goods and services of local suppliers throughout the state of Virginia. The direct economic activity also leads to induced effects totaling $761.7 million in economic output and 4,257 jobs. This is a reflection of economic activity in the state of Virginia generated across all industries that is the result of increased household spending. The combination of the direct, indirect, and induced effects leads to a total economic impact of approximately $3.6 billion, which is associated with 16,687 jobs.

3.5.2.3 Activity 3 – Selected Virginia Non-DOD Federal Facilities Engaged in Nuclear-Related Activities

Activity 3 consists of the selected non-DOD federal facilities previously identified in Table 9, chosen in consultation with E4 Carolinas, that are primarily engaged in nuclear-related research & development, waste remediation, and related activities throughout Virginia. These results are displayed in Table 47.

Table 47: Economic Impact of Non-DOD Federal Facilities Located in Virginia and Engaged in Nuclear-Related Activities

	Employment	Labor Income	Economic Output
Direct Impact	766	$83,688,511	$184,799,972
Indirect Impact	404	$38,350,776	$83,564,064
Induced Impact	400	$26,589,837	$71,694,418
Total Impact	**1,570**	**$148,629,124**	**$340,058,454**

Source: *IMPLAN, 2021*

The total direct employment base encompassing all of Activity 3 in Virginia is estimated to be 766 This workforce (along with all associated non-labor expenditures) is estimated to generate approximately $184.8 million in annual economic output. Additionally, this level of direct economic activity leads to indirect effects totaling approximately $83.5 million in economic output and 404 jobs. These estimates reflect the increased demand for goods and services of local suppliers throughout Virginia. The direct economic activity also leads to induced effects totaling $71.7 million in economic output and 400 jobs. This is a reflection of economic activity in Virginia generated across all industries that is the result of increased household spending. The combination of the direct, indirect, and induced effects leads to a total economic impact of approximately $340.1 million, which is associated with 1,570 jobs.

3.5.3 Fiscal Impacts: Virginia

The ongoing activities of the nuclear industry, in addition to generating a sizable volume of jobs and incomes statewide, also generates tax benefits as denoted in Table 48. Specifically, the IMPLAN modeling tool reveals that the tax revenue generated for the state of Virginia from the nuclear industry's $7.1 billion economic impact totals approximately $842.5 million that would not exist otherwise.

Table 48: Tax Revenue Generated by the Nuclear Industry in Virginia

Region	Tax Revenue
Virginia	$842,450,286

Source: *IMPLAN, 2021*

3.5.4 Construction and Operations Scenarios: Virginia

In addition to the current economic impact of the nuclear industry, the economic impacts resulting from the construction and subsequent operations of a new nuclear power plant in Virginia can also be modeled. This allows for a direct comparison of the differences between impacts associated with nuclear power plant construction vs. ongoing operations. Specifically, Table 49 illustrates the total economic impact that would result from a $1 billion investment towards the construction of a new nuclear power plant. By contrast, Table 50 illustrates the total economic impact that would result from a nuclear power plant facilitating approximately $1 billion in annual operations.

Table 49: Hypothetical Economic Impact of Nuclear Power Plant Construction in Virginia (per $1B)

	Employment	Labor Income	Economic Output
Direct Impact	7,099	$479,660,532	$1,000,000,000
Indirect Impact	1,472	$117,568,508	$311,261,076
Induced Impact	2,289	$131,012,529	$366,333,120
Total Impact	**10,860**	**$728,241,569**	**$1,677,594,196**

Source: *IMPLAN, 2021*

Table 50: Hypothetical Economic Impact of Nuclear Power Plant Operations in Virginia (per $1B)

	Employment	Labor Income	Economic Output
Direct Impact	966	$217,147,527	$1,000,000,000
Indirect Impact	1,179	$116,289,640	$505,229,732
Induced Impact	1,298	$73,069,420	$233,548,245
Total Impact	**3,443**	**$406,506,587**	**$1,738,777,977**

Source: *IMPLAN, 2021*

There are several differences to note between the impacts of construction and ongoing operations. First, consider that the employment effects associated with $1 billion in new construction are far higher than for operations. A $1 billion investment in new construction is estimated to generate a total of 10,860 jobs, compared to just 3,443 jobs for ongoing operations. This is primarily due to the difference in the nature of the industries being supported – the construction of a nuclear power plant requires more labor than its operations. The wage differences in these positions that reflect differences in occupations can also be observed. Tables 49 and 50 imply that the average wage for all jobs associated with construction-related activities is $67,058, which can be compared to $118,072 for all nuclear-related jobs associated with plant operations. Finally, as previously described, note again the unusually high employment multiplier effect of 3.6 for plant operations. This means that, on average, for every 10 jobs created by a nuclear power plant in Virginia, an additional 26 jobs are created elsewhere. This is far higher than the employment multiplier of 1.5 for new construction.

4. CONCLUSION

The nuclear industry maintains a significant economic impact in the Southeastern United States. This study specifically finds that the total economic impact of the nuclear industry on the five-state region of Georgia, North Carolina, South Carolina, Tennessee, and Virginia is $42.9 billion. This level of economic activity is also estimated to support 152,598 jobs and $13.7 billion in labor income that would not exist otherwise.

Putting such estimates into context, these results reveal that the nuclear industry is a major contributor to both job quantity and job quality in the Southeast. Job quantity can be observed through the employment multiplier effect, which is estimated to be 2.8 across the five-state region. This implies that for every 10 jobs created in the nuclear industry, another 18 jobs are created elsewhere in the five-state region. When examining nuclear power plants exclusively, this employment multiplier increases further to 4.5. This is more than twice as high as the average employment multiplier in the five-state region of 1.9. Such a high multiplier effect is primarily the result of the fact that nuclear power plants purchase a relatively high percentage of their raw materials from local vendors because of the need to minimize lead times, reduce transportation costs, and have access to knowledge and experience with respect to local geographic conditions.

Job quality can be observed through wage premiums offered to workers in the nuclear industry. The 152,598 jobs that are currently supported by the nuclear industry (which include all direct and secondary job creation) pay an average wage of $89,972. This represents a wage premium of 65.5 percent over the average job in the five-state Southeastern region.

Finally, note that because of such strong multiplier effects, future investments in new nuclear power plants have the potential to generate significant economic benefits for a local region. This study estimates that for every $100 in revenue generated by a new nuclear power plant in the five-state region, approximately $200 in total economic output would be created, representing a 2:1 ratio. With nuclear power already representing the largest source of clean energy in the United States, any future expansion has the potential to both help the U.S. meet its clean energy goals while simultaneously generating significant benefits for local economies across the nation.

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END NOTES

[1] The generations of nuclear technologies are generally considered as: Generation I – early prototype reactors built in the 1950s and 1960s no longer in operation; Generation II: large commercial light-water power reactors built in the 1970s and 1980s known as boiling water reactors (BWR) and pressurized water reactors (PWR), many of which are still in use today with safety upgrades; Generation III are light-water reactors built since the 1990s – 2010 with advanced safety and operational efficiency, some of which are designated Generation III+ for builds after 2010. See Abram, T. (2002). A Technology Roadmap for Generation-IV Nuclear Energy Systems, USDOE/GIF-002-00. (A Technology Roadmap for Generation-IV Nuclear Energy Systems, USDOE/GIF-002-00). United States Department of Energy, pp.5-6. For an overview of the differences between BWRs and PWRs, see U.S. EIA "Nuclear Explained: Nuclear Power Plants – Types of Reactors". A useful overview of Gen IV nuclear technologies can be found at the Generation IV System. Forum here: https://www.gen-4.org/gif/jcms/c_40486/technology-systems.

[2] See https://en.wikipedia.org/wiki/Generation_IV_reactor; https://en.wikipedia.org/wiki/Nuclear_microreactor

[3] See Arostegui, D. A., & Holt, M. (2023, February). Advanced nuclear reactors: technology overview and current issues. In Congressional Research Service Report for Congress, Washington, DC, Report (No. R45706).

[4] See World Nuclear Association (https://world-nuclear.org/information-library/non-power-nuclear-applications/transport/nuclear-reactors-for-space.aspx) for a discussion of space fisson systems.

[5] For a recent announcement regarding industrial applications for small nuclear reactors, see coverage of Dow, Inc and X-Energy at https://www.powermag.com/x-energy-and-dow-will-deploy-a-320-mwe-xe-100-nuclear-facility-at-gulf-coast-site/. NuScale announced in November 2023 its intention to terminate the Carbon Free Power Project, see https://www.nuscalepower.com/en/news/press-releases/2023/uamps-and-nuscale-power-agree-to-terminate-the-carbon-free-power-project.

[6] The U.K. Energy and Climate Intelligence Unit (https://zerotracker.net/) maintains a list of countries, subnational regions, cities, and companies that have committed to carbon neutrality.

[7] for 50 trillion estimate, see Morgan Stanley (https://www.morganstanley.com/ideas/investing-in-decarbonization). For 100 trillion estimate, see International Energy Agency (IEA)https://iea.blob.core.windows.net/assets/deebef5d-0c34-4539-9d0c-10b13d840027/NetZeroby2050-ARoadmapfortheGlobalEnergySector_CORR.pdf

[8] For more information about IMPLAN and how it calculated economic impacts, please visit: https://support.implan.com/hc/en-us/articles/360038285254-How-IMPLAN-Works

[9] Watts Bar Unit 2 came online in 2016 and was the first reactor to come online since 1996 when the Watts Bar Unit 1 came online (https://www.eia.gov/energyexplained/nuclear/us-nuclear-industry.php). Vogtle-4 is scheduled to enter into service in 2024.

[10] IEA (2022), Nuclear Power and Secure Energy Transitions, IEA, Paris https://www.iea.org/reports/nuclear-power-and-secure-energy-transitions, Executive summary.

[11] https://cardinalnews.org/2022/12/15/dominion-energy-plans-to-deploy-small-modular-nuclear-reactors-statewide-by-2032/

[12] See https://news.duke-energy.com/releases/duke-energy-files-updated-carbon-plan-to-serve-the-growing-energy-needs-of-a-thriving-north-carolina

[13] https://www.ans.org/news/article-5596/granholm-visits-clinch-river-site-to-show-support-for-smrs

[14] A description of what is included in each segment and subsegment of the value chain is included in the Appendix.

[15] See www.senuclear.org for a more comprehensive listing of companies in the SE nuclear value chain.

[16] For a discussion of workforce skills and degree requirements in nuclear engineering and related professions, see Townsend, L. W., Brady, L., Lindegard, J., Hall, H. L., McAndrew-Benavides, E., & Poston, J. W. (2022). Nuclear engineering workforce in the United States. Journal of Applied Clinical Medical Physics, 23. Detailed information regarding nuclear workforce skills, including relevant Standard Occupation Codes, associated with professional, technical, engineering, and craft/skilled trades, see U.S. Bureau of Labor Statistics (2021), National Industry-Specific Occupational Employment and Wage Estimates - NAICS 221113 - Nuclear Electric Power Generation and Tip Strategies (2015) Regional Workforce Study Prepared for the SRS Community Reuse Organization (Appendix B: Nuclear).

[17] Please note that the list does not include nuclear medical technology programs located at Caldwell Community College (NC), Forsyth Tech Community College (NC), Pitt Community College (NC), UNC Chapel Hill (School of Nuclear Medicine Technology & Molecular Imaging), Midlands Technical College (SC), Old Dominion University (VA), Augusta University (GA), Baptist Health Sciences University (TN), Columbia State Community College (TN), South College (TN), Chattanooga State Community College (TN). See https://www.mynextmove.org/profile/ext/training/29-2033.00 for additional information on nuclear medicine technology program offerings.

[18] Tables 11 - 50 report calculated values derived from the IMPLAN modeling software.

[19] Note that spending patterns used for these estimates were derived from the estimated capital cost distribution from the World Nuclear Association: https://world-nuclear.org/information-library/economic-aspects/economics-of-nuclear-power.aspx

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Picture 1, 7: https://www.istockphoto.com/en/photo/cooling-towers-of-nuclear-power-plant-against-blue-sky-gm186947209-27400551?

Picture 2: https://unsplash.com/photos/white-concrete-building-under-white-clouds-during-daytime-ixcHGhae2mg?utm_content=creditShareLink&utm_medium=referral&utm_source=unsplash

Picture 3: https://unsplash.com/photos/a-power-plant-emits-smoke-as-it-sits-in-the-middle-of-a-field---t5njUzxcs?utm_content=creditShareLink&utm_medium=referral&utm_source=unsplash

Picture 5: https://unsplash.com/photos/aerial-photography-of-city-during-night-time-1lfI7wkGWZ4?utm_content=creditShareLink&utm_medium=referral&utm_source=unsplash

Picture 6: https://www.pexels.com/vi-vn/anh/nh-goc-th-p-c-a-cac-toa-nha-nha-may-di-n-h-t-nhan-b-c-khoi-3044470/

Cover page: https://www.istockphoto.com/en/photo/nuclear-power-plant-in-czech-republic-europe-gm481891850-68184685

APPENDIX

The methodological basis for our work is the Global Value Chain (GVC) framework to examine the companies participating in the nuclear value chain in the region. The framework disaggregates final goods and services into their component parts and activities, tracing inputs from raw materials to final consumption, identifying companies producing them, and the organizations and institutions (i.e., regulatory requirements and industry standards) supporting the production system. At its heart, the GVC framework is an actor-oriented framework in which organizations in the private, public, and nonprofit sectors collaborate through various forms of supply chain governance and regulatory institutions to produce products and services consumed by end-users across different end markets. Examples of previous GVC reports related to the energy sector have analyzed green hydrogen, lithium-ion battery energy storage systems, photovoltaic solar power, industrial energy efficiency, the Smart Grid, carbon, capture and storage, and concentrating solar power.

To identify companies participating in the nuclear value chain, we first created a list describing the nuclear value chain actors (Table A-1). On the nuclear production (supply) side, it describes the companies that design, build, operate, maintain, and decommission nuclear power plants. On the demand side, it examines the actors in different end-markets for nuclear power, primarily utilities, but also industrial users interested in process and district heat, transportation applications, radioisotopes used across several industries, and research applications.

Table A-1: NUCLEAR VALUE CHAIN ACTORS

Segment	Subsegment	Description
Inputs	Minerals	The companies mining metals and metal alloys used in nuclear reactors and nuclear power plants.
	Metals & Alloys	The companies producing high-performance metals & alloys such as zirconium, nickel alloys, stainless steel, copper, and titanium critical to nuclear power plant construction and maintenance.
	Nuclear Fuel	The companies producing nuclear fuel used to sustain nuclear fission in a nuclear reactor. Fuels may be low-enriched uranium (3-5% U-235) used in light water reactors or High-Assay Low-Enriched Uranium (HALEU) at (5-19.75% U-235) needed for most Generation IV reactors.
	Construction materials & equipment	The construction material manufacturers (e.g., concrete, rebar, wire), construction equipment manufacturers (graders, bulldozers, cranes, tools), construction material and equipment wholesalers, and construction equipment rental & repair used by construction and installation contractors to build a nuclear power plant at a site. The materials and equipment may be generic building materials or specialized to meet regulatory requirements and specific site-construction needs.

Segment	Subsegment	Description
Components & Subsystems	**System Integrator ("Nuclear technology vendor")**	The company(ies) responsible for developing the nuclear reactor technology, including integrating the components for the nuclear island, conventional island, and balance of plant described under "components & subsystems". Components and sub-systems may be produced in-house or sourced externally.
	Component Suppliers for the Nuclear Power Plant ("NPP")	
	Nuclear Island ("NSSS")	The nuclear steam supply system (NSSS) of a nuclear power plant (NPP) produces steam for the turbine generator units, which generate carbon-free electricity. The NSSS is where the reactor is housed, using nuclear fuel (housed in a fuel assembly) to create nuclear fission. Containment structure: Companies producing the gas-tight shell surrounding a nuclear reactor to confine fission products. Nuclear reactor: the companies producing the reactor pressure vessel & internals, fuel assembly, and cooling system. Instruments & controls: the companies producing the instrumentation and controls for the NSSS.
	Conventional Island	Turbine generation system (TGS): Companies producing the TGS, which includes a turbine, generator, and condenser (heat exchanger). The TGS extracts thermal energy from pressurized steam and converts it into electricity. Service water system: Companies producing service water systems, components, and backup systems. The purpose of the service water system is to provide primary cooling and includes backup systems (diesel generators) to ensure uninterrupted cooling.
	Balance of Plant	Cooling tower: Companies capable of designing and producing the cooling tower, which is part of the secondary cooling system designed to transport heat from the primary system to the atmosphere via an evaporative cooling tower. Auxiliary systems for the NSSS and conventional island: [describe] HVAC: Companies producing the heating, ventilation, and air conditioning units (HVAC) for the NPP. HVACs maintain acceptable limits of temperature, humidity, and monitor contamination levels. Staff training, welfare & security facilities: companies specialized in the design and building of staff training, welfare and security facilities at the plant.
End user	**Power Generation (centralized)**	Utilities and other power plant owners using nuclear power plants for centralized electric power generation (may also include hydrogen production, use & storage).
	Industrial Heat & Power	Industrial power plant owners using nuclear power plants for heat and power applications at an industrial site (may also include hydrogen production, use & storage).
	Transportation	Space and marine (surface & subsurface) vessels using on-board nuclear reactors for on-board power for propulsion, electricity, and heat.
	Other (radioisotopes/ research)	Companies producing and using radioisotopes for industry, food & agriculture, medicine, research and other applications.

Segment	Subsegment	Description
Post-sales Services	**Operations & Maintenance (includes re-fueling)**	Companies involved in nuclear plant operation and maintenance services, including refueling. These companies ensure the safe operation of the plant and make certain that preventative and corrective maintenance of structures, systems, and components are conducted according to schedule.
	Training & Simulations	Companies engaged in providing operational training and experience for reactor operators, engineers, maintenance and plant security personnel.
	Life-extending modifications	Companies involved in providing products and services used to extend the operating life and/or to upgrade nuclear power plants.
End-of-Life	**Decommissioning & disassembly (D&D)**	Companies engaged in the decommissioning and disassembly of nuclear power plants, including dismantling radioactive systems or components. Large engineering firms active as EPC contractors often have D&D capabilities.
	Fuel storage & disposal	Companies engaged in the storage, reprocessing, or disposal of spent nuclear fuel at site-specific or centralized storage facilities.
	Materials recycling & disposal	Companies engaged in materials recycling and disposal of concrete, metal, and plastic. Approximately 90% of materials at a NPP can be recovered or recycled; 5% is disposed of as nuclear waste and another 5% as conventional waste.
Production support services	**EPC Contractor**	The company(ies) responsible for plant design, engineering, procurement & construction of the NPP. Site-specific plant design and engineering are often the bailiwick of the EPC contractor in consultation with the plant owner/operator and nuclear technology vendor and are either conducted in-house or with contracted parties. Procurement and construction activities may be performed by the EPC contractor, or a subcontractor of either the project owner, technology vendor, or the EPC contractor. The EPC function requires close coordination with technology vendors, component suppliers, plant owners, and regulators to ensure that NPP construction is completed on-time and on-budget.
	Support services	The legal, financial, strategy & market information service providers used to support the development, use, extension, and decommissioning requirements of a nuclear power plant.
Supporting Organizations & Policies	**Supporting organizations**	The organizations facilitating industry development through research activities, workforce development, or information exchange, meetings, and lobbying efforts on behalf of interested parties.
	Policies	The federal and state regulatory bodies and incentive policies (tax credits, REPS, carbon goals) supporting the development of nuclear power. This category also includes voluntary clean energy/net zero goals adopted by private firms that incentivize the development of clean energy sources, including nuclear energy.

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