

# North Carolina Innovation Corridor Industry Cluster and Market Analysis

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## Industry Clusters of Focus



Agricultural Technology  
(Agtech)



Human Health Technology  
(Biohealth)



Power Electronics  
for Transportation



Defense Innovation

# Industry Cluster Appendix Overview



## Industry Clusters of Focus



Agricultural Technology  
(Agtech)



Human Health  
Technology  
(Biohealth)



Power Electronics  
for Transportation



Defense Innovation

In support of the RTI Innovation Corridor study, the RTI Innovation Advisors conducted a high-level market analysis and considered the future of four industry clusters to build on to help transform the region's economy. RTI focused on four clusters that fit the following criteria:

1. Assets in place in the region that could be leveraged for growth
2. Emerging signals of growth and innovation such as patents, research, or job growth in the region
3. Potential to have a wide reach across tech-focused cities, medium-sized cities, and rural areas
4. Global market potential

Note: These industry clusters are good starting points, however, they are not the only ones with the potential for transformative growth across this region.

# Innovation Corridor Research Approach: Phases



Innovation and Economic Analysis

Qualitative Review of Regional Needs

Targeted Industry and Market Analysis

Blueprint for an Innovation Corridor

## Phase I

Summarized state and regional innovation economy.

Developed economic and innovation profiles for the Corridor and the four economic hubs.

Detailed in a separate Data Appendix.

## Phase II

Conducted exploratory interviews with stakeholders.

Ground-truthed Phase I findings, identified emerging and cross-cutting innovation trends, and refined research outcomes.

## Phase III

Explored industry clusters with high potential for tech-driven growth and economic opportunity.

Determined market size, potential, and capabilities required for growth. Spoke with industry representatives to determine opportunities and barriers.

## Phase IV

Conducted targeted interviews with stakeholders in each economic hub.

Assessed key investments required to enhance “quality of place” to attract business and talent.

Created a Blueprint for an Innovation Corridor.

# Industry Cluster Definitions and Research Questions



**Agricultural Technology (Agtech)** applies the tools of life science, digital technology, machine learning, and other forms of technology to improve or disrupt the global agricultural sector. These technologies enhance the productivity, sustainability, and/or profitability of the global agriculture industry.



**Human Health Technology (Biohealth)** encompasses the discovery, development, and manufacture of medical devices, pharmaceuticals, and other applications of biotechnology, engineering, and health technology to solve biological or medical problems related to human health.



**Power Electronics for Transportation** uses wide-bandgap (WBG) materials enabling next-generation electric vehicles that will replace internal combustion engine-powered vehicles, transforming the automotive industry and the transportation sector in general.



**Defense Innovation** addresses the U.S. Department of Defense's (DOD's) need for agile, modern, and soldier-centric solutions to enable a strong, modern national security by focusing new research, technology, products, and processes to support DOD missions.

This Industry Cluster Appendix reports findings from Phase 3 of the Innovation Corridor study answering the following key questions:

- Is there market potential?
- Is there expected growth over the next 5–10 years?
- What is the estimated/expected market size in 5 years?
- What capabilities/competencies are needed to develop these areas?
- What capabilities does North Carolina have to get started?

# Rationale for Industry Cluster Selection



**Agricultural Technology (Agtech):** Agtech has a strong presence in the Research Triangle area with potential application of agricultural technologies in the eastern region with animal and crop farms. Food will always be in demand and will be in higher demand as population increases globally. Eastern North Carolina is already viewed as an agtech testing location.



**Human Health Technology (Biohealth):** The entire health sector is represented in the region: from research to start-ups, accelerators, clinical trials/testing, regulatory knowledge, and biomanufacturing. The Corridor is home to four research universities and is the sixth largest recipient of National Institutes of Health (NIH) funding in fiscal year 2019. Market demand for biohealth tech will increase with population increases and exporting potential; there is a strong innovation support organization.



**Power Electronics for Transportation:** This nascent industry cluster has high growth potential and strong innovation assets with PowerAmerica. A cluster of power electronics and semiconductor companies lies in the Research Triangle area and west to Greensboro. Further, the transportation industry is set for disruption as electric vehicles (EVs) replace gas powered. Truck, automotive, and aerospace companies, and their supply chains, can position themselves for power electronics application needs for growth trends in this area in the future.



**Defense Innovation:** The cross-cutting defense industry is under disruption, with the Department of Defense (DOD) incorporating innovation methods that will drive industry from staid, large prime contractors to smaller, nontraditional solution providers. The state is well positioned with the fourth-largest footprint of military personnel and veterans who understand military application domains. The Research Triangle's strengths in computer programming, data science, and artificial intelligence, coupled with an opportunity for secondary industry benefits through dual-use technology commercialization, leaves the Corridor in a strong position to build out a National Security Innovation Network and DOD-funded research and test sites.

# Research Approach



This high-level market research was conducted to better define the potential of the four industry areas that emerged from Phase I of the project. Using an agile research methodology, RTI's Innovation Advisors conducted a preliminary assessment of the market potential over the next 5 to 10 years. To answer the key questions about each sector, our team took the following approach:

- 1 Define the industry sector.
- 2 Map the value chain and identify providers, customers, and support organizations.
- 3 Create an interview guide.
- 4 Interview six to nine companies and organizations from each sector's value chain.
- 5 Estimate the future market size and growth characteristics.
- 6 Determine steps to grow the industry via an interactive workshop.
- 7 Document results in final Blueprint deliverables.

# Agtech Industry Cluster Analysis



## What Is Agtech?

Agtech applies the tools of life science, digital technology, machine learning, and other forms of technology to improve or disrupt the global agricultural sector. These technologies typically focus on enhancing the productivity, efficiency, sustainability, and/or profitability of the global agriculture industry.

# Vision: Agtech as an Economic Force Multiplier

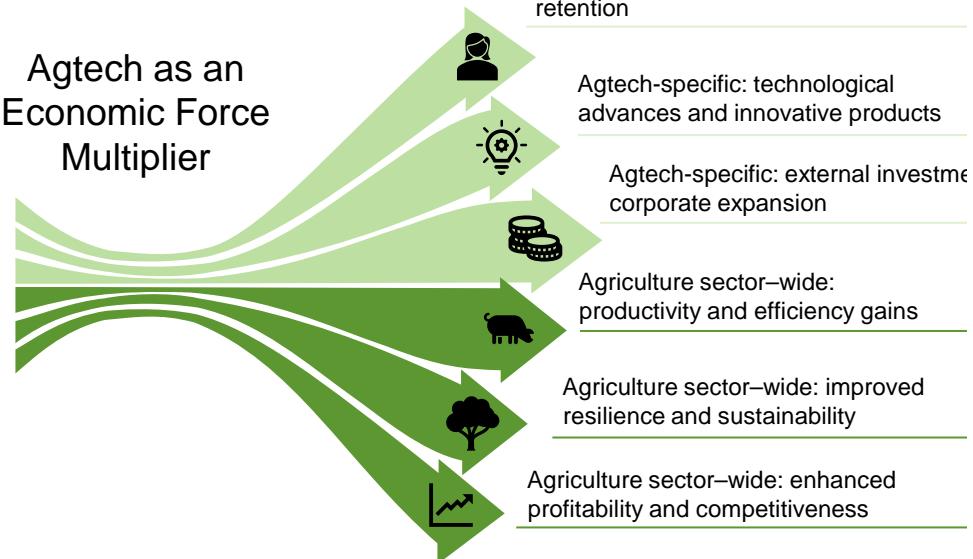


**We envision North Carolina as the global leader in developing, adopting, and integrating high-impact agtech applications, propelling a modern golden age of agriculture in North Carolina and beyond.**

A booming agtech industry is driven by active collaboration among large firms, innovative start-ups, state-funded research institutions, and forward-leaning farmers that fuels unprecedented gains in on-farm productivity, efficiency, sustainability, and profitability across the state.

A modern golden age for North Carolina agriculture emerges, enabled by a dynamic, integrated ecosystem of agtech developers and users who see their success as inextricably linked.

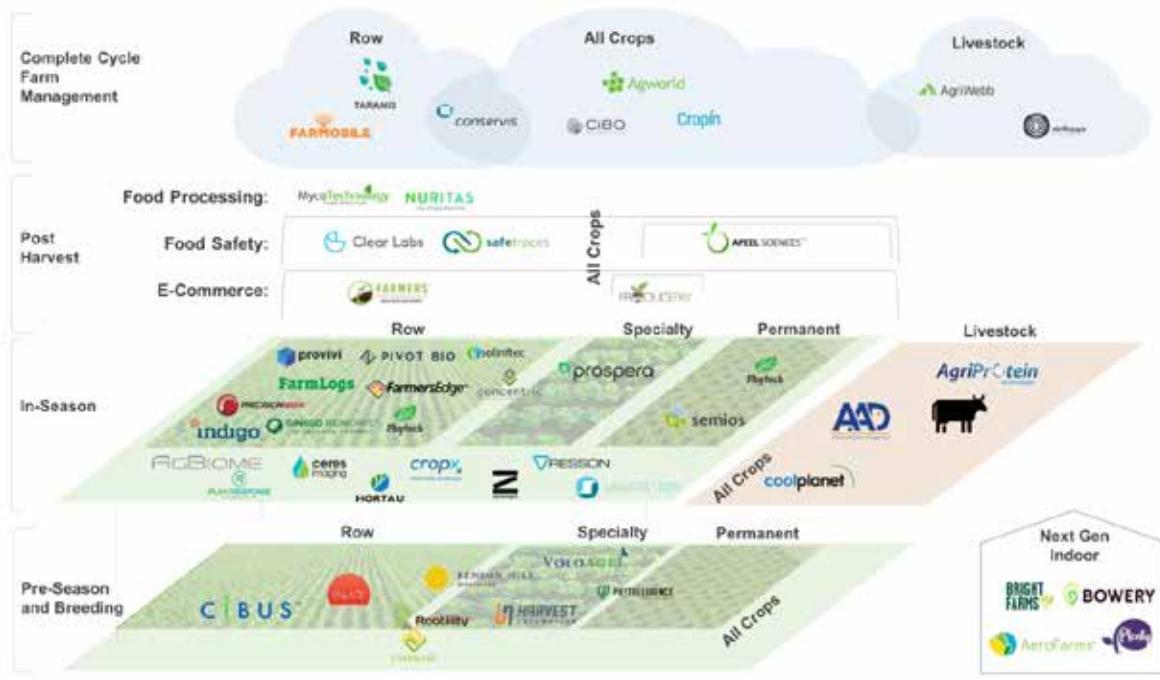
## Agtech as an Economic Force Multiplier



# Innovation Opportunities



## THRIVE 2050 Top 50 Agtech Landscape



**Six** of the 50 global companies featured in THRIVE's [2019 Top 50 Agtech](#) landscape are headquartered in or operate in North Carolina:

*Advanced Animal Diagnostics*

*AgBiome*

*Indigo Ag*

## *Pairwise*

PlantResponse

PrecisionHawk

The THRIVE Top 50 report highlights 50 growth-stage companies from around the world that are pushing the boundaries of innovation and technology in agriculture.

**THRIVE** is a global AgriFood innovation platform in Silicon Valley committed to advancing the future of food and agriculture.

# State of the Agtech Industry Cluster in North Carolina



## Agtech in North Carolina

- Home to 100+ agtech companies
- Includes global leaders (e.g., Syngenta, Novozymes) and notable start-ups (e.g., Pairwise, AgBiome)
- ~9,200 citizens employed by ag biotech companies
- Leading U.S. life sciences cluster boasting \$59 billion in annual economic activity
- Number of agriculture-related patents granted in North Carolina annually more than doubled since 2010



## Agriculture in North Carolina

- **\$91 billion** of economic activity yearly from agriculture
- 80+ different commercially grown crops across approximately 48,000 farms
- Average farm size in North Carolina is 168 acres
- 17% of North Carolina workforce in the industry
- Top national producer of tobacco and sweet potatoes; ranks second in poultry and egg receipts as well as hog and turkey production

Sources: [NCSU College of Agricultural and Life Sciences: NC Agtech and Agricultural Assets](#); [NC Biotechnology Center's NC Ag Tech Economic Growth Report \(January 2019\)](#); [NC Agriculture Overview: NC Department of Ag and Consumer Services](#)

# Trends Shaping the Agtech Industry Cluster



## Agtech Trends

- Robotics and artificial intelligence in farming (e.g., weed removal, fruit picking)
- Livestock management (e.g., sensors, wearables, food safety, waste to energy)
- The microbiome (e.g., biological pesticides, animal gut health)
- Genome editing for trait selection (e.g., disease resistance, market-preferred characteristics)
- Precision agtech (e.g., monitor plant health/soil conditions, enable efficient resource use), with farms of more than 2,000 acres leading adoption (USDA ERS 2016)
- Supply chain management (e.g., blockchain for traceability, farm-to-market linkages)
- Farm management applications (e.g., financing, insurance, digital leasing)

## Sector-Wide Trends

- Shift to farming to maximize profit, not just yield
- Consolidation of resources; vertical and backward integration in the food chain
- Aging farmers; entry of second- and third-generation farmers as "digital natives"
- Increased focus on farmland health and sustainability
- Uncertainty due to global tariff regimes, labor issues, commodity prices, and weather variability
- Demand for enhanced transparency and food safety among consumers
- Collaboration among big and small actors, companies, and farmers

# Agtech: Our Vision for North Carolina

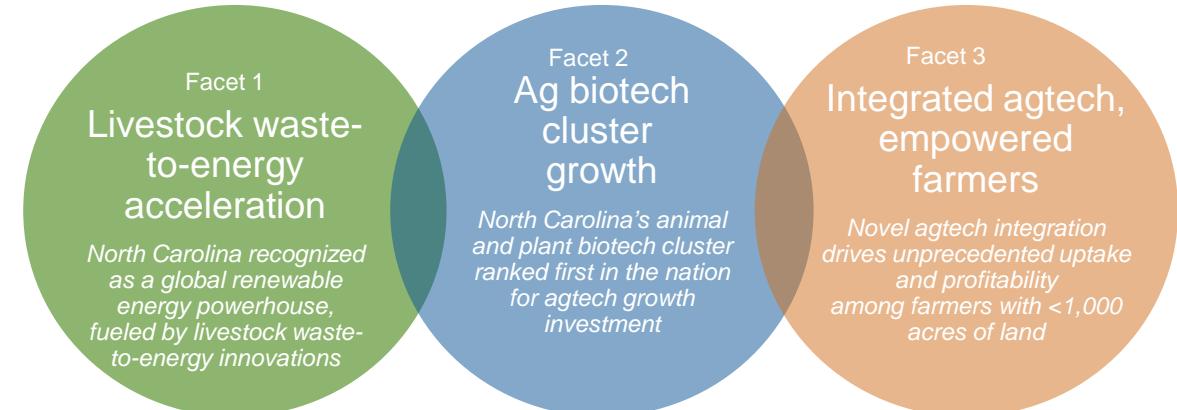


## Our Vision

**North Carolina as the global leader in developing, adopting, and integrating high-impact agtech applications, propelling a modern golden age of NC agriculture**

### Features

- A *booming agtech industry driven by active collaboration among large firms, innovative start-ups, state-funded research institutions, and innovative farmers*
- *Agtech innovations driving unprecedented gains in on-farm productivity, efficiency, sustainability, and profitability across the state*



# Agtech: Our Vision for North Carolina



## Facet 1: Livestock waste-to-energy acceleration

North Carolina's ample biomass resources (e.g., manure from hog farming operations) from small to large farms can be transformed from an underused asset to a valued renewable natural gas (RNG) fuel source, bringing added income to farms across the Corridor.

### Elements

- North Carolina's **ample biomass resources** (e.g., manure) transformed from an underused asset to a valued RNG fuel source
- **Creative partnerships, risk-sharing models, and incentive bundles** that shorten the project development timeline and the cost of pipeline access
- **Innovative distribution technologies and networks** that enable small farm participation in RNG production

## Facet 2: Ag biotech cluster growth

Agricultural biotech (ag biotech) is the application of biotechnology tools such as traditional breeding, genome editing, synthetic biology, and genetic engineering to alter living organisms, or parts of organisms, as a means to enhance the productivity, efficiency, and resilience of agriculture.

### Elements

- Firm establishment of North Carolina as ***the global leader*** in genome editing
- Growth of an **ag biotech start-up ecosystem**, including new venture incentive schemes
- Special focus on expanding the region's **emerging animal health cluster**
- **Formalized connections** among regional ag biotech companies
- **Improved access to** East Coast food distribution networks (e.g., to inform trait selection)

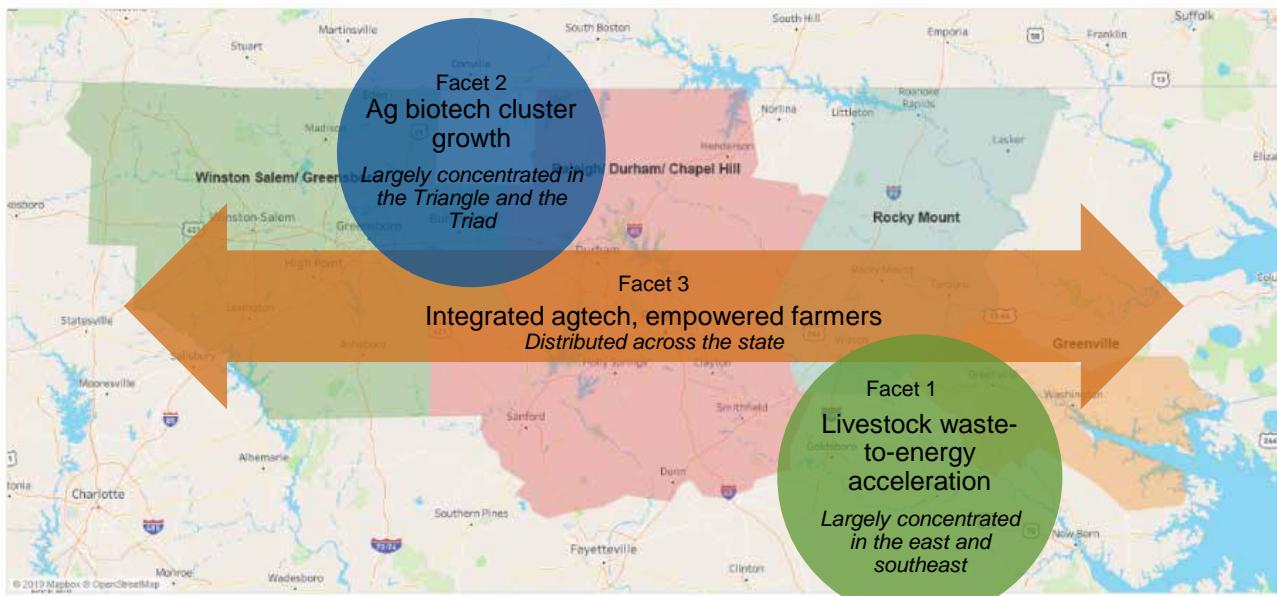
## Facet 3: Integrated agtech, empowered farmers

Farmers across North Carolina are longstanding producers and employers across the state. With better technology applications, data specialization techniques, and farmer-facing adoption incentives, farmers can be more consistently profitable, operating more sustainable businesses.

### Elements

- Dynamic suite of **interoperable, integrated** agtech applications tailored to help **North Carolina farmers turn profits** and build sustainable businesses
- **Unprecedented level of collaboration** between agtech developers, extension advisors, and farmers
- **North Carolina farmers empowered** as data specialists and innovative business managers
- Industry-wide data standards and farmer-facing incentives to drive adoption

# Agtech Vision: Multifaceted by Design

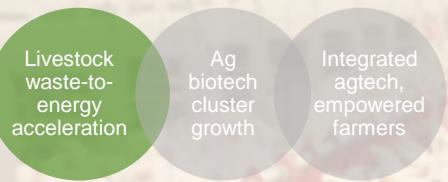


Enabling a **dynamic, future-ready Innovation Corridor** that spans from Winston-Salem to Greenville requires stakeholders to uphold an **aspirational vision for agtech as an economic force multiplier**.

This vision is **multifaceted by design**. The three facets of the proposed vision work together to take full advantage of the Innovation Corridor's agtech and agricultural resources in pursuit of **transformational change for small and medium-sized farms**.

True transformation is achieved through a concert of actions that, taken together, achieve more than any single, significant change. **This vision is, therefore, more than the sum of its parts**; thus, it should be viewed as an integrated view of what the future might hold for agtech in the Innovation Corridor.

# Realizing Our Vision: Livestock Waste-to-Energy Acceleration



**Facet 1: North Carolina recognized as a global renewable energy powerhouse, fueled by livestock waste-to-energy innovations**

North Carolina's ample biomass resources (e.g., manure from hog farming operations) from small to large farms can be transformed from an underused asset to a valued RNG fuel source, bringing added income to farms across the Corridor. As the third-richest state in bioresources in the nation, North Carolina has the assets to build a thriving livestock waste-to-energy sector.

## Market Potential

In 2025, the total global addressable biogas market value (combined for all bioenergy sources) is expected to be

\$37.7 billion

In 2025, the percentage of the global biogas market opportunity derived from agricultural waste is expected to be

45%

In 2030, the total global addressable biogas market value (combined for all bioenergy sources) is expected to be

\$40.3 billion



## Rationale for Prioritization

- Biomass resources available:** North Carolina stands as the third-richest state in bioresources in the nation, according to the National Renewable Energy Laboratory (EPA). Animal biomass makes up approximately 60% of the state's total bioresources, with the state home to 2,200 hog, 160 dairy, and 5,700 poultry farms. Anaerobically digesting all manure produced on the state's swine farms (8.7 million tons annually) would exceed the total energy consumed by 70,000 households (BioCycle).

- Conducive policy environment:** The state's renewable energy portfolio standards (REPS), passed in 2007, include a one-of-a-kind carve-out for animal waste-derived energy. Industry experts point to this progressive REPS approach as a key enabler to animal biogas industry growth.

- Accelerating demonstration effect:** Project developers remain optimistic that the pipeline of animal biogas projects will continue to grow, and indeed accelerate, as state-wide acceptance and understanding of animal biogas and RNG opportunities grows.

# Realizing Our Vision: Livestock Waste-to-Energy Acceleration



**Facet 1: North Carolina recognized as a global renewable energy powerhouse, fueled by livestock waste-to-energy innovations**

*"This opportunity is tremendous for the state; it is a unique, positive, growth environment."*

—Industry expert

*"Our industry needs support. The state is in a prime position to take advantage of what's here."*

—Industry expert

*"North Carolina could be powerhouse in renewable energy. We have renewable biomass. The state has a lot of opportunity to distinguish itself beyond REPS. Even more opportunity to be a leader."*

—Industry expert

*"The state of North Carolina has all the ingredients to move the biogas needle."*

—BioCycle (2018)



## Critical Partners to Advance the Vision

- **Smithfield Foods:** The company has set an ambitious goal to reduce its carbon emissions by 25% by 2025, with the intent to create waste-to-energy projects across 90% of its hog finishing spaces in North Carolina and beyond. The company created a joint venture with Dominion Energy called Align RNG and is supporting many of the biogas investments being undertaken across the state.
- **Utility companies:** Utility companies such as Duke Energy, Dominion Energy, and others active in the state serve as necessary partners in the animal biogas industry, especially in terms of enabling natural gas pipeline access.
- **Project developers:** A growing network of livestock waste-to-energy project developers are cropping up in the state, given the ample opportunity landscape. These individuals and companies offer necessary technical resources, as well as capital-raising skills, that are critical for enabling success with complex, multifaceted projects.
- **Livestock farmers:** Experts highlight the essential role that livestock farmers play in partnering on animal biogas projects. Growth of this industry represents a new source of income for farmers as well.
- **North Carolina State University's (NCSU's) Department of Biological and Agricultural Engineering:** The department supports waste-to-energy technology development.



## Other Resources Needed to Advance the Vision

- **Natural gas pipeline access:** The monetary and transaction costs associated with connecting RNG into the natural gas pipeline remain high and limit industry growth. Expanding the staff and resource base of the North Carolina Utilities Commission, the industry's chief regulator, could improve transparency. Increased acceptance of RNG connecting into the natural gas pipeline serves as another need.
- **An optimized investment stack:** North Carolina's animal biogas industry is somewhat nascent, meaning there is a prevailing wait-and-see mentality at play with most traditional lenders. Getting the math to work out amid high-interest rate, private-equity investments, among other factors, stands as an ongoing challenge for industry growth. More standardized investment options for animal biogas projects could alleviate this.
- **Community awareness building:** Industry experts note that many communities in eastern North Carolina remain skeptical about animal biogas projects because of environmental and health concerns. Continued community education remains an important need.
- **Resources for farmer participation:** Targeted resources and support to help more farmers engage in animal biogas projects (e.g., cost-sharing schemes, project management support) could be a win-win in terms of growing the number of biogas projects across the state and enabling farmers to access revenue from an underused resource: manure.

# Realizing Our Vision: Ag Biotech Cluster Growth



**Facet 2: North Carolina's animal and plant biotech cluster ranked first in the nation for agtech growth investment**

Agricultural biotech (ag biotech) is the application of biotechnology tools such as traditional breeding, genome editing, synthetic biology, and genetic engineering to alter living organisms, or parts of organisms, as a means to enhance the productivity, efficiency, and resilience of agriculture. The Corridor exhibits nationally recognized strengths in plant gene editing using clustered regularly interspaced short palindromic repeats as well as in biologics and plant stimulants. Biotech-enabled animal health and nutrition, such as for animal gut health, represents another subsector gaining traction across the Corridor.



## Market Potential

In 2025, the total global addressable ag biotech market value is expected to be **\$99.5 billion**

Of which crop biotech is expected to account for **\$52.8 billion**

Of which animal biotech is expected to account for **\$46.7 billion**

In 2030, the total global addressable ag biotech market value is expected to be **\$107.7 billion**

Of which crop biotech is expected to account for **\$58.8 billion**

Of which animal biotech is expected to account for **\$48.9 billion**



## Rationale for Prioritization

- World-class industry cluster:** North Carolina is home to over 100 ag biotech companies spanning multinational corporations and innovative startups. More than 50% of those companies in the Triangle, giving the region a natural cluster from which to expand support and services to these companies. The Triangle is considered a world leader in gene editing. Additional areas of strength include plant biologics and stimulants, and a growing animal health industry presence (NC Biotech Center).

- Positive momentum:** Positive signals of industry growth provide a basis for optimism. Since 2010, 18 ag biotech companies have announced prospective investments summing more than \$1 billion. Of the state's ag biotech companies, more than 50% have been founded in or relocated to the state since 2010, another indicator of ag biotech cluster momentum (NC Biotech Center).

- Rich ag biotech research and development (R&D) ecosystem:** North Carolina boasts a wealth of ag biotech institutional resources. Industry experts point to the state's research universities (e.g., Duke University, North Carolina Agricultural and Technical State University [NC A&T], NCSU, the University of North Carolina at Chapel Hill [UNC-CH]) as tremendous partners in the ag biotech field. A relatively new entrant to the ecosystem, the \$150 million Plant Sciences Initiative at NCSU is poised to become a world-class resource poised to accelerate the state's ag biotech contributions even further.

# Realizing Our Vision: Ag Biotech Cluster Growth



Livestock waste-to-energy acceleration

Ag biotech cluster growth

Integrated agtech, empowered farmers

**Facet 2: North Carolina's animal and plant biotech cluster ranked first in the nation for agtech growth investment**

*"NC and particularly the RTP region has probably more academic and industry focus on plant gene editing than any other tech hub."*

—Industry expert

*"If you want to drive innovative future industry, you need to create incentives for new companies."*

—Industry expert

*"Our strength is in having agile discovery platform and the flexibility to bring new ideas into play."*

—Industry expert



## Critical Partners to Advance the Vision

- **Growth-stage ag biotech start-ups:** North Carolina has a growing footprint of early and growth-stage crop and animal biotech companies, largely concentrated in the Triangle. Such growth-stage companies represent nimble, relatively risk-tolerant actors able to push the boundaries of science and industry development. These companies will be critical in setting the future trajectory of North Carolina as *the* global ag biotech innovation leader.

- **Large ag biotech companies:** Companies such as Syngenta and Novozymes represent foundational partners in the state's ag biotech ecosystem. These companies exhibit tremendous industry influence and serve as critical partners for growth-stage companies seeking to further develop and commercialize emerging products. Recent examples of large ag biotech companies taking an investment stake in North Carolina-based start-ups point to another essential role these companies play in promoting industry growth and innovation.

- **Downstream food buyers/distribution companies:** Somewhat nascent in the North Carolina ag biotech ecosystem, these companies actively set requirements for food products, which informs upstream trait selection and other ag biotech-related issues. In particular, strengthening connections between large food distribution companies that serve the East Coast corridor stands as an opportunity to further industry growth.



## Other Resources Needed to Advance the Vision

- **Resources and support designed for start-ups:** Industry experts point to the fact that many of the state-wide resources offered focus on recruiting manufacturing companies and/or large ag biotech companies to the state, rather than supporting emerging start-ups. Stepping out as *the* global ag biotech innovative leader means taking more deliberate, expanded steps to grow the ag biotech start-up ecosystem.

- **Focused support of the animal health/nutrition cluster:** Per the market potential figures to the left, animal biotech represents a large market opportunity that North Carolina is uniquely poised to seize. North Carolina is home to several innovative animal health and nutrition companies innovating on gut health, feed additives, vaccines, and other application spaces. The state's sizable livestock industry and NCSU's veterinary school—one of only 30 in the country—provide further assets from which to build. Focused efforts and resources are needed to accelerate and bolster growth in this important, strategically aligned subcluster.

- **Deepen collaboration as industry grows:** North Carolina has a lot to be proud of in terms of its ag biotech cluster. Industry experts point to the value of collaboration among industry representatives, noting that as companies expand throughout the Triangle and beyond, more institutionalized, regular opportunities to engage, exchange ideas, and build relationships will be needed.

# Realizing Our Vision: Integrated Agtech, Empowered Farmers



Livestock waste-to-energy acceleration

Ag biotech cluster growth

Integrated agtech, empowered farmers

**Facet 3: Novel agtech integration drives unprecedented uptake and profitability among farmers.**

Farmers across North Carolina are a longstanding producer and employer across the state. With better technology applications, data specialization techniques, and farmer-facing adoption incentives, farmers can be more consistently profitable, operating more sustainable businesses. The Innovation Corridor is well positioned to fill a significant market gap in proving models for small and medium-sized farmers to use agtech.



## Market Potential

In 2025, the total global addressable crop agtech market value is expected to be

**\$62.1 billion\***

*Composed primarily of crop biotech; \$9.3 billion is attributed to the precision ag market opportunity (defined as follows).*

By 2030, the total global addressable crop agtech market value is expected to increase to

**\$69.3 billion\***

*\$10.5 billion of this total is attributed to the precision ag market opportunity (defined as follows); the rest is attributed to crop biotech, described in Facet 2.*

*\*Market potential estimates include figures for sensors, drones, automated steering, radar, global positioning software, weather tracking and forecasting, people/inventory/financial management software, and radio-frequency identification.*



## Rationale for Prioritization

- Agriculture as a powerhouse for the North Carolina economy:** North Carolina boasts tremendous agricultural diversity, with farmers producing 80+ crops commercially across 48,000 farmers. This bounty is represented in the agricultural sector's importance to the North Carolina economy: \$91 billion in yearly economic activity (NC Department of Agriculture).

- Precision ag and "smart farming" boom:** According to AgFunder, "Growth in funding for startups operating upstream ... accelerated at its fastest pace on record in 2018 (44%) and dominated the leader boards for Seed, Series A and Series B stage deals. Investments in startups advancing farm management and sensing technologies totaled \$945M across 117 deals in 2018."(AgFunder)

- Unique innovation opportunity:** North Carolina agriculture exhibits several unique characteristics that present challenges and opportunities in the agtech space. North Carolina farms are generally smaller and more diverse operations compared with their Midwest counterparts. Large farms are more likely to adopt precision ag technologies, which often are used in tandem with one another (USDA ERS 2016). Making integrated suites of precision ag (and ag biotech) work for small farms like those representative of North Carolina agriculture stands as a big challenge—and an exciting innovation opportunity—poised to tap into a currently underrepresented market segment.

# Realizing Our Vision: Integrated Agtech, Empowered Farmers

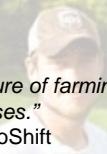


Livestock waste-to-energy acceleration

Ag biotech cluster growth

Integrated agtech, empowered farmers

**Facet 3: Novel agtech integration drives unprecedented uptake and profitability among farmers.**



*"The future of farming is about growing businesses."*

—NewCoShift

*"You can't take Midwest standards and truths [about economies of scale] and apply them here."*

—Industry expert

*"I'm really optimistic about the ability of individual producers to rise above complexity [of the market], with technology helping them to do that."*

—Industry expert

*"We stand a great case in NC to get close to the farmer, to understand their needs, to create solutions that work for them."*

—Industry expert



## Critical Partners to Advance the Vision

- **Farmers:** Making agtech work for North Carolina farmers—in terms of profits and savings realized—must be at the center of this effort. Industry experts point to the ingenuity and resourcefulness of North Carolina farmers as tremendous resources. Experts also express optimism about the change that may be ahead as second- and third-generation farmers who grew up as "digital natives" take on expanded farm leadership roles.
- **Data and analytics companies:** agtech faces ongoing challenges related to data privacy, security, and standardization that present barriers to farmer adoption. Also, maximizing how data are used for making smarter business decisions stands as a continued need. Innovative data analytics companies based in North Carolina are uniquely positioned to work closely with agtech developers and farmers to resolve currently unanswered questions. Although still new, the partnership between NCSU's Plant Sciences Initiative and SAS Institute represents one poised for future impact.
- **North Carolina agricultural extension services and crop consultants:** North Carolina boasts a robust agricultural extension system that, according to one industry expert, "has made great moves forward with more fresh approaches" in recent years. Extension agents, along with independent crop consultants, represent important resources for interfacing with farmers, sharing emerging research and technology options, and generally supporting farmers in their efforts to achieve sustainable profits and long-term business success.



## Other Resources Needed to Advance the Vision

- **Explicit focus on integration and farmer profitability:** Tech-driven efforts often miss essential elements of user desirability and financial viability essential to long-term adoption and scale. Advancing agtech integration will serve as a top priority, such that farmers can tap into an increasingly sophisticated yet seamless suite of agtech applications, specifically tailored to meet their needs as they connect to their business opportunities.
- **Expanded broadband access in rural areas:** Multiple industry experts point to poor broadband access in rural North Carolina as a key barrier to agtech adoption, given that many agtech applications require internet access for full functionality. This is especially important for connected systems that share data between equipment and locations.
- **Incentives to drive farmer adoption, especially among "digital natives":** Low commodity prices and weather events have contributed to thin margins across North Carolina farming operations. Farmers often prove reticent to spend scarce resources on anything other than a sure bet, which innovative products often are not. Incentives that enable farmers to say "yes" to high-potential agtech applications without taking on the full financial risk could be an important enabler of adoption.

# Realizing Our Agtech Vision: Suggested Next Steps



1

## **Be bold in envisioning a transformative future for agtech in North Carolina.**

Our state has a tremendous opportunity to connect the dots from agtech industry growth to agricultural sector transformation. In our borders, we have the ingredients for a radically integrated, innovative agricultural system that shows the world what is possible, where waste is used, resources are optimized, and profitability is maximized.

2

## **Prioritize farmer engagement and adoption.**

All facets of the agtech vision rely on learning from, engaging with, and driving adoption among farmers. Whether it is livestock waste-to-energy, emerging ag biotech products, or "smart farming" applications, farmers prove critical to agtech industry success. The proximity of agtech industry players and farmers in North Carolina represents a unique resource that could accelerate agtech industry success and agriculture sector transformation.

3

## **Avoid the urge to immediately start something new.**

Find ways to fully leverage existing resources (including cross-sector collaborative mechanisms) before starting something new. Build from what is already available to avoid further fragmenting the agtech ecosystem. Identify anchor institutions and maximize their convening power. Then, turn toward other opportunities that are needed to add value.

# Companies Engaged and Sources Referenced



*With gratitude, we acknowledge the contributions of the following companies and organizations:*

AgBiome | Carolina Precision Consulting, Inc. | Coastal AgroBusiness | FoodLogiQ | McLawhorn Crop Services, Inc. | North Carolina Biotechnology Center | OptimaBio | Pairwise | Power Resource Group | SAS Institute Inc. | Smithfield Renewables | Stephen Lilley Farms, LLC

## Additional Sources

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# Biohealth Industry Cluster Analysis



## What Is Biohealth?

Biohealth encompasses the discovery, development, and manufacture of medical devices, pharmaceuticals, and other applications of biotechnology, engineering, and health technology to solve biological or medical problems related to human health. Biohealth *excludes* hospitals, clinics, health care systems, service providers, and payers, although they are related.

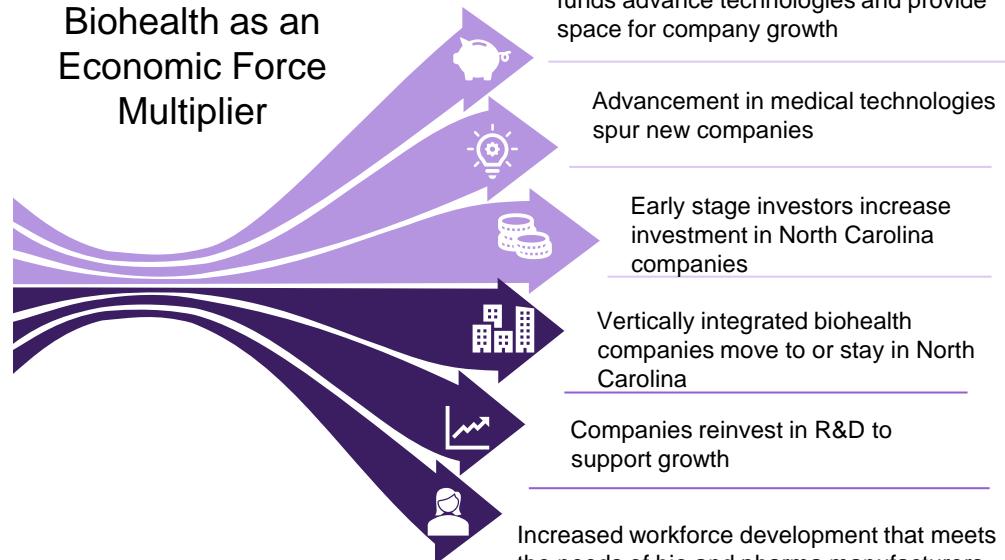
# Vision: NC Becomes a Leading Biohealth Epicenter in the United States



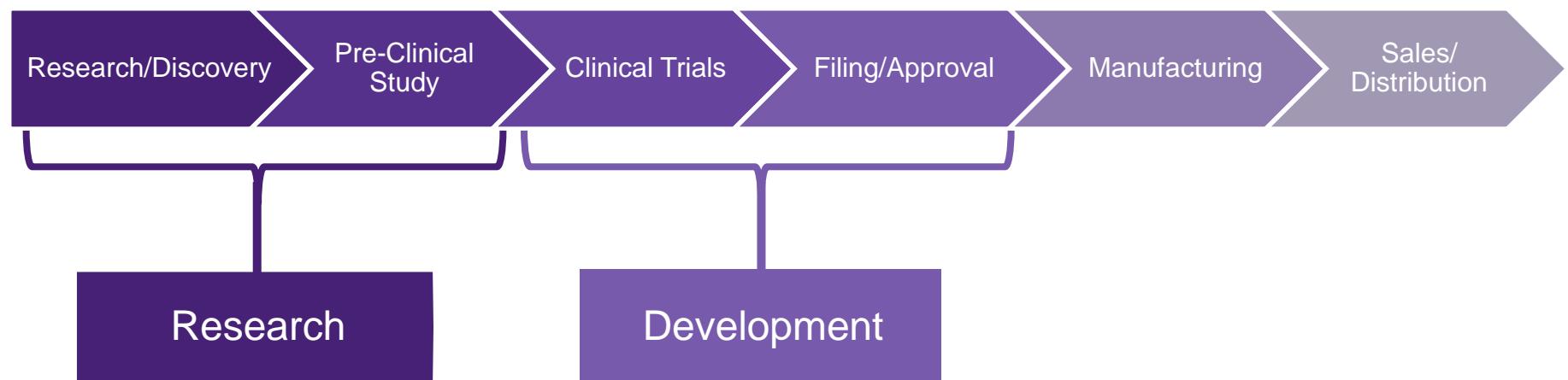
**We envision that North Carolina will become a leading biohealth epicenter, tripling in size as companies flourish from start-up to scale-up to large-scale manufacturing.**

North Carolina is home to all the key ingredients of a comprehensive, healthy biohealth ecosystem, from technology innovators to end users. However, many small companies struggle with crossing the technology “valley of death.” Targeted investment funds, workforce development programs, and a competitive business climate will enable companies to advance biohealth technologies far past proof-of-concept and/or to attract commercialization partners and more investment into the state. Additional workforce development programs will also meet the needs of the growing biomanufacturing sector, leading to exponential economic and job growth for North Carolina.

## Biohealth as an Economic Force Multiplier



# Stages for a Successful Biohealth Launch



# State of the Biohealth Industry Cluster in North Carolina



## Biohealth in North Carolina

- Four R1 research universities with a history of industry collaborations and spin-outs
- Strong and growing presence of start-ups and global companies
  - +\$1.7 billion in investments and +3,000 new jobs are created in North Carolina by life sciences companies, a large majority of which are biohealth
  - +5,000 biopharma manufacturing jobs are expected to grow by 2024
  - North Carolina is #1 in pharma and biomanufacturing by total employment
- Regional research agendas in regenerative medicine, nanotechnology, drug discovery, and rural health



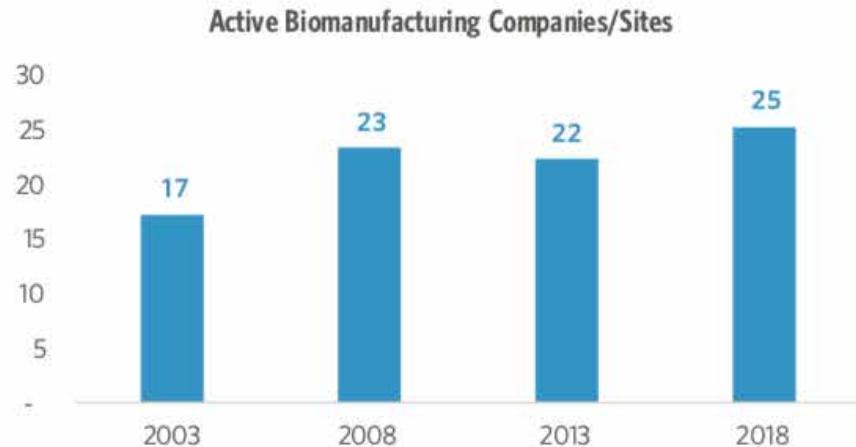
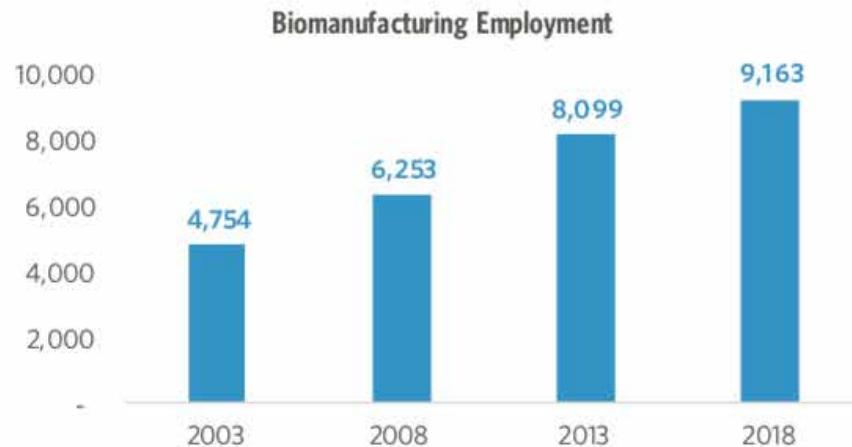
## Health Care in North Carolina

- Strong health care systems with top medical facilities
  - 126 North Carolina hospitals in 84 counties
  - 5 major medical centers (4 university affiliated and 1 unaffiliated)
- Key players and talent representing the entire health care continuum, including researchers, innovators, entrepreneurs, technicians, contract research organizations, manufacturers, clinicians, and providers.

# North Carolina's Growing Biomanufacturing Industry



**Figure ES-7: North Carolina Active Biomanufacturing Companies and Biomanufacturing Employment, 2003-2018**



Source: NCBiotech Company Database.

Source: 2018 Evidence and Opportunity: Impact of Life Sciences in North Carolina.

# Trends Shaping the Biohealth Industry Cluster



## Drivers

- Growing **aging population**
- Rising prevalence of **chronic diseases**
- Increased **disability-adjusted life years** (a measure of overall disease burden, expressed as the number of years lost due to ill health, disability, or early death)

## Biohealth Trends

- Rapid growth of **biomanufacturing**
- Increased **medical data** generation, leading to growing **digital health** opportunities, has overwhelmed hospitals
- Growing support of **precision medicine**, including increased activity in **cell and gene therapy**, **personalized nutrition**, and other technological advances
- Changes in **tax incentives** (e.g., medical device tax, North Carolina tax credits) affecting research and development investments
- Lags in policy **reimbursement** and the Medicaid process
- **Drug pricing** debate, with concerns over consumer health cost battling the potential for future drug discovery

# Realizing Our Biohealth Vision: Opportunity Spaces



## Our Vision

**The North Carolina biohealth industry will grow in global attractiveness as a result of increased investments to start and scale companies' technologies and to expand infrastructure for small-scale biomanufacturers.**

### Features

- A booming biohealth industry driven by active collaboration between companies and health care providers
- More late-stage biohealth technologies that further attract investors and vertically integrated companies that will come to or stay in North Carolina
- Large and skilled manufacturing workforce that supports large- and small-scale bio and pharmaceutical manufacturers

### Facet 1

**Robust start-up, scaling, and established biohealth companies**

*North Carolina successfully recruits and grows development and commercialization biohealth companies.*

### Facet 2

**Expanded biomanufacturing infrastructure for small-scale manufacturers**

*North Carolina as the leading bio and pharma manufacturing state in the United States*

# Realizing Our Biohealth Vision: Opportunity Spaces



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### Facet 1: Robust start-up, scaling, and established biohealth companies

The Corridor has a strong start-up culture, and by further supporting biohealth companies to advance the stage of their technologies, it will in turn attract investors and commercialization development partners to build out the biohealth cluster.

#### Elements

- State and regional development resources to support applied research and proof-of-concept work
- Public-private partnerships to increase R&D investment and scale-up opportunities
- Collaborations between industry and hospitals, health care systems, and/or medical facilities
- Additional spaces and building resources to support growing companies
- Additional early stage investments into North Carolina
- Increased presence of vertically integrated biohealth companies that serve as commercialization partners

### Facet 2: Expanded biomanufacturing infrastructure for small-scale manufacturers

As the industry moves toward precision medicine, there is a need for adaptable, on-demand manufacturing. North Carolina has a good presence in large-scale biomanufacturing, and there is an opportunity to build out smaller-scale production.

#### Elements

- Supply of trained and skilled manufacturing workforce that meets the demand of growing bio and pharma manufacturers
- Additional manufacturing training programs across the Innovation Corridor
- Enhanced manufacturing curricula that include cell therapy, gene therapy, and digitalization
- Support for small-scale manufacturers that stay in North Carolina
- Public-private partnerships to increase R&D investment and scale-up opportunities

# Realizing Our Vision: Overcoming the NC Valley of Death



Robust start-up,  
scale-up, and  
established  
companies

**Facet 1:** North Carolina successfully recruits and grows development and commercialization biohealth companies.

The Innovation Corridor has a strong start-up culture, and by further supporting biohealth companies to advance the stage of their technologies, it will in turn further attract investors and commercialization development partners to build out the biohealth cluster. Active collaborations between companies and health care providers could further enhance North Carolina's position in the biohealth industry. Many assets exist in the Innovation Corridor:

- Universities, including four R1 research institutions and five major medical centers
- Strong and growing presence of start-ups and global companies
- Shared regional research agenda and commitment
- Vibrant life sciences sector



## Market Potential

In 2018, the global medical device market size was valued at **\$425.5 billion**

In 2018, North Carolina's medical devices and equipment supported **11,639** jobs earning \$800 million in labor income and generating **\$92 million** in state and local government revenues.

In 2025, the global medical device market size is expected to be **\$612.7 billion**



## Rationale for Prioritization

- **Intellectual property (IP)-rich universities:** Universities are rich with IP. Advancing university-based assets from basic research to applied research would multiply the number of start-ups and spin-outs into industry.
- **Emerging digital health field:** There is increasing market demand for digital health solutions. The digital health companies in the Corridor have seen exponential growth, mirroring national trends.
- **Lack of development partners:** North Carolina lacks development and commercialization biohealth partners (i.e., vertically integrated companies and investors), which are needed to support and expand opportunities for biohealth start-ups and small businesses.
- **Weak infrastructure to support company growth:** As companies grow, their building infrastructure needs (i.e., additional spaces for office/laboratory/manufacturing space) increase. This type of development support will encourage company scale-up.

# Realizing Our Vision: Overcoming the NC Valley of Death



Overcoming the  
North Carolina  
biohealth valley  
of death

**Facet 1:** North Carolina successfully recruits and grows development and commercialization biohealth companies.

"NC is largely missing development and commercialization partners."  
—Industry expert

"NC has an inverted bell-curve of companies. It is a function of economic development and equity markets, and how companies are funded."  
—Industry expert

"[NC biohealth] companies often struggle with securing development support...there isn't a major NC resource for those who need development support...Companies are on their own for finding funding and investment that will help them cross the chasm."  
—Industry interviews [multiple]

"Incentives to support development or small-scale manufacturing are missing... Our startup wanted to stay in NC, but there weren't enough incentives for small-scale manufacturing. The emphasis has been to support large manufacturers."  
—Industry interviews [multiple]



## Critical Partners to Advance the Vision

- **Health care systems and hospitals:** Two company interviewees praised WakeMed and Duke for their collaboration in testing new medical technologies, allowing the companies to improve and create better products.

Fostering and promoting these industry–hospital collaborations will provide a competitive advantage for North Carolina biohealth companies.

- **Real estate developers:** Interviewees cite a need for additional incubators, shared biotech laboratories, laboratory–office mixed spaces, and manufacturing sites designated for small-scale manufacturing to provide additional spaces and better support company growth.

- **Early stage funders and investors:** Attracting broadly focused investors can support early stage development and scale-up. Many companies that were interviewed noted that North Carolina investors traditionally have a specific industry focus (e.g., drug development, health IT, software) and are generally risk averse.



## Other Resources Needed to Advance the Vision

- **Business support:** State-level support is needed to reduce company burn rates and encourage additional business R&D investments. Public resources and support will also help attract new additional biohealth companies into North Carolina and retain companies for growth in North Carolina.

- **State or regional development funding programs:** State or regional programs that will fund or provide loans, proof-of-concept, or applied research will help researchers and institutes better identify technologies with high commercialization potential.

- **North Carolina General Assembly:** Support for public–private partnerships will spike company investments in R&D and attract more vertically integrated companies.

# Realizing Our Vision: Expand Biopharma Manufacturing



**Facet 2: North Carolina as the leading bio and pharma manufacturing state in the United States**

As the industry moves toward precision medicine, there is a need to move from mass production to adaptable, on-demand manufacturing. North Carolina has a good presence in large-scale biomanufacturing, but we are missing an opportunity to build out smaller-scale production. Building out a better infrastructure and business environment to adapt to these market shifts will position the state to better capitalize on this market opportunity, in addition to creating jobs and expanding business opportunities across the Corridor.



## Market Potential

In 2018, the pharma contract development and manufacturing global market size was **\$90.0 billion**

In 2018, North Carolina's pharmaceutical industry supported **132,507** jobs earning **\$9.6 billion** in labor income and generating **\$1.4 billion** in state and local government revenues.

In 2020, 80 North Carolina biopharma sites supported 26,800 manufacturing employees. Employment is expected to grow by 5,000 jobs in 2024.

In 2024, the pharma contract development and manufacturing global market size is expected to be **\$126.6 billion**



## Rationale for Prioritization

- Large-scale manufacturing as a key differentiator:** North Carolina is #1 in biopharma manufacturing by total employment and #2 in concentration of pharma manufacturers (second to California). The BioPharma Crescent and other regions have successfully recruited large-scale manufacturers.

- Limited support for small-scale manufacturers:** As the industry moves toward precision medicine, there is a need to move from mass production to adaptable, on-demand manufacturing. Expanding the infrastructures to react to this shift will strengthen North Carolina.

- Manufacturing workforce demand outweighs supply:** Existing manufacturing workforce development programs, such as the Golden LEAF Foundation and Wake Tech's BioWork program, have been successful, but the demand still outweighs the labor force supply. Interviews report that companies are "poaching" manufacturing employees from one another.

# Realizing Our Vision: Expand Biopharma Manufacturing



Expanded biohealth manufacturing infrastructure

**Facet 2: North Carolina as the leading bio and pharma manufacturing state in the United States**

*[North Carolina] is a victim of our own success. We have attracted large manufacturers, but it has overwhelmed our workforce training capacity.”*

—Industry expert

*“We need more people trained to fill the [growing number of] manufacturing jobs. Wake Tech’s BioWork program is great, but the manufacturing sites aren’t in the city. We need similar programs closer to the manufacturing sites.”*

—Industry expert

*“New technologies such as gene therapy and cell therapy have overwhelmed our workforce training capacity.”*

—Industry expert



## Critical Partners to Advance the Vision

**• Colleges and universities:** Work collaboratively with area colleges and universities to strategically set up additional manufacturing training programs to better meet the manufacturing workforce demands. Develop and incorporate new curricula focused on cell and gene therapies and data and automation to address the move toward precision medicine and digitalization.

**• State and regional economic developers:** Provide additional support that would better support small-scale manufacturers to promote growth in North Carolina.

**• Real estate investors:** Engage real estate investors to build infrastructure to support biohealth company growth.

## Other Resources Needed to Advance the Vision

**• Additional spaces for growing companies:** Designate additional spaces that are allocated for manufacturing and are conducive for smaller companies working to scale up.

**• Business policy:** Create a more business-friendly environment that would encourage companies to stay in North Carolina. Job creation benefits or lease-to-own arrangements help support growing companies.

**• State or regional development funding programs:** State or regional programs could fund or provide loans to help businesses with scaling up and development.

# Realizing Our Biohealth Vision: Suggested Next Steps

1

- **Foster collaborations between industry and medical facilities** to provide a competitive advantage for North Carolina biohealth companies, especially in growing areas like digital health.

2

- **Set up regional or state development funds with private and public pooled funds** for applied research at universities and scaling up smaller businesses.

3

- **Develop a more business-friendly environment** that not only supports large biohealth businesses, but also supports small and growing companies that are working to scale up. Consider new models of business incentives to better recruit and/or retain and grow vertically integrated biohealth companies in North Carolina.

4

- **Designate new spaces and buildings for growing companies**, which include incubators, shared biotech laboratories, laboratory–office mixed spaces, and manufacturing sites conducive to small-scale manufacturing.

5

- **Coordinate with local universities and colleges** to develop additional programs and courses to build up the manufacturing workforce to meet growing industry demands. Enhance curricula to include gene therapy, cell therapy, and automation to align with biomanufacturing trends.

# Companies Engaged and Sources Referenced



*With gratitude, we acknowledge the contributions of the following companies and organizations:*

Bioventus | Continuous Precision Medicine | Gilero |  
GlaxoSmithKline | MEDTOX Diagnostics | North Carolina  
Biosciences Organization | North Carolina Biotechnology  
Center | Panaceutics | Precise Bio | Rho

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# Power Electronics for Transportation (PET) Industry Cluster Analysis



## What Is Power Electronics for Transportation?

New developments in power electronics using wide-bandgap (WBG) materials are enabling next-generation electric vehicles (EVs) that will replace internal combustion engine-powered vehicles, transforming the automotive industry and the transportation sector in general.

# Vision: Leverage NC's Assets to Create an EV Industry Hub

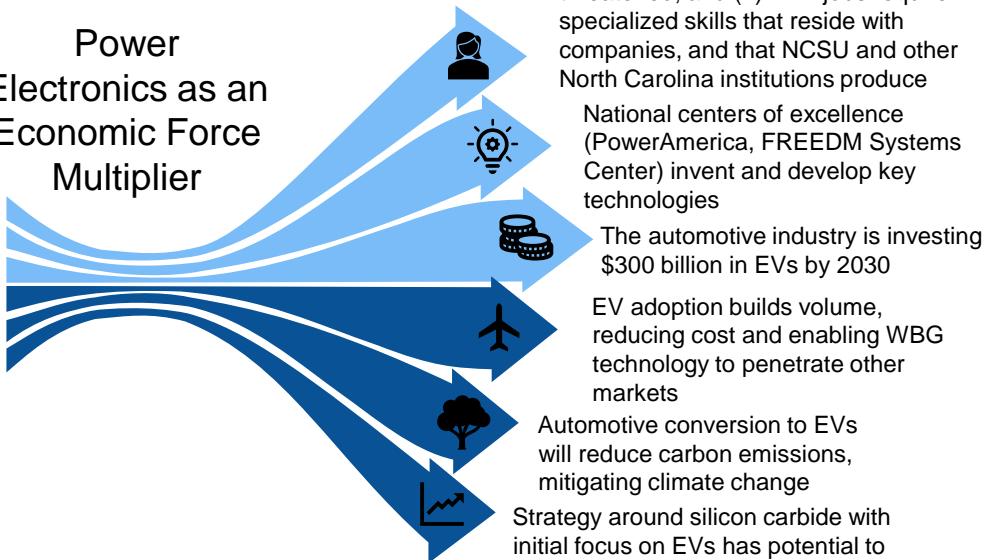


**We envision North Carolina leveraging its existing power electronics cluster to create a global hub for research, development, and manufacture of next-generation EVs, components, and supporting infrastructure.**

*Driven by the need to reduce carbon emissions from fossil fuel use and innovations in electrical energy storage and power conversion, the automotive industry is expected to convert largely to EV production over the next 10 years.*

*A key enabler of this transformation is the commercialization of WBG materials in power electronics, which enables the design of competitive EVs. North Carolina is home to companies and research organizations with enabling skills, resources, and technologies and is poised for leadership in the EV supply chain.*

## Power Electronics as an Economic Force Multiplier



(1) Current powertrain-related jobs are threatened, and (2) PET jobs require specialized skills that reside with companies, and that NCSU and other North Carolina institutions produce

National centers of excellence (PowerAmerica, FREEDM Systems Center) invent and develop key technologies

The automotive industry is investing \$300 billion in EVs by 2030

EV adoption builds volume, reducing cost and enabling WBG technology to penetrate other markets

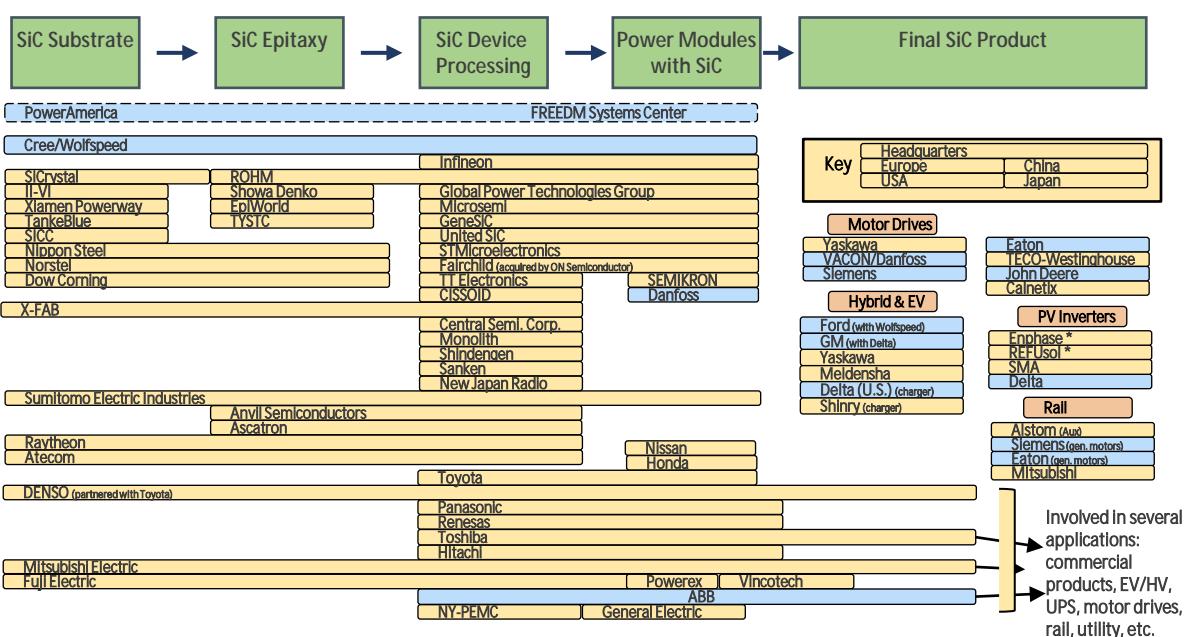
Automotive conversion to EVs will reduce carbon emissions, mitigating climate change

Strategy around silicon carbide with initial focus on EVs has potential to create a cross-sector hub that can extend beyond transportation to smart grid, 5G, and other power applications

# NC Is Home to a Strong Core of WBG Power Electronics Firms



## Silicon Carbide (SiC) Power Electronics Value Chain



Many key players in the power electronics landscape are in North Carolina, including these:

### Manufacturers

**Cree/Wolfspeed**

**Delta Electronics**

**ABB**

**Eaton**

### R&D Centers

**PowerAmerica**

**FREEDM Systems Center**

# Vehicle Electrification Is Happening—No Turning Back



Automakers have announced \$300 billion in investment in EV development.



Introducing 40 EVs by 2023  
\$11 billion investment



Plans to build EV versions of  
all 300 vehicles by 2030  
\$25 billion investment

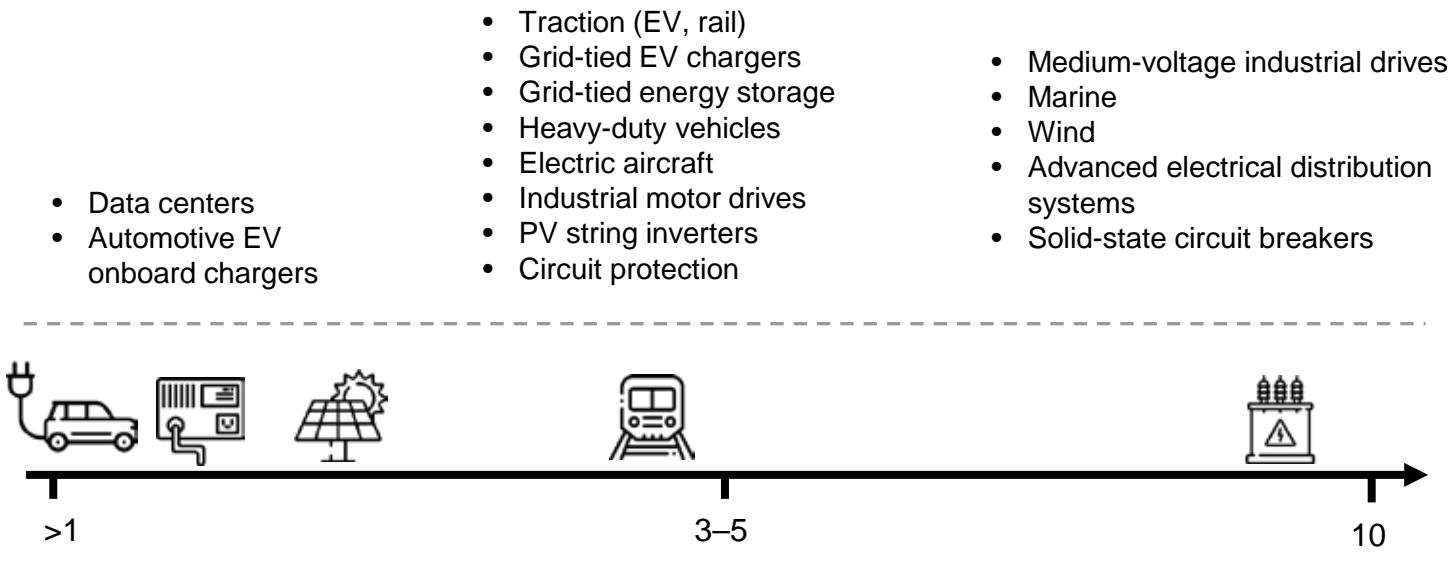


Plans to double EV  
production

*"We aim to have one million electrified vehicles on the roads within two years. This is our contribution toward effective climate protection."*

—Oliver Zipse, Chairman of the Board, BMW AG

# Opportunities Will Expand Beyond Automotive to Other Sectors



Sources: PowerAmerica Roadmap 2018; Power Electronics Industry Collaborative 2016 Roadmap; RTI analysis.

# Electrification Is an Opportunity But Also a Threat to NC Industry



## Threat: Poaching

**May 2019:** DURHAM, NC—As part of its long-term growth strategy, Cree, Inc. announces it will invest up to \$1 billion in the expansion of its silicon carbide capacity with the development of a state-of-the-art, automated 200mm silicon carbide fabrication facility and a materials mega factory at its U.S. campus headquarters in Durham, N.C.

—Cree

**September 2019:** “Cree’s decision to locate its state-of-the-art 200 mm SiC semiconductor facility at Marcy Nanocenter and its partnership with SUNY Poly’s Power Electronics Manufacturing Consortium is a game changing event for the Mohawk Valley Region.”

—Steve DiMeo, President, Mohawk Valley (NY) EDGE

## Threat: Loss of Traditional Automotive Jobs

By 2030, 15% of vehicles will be EVs, at which point EV production begins to greatly affect manufacturing.

“...Not every engine or transmission worker will find a job working on EVs. A lot of those jobs in those areas are going to disappear...It's just the nature of the beast.”

—Detroit News

# State of the Power Electronics Industry Cluster in North Carolina



## Power Electronics in North Carolina

- Home to Cree/Wolfspeed, the global leader in silicon carbide power electronics with vertical integration from materials to devices to modules, but North Carolina recently lost to New York on a \$1 billion new wafer manufacturing plant.
- NCSU is internationally recognized as a leader in power electronics and is home to the FREEDM Systems Center and PowerAmerica research centers.
- North Carolina is home to key power electronics original equipment manufacturers (OEMs) including ABB, Eaton, Danfoss, and Delta Electronics.



## Transportation in North Carolina

- North Carolina is home to over 230 unique automotive companies, including engine and transmission manufacturing, that may be negatively affected by the transition to EVs.
- Greensboro is home to Volvo Group North America's R&D technology center.
- Piedmont Community College collaborated with Tesla in developing one of its first EV service training programs.
- A significant aviation cluster exists in the Piedmont Triad area.

# Trends Shaping the Power Electronics and Transportation Industries



## Power Electronics Trends

- Commercialization of WBG materials (silicon carbide and gallium nitride) in power electronics, enabling EVs with acceptable or superior range, power, and cost, to address carbon emissions from transportation
- Cree/Wolfspeed investing \$1 billion in a new manufacturing plant to produce larger silicon carbide wafers, reducing cost and increasing penetration in EV markets—the plant was originally announced in North Carolina, then in New York after New York offered \$500 million in incentives
- The success of silicon carbide in EVs driving cost reduction, making silicon carbide increasingly attractive in lower-volume nonautomotive applications
- Adoption of gallium nitride WBG material in low-voltage applications such as consumer electronics and data centers

## Transportation Sector Trends

- The advantages of latest-generation EVs, and the need to reduce carbon emissions from the transportation sector to address climate change, are driving electrification of vehicles where possible.
- Natural gas-powered buses and commercial vehicles, once considered “clean,” are falling out of favor due to carbon emissions.
- In aviation,
  - electric motor-driven propeller propulsion is being considered as a solution for short flights; and
  - aircraft are being made “more electric” by replacing hydraulic systems (e.g., landing gear) with electric motor-driven systems requiring power electronics, reducing weight.

# Realizing Our Vision: North Carolina as "Electric Motown"



## Electric Motown

North Carolina recognized as a global hub for vehicle electrification, leveraging the presence of Cree/Wolfspeed, world-class research centers FREEDM and PowerAmerica, and downstream system manufacturers to grow a thriving ecosystem that will eventually attract EV OEMs

North Carolina can leverage its existing power electronics cluster to create a global hub for research, development, and manufacture of next-generation EVs, components, and supporting infrastructure. Not only will this help the Corridor build a thriving industry sector, but it also will help ease negative impacts in the current supply chain from these expected disruptions.



## Market Potential

In 2020, the WBG power electronics market is estimated to be 10% of the total power electronics market, or

\$1 billion

By 2027, the share of the power electronics market represented by WBG products is expected to be

40%

In 2027, the total value of the global WBG power electronics market is expected to be

\$13 billion

Source: PowerAmerica/IHS Markit.



## Rationale for Prioritization

- Strong base to nurture:** The Research Triangle area is already considered a hub for WBG power electronics due to the presence of Cree/Wolfspeed, NCSU/FREEDM Systems Center/PowerAmerica, and R&D centers for key product manufacturers.

- Potential for economic and job growth, or to mitigate losses:** EVs contain only 20% of the part count of internal combustion–driven vehicles. Engine and transmission manufacturers and component suppliers are particularly vulnerable. North Carolina needs a plan to mitigate the loss of component manufacturing business that will result from transition to EVs, at minimum.

- To stop poaching by other states:** Experts interviewed suspect New York's \$500 million investment to lure Cree/Wolfspeed's new \$1 billion wafer manufacturing plant from North Carolina was a good investment, considering the long-term potential to establish the Syracuse area as an EV ecosystem—an "EV city" cluster analogous to "Motor City" (Detroit, Michigan). An economic study to examine the impact of the loss of the new Cree facility would facilitate understanding and inform future economic development strategy.

# Realizing Our Vision: North Carolina as "Electric Motown"



## Electric Motown

**North Carolina recognized as a global hub for vehicle electrification, leveraging the presence of Cree/Wolfspeed, world-class research centers FREEDM and PowerAmerica, and downstream system manufacturers to grow a thriving ecosystem that will eventually attract EV OEMs.**

*"There is potential to maintain an advantage in silicon carbide manufacturing for some time because the manufacturing process is challenging, different, and not yet established elsewhere, unlike silicon or gallium nitride."*

—Victor Veliadis, Executive Director and Chief Technical Officer, PowerAmerica



## Critical Partners to Advance the Vision

- **Cree/Wolfspeed:** North Carolina is fortunate to have the R&D and manufacturing presence of the industry leader in silicon carbide power electronics headquartered here. Cree has stated that there is an opportunity to expand the community of power electronics system developers and manufacturers that use Cree devices and modules.
- **NCSU:** The electrical engineering and materials departments, along with co-located research institutes FREEDM Systems Center and PowerAmerica, have played a key role in commercialization of WBG power electronics applications in EVs, charging systems, and supporting electric power infrastructure. NCSU also produces excellent technical workers needed for this industry. Employers rate the quality of NCSU graduates highly, but there are too few of them, and they are often lured away from the region.
- **Research Triangle Cleantech Cluster:** RTCC is an established consortium that includes several key players and is already partially focused on this opportunity.
- **Economic Development Partnership of North Carolina (EDPNC):** As the lead organization attracting industry to the state, EDPNC is a critical partner responsible for implementing any strategy emerging from this effort.



## Other Resources Needed to Advance the Vision

- **Economic development strategy and incentives:** Although the effectiveness of incentives in general is debated in economic development circles, New York and other states may continue to lure companies away or outcompete North Carolina for new projects. Developing a proactive promotion strategy targeting EV suppliers that highlights the many advantages of North Carolina as a location for vehicle electrification will minimize the need for incentives.
- **More skilled manufacturing employees:** NCSU has developed job training for power electronics manufacturing workers, but the program will need to expand as the cluster grows.
- **An open silicon carbide foundry:** An open silicon carbide foundry would attract "fabless" device design companies to the area, which would collaborate with downstream module, subsystem, and system manufacturers, strengthening the ecosystem.
- **Hardware start-up funding:** FREEDM Systems Center has an extensive portfolio of valuable IP, but much of it languishes due to lack of start-up capital focused on hardware technology in the region.

# Realizing Our PET Vision: Suggested Next Steps



1

- **Study North Carolina power electronics and transportation supply chains** and determine potential effects of vehicle electrification to inform an industry strategy to retain and attract key innovation companies.

2

- **Increase job training and skill development** to fill growing power electronic workforce demands.

3

- **Establish an open silicon carbide foundry** that would attract “fabless” device design companies to the area, especially with the existing silicon carbide power electronic assets that exist in North Carolina.

4

- **Unleash or attract funding** to support start-ups in power electronics, creating a more dynamic ecosystem.

# Companies Engaged and Sources Referenced



*With gratitude, we acknowledge the contributions of the following companies and organizations:*

Cree/Wolfspeed | Delta Power Electronics Laboratory |  
FREEDM Systems Center at NCSU | PowerAmerica Institute

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- [Business Facilities](#)
- [Microwave Journal](#)
- [Detroit News](#)
- [GoUpstate.com](#)

# Defense Innovation Industry Cluster Analysis

## What Is Defense Innovation?

Defense innovation is the application of new technologies and processes to solve national security needs and enable technical superiority for the U.S. Department of Defense (DOD).

# Vision: NC Becomes the Silicon Valley of Defense Innovation



**We envision North Carolina to be the future hub of innovation for the defense industry, with innovative, secure, high-quality companies and organizations providing research, products, and services to DOD.**



## Defense Innovation as an Economic Force Multiplier

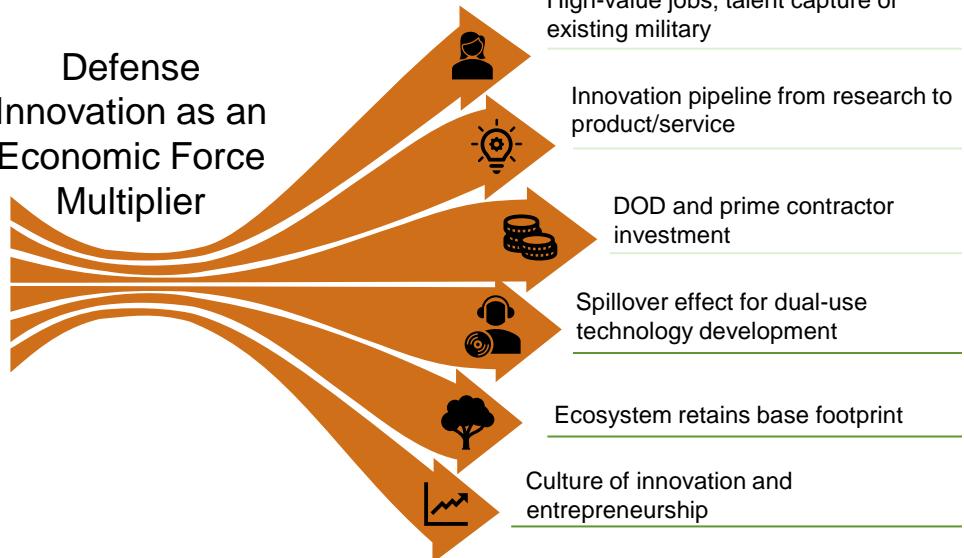


Image source: <https://www.military.com/daily-news/2019/05/16/army-fields-tiny-pocket-drones-paratroopers-fort-bragg.html>.

# State of the Defense Industry Cluster in North Carolina



## NORTH CAROLINA

#15  
\$10.9 B SPENT  
IN STATE

#27  
1.9% OF STATE GDP

2.2%  
OF TOTAL U.S.  
DEFENSE SPENDING

\$1,050  
PER RESIDENT

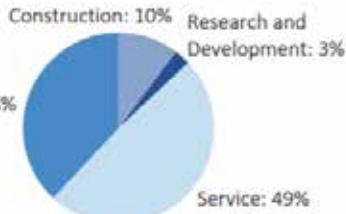
#23  
\$4.0 B CONTRACT  
SPENDING

#4  
142,943 NUMBER  
OF PERSONNEL

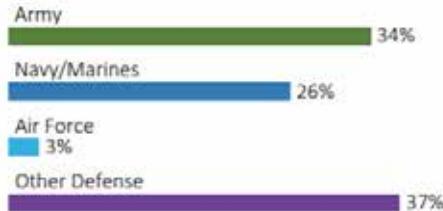
#6  
\$6.9 B PERSONNEL  
SPENDING

### DEFENSE CONTRACTS

#### By Type



#### By Service



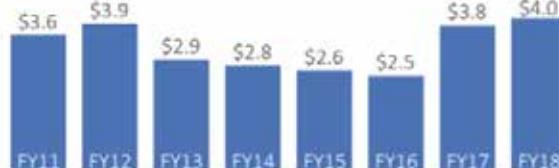
### Top Defense Contractors

(M = millions)

H-Squared LLC	\$567.0 M
Sodexo	\$123.9 M
WorldWide Language Resources	\$91.4 M
Astronautics Corporation of America	\$76.6 M
United Technologies	\$72.5 M
LGS Innovations	\$64.2 M
Raytheon	\$63.7 M
US Foods Holding	\$58.9 M
LC Industries Inc.	\$58.3 M
General Dynamics	\$56.3 M

### Contract Awards Performed

(by fiscal year, billions)



**North Carolina has the potential to expand DOD market share through innovative products and services.**

- North Carolina has the fourth-largest footprint in personnel but is 23rd in DOD contract spending.
- At 2.2% of the DOD budget, North Carolina companies have a wide-open opportunity for growth.
- Only 3% of the state's \$4 billion in DOD contracts is in R&D, yet North Carolina is strong in research, with a high concentration of research jobs (1.26 times the national average).

# NC Defense Growth Infrastructure and Innovation Assets



## Defense Growth Infrastructure

- An active network of companies and universities providing products and services to support the bases
- Support organizations focused on growing defense business:
  - North Carolina Department of Military & Veterans Affairs
  - Defense Alliance of North Carolina (DANC)
  - North Carolina Military Business Center (NCMBC)
  - North Carolina Defense Technology Transition Office
  - North Carolina Defense Industry Diversification Initiative (NCDIDI)
  - North Carolina Veteran's Business Association



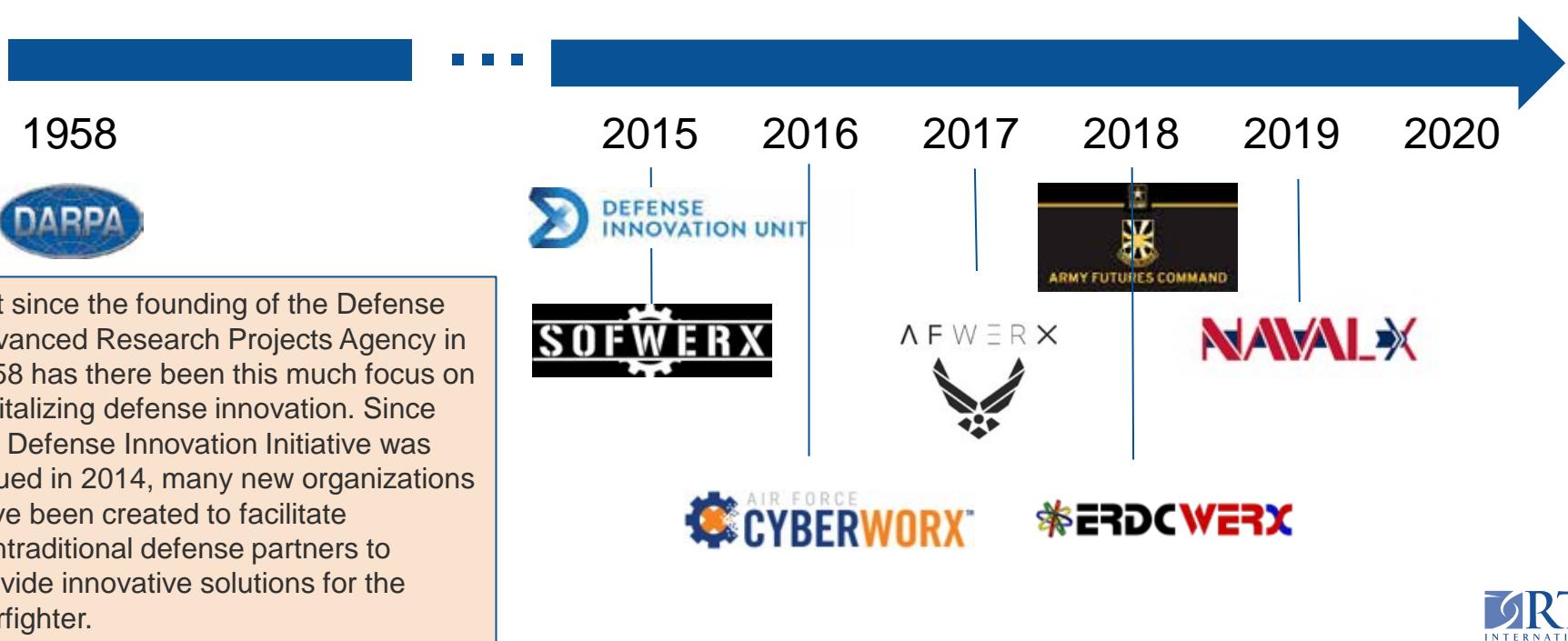
## Defense Innovation Assets

- Access to Army, Air Force, and Marines personnel to understand needs and test new innovations at the large bases in North Carolina
- The DOD National Security Innovation Network's Southeast Region headquarters established in Durham in 2018
- Finalist for the Army Futures Command, indicating North Carolina's reputation as an innovation hub
- World-class research laboratories, programs, and facilities
- Army Research Office, the major funding arm for army basic research, headquartered in Research Triangle Park
- Fastest growth in jobs in six technology focus areas of future importance to DOD
- Home to over 84,000 veteran-owned businesses

# In 2014, DOD Launched an Innovation Initiative



*"I am establishing a broad, department-wide initiative to pursue innovative ways to sustain and advance our military superiority for the 21st Century and improve business operations throughout the Department."* —Defense Secretary Chuck Hagel (2014)



Not since the founding of the Defense Advanced Research Projects Agency in 1958 has there been this much focus on revitalizing defense innovation. Since the Defense Innovation Initiative was issued in 2014, many new organizations have been created to facilitate nontraditional defense partners to provide innovative solutions for the warfighter.

# Technology Trends Shaping the Defense Industry Cluster



## Defense Innovation Trends

- DOD innovation activity targeting “non-traditional partners” and more flexible and faster contracting mechanisms will slowly change the landscape of innovation providers from prime contractors to small entrepreneurial businesses.
- Fiscal year 2020 prioritizes **innovation and modernization** to strengthen competitive advantage in all warfighting domains for the next few decades.
- DOD is shifting its emphasis from counterinsurgencies to **competition with China and Russia**.
- **Cyberwarfare and cybersecurity** have major emphasis and will be focus areas of the new **Space Force**, and **cybersecurity certification is critical for the defense supply chain**.
- DOD's newly launched Joint Artificial Intelligence Center and **strategy directing adoption of artificial intelligence** will help the United States to maintain its strategic position to prevail on future battlefields.

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Sources: <https://www.defensenews.com/digital-show-dailies/ausa/2019/10/14/what-risks-is-the-us-army-taking-to-prep-for-future-warfare/>; Washington Post: Pentagon takes aim at China and Russia in proposed \$750 billion budget ([https://www.washingtonpost.com/world/national-security/pentagon-takes-aim-at-china-and-russia-in-proposed-750-billion-budget/2019/03/12/d6179058-44ea-11e9-9726-50f151ab44b9\\_story.html](https://www.washingtonpost.com/world/national-security/pentagon-takes-aim-at-china-and-russia-in-proposed-750-billion-budget/2019/03/12/d6179058-44ea-11e9-9726-50f151ab44b9_story.html)); FCW: <https://fcw.com/articles/2019/03/11/budget-defense-cyber-ai.aspx>; Overview - FY2020 Defense Budget: <https://comptroller.defense.gov/Budget-Materials/>.

# Realizing Our Defense Innovation Vision: Opportunity Space



## Our Vision

**The defense industry of the future looks to North Carolina as THE place to access innovative, secure, high-quality companies providing research, development, products, and services.**

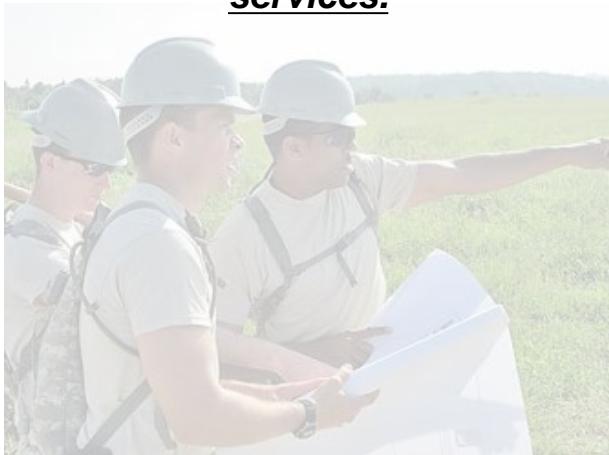


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### Facet 1

Secure defense industrial base providing innovation to DOD

### Facet 2

Testbed for defense innovation

# Realizing Our Defense Innovation Vision: Opportunity Space



## Our Vision

**The defense industry of the future looks to North Carolina as THE place to access innovative, secure, high-quality companies providing research, development, products, and services.**



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### Facet 1: Secure defense industrial base providing innovation to DOD

Innovative, high-quality companies providing research, development, products, and services in DOD secure business settings

#### Elements

A **strong, secure, and high-quality defense** industrial base that provides innovative research, products, and services to DOD and the U.S. defense industry in **six technology focus areas**:

- Advanced manufacturing
- Autonomous systems
- Data and knowledge management
- Human performance
- Materials
- Power

### Facet 2: Testbed for defense innovation

Test facilities near military bases with access to end users or military personnel to test and verify that research and products meet the demands

#### Elements

Access to military personnel at North Carolina bases connects researchers and innovators to end users and **enables a faster technology transition path**.

- Test facilities near North Carolina's military installation can provide an easy-to-access location for researchers and product developers to conduct technical testing with military end users.

# Realizing Our Vision: Secure Defense Industrial Base Providing Innovation to DOD



Given the changing nature of the industry, North Carolina has the potential to conduct more defense R&D by helping nontraditional companies identify opportunities in the defense market, navigate complex government contracting requirements, gain access to funders and users with needs, and develop cyber-secure business processes. Further, North Carolina can create or augment testbeds and test sites near the bases to facilitate these exchanges and move technology further into the hands of military users.



## Market Potential

	2020	2025	2030
U.S. defense budget	\$738 billion	\$832 billion	\$937 billion
Defense tech	\$405 billion	\$457 billion	\$515 billion
North Carolina contract awards	\$3.3 billion	\$15 billion	\$30 billion

The U.S. DOD budget has long been a substantial and stable portion of the total U.S. federal budget and is expected to continue to grow at a rate of 2.5%. The technology portion of the DOD budget is more than half of the total. North Carolina currently only accesses <1% of the defense tech portion, showing that there is room for growth.



## Rationale for Prioritization

North Carolina is a rapidly emerging market (first or second in job growth) for future defense sector growth areas of data and knowledge management, human performance, advanced manufacturing, and power.

North Carolina's research strength can gain access to more of DOD's over \$500 billion tech budget, which is estimated to generate an additional 4.3% of private R&D investment and employment.

# Realizing Our Vision: Secure Defense Industrial Base Providing Innovation to DOD



Given the changing nature of the defense industry, North Carolina has the potential to conduct more defense R&D by helping nontraditional companies identify opportunities in the defense market, navigate complex government contracting requirements, gain access to funders and users with needs, and develop cyber-secure business processes. Further, North Carolina can create or augment testbeds and test sites near the bases to facilitate these exchanges and move technology further into the hands of military users.



## Market Potential

In 2025, the defense technology portion of the U.S. DOD budget is expected to be **\$457 billion**

with an annual growth rate of **2.5%**.

In 2030, the defense technology budget is expected to be **\$515 billion**

NC currently accesses <1% of the defense tech portion, showing room for growth.



## Rationale for Prioritization

North Carolina is a rapidly emerging market (first or second in job growth) for future defense sector investment areas of data and knowledge management, human performance, advanced manufacturing, and power.

North Carolina's current defense technology market is \$4 billion, less than 1% of the anticipated 2025 budget, leaving opportunity for market share growth.

North Carolina's veteran population provides talent with domain understanding.

# Realizing Our Vision: Secure Defense Industrial Base Providing Innovation to DOD



*"After 2021, defense funding is projected to grow by 2.5 percent a year, on average, reaching \$937 billion in 2030."*

—Congressional Budget Office

*"A 10% increase in government-financed R&D generates 4.3% additional privately funded R&D. An analysis of wages and employment suggests that the increase in private R&D expenditure reflects actual increases in R&D employment, not just higher labor costs."*

—National Bureau of Economic Research



## Critical Partners to Advance the Vision

Aligned and coordinated effort with clear roles and goals by the following:

- North Carolina Department of Military and Veterans Affairs/North Carolina Governor's Office
- DANC
- NCMBC
- NCDIDI
- UNC General Administration
- Duke University



## Other Resources Needed to Advance the Vision

- Real estate investment in innovation hubs, similar model to the Capital Factory in Austin, Texas
- Private investment for start-up companies
- Focused, concerted effort to provide cybersecurity certification for all DOD supply chains in North Carolina

# Realizing Our Defense Innovation Vision: Suggested Next Steps



1

- **Convene defense-focused support organizations** to clarify roles and responsibilities for growing North Carolina's defense business and communicate roles to industry.

2

- **Move forward on implementation plans** from the recent [North Carolina Defense Asset Inventory and Target Cluster Analysis](#) study. The study's major next step is to establish implementation teams made up of North Carolina stakeholders focused on attaining defense contracts in each technology area.

3

- **Engage DOD innovation leaders**, real estate developers, and the lead organization from #1 to discuss establishing a central location, near the bases, for a defense innovation hub.

4

- **Attract start-up investors** or develop investment funds to enable nontraditional solution providers to develop dual-use technology solutions for DOD and commercial markets.

5

- **Certify North Carolina companies** in cybersecurity business practices to proactively meet DOD requirements for its future supply base.

# Companies Engaged and Sources Referenced



*With gratitude, we acknowledge the contributions of the following companies and organizations:*

Fayetteville Cumberland County Economic Development Corporation | Tanjo (Carrboro) | Triad Semiconductor (Winston-Salem) | Vector Solutions |

*Insights were also shared from the recently completed North Carolina Defense Asset Inventory and Target Industry Cluster Analysis Report.*

Fusion3 (Greensboro) | Gusto Global (Morrisville)

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