Delaware Science & Technology Ecosystem Assessment

Prepared for: Delaware Prosperity Partnership
Prepared by: TEConomy Partners, LLC

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DELAWARE PROSPERITY PARTNERSHIP

TECONOMY PARTNERS LLC

TEConomy Partners, LLC is a global leader in research, analysis, and strategy for innovation-driven economic development. Today, we're helping nations, states, regions, universities, and industries blueprint their future and translate knowledge into prosperity.

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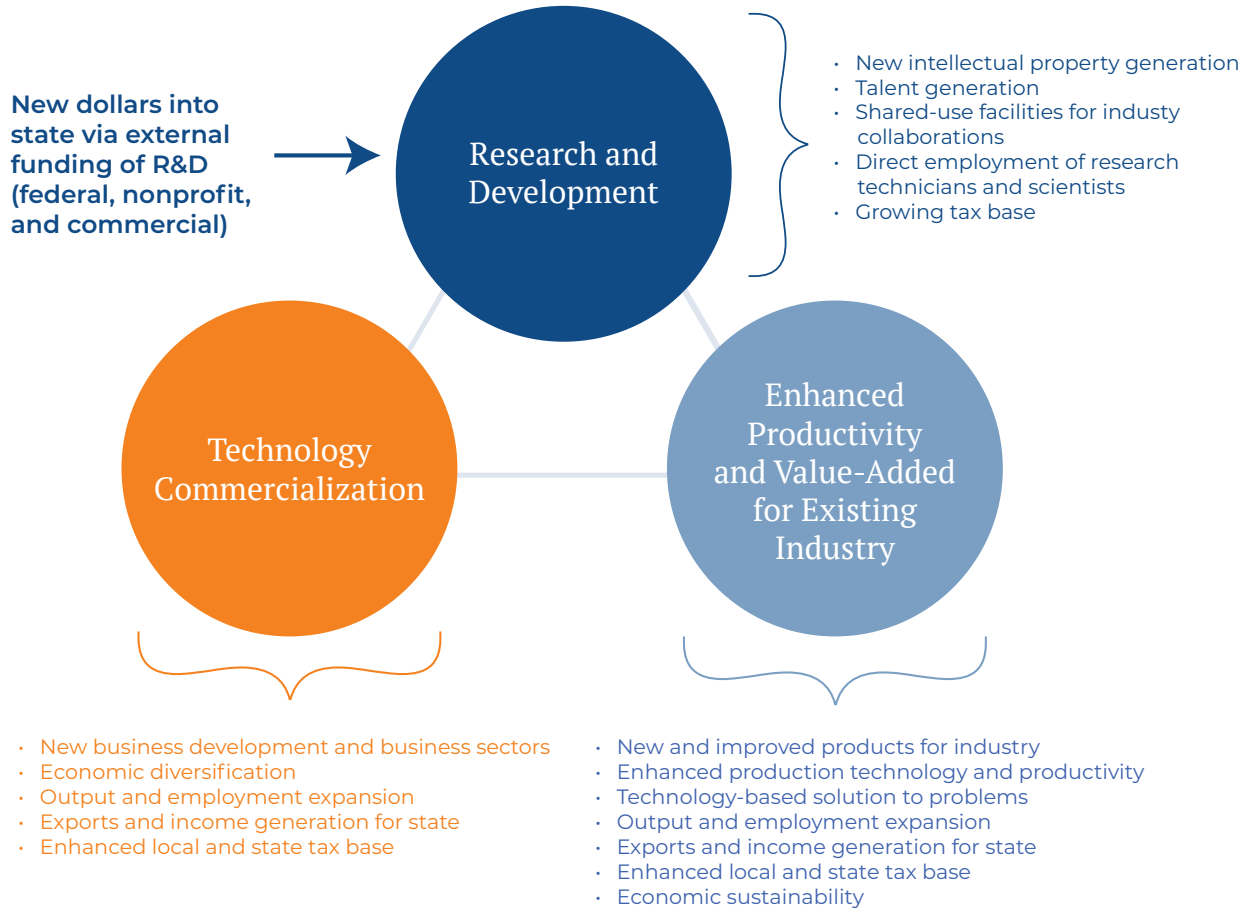
Executive Summary

The State of Delaware's economic growth has been driven for more than 200 years by scientific innovation, led by industry giants such as DuPont. Today, innovation continues to be a driving force of Delaware's growth and prosperity.

As illustrated in Figure ES-1, innovation-led development is a key driver of economic growth, high-quality jobs, and rising standards of living.

Figure ES-1. Innovation-Led Development is a Key Driver of Economic Growth



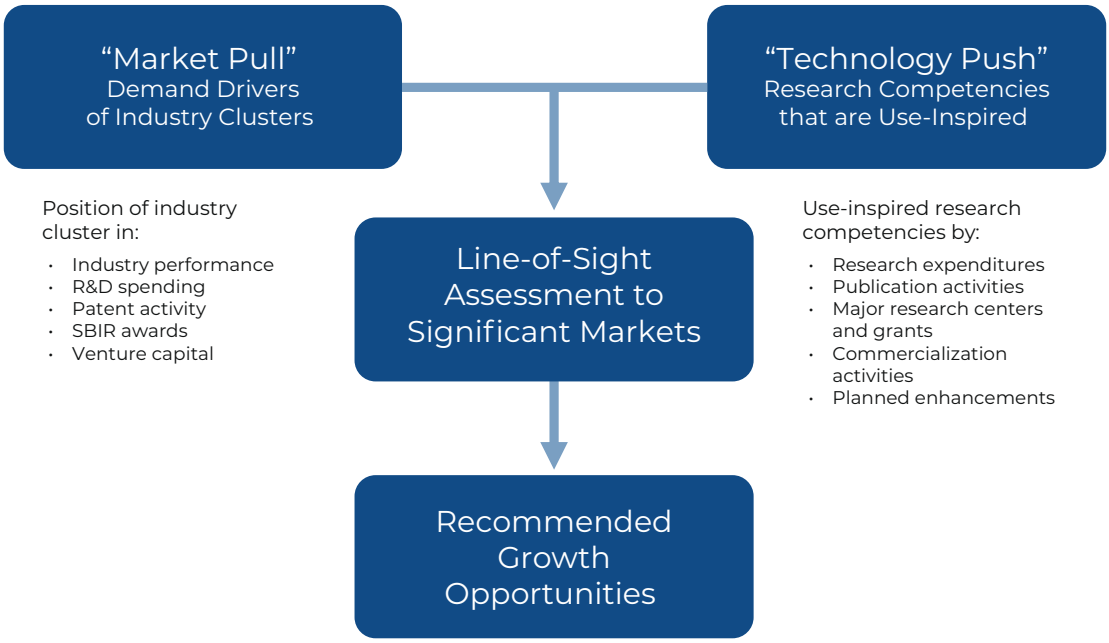
Source: TEConomy Partners, LLC.

Through the efforts of the Delaware Prosperity Partnership (DPP), the nonprofit public/private organization that leads Delaware's statewide economic development efforts, ensuring a robust innovation ecosystem continues to be a top priority. To this end, DPP commissioned a study to identify Delaware's innovation strengths and assess where the state can enhance the support ecosystem to more fully capture the economic potential of its science and technology (S&T) growth sectors.

Delaware's S&T Growth Opportunities

To identify Delaware's S&T growth opportunity areas, a rigorous, data-driven approach was undertaken to evaluate the state's competitive position. A line-of-sight assessment considered the "market pull" of industry innovation drivers found within established and emerging S&T industry clusters and how they aligned with the "technology push" of research capabilities found across the state's research institutions (Figure ES-2).

Figure ES-2."Line of Sight" Approach for Identifying Strategic S&T-Driven Industry Opportunities



Source: TEConomy Partners, LLC.

The intersection of where the state excels in the "market pull" of industrial innovation activities and the "technology push" of industry-facing core competencies represent the greatest opportunities for future economic growth. Taken together, they can offer a line-of-sight to innovation-led market opportunities that can help sustain the vibrancy of Delaware's leading existing industry clusters as well as position the state to respond to emerging market opportunities.

Ultimately, five existing S&T growth opportunity areas were identified for Delaware through the line-of-sight assessment. These five areas are those in which Delaware is best positioned to compete in innovation-led market opportunities that can help grow the state's leading industry clusters.

FinTech and Emerging Business Services Platforms

FinTech encompasses the digital and financial infrastructure that enables digital payments and online banking, but it also extends to applications and systems that enable the seamless integration of financial technology into every aspect of business and consumer life. Companies are no longer simply offering standalone financial products; instead, they are embedding financial services into software and services across end markets in e-commerce, logistics, and healthcare systems.

Next Generation Specialty Chemical Products

Next generation specialty chemical products represent a broad and growing market applications area that provides critical materials and formulations as a part of the upstream supply chain for a number of high-growth industries including semiconductors, healthcare, automotive, and energy technologies. These chemical compounds and chemically-derived materials enable higher performance, sustainability, and enhanced functionality across multiple applications, making this area a cross-cutting strength that supports multiple end-market applications.

Sustainable and High-Performance Materials

Next-generation sustainable and high-performance materials encompass a wide spectrum of advanced material classes engineered for superior performance and sustainability. These include innovative polymers and composites, nanoscale materials, and bio-derived substances that outperform traditional materials in strength, weight, durability, or functionality while also reducing environmental impact. Several key application verticals that this opportunity area spans include advanced polymers and plastics, high-performance composites, nanomaterials and photonic materials, biomaterials and soft matter, and hybrid and responsive materials.

Clean Energy Systems

Clean energy systems encompass a suite of technologies and processes designed to produce, store, and distribute energy with minimal environmental impact. These systems prioritize the use of renewable resources and aim to reduce greenhouse gas emissions, mitigate climate change, and promote sustainability. Key types of clean energy systems with the potential to be deployed on a commercial scale include fuel cells and hydrogen energy systems, solar photovoltaic systems, and wind energy systems.

Biopharmaceutical Manufacturing and Discovery

The rapid pace of biopharmaceutical research advances combined with the growth of fields such as cell and molecular biology, genomics, computational chemistry, and chemical biology is reshaping the way we discover, develop, and manufacture therapeutics, as well as diagnose and treat diseases and medical conditions. Biopharmaceutical research and manufacturing advances are not only at the forefront of creativity and innovation, but represent a convergence point for engineering, information technology, and physical sciences, such as chemistry and materials.

In addition, three emerging S&T growth opportunity areas were identified for Delaware through the line-of-sight assessment that can position the state to respond to emerging market opportunities:

- ***BlueTech Innovation***, encompassing marine science, ocean technology, offshore wind, aquaculture, and coastal resilience.

- ***Integrated Agriculture and Sustainable Food Production***, a sustainable approach to food production that combines different farming enterprises to create a self-sustaining, resource-efficient, and environmentally friendly system.

- ***Rehabilitative and Performance Enhancement Technologies***, encompassing treatments that represent a broad spectrum of interventions focused on restoring function, reducing pain, and improving a patient's quality of life. These existing and emerging S&T growth opportunities represent a unique portfolio of Delaware's technology strengths and provide a potential playbook for the state's innovation-led future.

Delaware's Innovation Ecosystem

In order to successfully leverage the identified S&T growth opportunities, Delaware must have a robust innovation ecosystem that helps increase the likelihood of impactful technologies, products, and services making it to the market. A holistic, objective, data-driven assessment of the capacities, gaps, and opportunities for the state's innovation ecosystem was undertaken. Delaware's performance was compared against six benchmark states and the national average, and the analysis can be summarized through seven key findings:

1. Delaware is a powerhouse in research and development (R&D) and patent activity, with growth rates far outpacing the U.S.
2. Delaware's research universities are seeing substantial growth in R&D funding and have made significant investments in their infrastructure to encourage innovation and entrepreneurship.
3. Despite growth in R&D, Delaware's universities are not commercializing research at a pace fast enough to promote broad-based economic vitality.
4. Delaware is home to a continuum of ecosystem support services to encourage innovation and entrepreneurship.
5. Delaware is seeing overall growth in risk capital and venture development, but increases are modest and starting from a low base of activity.
6. Delaware is lagging benchmark states and the nation in the growth of both STEM-related degrees and STEM employment share.
7. Although Delaware is seeing sustained startup activity in high-tech sectors, this has not translated into wide-spread advanced industry establishment or employment growth.

Overall, Delaware is home to some of the elements of a robust innovation ecosystem with the ability to impact economic vitality. However, the system is not functioning at maximum capacity, and, as a result, Delaware's innovation ecosystem needs to be further strengthened in order to strategically grow its innovation economy. Moving forward, the state must be strategic to ensure it continues to build positive momentum while also addressing the challenges facing its innovative firms.

Conclusion

The S&T growth opportunities represent a unique portfolio of Delaware's technology strengths and a potential playbook for the state's innovation-led future. By identifying those areas that have significant potential for moving research to market and strengthening the support ecosystem, DPP and its partners can develop targeted economic strategies and programs focused on growing high-impact businesses and increasing the competitive advantage of the state's key industry sectors.

Successfully seizing these opportunities will require intentional connections, investments, and a collaborative culture. As DPP looks to the future, these opportunity areas can serve as a guide to catalyze strategic partnerships, inform future investments, serve as a foundation for statewide innovation initiatives, build awareness of the state's unique strengths, and recruit and retain world-class innovators in Delaware.

Introduction

In today's knowledge-based economy, the ability to innovate is becoming the most important determinant of economic growth reflecting the acceleration of an economic era marked by increasing globalization of markets, the fast pace of technological change, and the growing strength of developing nations in generating highly educated and skilled talent to compete for economic growth.

As noted by the U.S. Council on Competitiveness in its recent report:

> *Technology and innovation—the combination of imagination, insight, ingenuity, invention, and impact in society—are the main drivers of U.S. economic growth and productivity, the main shapers of the future, and principal determinants of economic opportunities and national security for Americans. With such impact for the Nation, U.S. capacity, capability, and performance in leveraging new technology for economic gain and for innovating should be at the top of the economic and national security agenda, and of major concern to U.S. public and private sector leaders.*[1]

At a time when innovation and technological capabilities are the key driving economic forces, the value of research and development (R&D) activities increasingly depends upon not just the volume and quality but the ability to translate a university's research base into new product development, industry advancement, and new company growth. As the National Research Council explains in its report entitled Best Practices in State and Regional Innovation Initiatives: Competing in the 21st Century:

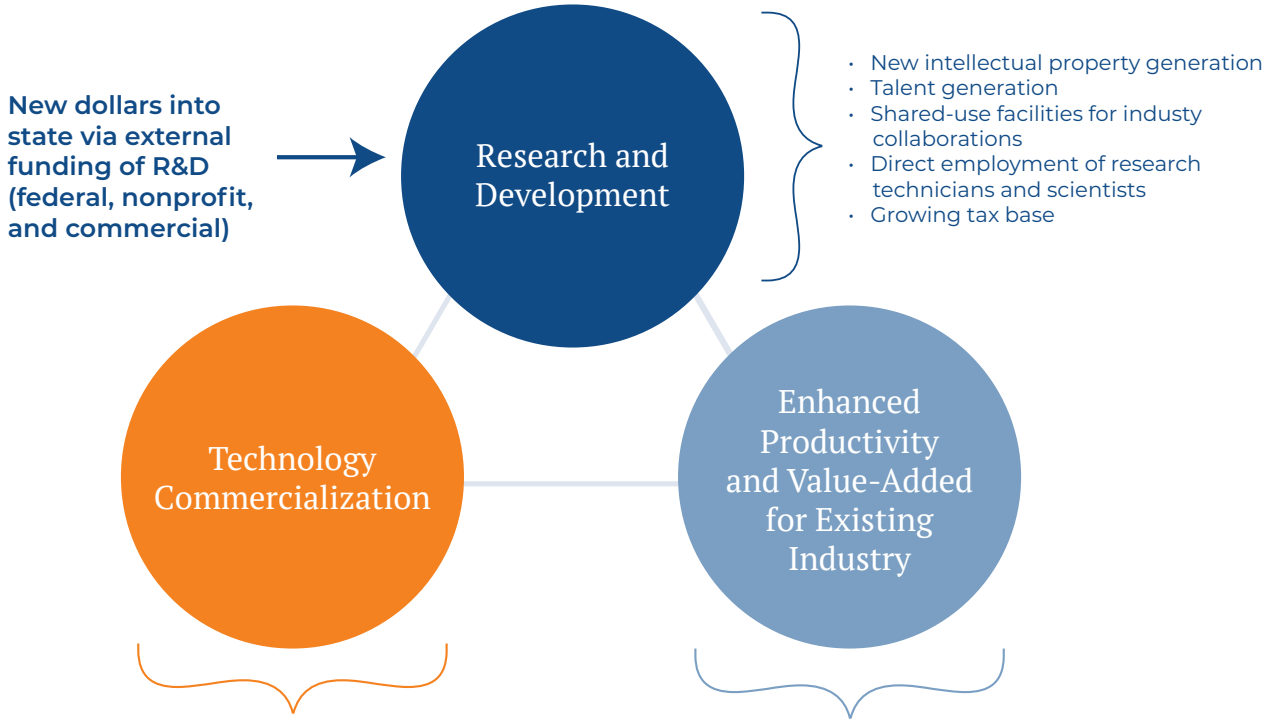
> *A key factor in the rise of the United States as a technological power has been a long tradition of close ties and frequent collaboration between companies and a network of first-rate universities. Underlying the success of innovation clusters such as Silicon Valley, Route 128, and the Research Triangle of North Carolina are local universities with a longstanding mission of spurring economic development by developing technology with and transferring technology to local industry and stimulating the creation of new businesses in university-centered incubators and science parks. Technology-intensive companies commonly locate their operations near the best universities in particular fields of science and engineering in order to enable their internal research departments to work with "star" scientists and to recruit promising students.*[2]

As illustrated in Figure 1, innovation-led development is a key driver of economic growth, high-quality jobs, and rising standards of living.

1 The Council on Competitiveness, *Competing in the Next Economy: The New Age of Innovation*, (National Commission on Innovation & Competitiveness Frontiers, 2020.) https://www.compete.org/storage/documents/documents/CoC_Commission_NextEcon_121620_FINAL.pdf

2 Charles Wessner, Editor, "Best Practices in State and Regional Innovation Initiatives: Competing in the 21st Century," National Research Council, 2013, page 49.

Figure 1. Innovation-Led Development is a Key Driver of Economic Growth



Source: TEConomy Partners, LLC.

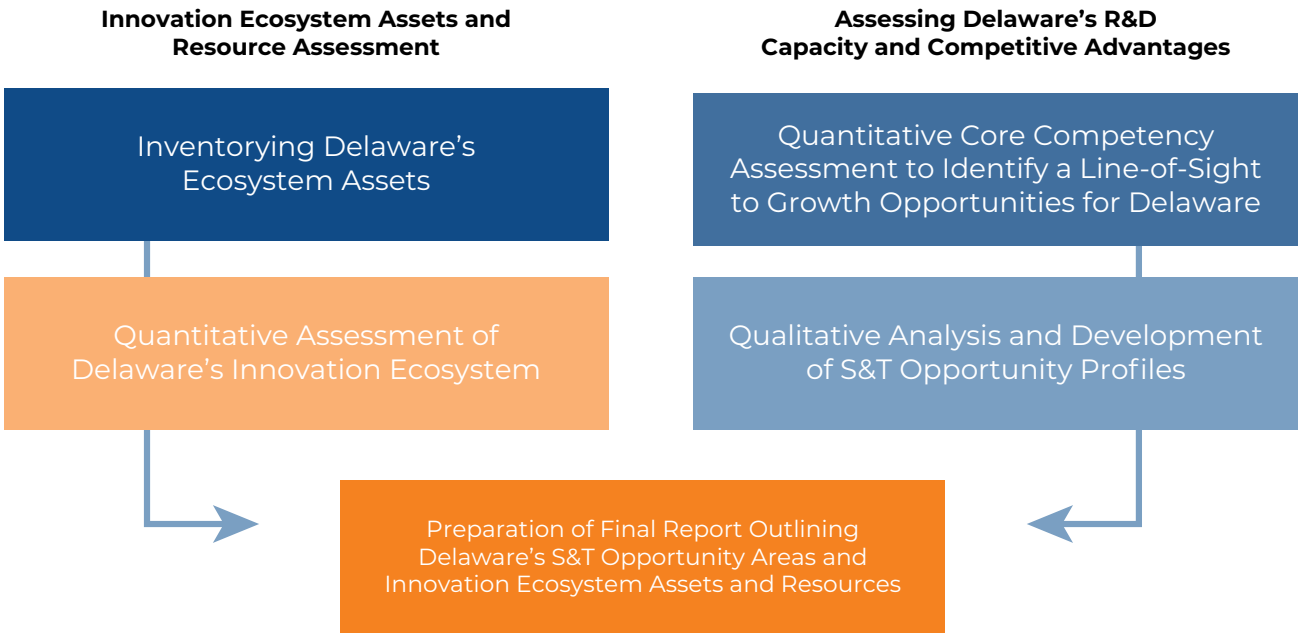
The State of Delaware's economic growth has been driven for more than 200 years by scientific innovation, led by industry giants such as DuPont. Today, innovation continues to be a driving force of Delaware's growth and prosperity. Through the efforts of the Delaware Prosperity Partnership (DPP), the nonprofit public/private organization that leads Delaware's statewide economic development efforts, ensuring a robust innovation ecosystem continues to be a top priority. To this end, DPP commissioned a study to identify Delaware's innovation strengths and assess where the state can enhance the support ecosystem to more fully capture the economic potential of its high-growth sectors. By understanding which industry sectors and research domains have significant potential for moving research to market, and by identifying the strengths and gaps in the support ecosystem, DPP and key partners can develop targeted economic strategies and programs focused on growing high-impact businesses and increasing the competitive advantage of the state's key industry sectors.

TEConomy Partners, LLC (TEConomy), a global leader in research, analysis, and strategy for innovation-driven economic development, was retained to lead the assessment in close collaboration with DPP and its stakeholders. As illustrated in Figure 2, the assessment was divided into two phases and was designed to answer the following key questions utilizing a combination of quantitative data and targeted stakeholder engagement:

- How is Delaware's innovation ecosystem performing, what are the strengths upon which to build, and what are the weaknesses and/or gaps that need to be addressed?

- What S&T areas will drive future economic growth for the State of Delaware?

Figure 2. Assessment Methodology/Approach



Source: TEConomy Partners, LLC.

DPP formed a project steering committee comprised of eleven thought leaders to help guide the assessment. Representing a cross-section of industrial and academic leaders, as well as key DPP stakeholders, this committee played an indispensable role throughout the process. The members of the steering committee are listed in the textbox.

The first section of this report synthesizes key findings from the innovation ecosystem assessment. The second section provides detailed information for each of Delaware's identified S&T growth opportunity areas.

Project Steering Committee

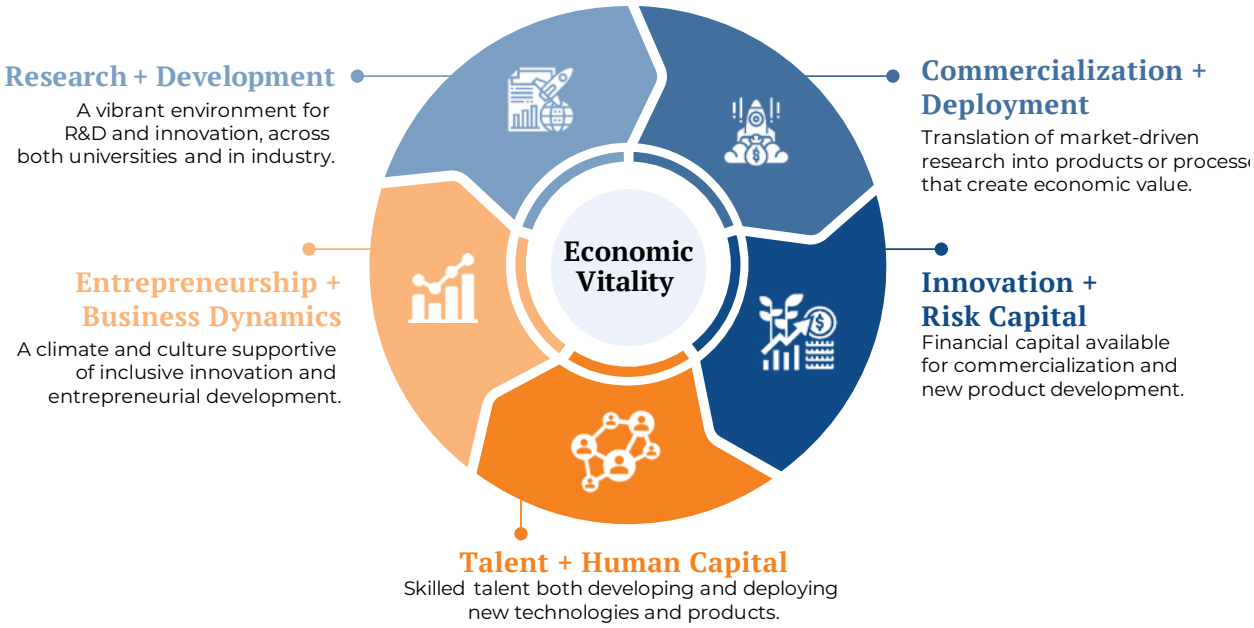
- Mike Bowman, CEO and President, Delaware Technology Park
- Shane Breakie, VP, Sustainability and Organic Growth, Chesapeake Utilities*
- Desa Burton, Executive Director, Zip Code Wilmington*
- Patrick Callahan, Head of Data and Analytics and Innovations, Labware**
- Sabrina Devito, Chief Strategy Office, Best Egg
- John Gavenonis, VP and GM, Chemistries and Supplies Division, Agilent Technologies
- Robert Herrera, Founder, The Mill and 9SDC**
- Julius Korley, Associate VP, Office of Economic Innovation & Partnerships, University of Delaware
- Heath Naquin, VP Government and Capital Engagement, University City Science Center
- Tracy Shickel, Associate VP Corporate Engagement, University of Delaware
- Cherese Winstead, Dean, College of Agriculture, Science and Technology, Delaware State University*

*DPP Board Member
** DPP Board Alumni

Delaware's Innovation Ecosystem

An innovation ecosystem is a dynamic network of interconnected entities that collaborate to foster creativity, technological advancement, and economic growth (Figure 3). This intricate system comprises various stakeholders, including entrepreneurs, startups, established corporations, universities, research institutions, investors, and government bodies, among others. Each of these components plays a vital role in nurturing and propelling innovative ideas from conception to market realization.

Figure 3. Elements of a Robust Innovation Ecosystem with Capacity to Impact Economic Vitality



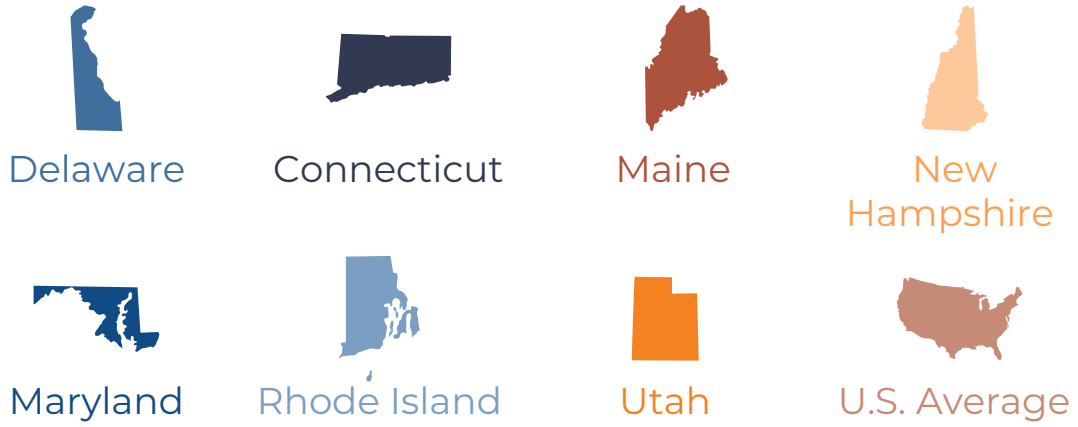
Source: TEConomy Partners, LLC.

Ultimately, the success of a state's innovation ecosystem depends on several factors, including access to funding, a supportive business environment, strong educational institutions, and a culture that embraces creativity and entrepreneurship. When these elements align, the ecosystem can become a powerful engine for economic development, job creation, and technological advancement, benefiting not just the direct participants but the broader society as well. When any component of the ecosystem is missing, or the elements of the ecosystem are not functioning together properly, economic vitality can be more limited.

To determine whether Delaware has developed a robust ecosystem for innovation—which increases the likelihood of impactful technologies, products, and services making it to the market—it is important to examine how the ecosystem is functioning in aggregate in order to identify where there are real strengths within the system as well as where any potential weaknesses exist. This requires an objective, data-driven assessment of the capacities, gaps, and opportunities for the state. By examining Delaware's current innovation ecosystem through this holistic lens, DPP and other key stakeholders can help inform future policy and investment recommendations based on existing opportunities to advance initiatives to address these ecosystem attributes.

Based on this context and discussions with DPP leadership and the project steering committee, TEConomy compared Delaware's performance against six benchmark states and the national average (Figure 4). This analysis can be summarized through seven key findings, as detailed below.

Figure 4. Quantitative Assessment Compares Delaware's Performance Against Six States and the U.S.



Source: TEConomy Partners, LLC.

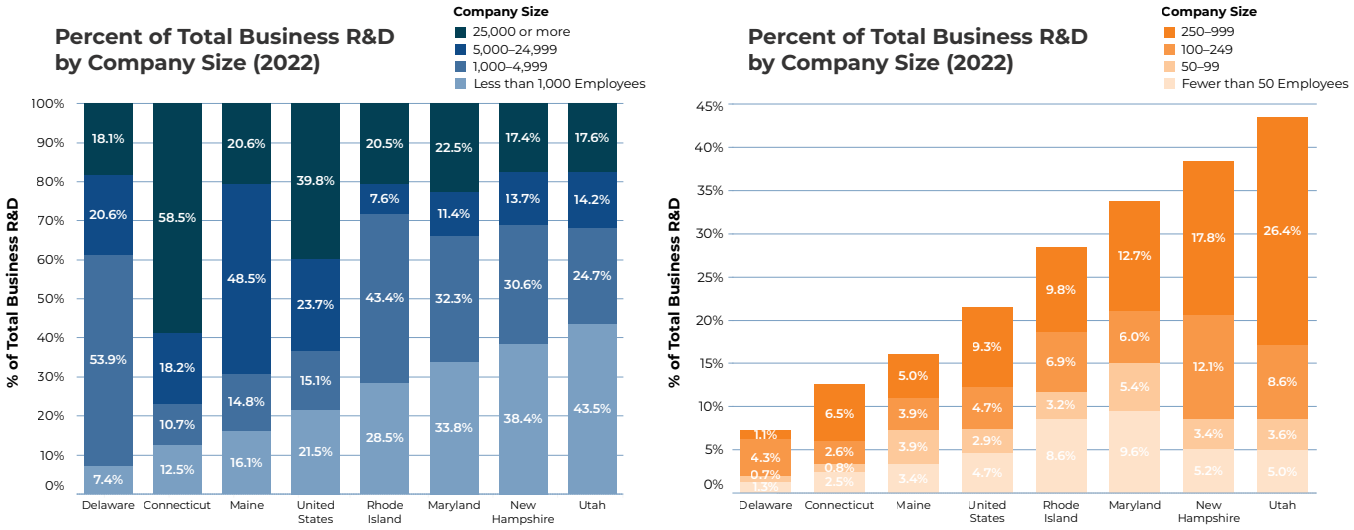
Finding 1: Delaware is a powerhouse in R&D and patent activity, with growth rates far outpacing the U.S.

A vibrant environment for R&D across industry and research institutions is a critical component of the innovation ecosystem. R&D refers to the activities undertaken to create new knowledge, products, services, or processes, or to improve existing ones. In a thriving R&D landscape, companies, universities, and government agencies collaborate and compete, fostering a culture of curiosity and problem-solving. These efforts not only lead to groundbreaking discoveries but also enhance efficiency, productivity, and competitiveness in the state's leading industry sectors. By investing in R&D, organizations can stay ahead of market trends, address emerging challenges, and create value for consumers and society at large. While R&D often requires significant time and resources without immediate returns, it is essential for a state's long-term success and sustainability in today's rapidly evolving global economy.

Delaware is a leading state for industrial R&D, ranking sixth nationally in R&D intensity (R&D as a share of state GDP) and leading all benchmark states. Delaware companies invested more than $2 billion in industrial R&D expenditures in 2022, which represents more than 3 percent of the state's total economic activity (GDP). Nationally, Delaware trails only Washington, Massachusetts, California, Oregon, and Michigan in industrial R&D intensity (industrial R&D as a share of GDP), and Delaware ranks 27th in total industrial R&D (far outperforming its small population and GDP size). Notably, industrial R&D has doubled since 2019, a rate of growth that is faster than the U.S. average and all other benchmark states.

However, compared to other states, Delaware's smaller and mid-sized companies represent a minimal portion of industrial R&D (Figure 5). Just 7.4 percent of industrial R&D in Delaware was conducted by companies with fewer than 1,000 employees, a share that is by far the lowest among benchmark states and considerably lower than the U.S. average. Approximately 2 percent of Delaware's industrial R&D was from companies with fewer than 100 employees, which is also the lowest amount amongst the benchmark states and lower than the U.S. average.

Figure 5. Percent of Total Business R&D by Company Size (2022)



Source: TEConomy's analysis of NSF BERD data.

An analysis of industrial R&D in Delaware finds that 69 percent of expenditures are focused on chemicals research, which includes both basic chemicals and pharmaceuticals. Of the nearly $2 billion in chemicals R&D, pharmaceutical R&D represents 82 percent, or $1.7 billion. Notable biomedical and pharmaceutical companies investing in R&D in Delaware include firms like Adesis, Agilent, Carelon Research (the research arm of Elevance Health, formerly named HealthCore), Datwyler, Incyte, Labware, Noramco, and Prelude Therapeutics (Figure 6). Leading companies investing in R&D in chemicals and advanced materials include Chemours, Dupont, Gore, Solenis, SunChemical (formerly BASF), and Ashland. The 'basic chemicals' segment of industrial R&D accounts for $192 million in spending in 2022.

Figure 6. Leading Delaware Companies Investing in R&D

Source: TEConomy Partners, LLC.

Beyond industrial R&D, **Delaware has experienced significant growth in patent activity since 2019.** Patents represent a primary means for protecting innovative products and processes, and as such can be a good proxy for understanding the types of innovation activity within a state and across regions. Although there are other forms of intellectual property protection through copyrights, trademarks, and trade secrets, patents help highlight areas of innovative activity.

TEConomy's analysis of patent activity focuses on Delaware residents, not necessarily companies and institutions. This provides the best proxy for a state's innovative capacity, since companies based in Delaware may have inventors located across the globe. On average, there were 1,466 patent records each year in Delaware from 2019 through 2024. Since 2019, patent activity among Delaware inventors has increased by nearly 16 percent, which outpaces the nation and all benchmark states. There was an average of 1.9 patent records per $10 million in GDP during these years, which is greater than the U.S. average but ranks fifth among seven benchmark states in patent intensity.

Finding 2: Delaware's research universities are seeing substantial growth in R&D funding and have made significant investments in their infrastructure to encourage innovation and entrepreneurship.

Research universities play a critical role in driving innovation and economic growth by conducting cutting-edge research that drives economic and societal progress, serving as engines of entrepreneurship, and providing an array of functional benefits.[3] As home to two research universities, University of Delaware (UD) and Delaware State University (DSU), Delaware benefits from this R&D capacity.

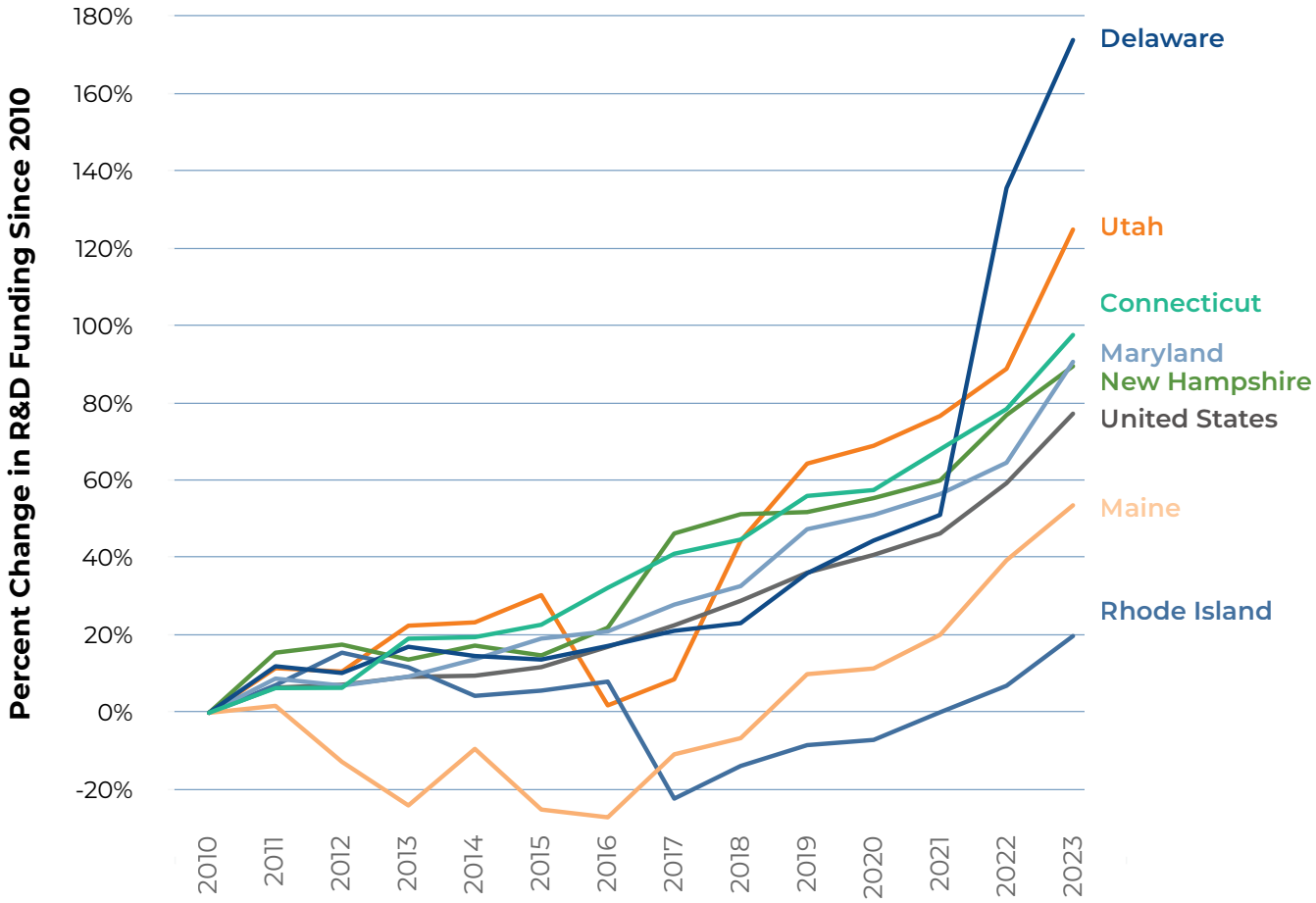
Delaware's two research universities conducted nearly $462 million in academic R&D in 2023.[4] Of this amount, UD represents 93 percent of the total academic R&D conducted ($428.1M), while DSU represents roughly 7 percent of the total ($33.5M). As one of only three states with no medical school, Delaware ranks favorably when excluding life sciences R&D. Among schools in the six identified benchmark states, UD ranks fifth in total R&D, but fourth when excluding life science-related research.

Delaware is working to leverage its designation as a National Science Foundation (NSF) Established Program to Stimulate Competitive Research (EPSCoR) jurisdiction. EPSCoR provides investments in scientific and engineering research and capacity-building in states and territories receiving a disproportionate share of federal R&D funds. Delaware EPSCoR is a collaborative effort amongst UD, DSU, Delaware Technical and Community College, Goldey Beacom College, and Wilmington University. The partnership aims to enhance the state's research capabilities through EPSCoR funding supported by NSF and other federal agencies. By leveraging state and federal resources, Delaware EPSCoR strengthens research infrastructure, promotes science, technology, engineering, and mathematics (STEM) education, and seeks to stimulate economic growth.

R&D at Delaware's colleges and universities has increased substantially since 2019, led by UD.[5] From 2019 to 2023, academic R&D in Delaware increased by 101 percent, or nearly $231 million. This represents the largest increase of any state during this 5-year period, and by far the most among benchmark states. UD's significant growth has been driven by a combination of factors, including hiring approximately 460 new faculty and providing "startup" funds to help new researchers establish their labs and procure the equipment essential to their work.[6] Growth is even more apparent when looking back to 2010, where Delaware's R&D grew by nearly 180 percent, a rate that is more than double the U.S. average (Figure 7).

3 TEConomy Partners, LLC. "The Importance of Research Universities." (2017)
4 TEConomy's analysis of NSF Higher-Ed R&D (HERD) 2022 Survey data.
5 Ibid.
6 See: https://www.udel.edu/udaily/2023/december/research-rankings-expenditures-nsf-herd/

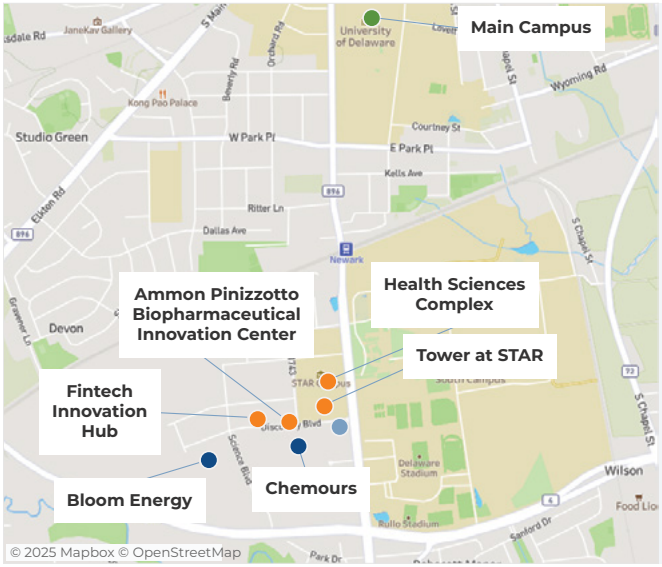
Figure 7. Indexed Change in Academic R&D Funding (2010=0 percent)



Source: TEConomy's analysis of NSF Higher-Ed R&D (HERD) data.

Beyond its research capacity, **UD is home to a wide range of initiatives to support technology transfer and entrepreneurship.** Perhaps the most influential investment in the innovation ecosystem stems from the STAR Campus, an intentional effort by UD to encourage R&D, entrepreneurship, and industry partnerships (Figure 8). Originally established in 2009 when the university purchased a former Chrysler assembly plant site, the STAR Campus has since transformed into a hub for science, technology, innovation, and entrepreneurship.

Figure 8. Notable Buildings and Tenants at the University of Delaware STAR Campus



Notable Campus Tenants:

Health Sciences Complex
- IBM (formerly SevOne)
- Independence Prosthetics-Orthotics
- ChristianaCare Go-Health Urgent Care
- Gene Editing Institute
- DTP@STAR
- UD Health Clinics

Tower at STAR
- Becker Morgan
- BioTek reMEDys
- WILMAPCO
- Predictive Analytics Group

Fintech Innovation Hub
- The Grain Exchange
- Delaware Bioscience Association
- RAAD360
- Tech Impact
- Discover Bank
- Delaware Technology Park
- UD OEIP, Spin In, SBDC and APEX Accelerator
- Innovative Precision Health
- NIIMBL
- Kendal

Source: TEConomy's analysis of STAR Campus.

Housed at the STAR Campus, UD's Office of Economic Innovation and Partnerships (OEIP), which includes the university's Technology Transfer Functions and Innovation Gateway Services, is a critical component of the state's overall innovation ecosystem. OEIP is home to NSF I-Corps@ UD, which supports the transition of technology concepts to the marketplace by supporting local entrepreneurial teams. This group also leads the Spin-In Program, which provides interdisciplinary student teams with real-world experiences in startup environments. Notably, OEIP also supports federal grant programs such as the APEX Accelerator (formerly PTAC) and the Small Business Development Center (SBDC) network. For more than 40 years, Delaware SBDC has provided support services to entrepreneurs free of charge due to funding by the U.S. Small Business Administration (SBA) and state government. Beyond its location in Newark at the STAR Campus, SBDC also has offices in Dover and in Georgetown.

Horn Entrepreneurship at UD is a university-wide initiative focused on entrepreneurship education that works with students to develop the skills and mindset to become innovative and successful. Horn Entrepreneurship offers numerous programs, resources, and support for both students and alumni, including:

- Academic programming (e.g., an entrepreneurship major and certificate programs)
- Venture Development and Acceleration Programs (e.g., Blue Hen Venture, Hen Hatch, Summer Founders, VentureON)
- Mentorship and Training (e.g., Lead Mentoring Program, ExpertConnect)
- Competitions and Challenges (e.g., Pitch Party, Big Ideas Challenge)
- Student Experience Programs (e.g., Signature Internship Program, Siegfried Fellows, InDE Fellowship, Free Lunch Friday)
- K-12 Programs (e.g., High School Course Offerings, Diamond Challenge, School Leadership).

The Horn Entrepreneurship program has helped solidify UD's ranking among the top entrepreneurship universities in the nation: UD is ranked 27th nationally by the Princeton Review and Entrepreneur and third overall in the Mid-Atlantic region.[7]

DSU has also invested considerably to enhance its innovation and entrepreneurial capabilities. DSU expended $33.5 million in R&D in 2023, the second most of any university in the state. Notably, this figure ranks sixth nationally among all historically black colleges and universities (HBCUs), and fifth when excluding medical schools.[8] Of the $33.5 million in R&D at DSU, most was in health and biomedical sciences fields ($12.8 million), followed by agriculture and natural resources ($6.7 million), and physics/astrophysics ($4.3 million).

In addition to R&D, DSU's College of Business offers an array of programs and services for Delaware-based entrepreneurs:

- Delaware Center for Enterprise Development: For more than 30 years, this center has provided business training, entrepreneurial education, and technical assistance to current and prospective entrepreneurs. Efforts led by DCED include:
    - Food Business Incubation Center: An affordable and professionally equipped commercial kitchen that also offers resources and technical assistance for food-related businesses.
    - The Garage: A maker space and ideation center where students, faculty, and community members can explore and develop their product or business ideas.
    - K-12 STEM Education: The DCED also supports youth development through programs like Camp Wall Street 101, a day camp for middle- and high-school students interested in finance, and through the JET program (Junior Entrepreneurs in Training), which teaches students enrolled in various Delaware public schools and who are members of local community centers about entrepreneurship.
- Center for Urban Revitalization and Entrepreneurship (CURE): DSU's newest program, CURE, has multiple locations in Downtown Dover. CURE Loockerman, located in a historic home, focuses on developing entrepreneurs through shared workspaces and a small business incubator that offers targeted training in marketing, branding, accounting, and business planning. A complementary location just four blocks away, CURE Division St., focuses on addressing the factors that impact entrepreneurship success, such as education, financial literacy, mental health, social networks, and family structure.

7 https://www.udel.edu/udaily/2024/november/horn-entrepreneurship-princeton-review-entrepreneur-rankings/

8 TEConomy's analysis of NSF HERD data (Table 33: Higher education R&D expenditures at historically black colleges and universities, ranked by all R&D expenditures, by R&D field: FY 2023)

Finding 3: Despite growth in R&D, Delaware's universities are not commercializing research at a pace fast enough to promote broad-based economic vitality.

While research and development are critical factors of the innovation ecosystem, it is also important to examine other measures that speak more specifically to the commercialization activities of universities. To identify innovation being driven from the state's research base, TEConomy leveraged data from Association of University Technology Managers (AUTM). The AUTM Licensing Activity Survey offers quantitative data and real-world examples about licensing activities at U.S. and Canadian universities, hospitals, and research institutions. The survey includes detailed information on topics such as research funding, the impact of innovation, patent activity, licensing income, and the number of startups as reported by AUTM members. While some AUTM data critics feel these measures simply recognize those universities with high volumes of activity versus quality outcomes or that the data are somewhat incomplete due to non-participation by certain universities, the data nevertheless represents a means of understanding nationally how research institutions in many states are contributing to commercialization and deployment activities.

It is important to note that university commercialization outcomes data collected in AUTM surveys only includes delineated information reported by UD. The state's other major research university, DSU, does not choose to participate in the AUTM survey.

As seen in Table 1, UD has been steady across most tech-transfer measures since 2019. One positive development is gross licensing income, which has increased substantially from 2019 to 2023, growing from less than $400,000 to nearly $4.6 million—an increase of more than 1066 percent. From 2019-2023, UD averaged six licenses/options per year, 44 invention disclosures, and 68 patent applications. Despite this progress, the university averaged fewer than two new startups per year over the period, creating only one startup in 2023 according to the AUTM survey.

Table 1. University of Delaware's Performance Across AUTM Licensing Survey Measures

AUTM Measure	2019	2020	2022	2023	Average (2019-2023)	Percent Change (2019-2023)
Total Licenses/ Options Executed	6	5	7	6	6	No Change
Gross Licensing Income	392,522	606,539	3,444,098	4,578,142	2,255,325	1066.3%
Invention Disclosures Received	45	47	38	47	44.25	4.4%
New Patent Applications Filed	68	66	51	85	67.5	25.0%
Startups Formed	2	2	2	1	1.75	-50.0%

Source: TEConomy's analysis of Association of University Technology Managers (AUTM) Data.

Generally, UD historically tends to underperform against other research universities in benchmark states (Text Box). As noted in Table 2, UD ranks seventh among fourteen benchmark institutions in average new patent applications filed per year from 2019-2023, eighth in average gross licensing income, tenth in invention disclosures received, tenth in startups formed, and tenth in total/gross licensing income. When standardizing these values by the university's research expenditures, UD fares better in certain fields. For example, the university ranks fifth in average gross licensing income per R&D expenditures, and fifth in average new patent applications filed per $10 million in research expenditures. However, the university ranks ninth in startups formed as a share of R&D, tenth in total licenses/options executed as a share of R&D, and tenth in invention disclosures received as a share of R&D.

Universities included in AUTM analysis:

- University of Delaware
- University of Connecticut
- Yale University
- Johns Hopkins University
- Morgan State University
- University System of Maryland
- University of New Hampshire
- Dartmouth College
- Brown University
- University of Rhode Island
- Brigham Young University
- University of Utah
- Utah State University

Table 2. University of Delaware's Tech Transfer Performance Compared to 13 Benchmark Institutions

Measure	Ranking (Average 2019-2023)	Ranking (Standardized by R&D)
Licenses/Options Executed	10	10
Licensing Income	8	5
Invention Disclosures	10	10
Patent Applications	7	5
Startups Formed	10	9

Source: TEConomy's analysis of Association of University Technology Managers (AUTM) Data.

It is worth noting that UD has made improvements in recent years to encourage technology transfer and commercialization among its faculty. In addition to investments in R&D infrastructure noted previously, the university has also made policy changes that help promote licensing, startup development, and patent applications:

- OEIP, in collaboration with Horn Entrepreneurship, gained approval from the UD Faculty Senate to allow UD faculty to earn tenure credits for entrepreneurial activities and community engagement.[9] Departments across the university are now modifying their guidelines to incorporate this change.

9 https://delawarebusinesstimes.com/supplements/delaware-organizations-foster-entrepreneurship-across-communities-industries/

- UD was selected to receive funding from the National Science Foundation's inaugural Accelerating Research Translation (ART) program, which helps the University invest in more infrastructure for translating research into practice.[10]

- The university has also introduced two programs to help faculty researchers explore commercialization opportunities.[11] The Concept to Clinic: Commercializing Innovation (C3i) Program provides technical development and business support for NIH-funded researchers interested in pursuing SBIR/STTR funding. Meanwhile, the Small Business Transition Grant for New Entrepreneurs supports career development and training opportunities for new entrepreneurs.

What Others Do: Georgia Research Alliance and Support for Commercialization

A best practice in commercializing research from universities to develop successful startups can be found in Georgia with the Georgia Research Alliance (GRA). GRA helps recruit and retain top researchers through its GRA Eminent Scholars, Senior Fellows, and Distinguished Investigator programs, which endow chaired research positions for faculty members who are leaders in their fields and demonstrate high commercial potential. To support these researchers and help them win more grants, GRA adds equipment and updates facilities, while also allowing all university scientists in Georgia to share these high-tech instruments.

GRA's most influential program to support commercialization of university-based research is GRA Ventures. In 2003, GRA Ventures was specifically created to move university technologies out of the lab and into the marketplace and to grow university-based startup companies in Georgia. To accomplish these goals, GRA awards the following:

- Phase I grants (up to $50,000) to university researchers to answer the question, "Is it commercially feasible to build a company around this technology?"

- Phase II grants (up to $100,000) to university researchers to continue prototype development and formulate a company.

- Phase III loans (up to $250,000) to companies that have a fully executed license from the university. These companies must also have Georgia-based management. The noncollateralized loan has favorable repayment terms and conditions.

- Early-stage direct investment capital to qualified companies through the GRA Venture Fund, LLC. The Fund includes 64 private investors, and every dollar invested by the state is matched at least 3:1 on every direct investment.

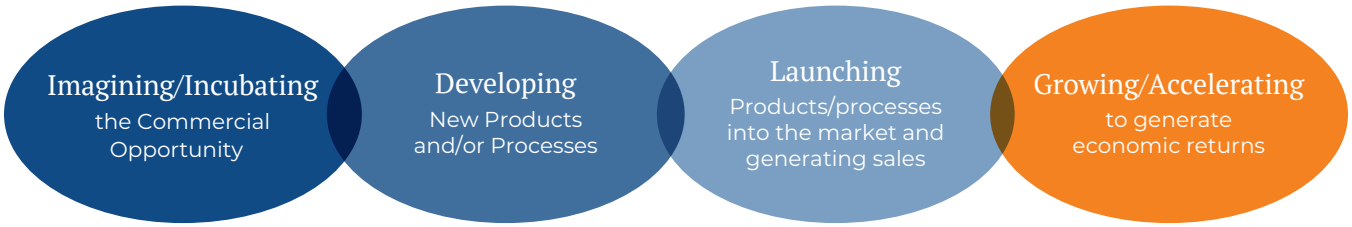
Since 2003, GRA has evaluated the commercial potential of more than 400 inventions or discoveries at universities. The most promising of these were awarded grants to help fund the technology research necessary to further develop the invention or discovery. This process has led to the formation of 226 early-stage companies/projects that employ more than 1,700 people and have generated $153 million in revenue.[12]

10 https://www.udel.edu/udaily/2024/february/national-science-foundation-accelerating-research-translation-engineering-driven-health-jill-higginson/
11 https://cbe.udel.edu/news/2024/11/13/strengthening-uds-innovation-culture/
12 https://gra.org/blog/216

Finding 4: Delaware is home to a continuum of ecosystem support services to encourage innovation and entrepreneurship.

In recent years, the State of Delaware has seen significant momentum in its innovation and entrepreneurship ecosystem. Today, Delaware is home to a continuum of ecosystem support services that span from imagining and incubating a commercial opportunity, developing new products and processes, launching these products into the marketplace, and growing and accelerating firms to generate economic returns (Figure 9).

Figure 9. A Continuum of Ecosystem Support Services Across Delaware



Colleges / Universities	Incubators / Co-Working	Accelerators / ESO's	Investment Capital	Clusters / Networks	Talent
• University of Delaware (UD) • Delaware State University (DSU) • Wilmington University • Goldey Beacom College	• Innovation Space • DTP@STAR Incubator • UD Venture Development Center • Growth Stage Incubator located within CAFE • Emerging Enterprise Center • Middletown Incubator	• UD Horn Entrepreneurship • DSU Center for Enterprise Development • DSU Center for Urban Revitalization and Entrepreneurship • Innovation Space Science Inc. Accelerator • DESCA Innovation 2 Invoice • CAFE FinTech Accelerator • First Founders Accelerator • E3 Accelerator • NCC Innovates • Launcher DE • Delaware SBDC	• UD Blue Hen Ventures • UD Hen Hatch • Delaware Biotechnology Institute Grants • Innovation Space First Fund • DESCA Investor Forum • Startup 302 • Longview Innovation • Leading Edge Ventures • Cinnaire DE • Grow NCC Fund	• DE Sustainable Chemistry Alliance (DESCA) • Innovation Space Spark Factory • Center for Accelerating Financial Equity (CAFE) • Delaware Bio	• DESCA Talent Pipeline • Tech Alliance of Delaware • Rodel Foundation • Zip Code Wilmington
	Co-Working • The Mill • Cowork Reho • CSC Station • The General Store • The Hive • The Hub			**Economic Development Organizations** • Delaware Prosperity Partnership • Kent Economic Partnership • Sussex Office of Economic Development • Wilmington Office of Economic Development • Delaware State Chamber of Commerce	

Source: TEConomy's analysis of Ecosystem Inventory (Figure is Not Exhaustive).

Beyond Delaware's colleges and universities, a range of influential programs are supporting innovation and entrepreneurship across the state. For example, the **Delaware Prosperity Partnership (DPP)** actively supports innovation and entrepreneurship by working to connect startups with essential resources, serving as a convening body for statewide initiatives, and coordinating funding competitions like Startup302. As Delaware's premier funding competition, Startup302 supports technology-enabled startups led by underrepresented founders and offers non-dilutive funding, mentorship, and networking opportunities across industry clusters most important to the state.

As another example, **The Innovation Space** offers state-of-the-art laboratory space and equipment for life science, clean tech, and advanced materials companies. Since its founding in 2017 as a nonprofit partnership between the State of Delaware, Dupont, and UD, The Innovation Space has helped connect new companies to more than $1.2 billion million in funding, supported more than 1,000 jobs, and assisted 140 companies in their growth, according to its recent impact reports.[13]Notable programs offered by The Innovation Space include:

- The Science Inc. Accelerator: A 14-week virtual, cohort-based accelerator program designed for early-stage science startups that offers expert coaching and guidance from Entrepreneurs-in-Residence (EIRs), access to industry and investment experts, and various opportunities to build networks with potential investors and collaborators.

- The First Fund Investment Program: Provides up to $200,000 in investment resources to early-stage startups, including cash, business-building expertise, and access to scientific equipment and multi-use laboratories.

- Spark Factory: A virtual pitch event that provides mentoring support to new founders who are beginning to build startups in the sciences.

13 https://innovationspace.org/impact

- Early Stage Growth Grant (EGG): Provides startups with up to two years of private laboratory space, including access to not only physical space but also Science Inc., Spark Factory, and access to EIRs, commercialization experts, and startup mentors. The competitive opportunity is open to early-stage companies (less than 5 years since incorporation) with committed funding of over $200,000.

The **Delaware Sustainable Chemistry Alliance (DESCA)** serves as a voice for the state's chemical industry and offers numerous programs to encourage growth in this industry sector:

- Innovation 2 Invoice: This program helps accelerate commercialization of deep-tech startups via workshops, mentorship, and investor forums. Programs like Tech2MarketSM train innovators in product development and business strategies, while Investor Forums connect startups with corporate partners and venture capital, helping raise over $85 million collectively and securing deals/relationships/acquisitions with companies like Shell, Koch Industries, Air Liquide, GE, BASF, Cargill, and AkzoNobel.

- Talent Pipeline: DESCA helps encourage connections with industry by supporting STEM education through programs like the Industry Insights Series and the Catalyzing Change STEM Talent Forum. These programs help students learn about career pathways and offer hands-on experiential learning in partnership with schools like DSU and companies like Dupont and Merck.

A significant asset catalyzing clean energy activity in Delaware is the **Mid-Atlantic Clean Hydrogen Hub (MACH2)**. This DOE-funded initiative received $750 million to produce green and pink hydrogen and help reduce emissions in heavy industries like steel and aerospace. The regional proposal was co-led by DESCA (featuring partnerships with PBF Energy and UD). The goal of the initiative is to create 10,000 jobs and establish hydrogen infrastructure across the Delaware, Pennsylvania, and New Jersey tri-state area.

A recent player in the state's fintech sector is the **Center for Accelerating Financial Equity (CAFE)**. Based at the FinTech Innovation Hub at the STAR Campus, CAFE focuses on advancing financial wellness for low- to moderate-income communities through technology-driven solutions. Core initiatives of CAFE include:

- CAFE Fintech Accelerator: Without taking equity, this accelerator supports mission-driven fintech startups that support financial inclusion through a hybrid eight-week program that offers investor connections, partnerships with financial institutions, and other mentorship services.

- GrowthStage Incubator: This incubator partners with the FinTech Innovation Hub to offer fintech companies with access to R&D resources, regulatory guidance, and corporate collaborations.

- Fintech Excellence Challenge: In partnership with UD, this new program will merge academic research with industry needs across five fintech-related domains: AI, cybersecurity, data science, regulatory compliance, and risk management.

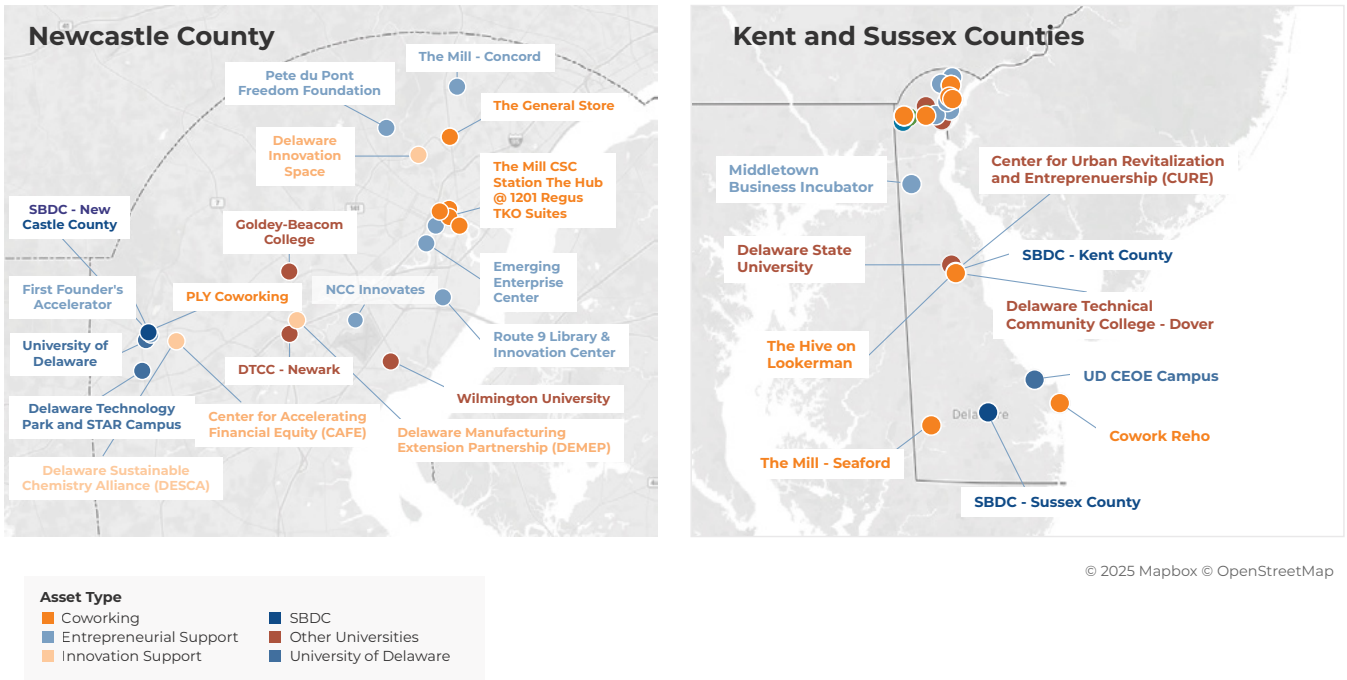
Two other programs in the state provide co-working spaces for incubation and community/ networking for entrepreneurs.

- The Mill, which started in 2016 in Downtown Wilmington and has since expanded to multiple locations, has become a hub for entrepreneurs, remote workers, startups, and established businesses, providing them with shared workspace and fostering a community of innovation.

- The Emerging Enterprise Center (EEC), an initiative of the New Castle County Chamber of Commerce, offers flexible workspace options to support startups and entrepreneurs. The EEC also hosts programs and events, such as the "Swim with the Sharks" pitch competition (alongside free training and education), monthly business growth workshops, and an annual Delaware Entrepreneurial Summit. The EEC has assisted with the growth of more than 500 companies that have created nearly 1,000 jobs and generated more than $187 million in revenue.[14] Notably, more than two-thirds of clients are women and/or minority-owned businesses.

As illustrated in Figure 10, while most of Delaware's activities are in New Castle County around Wilmington, there are also resources available to innovative entrepreneurs in Kent and Sussex County. Notable examples of 'downstate' resources for entrepreneurs include two branches of the state's SBDC network, the Middletown Business Incubator, co-working spaces like The Mill (Seaford, DE) and Cowork Reho, and DSU initiatives noted previously.

Figure 10. Notable Ecosystem Assets in Delaware's Three Counties



Source: TEConomy's analysis of Ecosystem Inventory (Figure is Not Exhaustive).

14 https://eecincubator.com/

Finding 5: Delaware is seeing overall growth in risk capital and venture development, but increases are modest and starting from a low base of activity.

Investment capital plays a crucial role in fostering innovation and scaling companies by providing essential funding, expertise, and resources to startups and small businesses. These financial mechanisms help entrepreneurs bring their products to market, encourage technological advancement across various industries, and advance economic growth and job creation. As noted previously, Delaware has seen significant momentum in its innovation and entrepreneurship resources in recent years. To understand how these activities impact levels of capital access in the state, TEConomy analyzed three distinct measures of entrepreneurial investment: SBIR/STTR Awards, Venture Capital, and 7(a) Loans from the SBA.

SBIR Awards

The SBIR (Small Business Innovation Research) and STTR (Small Business Technology Transfer) programs, which considers themselves "America's Seed Fund," is one of the broadest forms of early-stage, non-dilutive capital available to small technology companies. SBIR/STTR awards are competitive grants provided by U.S. federal agencies to small businesses to develop promising innovative technologies with commercial potential. TEConomy analyzed data from the SBA to examine the various agencies' SBIR/STTR programs, including both Phase I and Phase II awards.

Delaware companies have had a mixed record of success in winning SBIR/STTR awards over the period from 2019-2023:

- Delaware averaged 42 awards receiving on average a total of $23.5M per year, which ranked fifth and seventh among benchmark states.[15]

- Funding grew 39 percent, which ranks second among benchmark states and outpaces the national average (25 percent growth).

- When normalized for the size of the state economy, Delaware companies received $3.11 in SBIR/STTR awards per $10,000 GDP, faring better than the U.S. average ($1.94 per $10,000 GDP) and ranking third among benchmark states.

Venture Capital Investment

One direct way to measure the level of innovation-led entrepreneurship is to track venture capital investments across a range of risk-oriented industries, as these emerging technology companies can offer high growth potential and generate sizable returns on these equity investments. The database used to track venture capital investment from pre-seed through formal venture capital is from PitchBook. PitchBook is considered among the leading data providers for professionals in

15 TEConomy's analysis of SBIR.gov data

venture capital, acting as the data partner to the National Venture Capital Association and serving more than 4,000 users. TEConomy explored trends in risk capital investment (dollars and deals), and looking across deal-type, geography, and industry sector.

An initial scan of Pitchbook identified 1,963 companies receiving venture capital since 2019, including $12.8 billion in investments across 1,058 deals.[16] However, this is largely inflated due to Delaware's unique corporate franchise for headquarter companies. To overcome this, TEConomy used an intensive data cleaning approach that combined web scraping to ensure companies had active web presences, LinkedIn analytics to ensure companies had Delaware employees, and an analysis of the state's registered agents to ensure companies were not simply housed in Delaware. The "refined" company listing identifies 73 verified Delaware companies, who are responsible for $4.0 billion in investment across 139 deals since 2019.[17]

Compared to the benchmark states and the nation, Delaware has experienced considerably lower levels of venture capital activity over the period from 2019-2024 when examining this refined list of companies:

- Delaware companies averaged 23 venture capital deals per year, a rate that is lower than all benchmark states.
- Delaware companies averaged $176 million in venture capital per year, which ranks fifth among benchmark states.
- When normalized for state GDP, Delaware ranks seventh in the intensity of venture deals and sixth in the intensity of venture funding. However, it is worth noting that TEConomy did not give the same level of scrutiny to venture capital deals in other states, which suggests that these figures for Delaware may be relatively conservative in nature.
- Starting from a low base of activity, deal flow in Delaware has grown 54 percent, outpacing the national average (a 10 percent decline) and all other benchmark states, who saw stagnant levels of growth or declines.
- Likewise, levels of venture capital in Delaware have nearly doubled (93 percent growth), a rate that far outpaces the national average (23 percent). However, the raw value increases are modest since they stem from a small base of activity.

SBA 7(a) Loans

The SBA's 7(a) loan program is intended to help businesses secure financing for purposes such as working capital and equipment purchases. They are especially valuable to manufacturing and other capital-intensive companies who are in their growth stages. Of particular interest is how the 7(a) loan program impacts traded sector companies, those that are exporting their goods

16 TEConomy's analysis of Pitchbook data
17 Ibid.

and services outside of the state, thereby bringing new funds into the economy and creating a multiplier effect of jobs and economic growth.

Overall, Delaware is seeing lower levels of SBA 7(a) loans in traded sectors over the period from 2019-2024:[18]

- Delaware companies averaged 31 SBA 7(a) loans per year, which equated to $15.8 million in total value of the loans.
- The number of loans per year ranks last among benchmark states in both overall amounts and when standardized by GDP.
- When looking at the value of these loans, Delaware fares more favorably but still lags most benchmark states and the national average.

One bright spot is Delaware's growth in 7(a) loan performance in traded sector companies. In both 7(a) loan awards and in the value of loans, Delaware saw considerable growth from 2019 to 2024:

- The number of 7(a) loans grew by 91 percent, far outpacing the U.S. average (39 percent) and ranking first among the benchmark states.
- The value of 7(a) loans also grew substantially, quadrupling in Delaware (300 percent increase) and ranking first among benchmark states.

What Others Do: TEDCO's Maryland Venture Fund

TEDCO (Maryland Technology Development Corporation) is an independent instrumentality of the State of Maryland, established by the Maryland General Assembly in 1998, to facilitate the creation of businesses and support their growth in all regions of the state. In 2015, TEDCO acquired Maryland Venture Fund (MVF), which is now considered an evergreen fund.

TEDCO's Maryland Venture Fund plays a critical role in the state's innovation ecosystem by providing early-stage business support. TEDCO's evergreen funds support early-stage businesses in Maryland, typically offering investments between $500,000 and $2 million per company. TEDCO commonly acts as a first institutional investor and participates in early rounds, oftentimes leading or significantly contributing to investment rounds. Although the funds are sector-agnostic, they focus on technology and life science-based companies.

Since its inception, TEDCO has invested in or supported the growth of a portfolio of 442 of Maryland's leading technology companies.[19] In 2023, the direct job creation impact of these portfolio companies supported by TEDCO's six core research and investment vehicles exceeded 12,000 jobs, and these companies have produced nearly $2.7 billion in economic impacts.

18 TEConomy's analysis of SBA 7(a) Loan Data.

19 https://www.tedcomd.com/news-events/press-releases/2024/tedco-generates-27-billion-economic-benefits-marylands-ecosystem

Finding 6: Delaware is lagging benchmark states and the nation in the growth of both STEM-related degrees and STEM employment share.

Talented individuals are the lifeblood of innovation-driven economic growth. A robust pipeline of skilled workers, particularly those with higher education and science, technology, engineering, and mathematics (STEM) degrees, is essential for states seeking to compete in the global knowledge economy and foster sustainable economic development. To understand how Delaware is faring as it relates to talent and its role in innovation-led economic growth, TEConomy analyzed multiple elements of educational attainment, including the production of STEM degrees at colleges and universities, the presence of educated and STEM-oriented professionals in the workforce, and the extent to which alumni from the state's largest educational institutions are remaining in state and working in C-Suite positions.

In general, Delaware is making strides in educational attainment. Nearly one-third of Delaware's population has a college degree (32.6 percent), a share that is similar to the U.S. average (32.4 percent) but is lower than nearly all benchmark states (ranking sixth). Educational attainment grew by nearly 11 percent in Delaware from 2019-2023, a rate that is greater than the U.S. average (9.6 percent growth) and most benchmark states (ranking second).

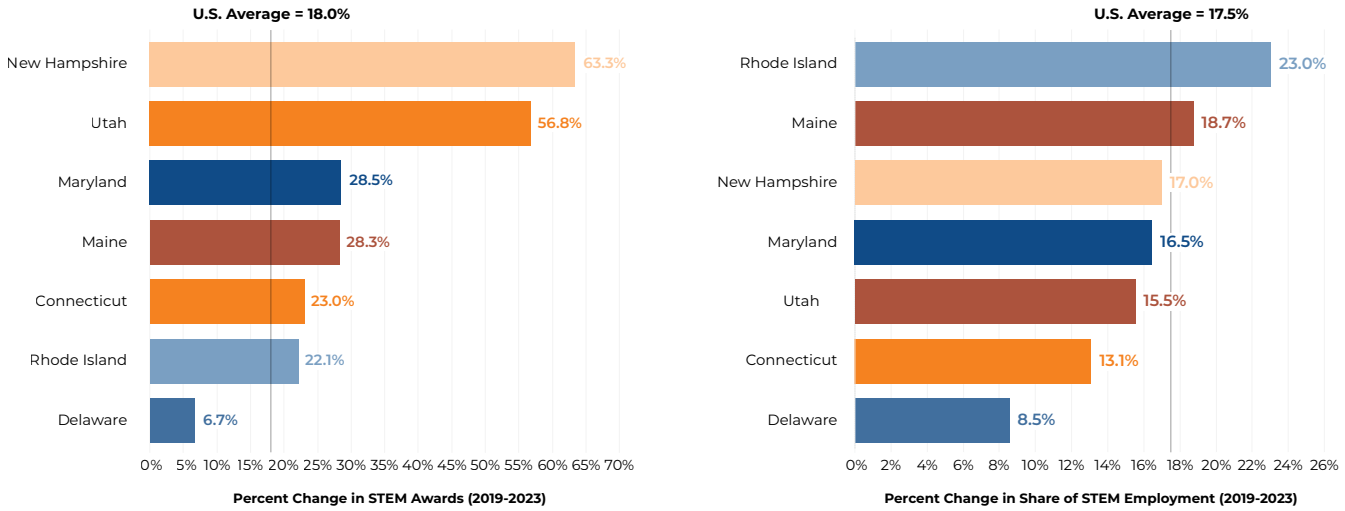
Delaware's colleges and universities averaged more than 3,000 STEM-related degrees per year from 2019-2023.[20] On average, Delaware's colleges and universities conferred 3,214 STEM awards (bachelor's level and above) from 2019-2023, a rate that is similar to Maine but lags all other benchmark states. STEM fields represent 29 percent of bachelor's and graduate degrees, a rate higher than the U.S. average. However, Delaware lags the U.S. average and other benchmark states in the growth of STEM-related degrees (7 percent growth from 2019-2023).

In terms of STEM employment, roughly 7 percent of the Delaware population is working in STEM fields, a share slightly lower than the U.S. average.[21] The share of Delaware's population working in STEM fields grew 9 percent from 2019-2023, a rate less than half the U.S. average and lagging all benchmark states. The number of Delawareans working in STEM fields grew by nearly 15 percent from 2019-2023, a rate that lags the U.S. average and most benchmarks. **Taken together, Delaware is trailing the benchmark states in the growth of both STEM degrees and STEM employment (Figure 11).**

20 TEConomy's analysis of IPEDS data

21 TEConomy's analysis of U.S. Census American Community Survey Data (2023 and 2019 Five-Year Estimates)

Figure 11. Percent Change in STEM Degrees and Population Working in STEM (2019-2023)



Source: TEConomy's analysis of IPEDS and U.S. Census Data.

TEConomy used LinkedIn Talent Insights to analyze outcomes for graduates of Delaware's three largest colleges/universities.[22] This analysis only examines graduates currently based in the U.S., and only includes bachelor's and graduate degrees, such as MA/MS, MBA, and PhD. The LinkedIn analysis includes variations found within LinkedIn, but no professional medical or law degrees/ schools were included.

Based on this analysis (Table 3), UD is the state's largest university (131,335 graduates on LinkedIn) and had the highest representation in C-Suite positions (4.6 percent) but has the smallest share of graduates staying in state (26.6 percent). Although DSU is relatively small (14,423 graduates on LinkedIn), a high share of graduates stay in-state (35.8 percent) and work in C-Suite positions in-state (1.2 percent). Meanwhile, more than 40 percent of Wilmington University's 40,847 graduates on LinkedIn are located in Delaware, the highest share of the three schools.

22 It is important to note that while not incorporated into this analysis, the State of Delaware is also home to Goldey-Beacom College, a private academic institution located in Wilmington that has a total enrollment of approximately 1,000 students. Goldey-Beacom College offers an MBA program as well as numerous bachelor's degrees of relevance to Delaware's advanced industries.

Table 3. Results of LinkedIn Talent Insights for Delaware's Largest Universities by Student Enrollment

Institution Name (including variations found within Linkedin, but not including medical or law schools)	Total Graduates on LinkedIn	Total Graduates Still In-State	Total Graduates in C-Suite Positions	Total Graduates in C-Suite Positions In-State	Share of Total Graduates Still in State	Share of Alumni Working in C-Suite Positions	Share of Alumni Working in C-Suite Positions In-State
University of Delaware	131,335	34,995	5,996	1,093	26.6%	4.6%	0.8%
Delaware State University	14,423	5,163	614	177	35.8%	4.3%	1.2%
Wilmington University	40,847	16,640	1,150	423	40.7%	2.8%	1.0%

Source: TEConomy's analysis of LinkedIn Talent Insights data as of 12/31/2024.

TEConomy compared Delaware's three largest universities with outcomes for other major research universities across the six benchmark states (using a similar set of institutions as the AUTM analysis). **Compared to benchmarks, a smaller share of Delaware's alumni is staying in-state or working in C-Suite positions.** Delaware ranks in the bottom half of benchmark states in the share of graduates staying in-state (29 percent, or fifth out of seven).[23] Delaware ranks sixth of seven states in the share of graduates working in C-Suite positions and tied for seventh in the share working in-state in C-Suite.

23 TEConomy's analysis of Linkedin Talent Insights data (as of 1/1/2025)

What Others Do: Connecticut and Rhode Island Programs Help Retain Talent

Connecticut's Technology Talent Bridge Internship Program is an initiative designed to foster stronger university-industry collaboration and help retain talent in the state. The program provides an opportunity for Connecticut small businesses to receive grant funding that can be used to hire student interns. The program's primary objective is to develop a talent "bridge" between the small business and the student, with the downstream objective of creating jobs. This in turn helps to reduce the net outmigration of young talented workers by exposing them to the opportunities that can be found within the state of Connecticut.

Grants up to $25,000 are available to support the hiring of one or two interns, with a required 50 percent match from the company. Companies must be registered in Connecticut, have fewer than 500 employees, and be at least one year old to apply. Interns must be actively enrolled in a Connecticut higher education institution or be Connecticut residents attending out-of-state colleges. Historically operated by CTNext (which has since wound down its operations), the program has since transitioned to the state's Department of Economic and Community Development.

In Rhode Island, a successful example of a program to help retain talent is the **Commerce RI Wavemaker Fellowship**. This competitive program seeks to retain skilled talent in Rhode Island by offering a refundable tax credit that helps cover student loan payments for up to four years. Specifically targeting graduates working in fields like STEM, design, healthcare, and technology sectors, the program has awarded more than 1,000 professionals with student loan payments since 2015, with an average award of approximately $3,900.[24]

In addition to the financial benefit, Wavemaker Fellows also participate in various personal and professional development programs, including social and professional networking opportunities and other community-based events. The program has a two-fold benefit of attracting and retaining talent in high-demand fields, and by boosting local businesses through early-career talent development, which enhances the overall workforce.

Delaware has recently launched an initiative modeled after Rhode Island's Wavemaker Fellowship called the **Delaware STEM Talent Advancement and Retention Fund (STAR Fund)**. The STAR Fund offers financial support for student loan payments to connect talented individuals with an associate, bachelor's, graduate, or post-graduate STEM degree from an accredited postsecondary institution with employment opportunities in Delaware.

24 https://governor.ri.gov/press-releases/governor-mckee-announces-re-opening-wavemaker-fellow-program

Finding 7: Although Delaware is seeing sustained startup activity in high-tech sectors, this has not translated into wide-spread advanced industry establishment or employment growth.

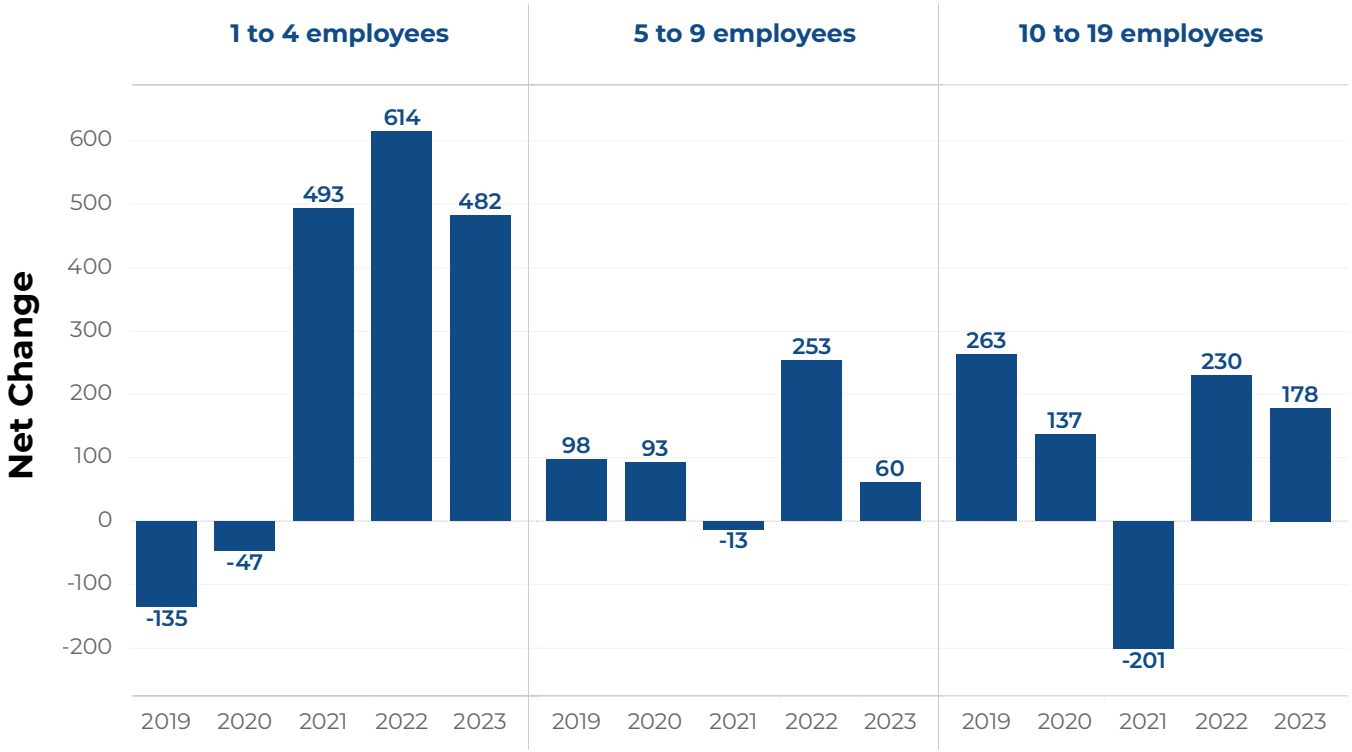
Understanding the dynamics of entrepreneurship and business growth is an essential part of the overall performance of an innovation ecosystem. The ability for companies to start, grow, and scale in a state—especially those in high-tech or "advanced industry" sectors—is crucial for a state's long term economic development prospects. In Delaware, where large businesses have traditionally been the economic anchors, the ability for entrepreneurs to grow in employment through the development of innovative products and services is necessary for the state to avoid stagnation or downturns. To understand Delaware's performance in business dynamics and entrepreneurship, TEConomy triangulated three diverse datasets.

First, TEConomy examined the Kauffman Foundation's Entrepreneurship Indicators, which are comprised of three different indices that track entrepreneurship and small business performance. The analysis of the Kauffman Entrepreneurship Indicators shows Delaware compares favorably in various measures of startup development: Delaware ranks first in the number of new employer businesses per capita, second in new employer businesses as a share of all employer firms, and second in startup jobs created per capita (trailing only Utah in both measures but outpacing the U.S. average).[25]

Next, TEConomy explored how new and small (fewer than 20 employees) traded sector firms are creating jobs. With this analysis, TEConomy focused solely on traded sector firms, or those in industries like Information, Manufacturing, Financial Services, and Professional Services. As illustrated in Figure 12, more jobs have been created than have been destroyed in Delaware's traded-sector small businesses since 2019.

25 TEConomy's analysis of Kauffman Foundation data

Figure 12. Net Job Creation in Traded Sector Industries by Firm Size in Delaware (2019-2023)[26]



Source: TEConomy's analysis of U.S. Census Business Dynamics Statistics Data.

When looking at just new businesses[27], Delaware also stands out: there were 1,494 jobs created by new traded sector firms in 2023, which represents a 90 percent increase from 2019 levels.[28] This rate was substantially higher than the U.S. average (7 percent) and ranks first among benchmark states.

To dig deeper than just traded sector firms, TEConomy also leveraged the Census' experimental Business Dynamics Statistics of High Tech Industries (BDS-HT), which measures business patterns in sectors with high concentrations of STEM jobs. High-tech firms in this data include those in industries like computer manufacturing, software publishing, and scientific R&D, which have STEM employment rates at least five times the national average.

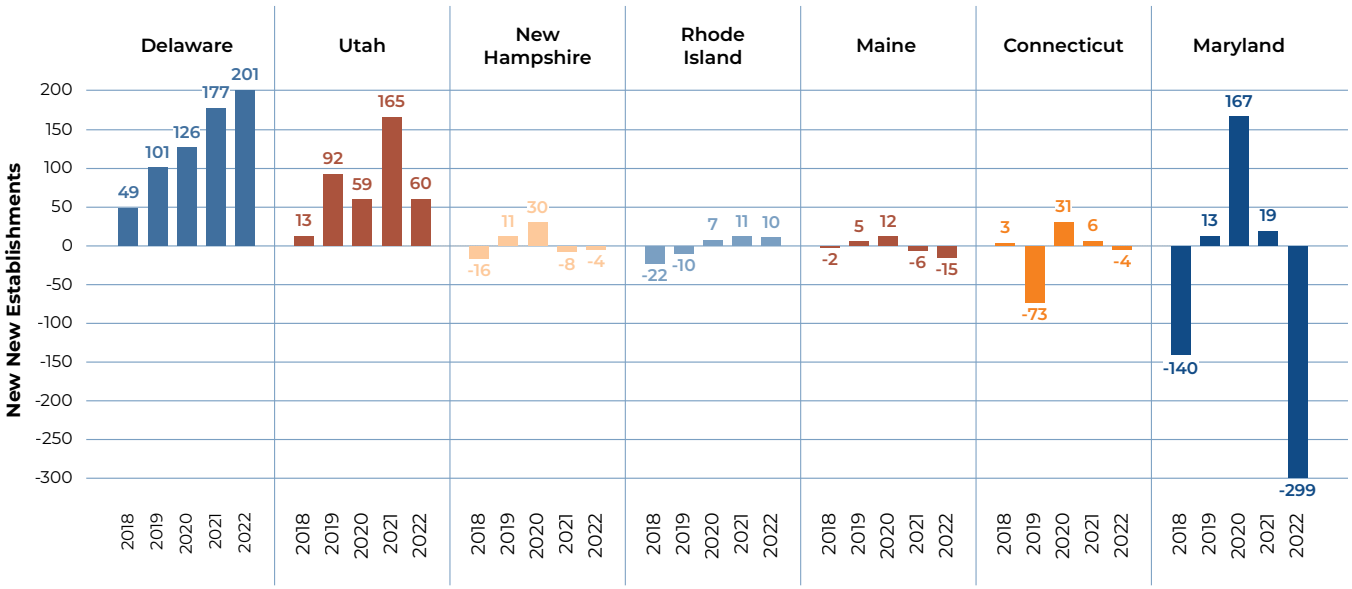
Based on this analysis, Delaware is seeing sustained growth in net new high-tech establishments by year, a trend that is defying most other benchmark states (Figure 13). Furthermore, a higher share of net new establishments in Delaware are in high-tech sectors when compared to other states: 23 percent of net new establishments in Delaware were in high-tech sectors, a share that is nearly four times the next highest state.

26 Traded Sectors Includes Information, Manufacturing, Financial Services, and Professional Services Firms (2-Digit NAICS)

27 The U.S. Census Bureau's Business Dynamics Statistics defines a "new firm" as one that started operating in a given year.

28 TEConomy's analysis of U.S. Census Business Dynamics Statistics (BDS) Data. Please note, the BDS data are compiled from the Longitudinal Business Database (LBD), which is a restricted-use, confidential, microdatabase. As a result, the same methodology that TEConomy undertook to analyze Pitchbook data, including the intensive data cleaning approach to ensure companies were not simply housed in Delaware, was not possible for this analysis.

Figure 13. Net New Establishments in High-Tech Sectors by Year



Source: TEConomy's analysis of Business Dynamics Statistics of High Tech Industries (BDS-HT) data.

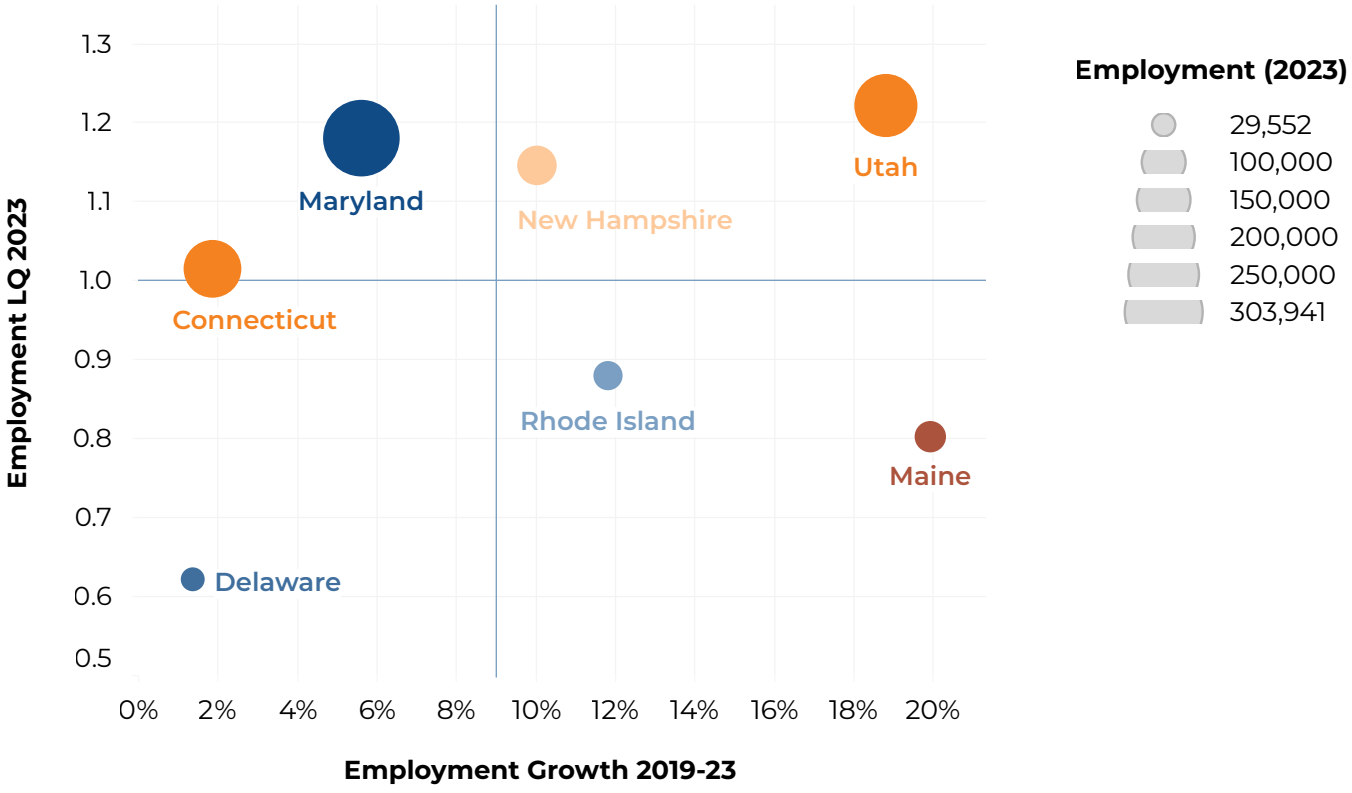
BDS-HT Data also highlights jobs that have been created and destroyed by firms operating in the high-tech sector. On net, Delaware's high-tech employers created 6,994 new jobs from 2018-2022, including 4,370 in 2022, which ranks third among benchmark states in overall net job creation in high-tech sectors since 2018. Roughly 27 percent of net job creation in Delaware was in high-tech sectors, a share that ranks second among all benchmark states.

As the above data sources show, Delaware fares positively across the three measures of business dynamics and entrepreneurship analyzed. While Delaware's ability to start new companies, see more companies created than destroyed, and see sustained growth in high-tech establishments is encouraging, the state has struggled to see companies grow and scale into large employers.

This is best seen through an analysis of advanced industries, those defined by the Brookings Institution as sectors with high R&D spending per worker and a significant proportion of STEM workers, encompassing 50 diverse sectors across manufacturing, energy, and high-tech services that drive innovation, productivity, and exports in the U.S. economy.[29] Delaware lags considerably in the concentration of advanced industry employment and growth-levels. Despite the R&D intensity of Delaware's economy, the state had an LQ of just 0.6 in advanced industries, which ranks last among benchmarks and the U.S. average (LQ=1.0). Delaware's advanced industry employment growth was minimal from 2019-2023 (2 percent), which similarly ranks last among benchmark states. As a result, Delaware is the only benchmark state that finds itself in the lower-left quadrant of Figure 14: a state with low levels of employment concentration and low levels of employment growth.

29 Muro, Mark, Jonathan Rothwell, Scott Andes, Kenan Fikri, and Siddharth Kulkarni. "America's Advanced Industries: What They Are, Where They Are, and Why They Matter." Washington, D.C.: Brookings Institution, 2015

Figure 14. Advanced Industry Employment, Concentration, and Growth in Delaware and Benchmark States



Source: TEConomy's analysis of Lightcast QCEW (Version 2024.4) and Brookings Advanced Industries NAICS.

What Others Do: Missouri Technology Corporation's Holistic Support for Tech-Based Companies

One best practice example of a state-based initiative supporting startups in high-tech sectors to help them grow and scale is the Missouri Technology Corporation (MTC). MTC is a public-private partnership established by the Missouri General Assembly to foster innovation and entrepreneurship within the state. MTC plays a crucial role in supporting the growth of new and emerging high-tech companies by providing strategic investments and support through various programs. One of its key initiatives is the Innovation, Development, and Entrepreneurship Advancement (IDEA) Fund, which includes programs like the TechLaunch and Venture Capital Co-Investment Programs. These programs offer matching equity or convertible debt investments to early-stage startups, helping them develop technologies and create jobs across Missouri. Since its inception, MTC has invested over $50 million in nearly 160 Missouri-based technology startups, significantly contributing to the state's economic development by attracting additional private capital and boosting the venture capital capacity.[30]

Beyond direct investments in companies, MTC also seeks to create a comprehensive ecosystem that supports innovation and entrepreneurship. For example, the Missouri Building Entrepreneurial Capacity (MOBEC) program provides grants to enhance R&D in targeted high-tech industry clusters and expand the capacity of non-profit organizations and research institutions supporting entrepreneurs. Through its leverage of state, federal, and industry funds, MTC helps support economic growth by focusing on the entire innovation ecosystem.

30 https://www.missouritechnology.com/2024/04/30/missouri-technology-corporation-achieves-50-million-investment-milestone-through-state-sponsored-venture-capital-program/

Conclusion: Delaware's Innovation Ecosystem Needs to be Further Strengthened in order to strategically grow its innovation economy.

Overall, this assessment finds that Delaware is home to some of the elements of a robust innovation ecosystem with the capacity to impact economic vitality, but that the ecosystem is not functioning at maximum capacity. Moving forward, the state must be strategic about how it grows its economy to ensure that it is able to continue its positive momentum while also addressing the potential challenges facing its innovative firms.

The strongest element of Delaware's innovation ecosystem is its R&D infrastructure, especially in the private sector. Delaware is a powerhouse in industrial R&D and is outpacing the nation in both R&D intensity and R&D growth. Delaware is also outpacing the nation in patent intensity and patent growth, a sign of its significant R&D assets in both the private and academic sectors. To further encourage innovation-led economic growth, Delaware should prioritize those areas of science and technology that represent the best growth opportunities for the state (see the next section of this report).

However, Delaware has historically underperformed in commercializing its research base into commercial market opportunities that result in economic impact. This comprehensive analysis of Delaware's innovation ecosystem provides a solid and necessary foundation for DPP and its stakeholders to chart a course for future growth. By leveraging the state's strengths, while addressing identified gaps, Delaware can position itself as a competitive hub for innovation. The insights gained from this assessment can help guide targeted initiatives to attract investment, foster entrepreneurship, and develop a robust talent pipeline. As Delaware builds on its rich legacy of science and technology, strategically addressing those areas where improvement is necessary will be crucial for the state to realize its full potential.

This section of the report highlights the comparative performance of Delaware's innovation ecosystem, looking at both the individual performance of the system's various components, as well as how the system is performing in aggregate. Understanding this performance is essential to identifying and enhancing high-growth opportunity areas, which is the focus of the next portion of this report. Delaware's high-growth opportunity areas are found at the intersection where there is robust research going on in the state and the interface of university actions. However, as has already been identified, the challenges facing Delaware are not related to the levels of R&D. Instead, they are focused on challenges related to commercializing R&D and translating areas of strength into new market opportunities.

As the following growth opportunities show, there are barriers that must be overcome to drive economic vitality. Understanding these barriers will help DPP and its stakeholders understand how to best accomplish this ambitious goal.

Science & Technology Growth Opportunities for Delaware

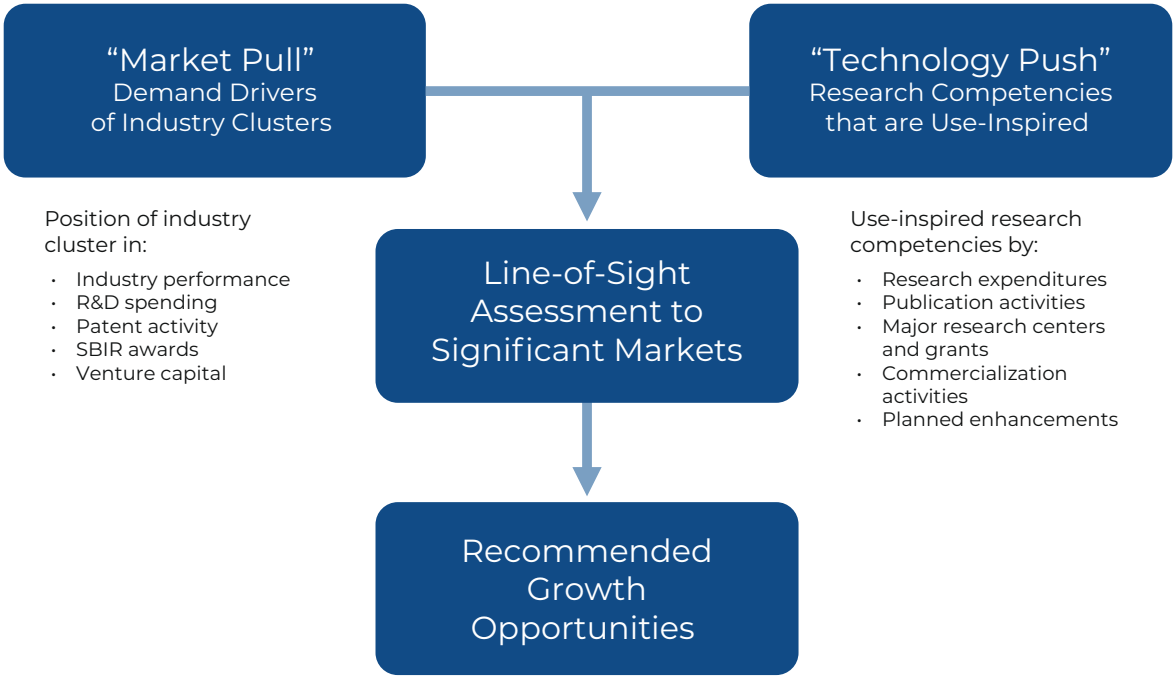
Each state has its own specific industry drivers and growth opportunities through which it is best positioned to differentiate itself and build world-class, specialized areas of expertise. At the same time, each research institution has its own set of core competencies—based on those focus areas where there is a critical mass of activity—in research, talent generation, and unique facilities.

Identifying these strategic areas of alignment within Delaware between its research institutions and its industry drivers can be challenging, as the opportunity set of technologies that research can advance is enormous. However, in order to maximize the potential for economic development impact, it is critical to identify strategic areas that align Delaware's research assets and competencies with the needs and opportunities of its industry innovation drivers.

In the face of ongoing technological innovation and disruption of existing industry business models, an assessment of innovation-led growth opportunities must be forward looking rather than retrospective. Traditional industry targeting analysis relies on examining in-depth trends and competitive position in industry activities that largely shed light on where an economy has been. While helpful, this is not sufficient to understand the development opportunities that can grow a state's economy into the future in the face of ever-changing technology and market dynamics. It is equally important to understand where an economy has the capacity to grow and leverage comparative advantage, which is informed by an analysis of core industry-facing technology competencies.

To better understand the alignment of Delaware's industrial innovation needs with the core competencies of its research institutions, TEConomy undertook a rigorous, data-driven approach to evaluate Delaware's competitive positioning within its target science and technology sectors. This **line-of-sight assessment** considered the "market pull" of industry innovation drivers found within established and emerging S&T industry clusters and how they aligned with the "technology push" of research capabilities found across the state's research institutions (Figure 15).

Figure 15."Line of Sight" Approach for Identifying Strategic S&T-Driven Industry Opportunities



Source: TEConomy Partners, LLC.

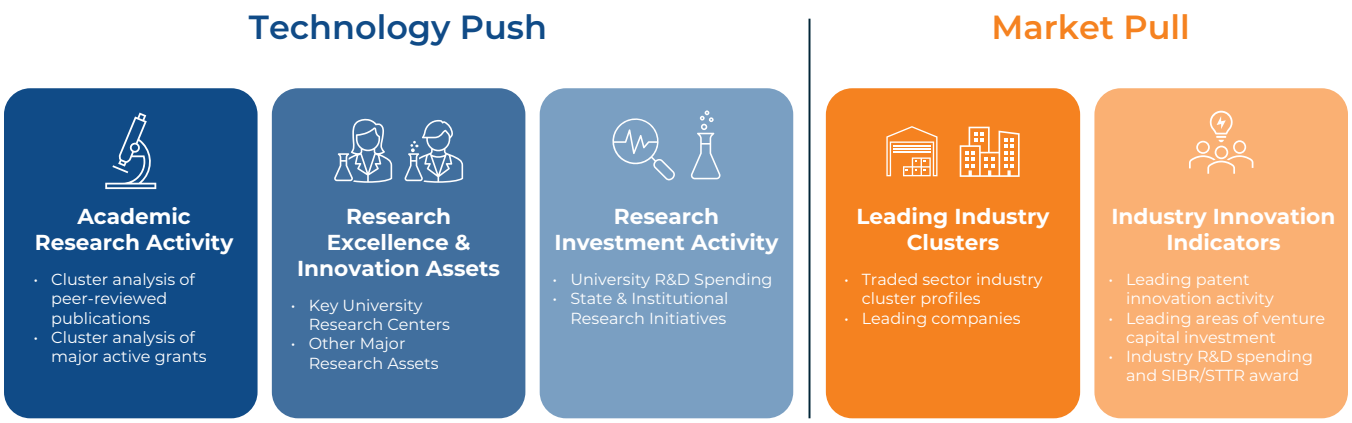
This strategic approach is very much in line with best-in-class efforts. As the former Senior Vice Provost at Georgia Tech, Dr. Steven Cross, said in explaining his university's nationally recognized efforts in concurrently advancing research and economic development impact:

> *"Georgia Tech defined an industry facing research strategy focused both on leading-edge, use–inspired [university] research and economic development…Georgia Tech pursues a concurrent strategy centered on the core research areas…selected because they are appropriate aggregations of core university competencies represented in over 300 research centers and laboratories at Georgia Tech, their inter-disciplinary and trans-disciplinary nature, the alignment with strategic markets within the region, and the existence of industry partners interested in working with Georgia Tech."*[31]

The intersection of where the state excels in the "market pull" of industrial innovation activities and the "technology push" of industry-facing core competencies represent the greatest opportunities for future economic growth. As depicted in Figure 16, identifying these growth opportunity areas involves analyzing a number of key indicators. Taken together, these indicators can offer the line-of-sight to growing innovation-led market opportunities that can help sustain the vibrancy of Delaware's leading existing industry clusters as well as position the state to respond to market opportunities in new emerging industries that evolve in the future.

31 Stephen E. Cross, "Strategic Considerations in Leading an Innovation Ecosystem," Global Science and Technology Forum Journal of Business Review, 2013, vol 2, no 3, 104–109.

Figure 16. Key Indicators and Analyses Leveraged for the Line-of-Sight Assessment of Delaware's Growth Opportunities



Source: TEConomy Partners, LLC.

Using the framework shown above, TEConomy conducted a line-of-sight assessment of forward-looking, innovation-led, growth opportunities for Delaware that involved three steps (see Appendix A for the detailed analysis findings):

1. **TEConomy assessed Delaware's core technology competencies across its university activities to outline areas of technology push.** In this step, a variety of innovation databases were analyzed to provide insights into specific areas of technology and innovation strengths found in the state to develop insights based on:

    - In-depth analysis of thematic areas of specialization and critical mass in academic research activity by examining peer-reviewed research publications and investigator-initiated grants.
    - Research excellence and the presence of key centers, labs, and other institutes supporting industry-facing innovation and technology development.
    - Research investment activity highlighting where the state's institutions have been growing their research enterprise.
    - Consideration of the context of key publications and grant awards in the Philadelphia region with industry collaborators as an indicator of the potential for broader regional commercialization opportunities.

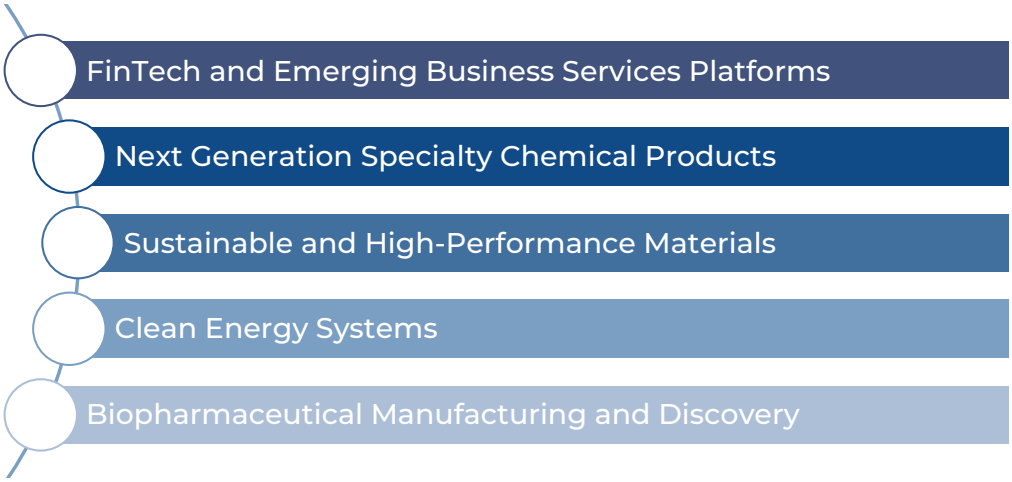
2. **TEConomy assessed the market pull of innovation activities of Delaware's traded sector industry clusters.** The assessment of industry's market pull for innovation considered the current position and recent trends of leading industry clusters based on a broad set of measures of industry performance and innovation activities that included:

    - Examination of multiple facets of economic performance of the state's traded sector industry clusters using a variety of industry performance measures.
    - Identification of areas of active industry-led innovation through examination of indicators related to industry-led spending and investment, intellectual property generation, and other signals of innovative technology or market focus on the part of Delaware companies.
    - Consideration of the context of key industry dynamics, emerging companies, and areas of leading investment funding in the Philadelphia region as an indicator of potential regional end market drivers.

3. **TEConomy considered the alignment of the market pull of industry cluster performance and innovation activities and the technology push of core competencies that provide line-of-sight to innovation-led growth opportunities with high market potential.** This involved the synthesis of the analyses noted above in addition to one-on-one and small group discussions with industry and university leaders and stakeholders across Delaware regarding key areas of technology focus and opportunities. This information was further supplemented with intelligence gathered from market research reports to identify how the state is positioned in innovation-led growth opportunities.

Ultimately, five existing S&T growth opportunity areas were identified for Delaware through the line-of-sight assessment (Figure 17). These five areas can be considered those in which Delaware is best positioned to compete in growing, innovation-led, market opportunities that can help sustain the state's leading industry clusters as well as advance emerging market opportunities in new industries of the future.

Figure 17. Delaware's S&T Growth Opportunity Areas



Source: TEConomy Partners, LLC.

The narrative that follows profiles Delaware's five existing S&T growth opportunities. The profiles are organized to provide the following intelligence gathered for each opportunity area:

- An explanation of what the S&T opportunity area is and the key technologies that support it.
- An examination of the market outlook and growth dynamics surrounding the S&T opportunity area.
- An explanation of why this opportunity is a fit for Delaware in the context of the market pull of emerging or existing industry clusters and the technology push of core technology competencies.
- Implications/potential barriers for realizing future growth based on insights/discussions with Delaware stakeholders from industry, universities, and the broader community.

In addition, three emerging S&T growth opportunity areas were identified for Delaware through the line-of-sight assessment:

- BlueTech Innovation,
- Integrated Agriculture and Sustainable Food Production, and
- Rehabilitative and Performance Enhancement Technologies.

Profiles are also provided for the three emerging S&T growth opportunities. The profiles are organized to provide the following intelligence:

- An examination of what is driving this emerging area for Delaware.
- An explanation of what is needed in order to grow/maximize this opportunity in Delaware in the future.

Delaware S&T Growth Opportunity Area: FinTech and Emerging Business Services Platforms

The financial technology (FinTech) industry has undergone a transformative evolution, reshaping how businesses and consumers interact with financial services. Once a niche segment, FinTech has become a driving force in global finance, influencing everything from digital banking and alternative lending to AI-driven fraud detection, blockchain transactions, and embedded finance solutions. As financial services continue to shift toward automation and data-driven decision-making, new business models are emerging that challenge traditional banking institutions and legacy systems.

Amidst a rapidly changing global financial services landscape, Delaware's own financial sector is at a critical transition point. While the state has a well-established foundation in traditional banking, credit card lending, and corporate finance, the increasing integration of digital tools and platforms is reshaping industry operations and competitive dynamics. The firms that historically anchored Delaware's financial ecosystem—major banks, credit issuers, trust managers, and corporate finance operations—must now determine how to effectively integrate or partner with new FinTech frameworks, which often leverage machine learning models and other emerging technologies that can be rapidly adopted and scaled up. Simultaneously, the growing presence of FinTech startups and alternative lenders in the state presents an opportunity to extend Delaware's financial industry into new markets, provided that regulatory frameworks, research collaborations, and capital access mechanisms evolve to support this transformation.

What Are FinTech and Emerging Business Services Platforms?

FinTech encompasses the digital and financial infrastructure that enables digital payments and online banking, but it also extends to further applications and systems that enable the seamless integration of financial technology into every aspect of business and consumer life. Companies are no longer simply offering standalone financial products; instead, they are embedding financial services into software and services across end markets in e-commerce, logistics, and healthcare systems.

Within FinTech, there are several major market application verticals driving investment in new technologies. One of the most significant shifts is occurring in digital banking and alternative lending, where traditional banking models are being disrupted by AI-powered financial technologies. FinTech companies are developing more sophisticated credit risk assessment models, leveraging alternative credit scoring algorithms that go beyond traditional FICO scores to evaluate financial behavior. This allows underserved consumers to gain access to credit based on broader behavioral and transactional data rather than historical creditworthiness alone. The rise of Buy Now, Pay Later (BNPL) platforms is further transforming the lending landscape, enabling consumers to split purchases into interest-free installments without traditional credit cards.

Artificial intelligence tools are also playing an increasingly integrated role in fraud detection, risk assessment, and financial decision support. By leveraging machine learning models and consumer spending patterns, financial institutions can enhance underwriting accuracy and more effectively tailor personalized lending strategies to various segments of their customer base. AI-based virtual financial assistants are becoming commonplace as a first line of interaction with customers, providing real-time customer support and financial advice while reducing operational

Market Outlook and Growth Dynamics

The expansive global market for FinTech products and services, including WealthTech, lending and financing, InsurTech, RegTech, and other segments, was estimated at $355 trillion in 2022 and expected to grow at a cumulative annual rate of 16.9% through 2027. Several additional related markets include:

- **AI-based FinTech services** – valued at $7.1 billion in 2023, CAGR of 24.0% through 2027.
- **DeFi applications, including smart contracts, blockchain, and other decentralized exchange systems** – valued at $18.5 billion in 2023, CAGR of 39.5% through 2027.
- **Mobile wallets and payment technologies** – valued at $5.3 trillion in 2023, CAGR of 23.1% through 2027.

Key market dynamics driving increased need for fintech solutions include:

- The rise of digital-first banking solutions and shift away from physical branch locations as the primary customer access point for financial services.
- The integration of AI and machine learning into traditional financial business processes, enabling real-time assessments and automated customer service.
- ·The expansion of embedded finance, where lending, payments, and insurance are seamlessly integrated into non-financial applications, such as e-commerce platforms and mobile apps.
- The rapid growth of decentralized finance (DeFi) and blockchain-based digital assets.

Source: BCC Research

costs for firms. Yet another example of this integration is algorithmic trading and robo-advisors that are increasingly supporting wealth management by continuously analyzing market conditions and automatically rebalancing portfolios with minimal human intervention.

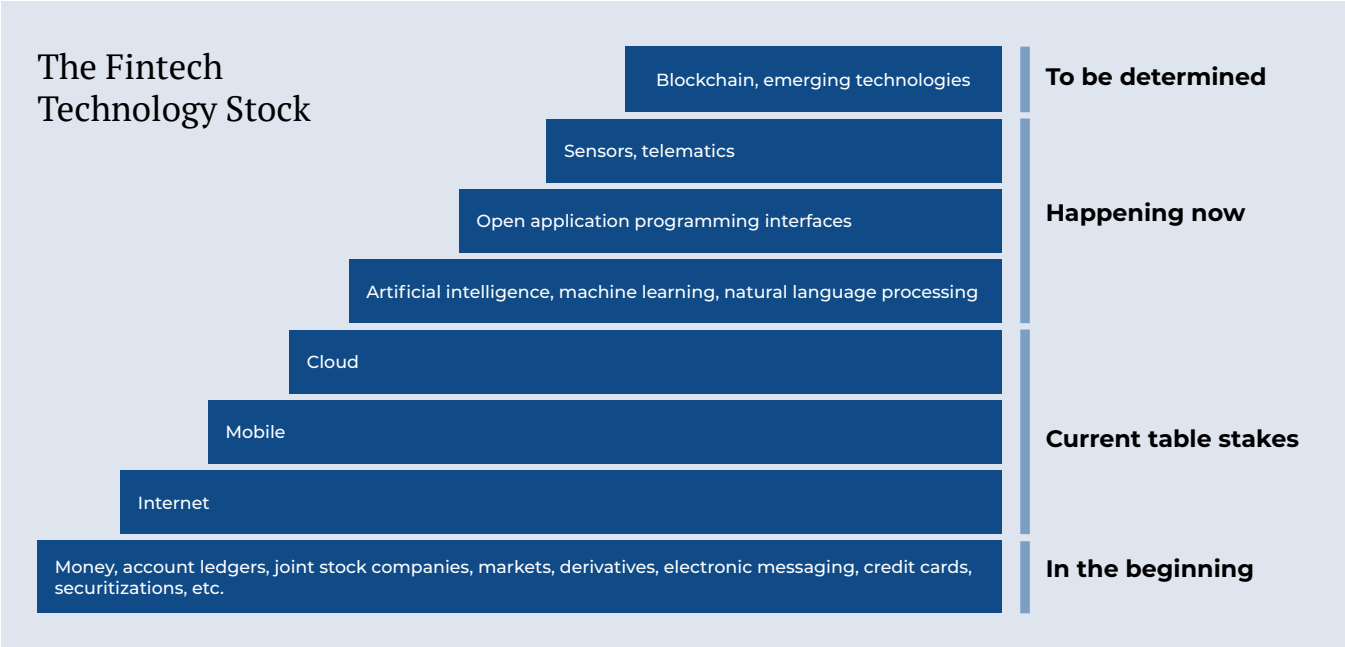
Beyond traditional banking and lending, blockchain technology and novel digital payment architectures are driving increasing adoption of decentralized financial ecosystems that provide greater security, lower transaction costs, and improved accessibility. Decentralized finance (DeFi) platforms allow individuals to borrow, lend, and trade assets without relying on centralized financial institutions while also automating financial agreements, ensuring that transactions are executed only when predefined conditions are met. These innovations are not only enhancing efficiency but also enabling businesses and consumers to conduct international transactions more seamlessly and reducing intermediary fees.

Finally, as financial transactions become more digitized, business process automation and regulatory technology (RegTech) solutions are emerging as critical tools for ensuring compliance in an increasingly complex financial environment. AI-powered anti-money laundering (AML) detection systems are improving fraud prevention by analyzing suspicious transaction patterns

in real time, significantly outpacing human auditors in both speed and accuracy. Similarly, automated compliance monitoring tools are helping financial institutions adhere to evolving regulations, reducing legal risks, and streamlining regulatory reporting requirements.

The evolution of FinTech technologies follows a clear trajectory from foundational financial systems toward increasingly sophisticated digital infrastructures that leverage AI, cloud computing, and distributed solutions. As depicted in Figure 18 below, these advancements layer upon each other, creating an ecosystem where financial services are no longer static institutions but adaptive and embedded within broader digital ecosystems. This context requires not only new technological innovations and skill sets, but also the ability to coordinate across and within an interconnected system of traditional banks and lenders and value-added fintech product and services providers that supplement the core capabilities of legacy institutions.

Figure 18. Conceptual Illustration of the FinTech Technology "Stack" Which Enables Emerging Applications Through Building on Existing Financial Services Infrastructure



Source: Gary Gensler, MIT Sloan.

Why is this S&T Opportunity Area a Fit for Delaware?

Delaware has long been a leader in financial services, home to a thriving ecosystem of banks, lending institutions, and corporate finance operations. The state's business-friendly regulatory environment has made it the legal home of over 66 percent of Fortune 500 companies[32], positioning it as a center of financial innovation. While the state's historical role as a financial services hub provides a strong foundation for FinTech growth, the shift toward AI-driven decision-making, real-time analytics, and decentralized transaction models requires deliberate adaptation. Though relatively recent, there is evidence that Delaware's major banking institutions, emerging FinTech companies, and research institutions are beginning to put into place the collaborative mechanisms to help develop a supporting ecosystem for the advancement of emerging fintech applications. At the same time, Delaware's regulatory expertise and legal infrastructure—which have long been leveraged to attract financial institutions—can still serve as a strategic advantage in shaping the next generation of financial services policy and governance.

Despite a strong history of industry-driven activity, Delaware's research and academic capabilities in this space are still emerging. Recognizing the rapid shift in financial services and the potential opportunity, the UD has expanded its FinTech research investments and capabilities to help generate increased levels of tech "push" across several fronts, including:

- **The FinTech Innovation Hub at STAR Campus** is a state-of-the-art facility located on the Science, Technology, and Advanced Research (STAR) Campus. This six-story building, developed in collaboration with Delaware Technology Park and supported by a $40 million investment from Discover Bank, serves as a nexus for research and talent development in financial technology, with efforts that aim to address broad challenges in financial health such as financial equity and inclusion.

- To help drive more interdisciplinary collaboration and focus in this area, UD has also established **a dedicated FinTech Consortium**, housed within the **Data Science Institute**, which brings together experts from various domains to advance research in AI-driven financial analytics, policy implications, and regulatory technology. It facilitates member participation in events such as symposia, workshops, and hackathons, and increasingly fostering connections between academia and industry stakeholders.

- In response to the growing demand for professionals skilled in financial technology, UD has developed **a new FinTech degree program** that integrates coursework in finance, business analytics, cybersecurity, and AI. This program is one of the first offered by an AACSB-accredited business school and notably addresses pressing talent needs for both FinTech startups as well as major banks. Additionally, a regulatory compliance minor or certificate program is under development, modeled after the successful Trust Minor Program that was created with industry funding from JPMorgan Chase.

32 Delaware Division of Corporations

Emerging efforts across other supporting initiatives and organizations are also driving momentum towards further development of the fintech innovation ecosystem in the state, including:

- Complementing its FinTech initiatives, UD has established the **Artificial Intelligence Center of Excellence (AICoE)** that is intended to serve as a catalyst for advancing multidisciplinary research AI domain areas. Within this new center, one of the applications areas where researchers are leveraging scalable AI models is the development of high-performance computing applications for financial risk modeling and fraud detection.

- Based within the FinTech Innovation Hub, the **Center for Accelerating Financial Equity (CAFE)** is a 501(c)(3) nonprofit organization dedicated to advancing financial health and inclusion for low- to moderate-income (LMI) individuals through supporting FinTech technology startups and strategic partnerships. Through its flagship FinTech Accelerator Program, CAFE offers a hands-on, immersive experience where founders gain direct exposure to financial institutions, regulators, and investors.

The FinTech Innovation Hub's Role as a Hub for Delaware's Emerging Fintech Ecosystem

The FinTech Innovation Hub at the University of Delaware's STAR Campus is a six-story, 100,000-square-foot facility dedicated to advancing financial technology and research activity on drivers of economic equity. Established through a partnership between the University of Delaware, Delaware Technology Park, and Discover Bank, the hub serves as a collaborative space for academia, industry, and nonprofit organizations. It houses teams from UD's Alfred Lerner College of Business and Economics and the College of Engineering, as well as entities like CAFE's accelerator program and Tech Impact's Data Innovation Lab, which employs fellows to work on data-driven projects benefiting Delaware and its communities. The hub's tenants encompass an interdisciplinary mix of fintech startups, data analytics firms, and financial services companies, and it also serves as a key hub for other initiatives such as the UD Data Science Institute's FinTech Consortium.

Delaware's prominence as a financial hub is deeply rooted in its strategic legislative initiatives and the subsequent influx of major financial institutions. A pivotal moment in this trajectory was the enactment of the Financial Center Development Act of 1981, which aimed to establish Delaware as an attractive destination for financial services companies by allowing holding companies to establish in the state as well as other provisions such as the elimination of interest rate ceilings that positioned the state competitively. This legislative change prompted a significant migration of financial institutions to the state that has anchored Delaware as a major hub for credit card lending and financial services for decades, attracting institutions such as JPMorgan Chase, Barclays, Capital One, Bank of America, and other major financial institutions that anchor Wilmington's finance cluster. This has led to a critical mass of employment in the financial services industry cluster in Delaware totaling over 34k jobs in 2023 with a level of employment concentration over 3.2 times that of the national average. Speaking further to the role that this industry base plays in driving the state's economy, the finance and insurance industry cluster was responsible for 16.4 percent of Gross State Product in 2023.

In addition to traditional banking giants, Delaware's conducive regulatory landscape has fostered the growth of alternative lending platforms. Companies like Best Egg and Upgrade have capitalized on the state's business-friendly environment to innovate and expand their FinTech-driven lending models. The state has begun attracting more significant levels of venture capital investment in FinTech despite relatively modest overall deal flow (8 percent of total venture capital deals over the 2019 to 2024 period), with an average value per deal of $22.1 million that outpaces broader U.S. trends in average deal size. There is also ample evidence that the state continues to maintain its base of innovation via its "human capital" in financial services. Since 2019, Delaware inventors at major financial companies have generated a significant cluster of patenting activity focused on data processing and analytics technologies used for financial services and transactions processing, information security, and fraud detection applications. In addition, broader organizations such as the American Fintech Council have begun expanding their partnerships with the Fintech Innovation Hub and CAFE, broadening the industry collaborator network of the state.

Given Delaware's critical mass of industry as well as a growing number of FinTech startups and research-driven initiatives, it is critical that the state be able to identify and focus on key markets where it is best positioned to drive growth in a competitive and fast-moving FinTech landscape that spans international markets. Specific opportunities for Delaware to expand its competitive position in FinTech based on its research and industry strengths include applications areas such as:

- **Alternative Lending Services and Consumer Finance Accessibility:** Delaware's longstanding expertise in consumer lending and credit card banking provides a foundation for expanding alternative lending models that improve financial inclusion and credit access. Companies such as Best Egg and Upgrade, which operate in Delaware, are using AI-driven underwriting models to offer more personalized, risk-adjusted loan products. Further areas of emerging innovation include:
    - AI-powered alternative credit scoring models can supplement or replace traditional FICO-based lending, incorporating factors such as cash flow analysis, rental payment history, and behavioral spending patterns.

- Buy Now, Pay Later (BNPL) services continue to grow as an alternative to credit cards, allowing short-term, no-interest financing integrated directly into digital checkout processes.

- Embedded finance platforms present opportunities to integrate with e-commerce, gig economy services, and small business financing models.

- **AI-Driven Business Process Automation and Financial Models for Legacy Banking:** As financial institutions shift towards automation of many aspects of large scale data processing, Delaware-based banks and FinTech firms are simultaneously investing in AI-driven business process automation to improve customer service, risk assessment, and fraud detection. Call center automation is a key near-term use case, with major AI applications such as AI-powered chatbots and voice assistants that handle routine customer service tasks, agent efficiency tools that enhance human agent performance by quickly retrieving customer data, summarizing previous interactions, and suggesting solutions, and AI-driven analytics that analyze real-time customer interactions to improve compliance monitoring, fraud detection, and quality assurance.

- **Management of Trusts and Digital Asset Services:** Delaware is already a national leader in trust and asset management services, but new FinTech-driven solutions are transforming the sector by introducing digital trust administration, blockchain-powered asset transfers, and AI-driven estate planning. AI-driven wealth management platforms are helping clients with automated financial planning, tax optimization, and risk-adjusted investment strategies. Tokenization of assets and digital securities, a process where ownership rights of an asset are represented as digital tokens and stored on a blockchain, is also expanding, enabling fractional ownership models for real estate, private equity, and alternative investments. Lastly, "smart contract"-enabled trust administration is beginning to streamline estate execution and fiduciary management by reducing paperwork and manual oversight.

- **Modeling Policy and Regulatory Impacts on FinTech Adoption and Innovation:** As digital banking, blockchain, and AI-driven financial products evolve, Delaware has the potential to position itself as a leader in regulatory innovation through its existing involvement in industry partnerships. Designing regulatory sandboxes that allow FinTech firms to test new financial products in a controlled environment helps accelerate market adoption while ensuring compliance, while ongoing research in policy simulations and regulatory modeling can help predict the impact of new financial regulations and provide decision support applications for industry and government stakeholders.

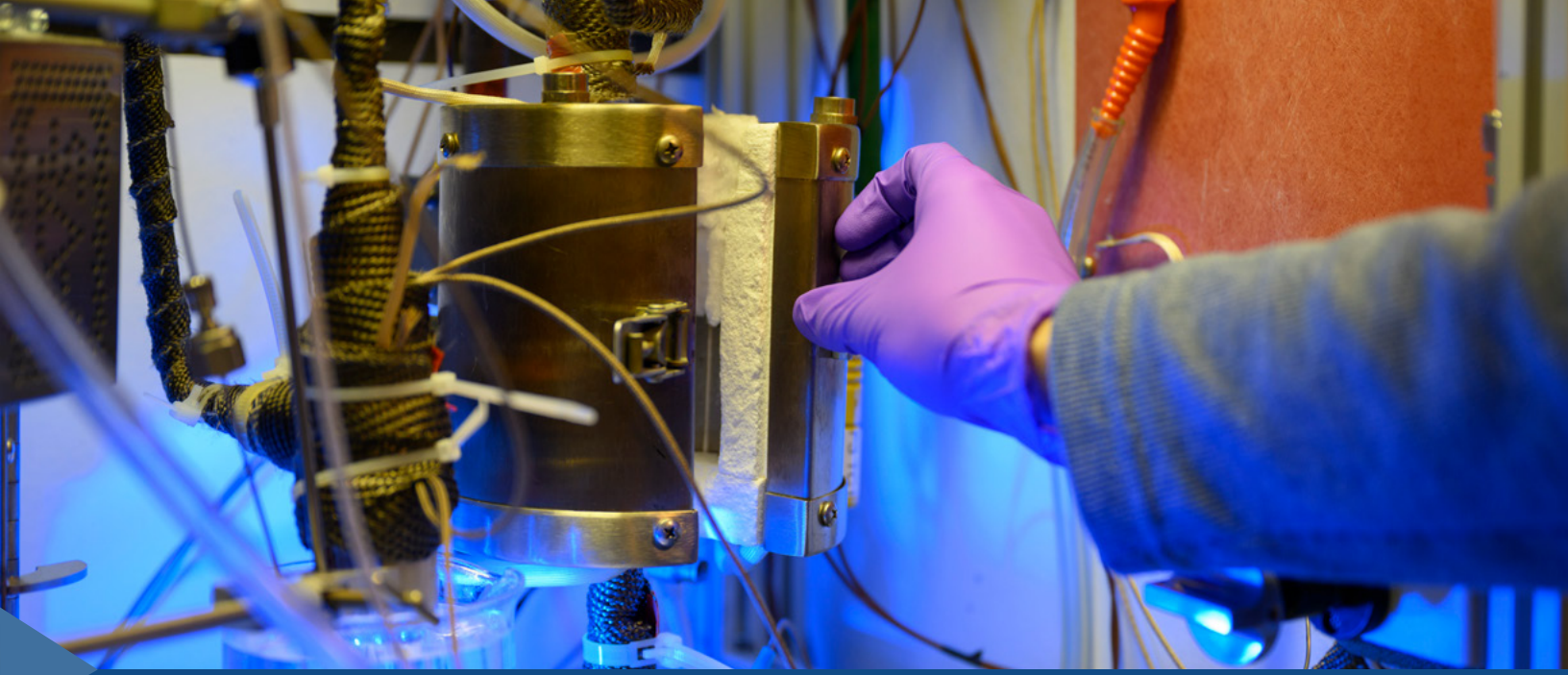
Implications for Future Growth

Despite its strong research institutions, deep financial industry roots, and growing portfolio FinTech activity, Delaware faces several barriers that must be addressed to fully capitalize on its potential as a FinTech innovation hub. While the state has benefited from a legacy banking presence and regulatory advantages, the transition to analytics-driven financial services, digital banking, and embedded finance requires strategic investments in capabilities that competitor FinTech markets have developed in their ecosystems as well as closer coordination across the state's finance and banking ecosystem.

To help ensure Delaware's market position for future growth, several key issues were identified in conversations with key stakeholders that need to be addressed:

- **AI, Data Science, and FinTech Talent:** Delaware has struggled to develop and retain FinTech-ready graduates, limiting the pipeline of skilled professionals needed for software engineering, AI integration, and financial analytics. As one example, Delaware lags regional competitors like Drexel University in producing graduates with strong FinTech, AI, and data science skill sets, in part due to experiential learning models that better prepare students for industry roles. Compounding this issue, many UD graduates leave for larger FinTech hubs like New York and Philadelphia where industry presence and salaries are more competitive. Finally, industry-academic partnerships are still somewhat underdeveloped, making it difficult for students to gain hands-on experience in AI-driven financial applications, product management, and risk modeling before entering the job market. New programs launched by Delaware's universities are still in their early stages and need stronger industry engagement to scale effectively, while dedicated training programs to address critical gaps in regulatory compliance and risk management skills remain limited. If further scaled, Delaware has the opportunity to be a leader in FinTech talent generation. In addition to university-based efforts, Delaware's broader FinTech ecosystem is supported by high-impact workforce development programs such as ZipCode Wilmington, a nationally recognized coding bootcamp offering accelerated software engineering training tailored to the needs of financial services employers. Other initiatives like Code Differently, Tech Impact's TechHire program, and programs supported by the Tech Council of Delaware are expanding access to tech careers through targeted upskilling and inclusive training pathways. These community-based and nonprofit programs are working to address key talent gaps in FinTech, cybersecurity, and data science. However, greater integration with industry hiring pipelines and continued investment is needed to scale their impact.

- **Venture Capital and Startup Funding:** Access to capital remains a significant challenge for FinTech startups in Delaware, as the state has few dedicated venture capital firms and limited early-stage funding mechanisms. Stakeholders noted that Delaware lacks a structured venture capital network for FinTech, forcing startups to seek capital from Philadelphia, New York, or Silicon Valley investors, often leading companies to relocate. The FinTech Innovation Hub's accelerator programs at STAR Campus are still building momentum and there is no dedicated FinTech investment support at the state level, missing an opportunity to incentivize new startup formation and support in-state entrepreneurs in securing early-stage funding.



- **Regulatory and Business Climate Challenges:** Delaware has historically leveraged its legal and regulatory environment to attract financial institutions, but it has yet to fully adapt to the needs of digital-first FinTech firms. Stakeholders noted the potential to implement a regulatory sandbox, which could allow FinTech companies to test innovative financial products in a controlled environment, a model successfully deployed in other states and international hubs for FinTech companies. Another potential area for the state to explore is supporting a Delaware FinTech banking charter, which could enable startups to operate across multiple states under a Delaware-based framework, reducing regulatory complexity and making the state a more attractive base for digital banking firms. Finally, regulatory hurdles currently limit innovation in alternative lending models and other emerging financial technologies, slowing the ability of FinTech startups to scale new technologies relative to competitor markets in other states.

- **Disconnect Between Legacy Banking Institutions and FinTech Ecosystem:** Delaware's legacy financial services firms (e.g., JPMorgan Chase, Capital One, Bank of America) maintain a strong presence in the state but have not yet fully integrated with Delaware's FinTech research assets. Large commercial banks tend to prioritize workforce access over early-stage FinTech innovation, meaning that while they hire UD graduates, they are not necessarily significantly investing in Delaware-based FinTech startups or R&D partnerships. Regulatory compliance presents an area of potential shared workforce challenges to build partnerships around, but there are few formal collaborations between large banks and UD to develop compliance technology and business process automation training programs, an area of high industry demand.

Delaware S&T Growth Opportunity Area: Next Generation Specialty Chemical Products

Delaware has long been a center for scientific and industrial innovation in the specialty chemicals sector. The state's deep-rooted legacy in materials science, chemical engineering, and applied innovation is a direct result of its historical association with DuPont, which has influenced global advances in polymers, coatings, semiconductor materials, and bioprocessing. Today, this legacy continues through a thriving ecosystem of research institutions, corporate R&D hubs, and public-private partnerships aimed at developing next-generation specialty chemical products.

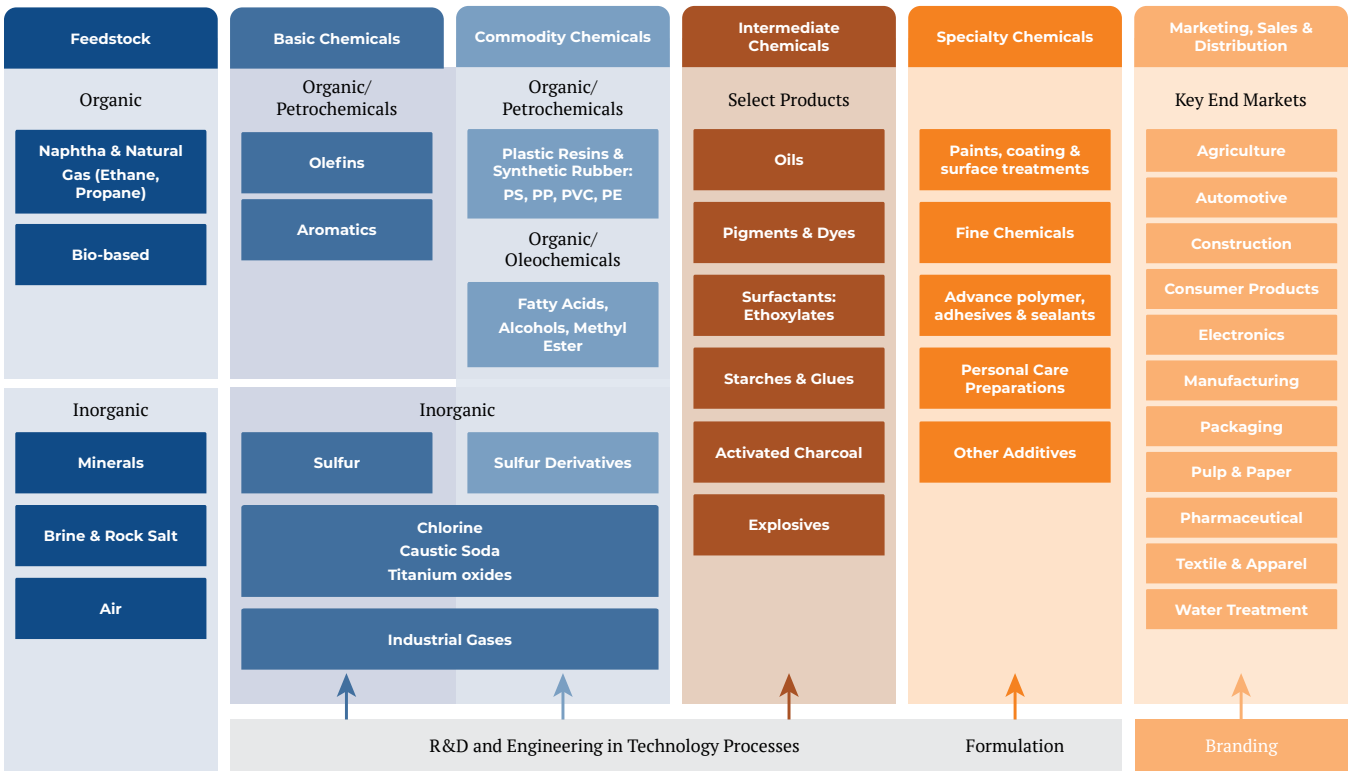
As industries evolve and prioritize advanced materials, sustainability, and high-performance formulations, Delaware is well-positioned to play a critical role in the future of specialty chemicals. Leading-edge applications such as semiconductors, personal protective equipment (PPE), thermal management, water technologies, advanced mobility, and biomaterials are poised for significant growth, offering Delaware a unique opportunity to invest in maintaining its leading position based on its strengths in chemical innovation, research excellence, and industrial scalability.

What Are Next Generation Specialty Chemical Products?

Next generation specialty chemical products represent a broad and growing market applications area that provides critical materials and formulations as a part of the upstream supply chain for a number of high-growth industries including semiconductors, healthcare, automotive, and energy technologies. These chemical compounds and chemically-derived materials enable higher performance, sustainability, and enhanced functionality across multiple applications, making this area a cross-cutting strength that supports multiple end market applications.

The specialty chemicals market is a highly diversified segment of the broader chemical industry, characterized by high-value, performance-enhancing chemical formulations tailored for specific applications. Unlike commodity chemicals, which are produced in large volumes with relatively uniform characteristics, specialty chemicals are differentiated by their unique functional properties for specific use cases within the value chains of other industries such as electronics, healthcare, automotive, energy, water treatment, and advanced manufacturing. The market is generally structured into several major product categories, including specialty polymers, coatings, adhesives, sealants, and elastomers (CASE), catalysts, surfactants, biochemicals, and other additives. Ultimately, these products are used in customized formulations to enhance durability, efficiency, sustainability, and performance in end-user markets as shown in Figure 19.

Figure 19. Example Representation of the Global Chemicals Value Chain



Source: Bamber, Penny & Frederick, Stacey & Gereffi, Gary. (2016). The Philippines in the Chemical Global Value Chain.

Specialty chemicals play a crucial role across diverse end-user industries, providing solutions for a variety of different use cases. Several key end market consumers for specialty chemicals products include:

- **Automotive and Transportation:** Specialty polymers, adhesives, and coatings improve lightweighting, fuel efficiency, and durability in electric vehicles (EVs) and aerospace applications. Fluoropolymer-based coatings enhance battery safety and thermal management in lithium-ion battery systems, while advanced lubricants reduce friction in high-performance engines.

- **Electronics and Semiconductors:** High-purity specialty chemicals enable chip fabrication, printed circuit board (PCB) manufacturing, and display technologies. Photoresists, dielectric materials, and wet etching chemicals are critical for semiconductor lithography, while conductive inks and adhesives support next-generation flexible electronics and wearables.

- **Pharmaceuticals and Biotechnology:** Specialty chemical capabilities support drug formulation, biologics production, and pharmaceutical excipients. Polymeric drug delivery systems, active pharmaceutical ingredients (APIs), and biocompatible coatings enhance targeted therapeutics and controlled-release formulations.

- **Energy and Sustainability:** Specialty catalysts and membrane technologies advance hydrogen production, fuel cells, and carbon capture applications. Proton exchange membranes (PEMs) and anion exchange membranes (AEMs) enable electrolysis and fuel cell efficiency improvements, supporting clean hydrogen infrastructure development.

- **Consumer Products and Personal Care:** Surfactants, emulsifiers, and performance additives improve cosmetics, detergents, and home care formulations. Biodegradable polymers are also increasingly replacing traditional plastics in packaging and personal care products.

- **Construction and Infrastructure:** High-performance sealants, coatings, and additives enhance concrete durability, fire resistance, and thermal insulation in green building applications. Self-healing concrete polymers and advanced weatherproofing coatings improve the lifespan of infrastructure projects.

- **Agriculture and Crop Protection:** Specialty chemicals play a crucial role in precision agriculture, seed treatments, and biopesticides. Controlled-release fertilizers, biodegradable pesticide coatings, and soil-enhancing additives improve crop yields while reducing environmental impact.

In addition to serving as feedstocks and functional additives, specialty chemicals also play a fundamental role within materials markets through materials chemistry applications. By enabling precise control over material properties during production, specialty chemicals contribute to the development of next-generation polymers, composites, nanomaterials, and biomaterials that exhibit enhanced materials properties. These advancements are particularly critical in industries with specialized requirements around specific materials properties such as semiconductors, aerospace, energy storage, and medical devices, where engineered materials must meet stringent performance requirements. Through innovations in catalysis, surface science, molecular design, and formulation chemistry, specialty chemicals facilitate the customization and optimization of these materials and thus also play a key role in advanced manufacturing and next-generation materials solutions.

Notably, traditional chemicals manufacturers are facing a key inflection point amidst uneven growth and declining margins in their traditional core industrial chemicals markets while also pivoting to new higher-growth markets and addressing customer demand sustainable for more sustainable, lower environmental impact products. As a result, the industry is actively investing in potentially transformative innovation, with several high level trends identified in Figure 20. At the same time, companies are actively consolidating around core products and reducing production costs, with potentially significant impacts to the industry landscape amidst restructuring and disruption of traditional end markets. Delaware's chemical companies are facing these same headwinds, making it more critical than ever for the state to coordinate around strategies that support innovation and position the industry base for future growth.

Figure 20. Recent Innovation Dynamics Identified in Chemicals Industry

Type	Subtype	Use cases
Product innovation	Feedstock substitution (such as renewable feedstocks)	Developing new polymers like biodegradable ones for laundry detergent applications
	Improved chemical formulations (such as drop-in chemicals)	Increasing efficiency and function at low temperatures and mild pH using enzymes in detergents
	End-market applications solutions (such as solutions that enhance performance, quality, and environmental footprint of the final product)	Developing coatings that provide better corrosion resistance for machinery, extending their lifespan and reducing maintenance costs
Process innovation	Process intensification	Using low-volume flow electrochemical microreactor for rapid and automated process optimization
	Digitalization and automation	Implementing digital twins for chemical plant asset integrity management
	Sustainable processes	Using green chemistry techniques
Ecosystem innovation	Collaborative R&D	Creating partnerships between chemical companies and academic institutions/innovation hubs
	Open innovation platforms	Crowdsourcing ideas for new chemical products
	Co-inventing with the customers	Developing collaborative partnerships between chemical companies and farmers to understand the latter's needs and developing solutions accordingly
	Sustainability practices	Implementing circular economy principles

Source: Deloitte analysis of reports and articles from BASF, Cleaning Institute, Covestro, Royal Society of Chemistry, AIChE, Eastman, EPA, Chemours, and Cefic.

Source: Deloitte 2025 Chemical Industry Outlook.

Market Outlook and Growth Dynamics

The global market for specialty chemicals is estimated at $1.3 trillion in 2023 and expected to grow at a cumulative annual rate of 4.9% through 2029. The broad, cross-cutting nature of the specialty chemicals market is reflected in the significant size of several of its various key submarkets, in particular:

- **Coatings, adhesives, sealants, and elastomers (CASE)** – valued at $490 billion in 2024, CAGR of 5.8% through 2029.
- **Food and feed additives** – valued at $133 billion in 2024, CAGR of 5.4% through 2029.
- **Plastic additives** – valued at $124 billion in 2024, CAGR of 4.8% through 2029.
- **Electronic chemicals** – valued at $100 billion in 2024, CAGR of 6.7% through 2029.
- **Water treatment chemicals** – valued at $65 billion in 2024, CAGR of 3.7% through 2029.

Key market dynamics driving increased need for domestic production of specialty chemicals include:

- Growing markets in semiconductors, battery technology, and electric vehicles, which rely on high-performance chemicals for use within devices and at the chip level.
- Increasing importance of innovative technologies in enabling sustainable chemicals and incorporation of circular economy strategies that minimize waste as well as environmental impact relative to traditional industrial chemical production.
- Increasing use of bio-based and highly customized chemical formulations across a variety of large end use markets such as construction and agriculture.
- Emphasis on reshoring and nearshoring chemical production operations to mitigate supply chain risks.

Source: BCC Research

Why is this S&T Opportunity Area a Fit for Delaware?

Delaware's longstanding expertise in specialty chemicals is rooted in over two centuries of scientific innovation, beginning with DuPont's establishment in 1802. This legacy has led to the development of globally recognized advancements in polymers, coatings, fluorochemicals, and industrial materials, fostering a skilled workforce and a track record of research and industry collaborations. Today, the state continues to be one of the national hubs for next-generation specialty chemical innovations, supported by excellence within R&D institutions and existing corporate research centers.

Delaware's academic and research programs in chemistry and chemicals engineering represent a world class hub for new talent development and has the potential to be further leveraged to serve as a pipeline of ideation to catalyze a vibrant innovation ecosystem. UD has one of the top-ranked chemical engineering programs in the nation focused on conducting industry-facing research in polymer science, catalysis, biomaterials, and energy storage. UD's research institutes and specialized centers offer critical infrastructure for testing, synthesis, and commercialization and fosters industry-academic partnerships at UD's STAR Campus (Science, Technology & Advanced Research Campus) where the Chemours Discovery Hub is co-located. This excellence is evident in key research themes present across recent publications and grants activity in areas such as electrochemical catalysis applications, sustainable chemical manufacturing and biofuels production, and a wide variety of advanced polymer applications spanning use cases across energy systems, biomedical, and high-performance materials.

Key Assets Supporting Delaware's Specialty Chemicals Innovation Ecosystem

The Chemours Discovery Hub, located on UD's STAR Campus, is a state-of-the-art research center focused on next-generation fluoropolymers, specialty coatings, and sustainable materials. As the global R&D headquarters for Chemours, the Discovery Hub provides a highly collaborative environment for scientists and engineers, working on breakthrough technologies in clean energy, semiconductor materials, and sustainable chemical formulations. The facility represents a $150 million investment with 130 labs and housing 330 scientific jobs

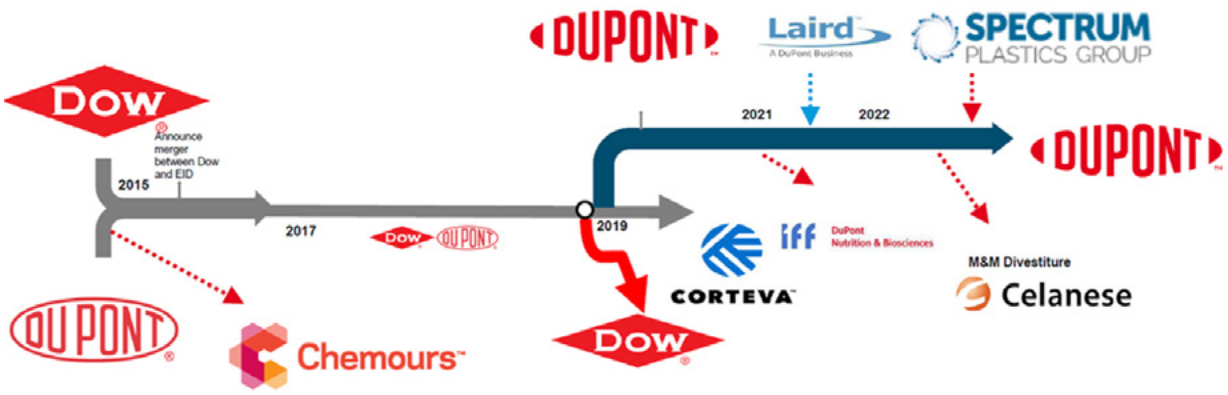
The DuPont Experimental Station, established in 1903, stands as one of the world's first industrial research and development facilities. Over its storied history, it has been the birthplace of chemicals and materials sciences innovations such as Nylon, Kevlar, and Tyvek that have become integrated with industries globally. Today, the Experimental Station focuses on cutting-edge research in areas like sustainable solutions, advanced materials, and biotechnology, both at DuPont but also at other tenant companies now housed there. The site is currently at a point of transition, with ongoing redevelopment from a traditional R&D hub towards a collaborative S&T business development complex.

The Innovation Space, a 501c3 non-profit developed in partnership with the State of Delaware, DuPont, and the University of Delaware, helps to support and coordinate early-stage science-based companies via its virtual accelerator program, early-stage investment fund, and mentoring programs. The Innovation Space is located on Dupont's Experimental Station campus and is comprised of 130,000 square feet of state-of-the-art multi-use laboratories.

Additionally, university R&D spending trends show that Delaware is over 17 times more specialized in its research expenditures in chemical engineering than the county, with nearly $92 million in total funding in this space in 2023.

DuPont's presence in Delaware, and its subsequent cohort of spin-outs, has established a reputation for industry-driven innovation in this opportunity area that continues to be a competitive advantage today (Figure 21). Delaware's current position in the specialty chemicals industry is deeply intertwined with its industry history, including scientific discoveries in polymer chemistry, materials science, and industrial chemicals that have shaped a variety of other industries overtime. Today, this complex supply chain has incorporated next generation specialty chemical compounds and materials into their operations. This history, in combination with the ongoing restructuring of DuPont, has created "alumni" companies focused on additional chemicals-driven markets and has anchored a highly skilled workforce with a deep concentration of chemical engineers, materials scientists, and process chemists who work across the industry ecosystem. Delaware is home to several global leaders in specialty chemicals, including Chemours, Solenis, and FMC, which continue to develop high-value formulations and chemically-based products.

Figure 21. Evolution of DuPont Portfolio Companies and Portfolio Diversification Within Specialty Chemicals Markets



Source: DuPont.

Based on the end markets that Delaware industries primarily serve today as well as areas of ongoing R&D investment by anchor companies, there are several key application verticals where the state is particularly well positioned to drive activity across the specialty chemicals landscape:

- **High-Performance Semiconductor and Electronics Compounds** support increasing miniaturization and performance demands for a growing domestic semiconductor and microelectronics industry in areas such as advanced lithography for photoresists and coatings that enable ultra-small chip features, dielectric and conductive polymers that improve signal transmission and thermal performance, and packaging and encapsulation methods that leverage chemical compounds to enhance durability, heat resistance, and efficiency in electronic devices.

- **PPE, Protection, and Safety Materials** remain a critical requirement across many industries where the need for stronger, lighter, and more durable protective materials continues to drive markets in defense, healthcare, and industrial safety applications. Chemical-resistant membranes are the basis for many protective materials used in operations handling hazardous materials, while antimicrobial and breathable coatings allow for use-inspired design of protective clothing and equipment that enhances protection while ensuring functionality.

- **Thermal Management and Refrigerants** leverage chemistry methods to develop high-performance cooling materials and systems that are essential for electronics, industrial systems, and HVAC. In particular, emerging markets exist for applications in immersion cooling for data centers around fluorochemical-based cooling solutions that reduce energy use, Low Global Warming Potential (GWP) refrigerants that can replace legacy refrigerants, and novel phase-change materials that store and release heat efficiently.

- **Water Technology and Industrial Filtration** for industrial and municipal water systems that leverage technologies to perform high-efficiency filtration and deploy treatment chemicals to ensure sustainability. Some technologies relevant to Delaware's industry and innovation base include reverse osmosis and nanofiltration membranes used for desalination, water purification, and wastewater reuse, ion exchange resins essential for softening water, removing heavy metals, and chemical separations, and sustainable water treatment additives that enhance efficiency and longevity in filtration systems.

- **Advanced Mobility and Automotive Materials**, which provide lightweight, high-performance properties that are critical to the future of electric and autonomous vehicles and include structural composites and high-strength, lightweight materials improving fuel efficiency, battery components such as advanced polymer separators, electrolytes, and solid-state battery materials, and thermal interface materials for enhanced heat dissipation for EV power electronics.

- **Healthcare and Biomaterials** in which the specialty chemicals industry is deeply embedded in biopharmaceutical and regenerative medicine applications around advanced drug delivery materials composed of polymers and nanoparticles engineered for controlled release of pharmaceuticals, tissue engineering and regenerative scaffolds materials used in artificial

organs and wound healing, and biocompatible coatings that prevent infection and improve implant durability.

- **High-Performance Coatings and Formulated Chemicals** used in aerospace, industrial manufacturing, and consumer applications, including:

    - Protective Coatings such as corrosion-resistant materials for infrastructure and industrial machinery.
    - Functional Additives that enhance properties such as UV resistance and hydrophobicity.
    - Sustainable Coatings that are bio-based or low-VOC (volatile organic compound) formulations that have reduced environmental impacts.

Overall, Delaware's ability to connect cutting-edge research with industrial applications sets it apart as a leading hub for next generation specialty chemical products. Delaware is well-positioned as a regional hub for commercialization in advanced materials, life sciences, and clean technology due to its legacy in industrial chemistry and its proximity to Philadelphia, New Jersey, and Maryland. Delaware's most unique strength is its ability to bridge research and commercialization thereby translating research into commercial-scale production—whereas other east coast hubs are discovery-focused and lack large-scale manufacturing capacity.

Implications for Future Growth

Despite its strong research institutions, deep industry expertise, and history of leading industry position in specialty chemicals, Delaware faces several structural and strategic challenges that could hinder its ability to fully capitalize on this opportunity area. As global competition intensifies and industries demand faster commercialization of new materials, Delaware must address key barriers related to early stage company formation, venture capital availability, workforce readiness, and regulatory modernization. While the state benefits from a strong foundation in chemical innovation that has naturally diffused across its institutions via its legacy workforce, gaps in early-stage funding, research translation, and infrastructure investment could limit its ability to sustain long-term competitive advantages.

Based on the opportunity and market headwinds outlined above, several key issues were identified in conversations with key stakeholders that need to be addressed:

- **Startup and Entrepreneurship Activity:** Despite UD boasting a top-ranked chemical engineering program and strong research output in polymer science, catalysis, and advanced materials, very few startups emerge from the state's research ecosystem. Stakeholders noted that this lack of startup formation is partly due to a faculty culture that prioritizes academic publishing and industry collaboration over entrepreneurship, leaving professors and graduate students with limited exposure to commercialization pathways and relying on industry-driven spinouts to generate new ventures.

- **Scale-Up Facilities and Pilot Production Capacity:** In addition to entrepreneurial talent, many early-stage specialty chemical technologies require pilot-scale manufacturing and process validation before they can attract commercial investment. However, stakeholders noted that

the state lacks shared-use infrastructure for mid-scale production, creating a gap between lab discoveries and commercial-scale manufacturing. Emerging companies often struggle to find local pilot-scale testing facilities "outside the fence" of existing companies, forcing them to relocate to out-of-state contract manufacturing organizations (CMOs) or tech parks in other regions. Existing incubators are not able to bridge the gap to small-batch production for specialty chemicals alone. Flexible, small-batch chemical production facilities are needed for sustainable polymers, bio-based materials, and high-performance coatings to support new innovations.

- **Aging Talent:** The specialty chemicals sector in Delaware is facing an ageing technical workforce. A significant portion of the state's skilled chemical manufacturing workforce is nearing retirement, and there are insufficient training pipelines to replace retiring workers with younger talent. This shortage is particularly acute in roles requiring advanced formulation skills, precision chemical processing, and materials characterization. These are areas where stakeholders noted that Delaware at one time led the market but now faces growing competition from other states.

- **Regulatory Challenges:** Delaware's chemical regulatory framework was designed to accommodate large-scale legacy manufacturing plants. As a result, it may inadvertently hinder the growth of smaller, high-tech chemical startups and advanced lab-based manufacturing operations. Emerging specialty chemical firms focused on sustainable formulations, green chemistry, and bio-based materials require flexible, adaptive regulatory structures that encourage pilot-scale production and rapid iteration.

- **Rising Competition from Sustainable Chemistry Hubs:** The global shift toward green chemistry and bio-based materials has led to regional clusters emerging in other states where universities and industry partners have invested in capturing market share in sustainable chemical manufacturing. Delaware must differentiate its specialty chemicals sector to compete in a market that is rapidly evolving toward low-carbon, non-toxic, and biodegradable alternatives. Other states are aggressively investing in green chemistry innovation via state-led initiatives, which in turn is attracting larger supplier networks seeking to modernize their product offerings and acquire new technologies emerging from cohorts of startups in the ecosystem. To maintain its competitive position, Delaware must find ways to support the growing ecosystem of specialty chemical companies across a number of market verticals around its existing anchor companies.

- **Aging Research Infrastructure:** Despite recent activity and buildout around innovation hubs, stakeholders noted several concerns about aging research and shared-use infrastructure. To maintain its global competitiveness in specialty chemicals, Delaware must continue to invest in best-in-class equipment and infrastructure, particularly in areas critical to materials discovery, catalysis, and advanced manufacturing. Private sector facilities have continued to advance, and research infrastructure must keep pace in order to remain relevant as a partner for joint projects.

Delaware S&T Growth Opportunity Area: Sustainable and High-Performance Materials

Delaware has long been a hub for innovation in materials science, with a legacy of research and industry leadership spanning polymers, composites, and advanced functional materials. Today, as global industries seek sustainable and high-performance materials to drive next-generation manufacturing, Delaware's expertise in developing novel materials places it at the forefront of this growing market. The state's university research centers, corporate R&D hubs, and public-private partnerships form a strong ecosystem for pioneering materials that enhance performance while reducing environmental impact.

The demand for sustainable and high-performance materials is accelerating across multiple sectors—including automotive, aerospace, electronics, biopharmaceuticals, and energy—driven by advances in nanotechnology, bioengineering, and polymer science. Delaware's signature strengths in plastics circularity, hybrid and responsive materials, and biomaterials for healthcare offer a foundation for continued leadership in this evolving industry. Notably, this growth is fueled by demand from both existing markets that require new innovations in upstream processes as well as emerging markets leveraging novel materials. No single market size defines this cross-cutting area—rather, its growth is reflected in multiple segments from biopolymers to nanocomposites. A common theme is the convergence of performance and sustainability, where materials innovation now aims to deliver superior functionality in addition to minimizing environmental impacts. This convergence positions regions with strong materials R&D ecosystems, like Delaware, to capitalize on rising demand for novel materials solutions.

What Are Sustainable and High-Performance Materials?

Sustainable and high-performance materials encompass a wide spectrum of advanced material classes engineered for superior performance and sustainability. These include innovative polymers and composites, nanoscale materials, and bio-derived substances that outperform traditional materials in strength, weight, durability, or functionality while also reducing environmental impact. Several key application verticals that this opportunity area spans include:

- **Advanced Polymers and Plastics**, in particular polymeric materials that are inherently recyclable, biodegradable, or produced from renewable feedstocks. Examples include bio-based plastics, high-strength thermoplastics, and chemically recyclable polymers that

enable a circular lifecycle (repeated reuse or upcycling). These materials maintain or improve on the properties of conventional plastics and elastomers but with a dramatically smaller environmental footprint.

- **High-Performance Composites**, materials that combine fibers (like carbon or glass fiber) with matrices (polymers, metals, ceramics) to achieve exceptional strength-to-weight ratios and custom properties. Next-gen composites include light yet strong materials for aerospace and automotive uses, novel tailored fiber composites for complex shapes, and even natural fiber composites for sustainable construction. They aim to deliver metal-like performance at a fraction of the weight, with applications from aircraft components to wind turbine blades.

- **Nanomaterials and Photonic Materials**, encompassing several types of engineered materials at the nanometer scale (such as nanoparticles, nanotubes, 2D materials) and materials designed to control light (photonic crystals, quantum dots, advanced semiconductors). These offer unique electrical, optical, and mechanical properties not found in bulk materials. For instance, nanostructured materials enable better catalysts and battery electrodes, while compound semiconductor materials are being explored for photonics, optoelectronics, and quantum computing beyond traditional silicon. Such materials underpin next-generation electronics, sensing technologies, and quantum devices by enabling faster, more efficient, or new functionalities.

- **Biomaterials and Soft Matter**, materials inspired by or derived from biological systems for use in medicine, biotechnology, and other fields. This includes polymer-based biomaterials for drug delivery, gene therapy, and tissue engineering, as well as soft matter like hydrogels, colloids, and elastomers that can mimic biological tissues. These materials are designed to be biocompatible and tunable (e.g., nanoparticles for mRNA vaccine delivery, or scaffold materials that help cells grow in regenerative medicine). Bio-inspired “smart” materials (e.g., self-healing polymers, stimuli-responsive gels) also fall in this category, translating mechanisms from nature (like self-repair or adaptability) into synthetic materials.

- **Hybrid and Responsive Materials**, a cross-cutting class that includes responsive polymers, metamaterials, and multi-material systems that change properties in response to the environment. They might stiffen under load, change color with voltage, or morph shape, enabling applications in soft robotics, adaptive surfaces, and advanced sensors. Researchers are increasingly integrating these capabilities to create materials that can dynamically respond to stimuli, bridging chemistry, physics, and engineering in material design.

Overall, “next generation” sustainable/high-performance materials are distinguished by how they are developed and what they enable. They often result from the convergence of multiple disciplines that offer new opportunities for traditional industrial chemistry and materials production. For example, combining polymer chemistry, catalysis, synthetic biology, and data science to invent fully recyclable plastics. At the same time, they also serve as critical building blocks in emerging technologies ranging from membranes in hydrogen fuel cells to nanocomposites in flexible electronics. The

Market Outlook and Growth Dynamics

Recognizing the broad nature of market opportunities in this space, several key global market segments particularly relevant to Delaware's opportunities include:

- **Plastic Additives** – valued at $61.5 billion in 2024, CAGR of 5.6% through 2029.
- **Smart Polymers, including coatings, films, and other applications** – valued at $23.8 billion in 2023, CAGR of 18.0% through 2028.
- **Nanotechnology end use markets** – valued at $68 billion in 2023, CAGR of 22.0% through 2028.
- **Plastics Recycling** – valued at $42.4 billion in 2024, CAGR of 6.4% through 2029.
- **Bio-based Composite Materials** – valued at $6.3 billion in 2024, CAGR of 7.4% through 2029.

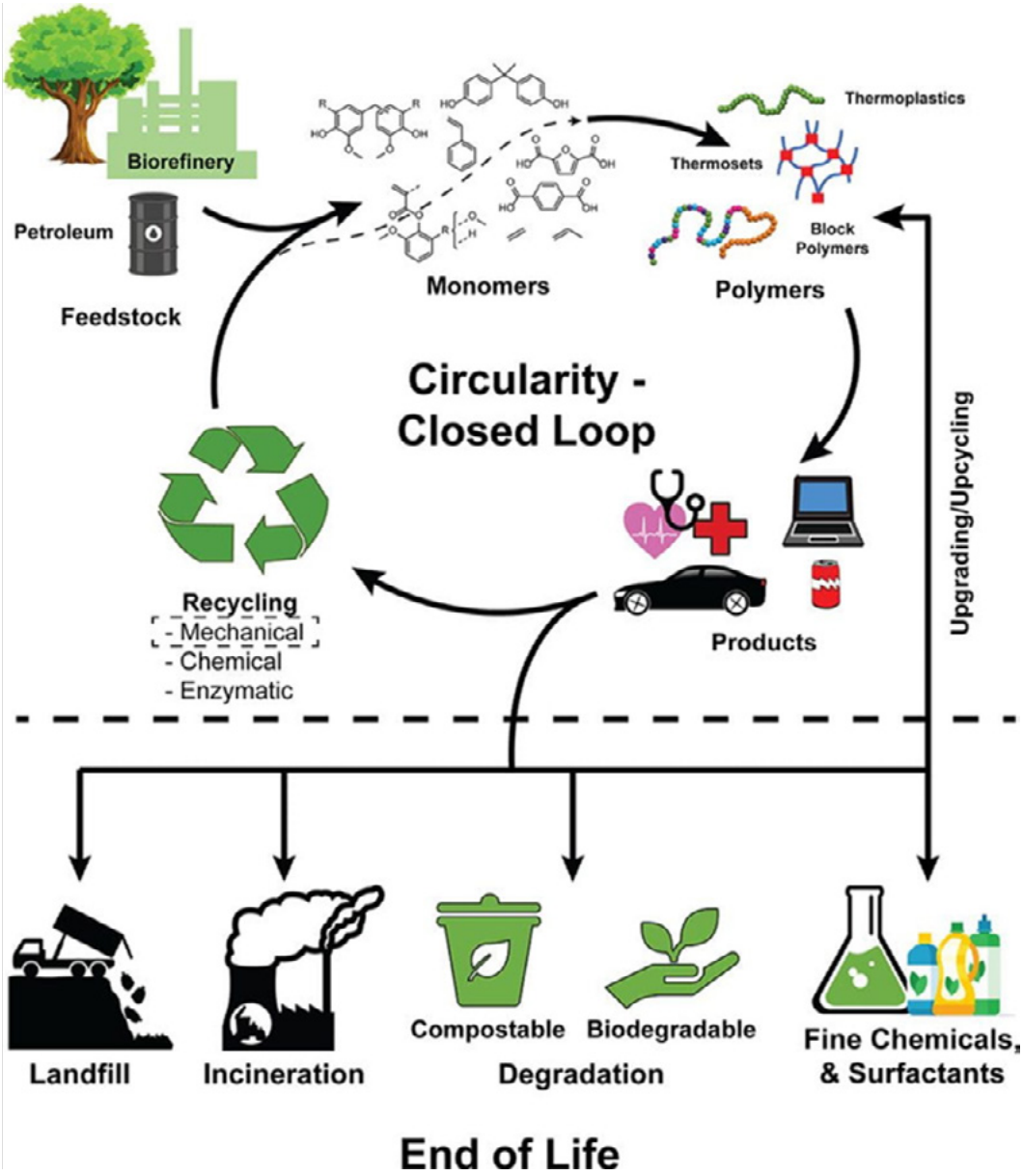
Key market dynamics driving increased need for novel materials solutions include:

- **Global sustainability push** driven by increasing consumer demand for eco-friendly products, government regulations, and corporate ESG goals.
- **High-Growth industry demand for feedstock and high-performance materials** in electronics, vehicles, aerospace, and renewable energy is spurring the need for advanced materials that offer lighter weight, greater strength, and improved performance.
- **AI- driven innovation in materials design and creation** is leading to breakthroughs in nanotechnology, polymer science, and materials chemistry that are enabling next-generation materials with unprecedented properties.
- **Scaling models for circular economy and bio-based feedstocks** are leading to investment in plastics upcycling, biodegradable plastics, and bio-composites as regulations tighten on waste and carbon emissions.
- **Materials supply chain resilience concerns** have led to a strategic emphasis on reshoring/ nearshoring advanced materials production to mitigate global supply chain risks.

Source: BCC Research

The convergence of sustainable polymers, bio-based materials, nanomaterials, advanced composites, and other advanced materials also presents a transformative opportunity in the form of circular economy and life cycle engineering applications, particularly in recycling and upcycling of plastic and polymer-based products. By integrating feedstock sustainability, waste management, and material deconstruction technologies, researchers and industry are developing next-generation materials designed for closed-loop production cycles. Innovations in chemical and mechanical recycling, bio-derived polymers, and AI-driven materials discovery are enabling upstream cycling—where waste plastics and industrial byproducts are repurposed into high-performance materials with enhanced properties (Figure 22). This approach ensures that polymers, composites, and specialty materials are not just recyclable, but also upgraded into higher-value applications across industries such as packaging, automotive, aerospace, and renewable energy.

Figure 22. Example of Sustainable Plastics Upcycling Highlighting Potential for New Innovations Supporting Circular Product Life Cycles



Source: Washington University, St. Louis.

Why is this S&T Opportunity Area a Fit for Delaware?

Delaware's longstanding expertise in materials and chemical innovation makes it a natural hub for discovery and commercialization of new materials. Much like the state's position in chemical engineering, the presence of major industry R&D activity in materials products established Delaware as a leader of innovation in polymers, specialty chemicals, and industrial materials. Alongside (and sometimes as a result of) their work in chemicals development, DuPont and its successor companies pioneered breakthroughs in polymers, fibers, and coatings, building a skilled workforce and deep know-how in materials science. Delaware continues to be recognized as a national center for next-generation materials innovation, benefitting from a concentration of R&D talent and infrastructure and offering a line of sight to materials-driven markets, which complement and play off of strengths in specialty chemicals.

Delaware's universities are a driving force behind the state's strength in advanced materials. Materials science is one of the state's top areas of academic publishing (over 25 percent more concentrated activity than national research publishing trends), while university research expenditures in materials sciences increased to nearly $20.3 million by 2023, a level nearly 15 times more concentrated than R&D spending across universities nationally. As noted in other growth opportunity profiles, UD boasts one of the top-ranked chemical engineering and materials science programs in the nation, with industry-focused research specializations in polymer science, membranes, biomaterials, nanomaterials and thin film materials, and high-performance energy storage materials. The university hosts specialized research institutes and centers that provide cutting-edge facilities for synthesis, characterization, and prototyping across a combination of different innovation hubs and often in proximity to activity also focused on specialty chemicals development. For example, the Chemours Discovery Hub at UD is a hub for next-generation fluoropolymers, sustainable coatings, and clean energy materials in addition to its role in supporting chemicals research.

Within Delaware's universities, interdisciplinary centers lead innovation in this opportunity area. The Center for Plastics Innovation (CPI), an Energy Frontier Research Center, positions UD as a national leader in plastics upcycling, recycling, and sustainable polymer development. Over the past four years, the Center for Plastics Innovation has pioneered new ways to break down common plastics like polyethylene and polypropylene into valuable materials using advanced catalysts, microwave-assisted processing, and AI-driven analysis. Building on these achievements, the center's activity aims to transform plastic recycling by developing low-energy, highly selective upcycling methods that create high-value materials while reducing environmental impact. CPI researchers are developing new methods to deconstruct and upcycle plastic waste into valuable chemicals and create recyclable polymers, drawing on UD's strengths in polymer chemistry, catalysis, and even synthetic biology. This center recently earned a $14.5M renewal from the U.S. Department of Energy to continue its breakthrough work in tackling plastic waste. Complementing CPI, another major anchor of materials science activity is UD's Center for Hybrid, Active, and Responsive Materials (CHARM)—an NSF-funded MRSEC that was awarded an $18 million, 6-year award in 2020—drives cutting-edge research in soft matter, bio-inspired materials, and stimuli-responsive polymers. The center integrates fundamental research with applied discovery, fostering collaborations between chemists, physicists, engineers, and biologists, with

work that has implications across a wide range of industries from advanced manufacturing and biomedical applications to energy storage and smart coatings.

Yet another pillar is the UD Center for Composite Materials (CCM), founded in 1974, which is an internationally recognized center of excellence in composite materials research and education. CCM has long-standing partnerships with the U.S. Army, Navy, DARPA, and hundreds of industry partners across aerospace, automotive, and durable goods sectors, reinforcing Delaware's prominence in advanced composite technology (e.g., new lightweight armor, vehicle components, and manufacturing methods for composites).

Delaware's research enterprise in materials extends into emerging high-tech domains as well. UD's materials growth facilities support work on nanomaterials and compound semiconductors for photonic and quantum applications, attracting collaboration from defense contractors (like Northrop Grumman) and positioning Delaware as a player in next-gen electronics. In the biopharmaceutical arena, researchers are creating novel biomaterials for drug delivery and cell therapy, with partnerships involving AstraZeneca, Merck, Bristol Myers Squibb, and the NIH-funded NIIMBL institute. This convergence of materials science and bioengineering is leading to innovations like polymer nanoparticles for gene therapy and scaffolds for tissue regeneration.

Delaware's has similarly positioned itself as a significant player within the advanced materials sector through the major companies that have developed new market-leading materials products. Several major chemicals companies have significant materials-based portions of their product and R&D portfolios, including DuPont, Chemours, and W.L. Gore. Additional companies based in Delaware include Advanced Materials Technology (AMT), which specializes in enabling scientific materials and separations science, ILC Dover, which specializes in high-performance flexible materials, and the TMI Group of Companies, which manufactures and markets physical property testing instruments for materials industries. The state is also home to a variety of legacy industry chemicals and materials companies that generate a constant demand for new process and sustainability innovations to support greater efficiency and environmental performance in materials production. These legacy companies continue to evolve their product lines by integrating sustainable and high-performance materials into their portfolios, particularly in areas such as advanced polymers, composites, and specialty membranes for industrial and consumer applications.

Delaware's industrial ecosystem supports strong collaboration between major corporations, research institutions, and scaling companies around development of next-generation materials. The DuPont Experimental Station, a major industrial research campus housing DuPont's core R&D operations along with multiple science-driven companies and innovation partners, remains a central hub for materials innovation. It has served as the birthplace of many groundbreaking materials innovations, including Nylon, Kevlar, Tyvek, Neoprene, and Teflon, and the site remains a global research epicenter for next-generation polymers, composites, adhesives, and surface engineering technologies, with a strong focus on sustainable and high-performance materials. Beyond these established players, Delaware has cultivated a growing network of small and mid-sized materials firms engaged in emerging fields such as soft matter, bio-based composites, and high-strength polymers.

In combination, the collection of use-inspired research centers, industrial R&D sites, scientific talent, and forward-looking focus of emerging innovation positions Delaware well to advance materials innovations across several potential markets, including:

- **Sustainable Polymers and Circular Plastics:** Delaware's unique research enables it to take a systems-level approach to sustainability by integrating feedstock sustainability, waste management, and material deconstruction into the development of next-generation recyclable and upcycled plastics. At the forefront are novel chemical and mechanical recycling processes to convert plastic waste into high-value raw materials and leveraging polymer chemistry, catalysis, and synthetic biology to create new polymer formulations that enable closed-loop recycling. These advances have applications across packaging, automotive, consumer goods, and industrial manufacturing, where demand for circular materials continues to rise.

- **Bio-based Materials:** the state's materials research ecosystem is also driving bio-based alternatives to petroleum-derived plastics and composites. Synthetic biology-based plastics, bio-derived feedstocks, and AI-driven materials discovery are key focus areas, with researchers at leading efforts to engineer sustainable polymers from renewable sources. Advances in biopolymer synthesis and bio-composite materials are enabling the development of biodegradable packaging, bio-based adhesives, and structurally reinforced natural fiber composites.

- **Soft Matter and Smart Materials:** The state has key innovation assets focused on bio-inspired and responsive materials that self-heal, adapt, or react to environmental stimuli. Delaware researchers are engineering stimuli-responsive gels, tunable adhesion surfaces, and shape-morphing polymers for applications in soft robotics, wearable electronics, and adaptive coatings. These materials mimic biological properties—such as self-repair, flexibility, and selective permeability—making them valuable for biomedical devices, protective materials, and industrial automation.

- **Nanomaterials and Advanced Functional Surfaces:** Delaware's expertise in nanotechnology and materials characterization supports the development of functionalized surfaces, ultra-thin coatings, and high-performance films. Existing industry and university facilities provide critical infrastructure for fabricating and testing nanostructured materials. Active research focuses on nano-engineered coatings, self-cleaning surfaces, conductive films, and high-strength nanocomposites, which have direct applications in semiconductors, printed electronics, quantum computing, and next-generation optics, where precision material properties at the nanoscale enable breakthrough performance enhancements.

- **High-Performance Materials Applications:** Delaware's longstanding strengths in engineered materials are driving high-performance applications in addition markets. The state is home to leading research hubs developing:

    - **Semiconductor and Photonic Materials:** Compound semiconductors and quantum materials for next-generation computing, optoelectronics, and advanced sensor systems.

- **Energy Materials:** Delaware-based firms are pioneering ion-exchange membranes for fuel cells, next-gen battery materials, and high-efficiency energy storage components.
- **Aerospace and Defense Composites:** Key centers work with military, aviation, and automotive industries to develop lightweight, high-strength fiber composites for armor, vehicle structures, and aerospace components.

While sustainability and circular applications for plastics and polymers are likely to provide the largest near-term market opportunities across existing and emerging industry sectors, the areas outlined above highlight the broad range of potential opportunities that the state can seek to further develop. It will be critical going forward for Delaware to identify and quickly move to engage in key submarkets of materials sciences based on broader national and international trends driving market activity.

Implications for Future Growth

While Delaware is well-positioned in this field, realizing the full potential of a portfolio of materials innovation opportunities will require navigating several challenges. Broader market factors such as the high cost of producing sustainable materials and limited availability of bio-based resources can slow adoption. Moreover, scaling new materials from lab to market often demands substantial capital, infrastructure, and industry buy-in. To help ensure Delaware's market position for future growth, several key issues were identified in conversations with key stakeholders that need to be addressed:

- **Sustained Investment in the Face of Competition:** Delaware's leadership in areas like plastics sustainability is at risk without continued investment. Competing states have injected significant funding into academic-industry consortia and research centers, outpacing Delaware in certain niches. Maintaining an edge will likely require increased state support or private investment to expand research programs, facilities, and commercialization efforts in advanced materials in an era where federal funding for key innovation centers is less stable.

- **Expanding Industry Partnerships and Talent Retention:** Strengthening the bridge between academia and industry is crucial to continue to anchor leading scientific talent at research hubs in the state and drive commercialization of new technologies. Stakeholders noted the need for more structured internship programs, local job opportunities for graduates, and support for startups so that the highly skilled materials science talent trained in Delaware stays in the state. Expanding public-private partnerships in new and emerging areas as well as fostering a more robust venture capital network with a risk tolerance for commercializing "hard science" through leveraging existing corporate hubs would help ensure that homegrown innovations can find commercialization pathways in Delaware rather than elsewhere.

- **Infrastructure Capacity:** Some of Delaware's research infrastructure requires modernization and recapitalization to keep up with technological advances and maintain competitiveness. For example, UD's major materials characterization facilities (microscopy, etc.) need upgrades to continue driving engagement from major industry partners. Additionally, a lack of pilot-scale processing and scale-up facilities in areas like plastics recycling or biomaterials manufacturing can be a bottleneck in translating lab discoveries into industrial prototypes.

Delaware S&T Growth Opportunity Area: Clean Energy Systems

The global energy landscape is undergoing a significant transformation, with a concerted shift toward clean and renewable energy sources. This transition is driven by the imperative to reduce carbon emissions, enhance energy security, and promote sustainable economic growth. Key systems-level technologies at the forefront of this movement include fuel cells, hydrogen energy systems, solar photovoltaic (PV) installations, and wind energy development, and integration of these technologies represents an ongoing trend reshaping energy production and distribution models worldwide.

Fuel cells and hydrogen energy systems have emerged as pivotal components in the clean energy paradigm. Fuel cells efficiently convert chemical energy from hydrogen into electricity, emitting only water as a byproduct. This technology is gaining traction across various sectors, including transportation, industrial applications, and stationary power generation. The global fuel cell market is projected to grow substantially in the coming years, driven by advancements in technology, supportive policies, and increasing investments in hydrogen infrastructure. Solar photovoltaic (PV) and wind energy systems and installations have also experienced remarkable growth, becoming mainstream sources of electricity generation. Advances in materials science, manufacturing processes, and economies of scale have led to significant cost reductions, making these technologies competitive with traditional fossil fuels. The integration of solar and wind energy into the grid is facilitated by innovations in energy storage and smart grid technologies, ensuring reliability and efficiency.

Delaware, with its strategic coastal location, base of research assets focused on various technologies that make up the “stack” of and supportive policy framework, is well-positioned to capitalize on these trends. The state’s commitment to renewable energy is evident in its Renewable Portfolio Standard (RPS), which mandates that 25 percent of electricity sales come from renewable sources by 2025, with 3.5 percent specifically from solar energy. In addition, as the U.S. accelerates investment and piloting in clean hydrogen through initiatives like the Mid-Atlantic Clean Hydrogen Hub (MACH2), Delaware’s expertise in electrochemical systems, membrane technologies, and industrial-scale hydrogen applications places it at the center of a rapidly growing hydrogen value chain, bridging research innovation with real-world deployment across power generation, heavy transportation, and industrial decarbonization.

What Are Clean Energy Systems?

Clean energy systems encompass a suite of technologies and processes designed to produce, store, and distribute energy with minimal environmental impact. These systems prioritize the use of renewable resources and aim to reduce greenhouse gas emissions, mitigating climate change and promoting sustainability. Key types of clean energy systems with the potential to be deployed on a commercial scale include:

- **Fuel Cells and Hydrogen Energy Systems:** Fuel cells are electrochemical devices that convert hydrogen and oxygen into electricity, heat, and water. They operate quietly and efficiently, with applications ranging from portable electronics to large-scale power plants. Hydrogen energy systems involve the production, storage, and utilization of hydrogen as a clean fuel. Hydrogen can be produced through various methods, including electrolysis powered by renewable energy, making it a versatile energy carrier in a decarbonized economy.

- **Solar Photovoltaic (PV) Systems:** Solar PV systems convert sunlight directly into electricity using semiconductor materials. They can be deployed at various scales, from small residential rooftops to large utility-scale solar farms. Solar PV technology has seen rapid advancements, leading to increased efficiency and reduced costs, thereby enhancing its adoption globally.

- **Wind Energy Systems:** Wind energy systems harness the kinetic energy of wind to generate electricity through wind turbines. Offshore and onshore wind farms have become integral components of the renewable energy mix, offering substantial generation capacity with zero emissions. Technological improvements have led to larger, more efficient turbines, contributing to the competitiveness of wind energy.

In Delaware, these clean energy systems are already being integrated into the state's energy infrastructure. The development of offshore wind projects, such as the proposed Skipjack Wind Farm, underscores Delaware's commitment to expanding its renewable energy portfolio. Additionally, the state's support for solar initiatives has led to the establishment of significant solar installations, contributing to local energy generation and job creation. At the same time, Delaware is emerging as a key player in the hydrogen economy, with research institutions and industry partners advancing hydrogen production, storage, and fuel cell applications. UD's Center for Clean Hydrogen and industry collaborations with firms like Versogen and Chemours are positioning the state as a hub for low-cost green hydrogen and next-generation electrolysis technologies, reinforcing Delaware's role in the broader transition to low-carbon energy systems.

Market Outlook and Growth Dynamics

The global markets for various elements of the clean energy systems portfolio include:

- **Hydrogen Fuel Cells** – valued at $5.1 billion in 2024, CAGR of 16.5% through 2029.
- **Green and Blue Hydrogen Generation** – valued at $13.8 billion in 2024, CAGR of 42.0% through 2029.
- **Hydrogen Storage technologies** – valued at $5.3 billion in 2023, CAGR of 7.6% through 2028
- **Ion Exchange materials for energy generation and storage** – valued at $1.1 billion in 2023, CAGR of 12.5% through 2028.
- **Offshore Wind Power** – valued at $20.8 billion in 2022, CAGR of 13.7% through 2027.
- **Solar PV Power** – valued at $171 billion in 2022, CAGR of 14.4% through 2027.

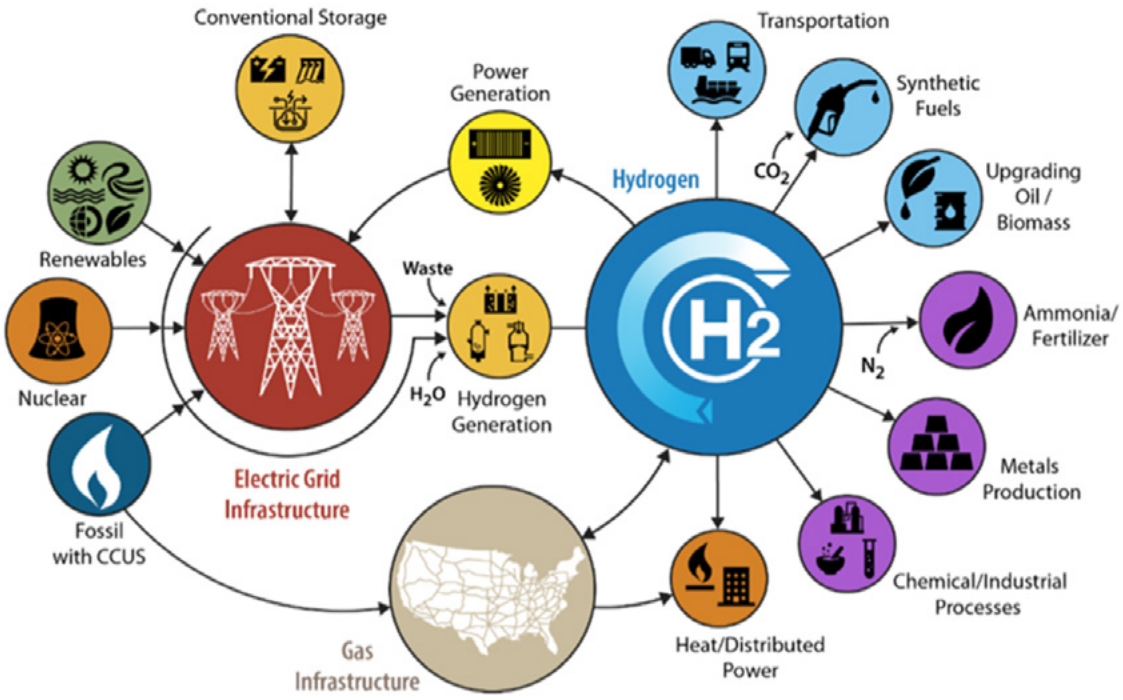
Key market dynamics driving increased need for commercializable, scalable clean energy solutions include:

- **Increasing demand for nontraditional power generation options** to support growing electrification of vehicles and industrial systems as well as expanding power needs for data centers.
- **Cost competitiveness of renewable energy versus traditional power sources,** reflecting the falling levelized cost of energy (LCOE) for solar and wind over the past decade.
- **Maturing fuel cell and hydrogen energy technologies** that have begun to gain traction within key industry sectors.
- **Expansion of energy storage and grid modernization efforts** as governments and utilities are investing heavily in energy storage infrastructure, smart grid technologies, and decentralized energy systems to ensure grid stability and efficiency.

Source: BCC Research

Notably, these technologies are also part of a broader effort to modernize and diversify power supply, with clean energy systems offering versatility across multiple sectors while enabling deeper integration of additional types of renewables into a modernized energy grid. Figure 23 provides just one example of how scaling hydrogen systems can serve as a bridge between renewable and traditional generation, energy storage, and end-use applications, addressing the intermittency challenges associated with wind and solar by storing excess energy in the form of green hydrogen. This stored hydrogen can then be utilized for grid stabilization, power generation, industrial applications, and transportation fuels, effectively decarbonizing hard-to-electrify sectors such as metals production, ammonia synthesis, and heavy-duty transportation. By integrating hydrogen production with a diverse mix of renewables, nuclear, and fossil fuels with carbon capture (CCUS), the energy system becomes more resilient and adaptable to fluctuating demand and supply conditions. Delaware is well-positioned to expand its role in clean energy systems at the nexus these efforts across multiple different types of energy systems as well as the ways in which they interoperate together at the grid level.

Figure 23. Role of Hydrogen Systems as Key Component of Future Energy Systems and Infrastructure



Note: CCS stands for carbon capture, utilization, and storage
Source: U.S. Energy Information Administration, Hydrogen Program Plan, November 2020.

Why is this S&T Opportunity Area a Fit for Delaware?

Delaware's unique combination of geographical advantages, policy initiatives, research capabilities, and leading role within public-private consortiums positions it well to become a leader in clean energy systems as the commercial market continues to mature.

Amongst its research institutions, Delaware has the capacity to support a portfolio of clean and renewable energy applications areas. Thematic technology areas present across research activity, including recent publications, grant awards, and research center efforts include:

- **Green hydrogen and fuel cell technologies:** The Center for Clean Hydrogen at UD is pioneering Anion Exchange Membrane (AEM) fuel cells, low-cost hydrogen electrolysis, and advanced hydrogen storage solutions, positioning Delaware as a leader in fuel cell technology innovation.
- **Wind energy, including hardware design and wind forecasting:** Researchers at UD's Center for Research in Wind (CReW) are optimizing wind turbine materials, offshore wind resource forecasting using LIDAR systems, and aerodynamic design improvements to enhance energy capture and reliability.
- **Photovoltaic technologies and thermal storage systems:** Delaware's Institute of Energy Conversion (IEC) is advancing high-efficiency tandem solar cells, perovskite photovoltaics, and solar-integrated thermal storage to improve grid reliability and renewable energy utilization.
- **Biofuels and biomass conversion:** UD's Catalysis Center for Energy Innovation (CCEI) is developing catalysts for converting biomass into biofuels, renewable chemicals, and sustainable bioplastics, reducing reliance on fossil-based resources.
- **Battery technologies:** The Center for Fuel Cells and Batteries (CFCB) at UD is researching solid-state batteries, lithium-sulfur energy storage, and second-life battery applications, enhancing performance and sustainability in energy storage systems.
- **Improvements to catalytic reactions and process intensification:** Delaware researchers are advancing plasma-assisted catalysis for ammonia synthesis, electrocatalytic CO_2 reduction for fuel production, and microchannel reactor designs, improving the efficiency of hydrogen and biofuel generation.

This research activity is anchored by a network of specialized centers, each contributing to advancements in renewable energy, hydrogen technology, and next-generation energy storage. The University of Delaware Energy Institute (UDEI) serves as a coordinating hub, connecting research efforts across the Institute for Energy Conversion (IEC), the Center for Fuel Cell Research (CFCB), and the Center for Catalytic Science and Technology, which collectively focus on solar photovoltaics, fuel cells, and process intensification. The Catalysis Center for Energy Innovation (CCEI) and the Center for Research in Wind drive innovation in biofuels, offshore wind technology, and turbine performance optimization, while the Center for Clean Hydrogen partners with the National Renewable Energy Laboratory (NREL) and private industry to accelerate hydrogen production and electrochemical system deployment. DSU also contributes to clean energy materials research through its ANERA-RISE program, enhancing regional expertise in advanced nanomaterials for renewable energy applications.

At the heart of Delaware's research excellence in this area is the Center for Clean Hydrogen (CCH) at UD. The center serves as a national hub for hydrogen technology R&D, offering state-of-the-art

facilities for testing and validation of fuel cell and electrolyzer technologies. The center's research focuses on advancing membrane and catalyst technologies for fuel cells and electrolyzers, developing scalable AEM electrolysis systems for cost-effective hydrogen production, and improving hydrogen storage and infrastructure for deployment in industrial and transportation applications. As a part of its mission, CCH provides critical testing infrastructure, allowing companies to validate new membrane materials, catalysts, and full electrolysis systems to support commercialization in ways not possible outside of larger national lab environments. Industry partners using the center's capabilities include Plug Power, Chemours, and Fortescue Future Industries, and the center is also exploring standardization and regulatory leadership to accelerate commercialization of hydrogen technologies.

This research and testing capacity is also supported by a robust hydrogen workforce development pipeline, UD launching the first master's degree program in electrochemical engineering in the U.S., directly addressing the workforce gap in fuel cell and hydrogen technology. The university is developing hydrogen-related certifications and training programs to provide skilled labor for hydrogen production, system integration, and fuel cell maintenance, while Delaware Technical Community College and local trade schools are also exploring specialized training programs for hydrogen and fuel cell technicians.

While the pureplay hydrogen power industry is still emerging alongside a growing U.S. renewable energy industry portfolio of wind and solar installations, Delaware's leadership in hydrogen technology is deeply rooted in its history of industry-driven materials science innovation. The development of Nafion membranes by DuPont in the 1960s was a foundational breakthrough in fuel cell and electrolyzer technology, and this technology remains central to proton exchange membrane (PEM) fuel cells and electrolyzers, which are widely used for clean hydrogen production and fuel cell applications. Today, Delaware-based firms Chemours, W.L. Gore, Bloom Energy, Air Liquide, and Versogen are continuing to advance industry-driven innovation, developing cutting-edge membrane materials and electrolyzer systems that are being commercialized for a variety of applications. Complementing this focus, UD has become a national leader in Anion Exchange Membrane (AEM) fuel cell technology, which offers a lower-cost alternative to PEM fuel cells by using non-precious metal catalysts. Collectively, this technology commercialization and deployment environment can be considered one of the world leaders in ion exchange membranes and their use within fuel cells and hydrogen systems, encompassing activity such as:

- Chemours produces Nafion membranes, a key material for PEM fuel cells and electrolyzers.
- W.L. Gore manufactures Gore-Select membranes, which are used in Toyota's Mirai fuel cell vehicle.
- Bloom Energy develops solid oxide fuel cells (SOFCs) for stationary power applications, including data centers and industrial sites.
- Versogen, a UD spinout, is commercializing AEM electrolyzers, enabling cost-effective green hydrogen production using alkaline electrolytes instead of expensive platinum-group metals.
- Air Liquide, one of the world's largest hydrogen producers, has a major technology center in Delaware focused on hydrogen infrastructure.
- Fortescue Future Industries, an Australian energy company, established a U.S. R&D center in Delaware to advance membrane-based electrolyzer technology.

There is also significant infrastructure supporting Delaware's locations as a geographic hub for clean energy systems activity. The state is a key participant in the Mid-Atlantic Clean Hydrogen Hub (MACH2), which recently secured $750 million in federal funding through the U.S. Department of Energy's Regional Clean Hydrogen Hubs program. The initiative is focused on expanding hydrogen production, storage, and distribution in Delaware, Pennsylvania, and New Jersey. Delaware's coastal location offers significant potential for offshore wind energy development. The proposed Skipjack Wind Farm, to be situated approximately 19 miles off the Delaware coast, highlights the state's capacity to harness offshore wind resources. This project, with a planned capacity of 966 MW, is set to contribute substantially to the region's renewable energy supply and supports additional testing and demonstration activities alongside emerging offshore platforms and marine autonomous systems that are being developed as part of the region's growth of "blue economy" innovation.

The Center for Clean Hydrogen at UD: A Key Hub Supporting the MACH2 Initiative

The Center for Clean Hydrogen is a leading research hub dedicated to advancing low-cost, scalable hydrogen production, storage, and utilization technologies. The center focuses on Anion Exchange Membrane (AEM) electrolyzers, which provide a cost-effective alternative to conventional proton exchange membrane (PEM) systems by eliminating the need for expensive precious-metal catalysts. Researchers at the center are also pioneering next-generation fuel cell designs, hydrogen-compatible infrastructure, and new storage materials to enhance the feasibility of hydrogen as a widespread energy carrier.

As a key partner within the Mid-Atlantic Clean Hydrogen Hub (MACH2) initiative, a $750 million federal initiative, the center collaborates with leading industrial partners like Chemours, Plug Power, and Air Liquide to refine hydrogen production and fuel cell technologies while working alongside state agencies and workforce programs to build a skilled labor base for the hydrogen economy.

The state's Renewable Portfolio Standard (RPS) has also been instrumental in driving renewable energy adoption. By setting ambitious targets for renewable energy integration, Delaware has created a favorable environment for investments in solar, wind, and other clean energy technologies. This policy framework ensures a stable and predictable market for clean energy projects, mandating that Delaware's utilities derive 40 percent of their energy from renewable sources such as wind and solar by 2035.

Collectively, this mix of research strength and strategically positions Delaware to capitalize on emerging opportunities in the clean energy sector as the market continues to mature and evolve across multiple types of technologies. In particular, the state's combination of unique research strengths and industry presence highlight opportunities in:

- **Industrial Fuel Cell Applications:** Leveraging excellence in hydrogen technology: Delaware's ongoing innovation and commercialization activity in hydrogen and fuel cell technologies present significant prospects across various key markets with high growth potential including:

- Heavy-Duty Transportation: Hydrogen fuel cells offer a sustainable solution for powering long-haul trucks, locomotives, and maritime vessels, providing longer ranges and faster refueling compared to traditional battery-electric systems.

- Industrial Decarbonization: Hydrogen plays a crucial role in decarbonizing energy-intensive industries, such as steel production, ammonia synthesis, and petroleum refining, by serving as both a feedstock and a clean energy source.

- Data Centers and Grid-Scale Energy Storage: Utilizing hydrogen-based energy storage systems can effectively balance renewable energy supply and demand, ensuring reliability and resilience in power grids, and providing backup power for data centers.

- **Advanced Hydrogen Storage and Distribution Infrastructure:** Delaware researchers are working on next-generation solid-state hydrogen storage materials, pressurized hydrogen tanks, and liquid organic hydrogen carriers (LOHCs) to improve the safety and efficiency of hydrogen storage. Additionally, Delaware's participation in broader federal initiatives and public-private consortia includes research into retrofitting existing natural gas infrastructure for hydrogen transport, optimizing pipeline materials and compression technologies, and developing safety regulations.

- **Offshore Wind Staging and Deployment:** Delaware's strategic coastal location in combination with key research hubs offers unique advantages for the offshore wind industry in:

  - Assembly and Deployment, where the state's proximity to designated offshore wind energy areas positions it as an ideal staging ground for assembling and deploying wind turbine components, facilitating efficient logistics and reducing transportation costs.

  - Offshore installations operations and maintenance, where establishing operations and maintenance hubs in Delaware can support the long-term sustainability of offshore wind platforms and continue to develop a specialized workforce that attracts international companies and investors.

- **Solar Photovoltaics (PV) Research and Deployment:** Several Delaware-based research centers have longstanding excellence in development of thin-film solar cells, and the state has significant installed solar capacity across multiple solar farms, which provides the ability to do system and grid interconnection-level piloting and demonstration.

Implications for Future Growth

While Delaware is well-positioned to be a research leader and first adopter in clean energy systems, several barriers must be addressed to fully capitalize on these opportunities. Despite its strong research assets, growing industry partnerships, and participation in federal initiatives, challenges related to infrastructure investment, talent, regulatory clarity, and market visibility could limit the state's ability to scale and commercialize these technologies effectively as well as attract industry partners seeking to scale up a U.S. presence in these emerging markets.

To help ensure Delaware's market position for future growth, several key issues were identified in conversations with key stakeholders that need to be addressed:

- **State Investment and Policy Support for Hydrogen Innovation:** Despite Delaware's high concentration of hydrogen research expertise and industry leaders, state-level investment in hydrogen innovation has been comparatively low. Unlike other advanced sectors, hydrogen has yet to receive direct economic development incentives or strategic funding allocations from the state. The absence of targeted grants, early-stage venture support, or state-backed pilot projects has left startups and research institutions reliant on federal grants and private-sector investment, slowing the potential pace of commercialization.

- **Infrastructure and Permitting Challenges:** The buildout of clean energy infrastructure, particularly for hydrogen production, storage, and fueling networks, requires substantial capital investment and regulatory alignment. Stakeholders noted that Delaware faces permitting delays and regulatory uncertainty, particularly in developing new electrolyzer testing facilities and integrating hydrogen into existing gas infrastructure. Without a streamlined regulatory framework for hydrogen deployment, pipeline retrofits, and offshore wind integration, companies face barriers to launching full-scale commercial projects.

- **Clean Energy and Hydrogen Talent:** The transition to hydrogen-based industrial applications, fuel cell manufacturing, and offshore wind operations require a highly skilled workforce that can operate new types of industrial energy generation and storage systems. While the state's universities have launched new programming to address this gap and other workforce training initiatives are emerging, there remains a deficit in specialized technician and engineering training for clean energy system integration, fuel cell maintenance, and hydrogen storage safety. Developing targeted workforce programs, akin to technician training models being advanced in other states for biopharma and advanced manufacturing industries, could help bridge this gap and ensure a steady pipeline of qualified talent.

- **Challenges in Market Visibility and Industry Engagement:** Despite hosting an internationally significant hydrogen and fuel cell industry cluster, Delaware's position as a leader in clean energy remains under-recognized. Many national hydrogen industry groups and funding agencies do not fully acknowledge Delaware's role in fuel cell membrane technology, electrolyzer development, and offshore wind infrastructure. Increasing participation in federal energy summits, hydrogen technology roadmaps, and clean energy investment forums is critical to ensuring that Delaware secures funding and attracts corporate investment as other competitor states also continue to invest in this emerging market and attract both domestic and international companies to anchor new locations in attractive business environments.

Delaware Growth Opportunity: Biopharmaceutical Manufacturing and Discovery

The rapid pace of biopharmaceutical research advances combined with the growth of fields such as cell and molecular biology, genomics, computational chemistry, and chemical biology is reshaping the way we discover, develop, and manufacture therapeutics, as well as diagnose and treat diseases and medical conditions. Biopharmaceutical research and manufacturing advances are not only at the forefront of creativity and innovation, but represent a convergence point for engineering, information technology, and physical sciences such as chemistry and materials.

In recent years, major new opportunities in biopharmaceutical development have emerged across a portfolio of new classes of therapeutics, such as protein inhibitors and degraders, nano-based drug delivery, tissue engineering, stem cell therapies, gene therapy, immunotherapies, and personalized medicine. At the same time, a convergence of life sciences and information technology is taking place leading to new methods for high throughput screening of drugs, advanced design of chemical entities, and improvements in manufacturing through more fully integrated production technologies. States that can attract and retain the talent and investment needed to support robust biopharmaceutical research and production value chains can drive lasting vibrancy in their innovation ecosystems as these new technologies continue to emerge.

In addition to its role in driving innovation, the biopharmaceutical manufacturing and discovery sector has garnered much attention across the nation because it stands out as one of the leading sectors in high quality job creation, advanced manufacturing, and global competitiveness. Another reason for the interest in biopharmaceutical industry development by states is the recognition of its substantial footprint that anchors broader supply chains and industry commercialization efforts in both R&D and in support of the production and distribution of pharmaceutical and biotechnological products. A report for the Pharmaceutical Research and Manufacturers Association (PhRMA) on biopharmaceutical manufacturing found that the nearly 1,200 facilities in the U.S. that are manufacturing FDA-approved products are spread across 44 states, the District of Columbia, and Puerto Rico, with 37 states and Puerto Rico having five or more facilities manufacturing FDA-approved medicines.[33] These hubs of activity are often key drivers for talent and innovation across states and regions and actively interface with the extensive network of research universities and academic medical centers found in the U.S., supporting large value-added employment impacts and high levels of STEM talent attraction.

The combination of the biopharmaceutical sector advancing growth through innovation and its broad footprint has led to nearly every state being actively involved in advancing biopharmaceutical development. Similarly to other states, Delaware has significant opportunities to grow its life science ecosystem through building out its biomanufacturing and discovery ecosystem to support the next generation of therapeutics development and production.

33 PhRMA, Making Cutting-Edge Medicines Today and Leading the Way on Medicines of Tomorrow, Prepared by TEConomy, April 2019

What are Biopharmaceutical Manufacturing and Discovery?

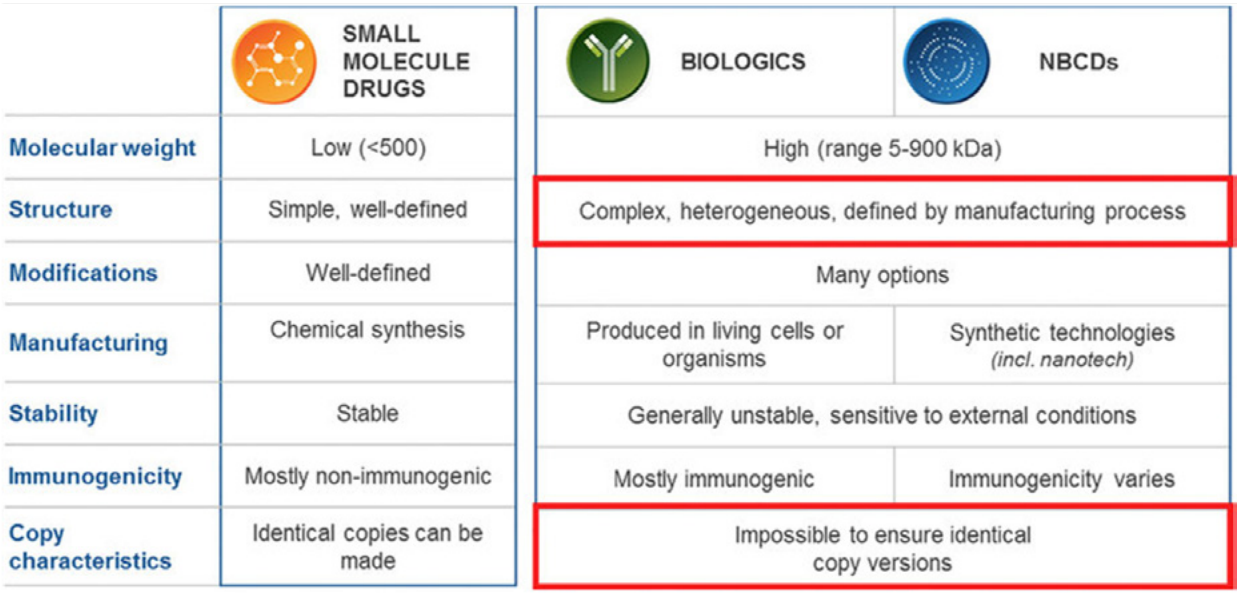
A defining feature of biopharmaceutical manufacturing is that it is integrally linked with discovery as part of a larger innovation complex focused on advancing new product development to generate revenue growth and competitiveness. Over the past 20 years, more than 940 novel medicines have been discovered and produced to address cancer, cardiovascular diseases, neurology, and infectious diseases, among others. By 2035, it is estimated that 700 new medicines could be launched that can prevent, slow, or stop disease progression. Currently, there is a pipeline of nearly 13,000 new medicines in various stages of clinical development.[34]

To meet the demands for innovation in biopharmaceutical product development, a diversified and dynamic ecosystem has emerged that complements established biopharmaceutical companies involving a set of institutions that supports academic basic, translational and clinical research, emerging venture capital-backed biotech companies advancing novel therapeutics and platform production technologies, contract research organizations supporting pre-clinical and clinical trials, and contract manufacturing organizations for different stages of production of small molecule and biologics. Well-established biopharmaceutical companies today are no longer solely reliant on vertically integrated research and manufacturing operations and are instead highly integrated within and across these diverse ecosystems for biopharmaceutical manufacturing and discovery.

A closer look at biopharmaceutical manufacturing reveals that its direct connection to scientific discovery translates into production processes that are complex and continually evolving. The traditional approach to biopharmaceutical manufacturing involved small-molecule medicines produced using chemical synthesis. With the recent advances for targeted therapies, more complex small molecules compounds are now required, involving specialized, highly potent active pharmaceutical ingredient manufacturing processes and drug delivery solutions driven by new advances in medicinal chemistry and synthesis. At the same time, with the advancement of biotechnology and genomic-based discovery, a second platform for biopharmaceutical manufacturing has scaled to market over the past two decades involving large-molecule biologics produced using scale-up or fermentation of living cells. These large-molecule biologics production processes are now helping to bring to market advanced treatments in cell therapeutics, gene therapies, and immunotherapies. Today, discoveries of novel new medicines involve nearly an equal mix between small-molecule chemical synthesis and large-molecule biologic scale-up using living cells.[35] These two realms are also beginning to merge to produce new classes of drugs such as antibody-drug conjugates, oncology therapeutics, which typically combine a monoclonal antibody and chemotherapy to improve targeting, or Non-Biological Complex Drugs (NBCD), a class of medicinal products that are not biological medicines but instead are based on synthetic medicinal products where the active substance is not a simple, easily identifiable molecule, but rather a complex, often nanoparticulate structure (Figure 24).

34 See https://www.ifpma.org/insights/delivering-the-next-generation-of-medicines-and-vaccines-for-a-healthier-future/
35 Ibid.

Figure 24. Comparison of Key Characteristics of Existing Small Molecule and Biologics Drugs Versus Emerging Drug Classes Such as NBCDs



Source: Flühmann, Beat & Ntai, Ioanna & Borchard, Gerrit & Simoens, Steven & Mühlebach, Stefan. (2018). Nanomedicines: The magic bullets reaching their target? European Journal of Pharmaceutical Sciences. 128. 10.1016/j.ejps.2018.11.019.

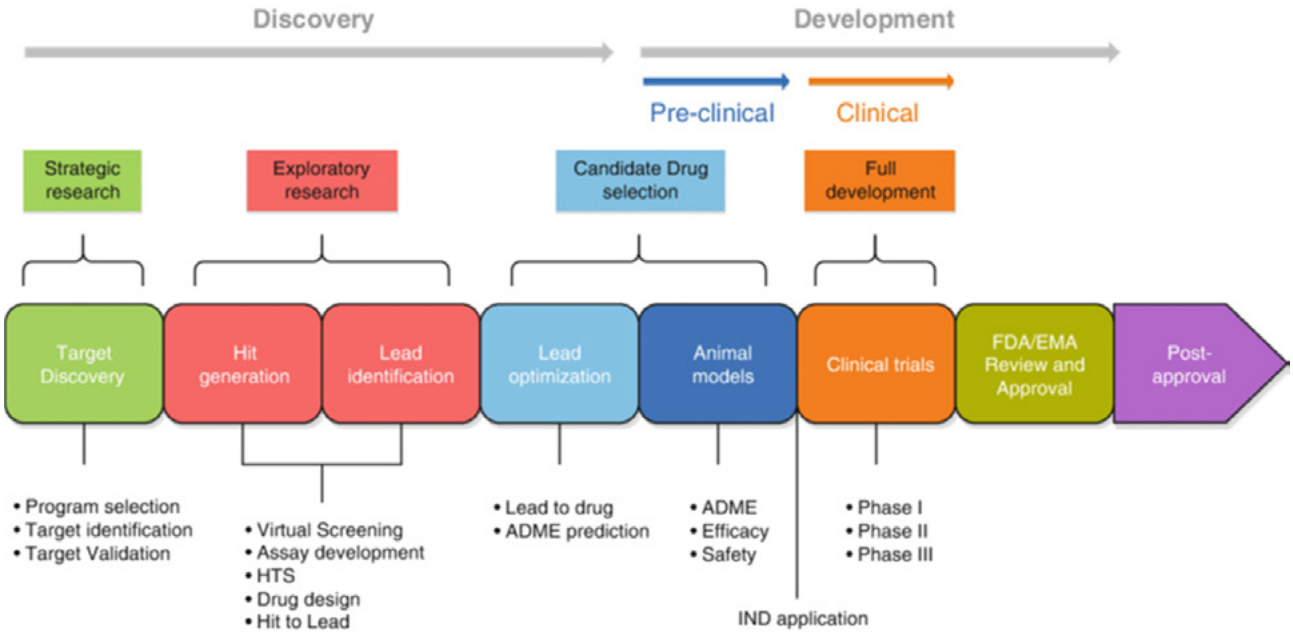
Despite the increasingly complex set of drugs being developed and brought to market, a key driver of biopharmaceutical manufacturing across small-molecule chemical agents or large-molecule biologics is the shared common production stages and high standards of safety, quality, and reliability required. While the specific production methods might be different, according to interviews with biopharmaceutical manufacturing executives, many of the skill sets are the same across purification, packaging, quality, and process control required to manufacture medicines. To a degree unmatched in other manufacturing industries, all biopharmaceutical manufacturing is conducted under especially high standards, with strict requirements and rigorous approvals by the U.S. Food and Drug Administration (FDA) to ensure the safety, quality, and reliability.

In part due to these common drivers of production, in recent decades there has been a significant rise in the outsourcing of biopharmaceutical manufacturing to dedicated contract development and manufacturing organizations (CDMOs). The key drivers for outsourcing biopharmaceutical manufacturing include offsetting the high costs of investments in manufacturing facilities, meeting the increased pressures for speed to market, and advancing the specialized expertise needed to produce more complex therapies entering the market. Today, CDMOs play a central role in biopharmaceutical manufacturing for both emerging and well-established biopharmaceutical discovery companies as the roles of outsourcing partners have evolved from mere auxiliary support to leaders of innovation. The CDMO industry has been highly fragmented, but trends are towards consolidation, expansion of production facilities to offer more “one-stop-shopping” for all

phases of biopharmaceutical manufacturing and packaging, and upgrading of technologies to meet the growing demand for more complex biopharmaceutical therapies.[36]

Meanwhile, the complementary process of drug discovery that occurs before manufacturing involves a lengthy and diverse range of activities from research and discovery to preclinical development and then clinical research testing to identify and develop new medications that can then be scaled for production. It involves collaboration across multiple scientific disciplines, such as biology, chemistry, and medicine, and plays a key role in ensuring the pipeline of new therapeutics. From the time a potentially promising candidate medicine is identified, on average it takes ten to fifteen years for a medicine to make its way through the entire R&D process to FDA approval. Throughout the process, there are significant challenges, including the high cost of development, the risk of failure at any stage, and the need for rigorous safety and efficacy testing. Key elements of this process are illustrated in Figure 25; notably later clinical stages of drug discovery involve extensive regulatory review and approval steps, which narrow down the number of potentially successful drugs reaching market. At this stage, only about 12 percent of the candidate medicines that make it into Phase I clinical trials will be approved by the FDA, illustrating the high cost of developing new therapeutics.

Figure 25. Representation of the Drug Discovery and Development Process



Source: Duelen, Robin & Corvelyn, Marlies & Tortorella, Ilaria & Leonardi, Leonardo & Chai, Yoke & Sampaolesi, Maurilio. (2019). Medicinal Biotechnology for Disease Modeling, Clinical Therapy, and Drug Discovery and Development. 10.1007/978-3-030-22141-6_5.

Critical to advancing drug discovery in the early preclinical stages illustrated in Figure 25 are life science tools, encompassing a wide range of instruments, technologies, software, and

36 BCC Research, Global Markets for Contract Pharmaceutical Manufacturing, Research and Packaging, 2024

methodologies used in the research and development process for developing new medicines. These tools are crucial for advancing scientific knowledge, from basic research to clinical applications, and enable scientists to understand biological processes, develop new therapies, and improve diagnostics and healthcare outcomes. Further support for medical discoveries is provided through contract research organizations. These organizations provide specialized services that help companies conduct R&D spanning from early discovery and preclinical studies to clinical trials and post-market surveillance. Contract Research Organizations (CROs) offer specialized expertise and resources, which reduces the need for biopharmaceutical companies, especially early-stage companies, to build their own research teams or invest heavily in infrastructure. This can accelerate the discovery and development process. CROs also typically have access to a global network of research sites, hospitals, clinics, and other healthcare facilities, which is vital for conducting multicenter clinical trials. This expands the reach of research and accelerates patient recruitment.

Market Outlook and Growth Dynamics

There are many segments and components of the market for biopharmaceutical manufacturing and discovery reflecting the diversified ecosystem that supports its activities. What stands out across these market segments is their substantial size and growth potential.

Total Biopharmaceutical Market Based on Medicines Sold: The global biopharmaceutical market across all medicines stood at $1,600 trillion dollars in 2023, and is expected to reach $2,300 billion in 2028, a healthy compounded annual growth rate of 7.55%.

- *Small Molecule Therapies:* The global market reached $1,028 billion in 2023, or 64% of all medicines sold. It is expected to rise to $1,408 trillion by 2028, a compounded annual growth rate of 6.49%.
- *Biologics:* The global market reached $572 billion in 2023, and is expected to reach $1,408 billion by 2028, a compounded growth rate of 9.27%.

Total Contract Development and Manufacturing Market: valued at $123.6 billion in 2023, CAGR of 7.0% from 2024-2029.

- *Small Molecule Therapies:* valued at $88.9 billion in 2023, CAGR of 5.1% from 2024-2029.
- *Biologics and Advanced Cell and Gene Therapies:* valued at $34.7 billion in 2023, CAGR of 11.1% from 2024-2029.

Life Science Tools: estimated at $153.8 billion in 2025, and is expected to reach $215.9 billion by 2030, a compounded annual growth rate of 7.02%.

Total Contract Research Market: valued at $103.4 billion CAGR of 8.2% from 2024-2029.

- *Drug Discovery* – valued at $6.7 billion in 2023, CAGR of 6% from 2024-2029.
- *Pre-Clinical Services* – valued at $12.9 billion in 2023, CAGR of 8% from 2024-2029.
- *Clinical Trials* – valued at $77.7 billion in 2023, CAGR of 8.5% from 2024-2029.

Key trends driving growth dynamics across these markets include:

- **Continued pressure by the U.S. government to push for reshoring of biopharmaceutical manufacturing activities to the U.S.** to reduce reliance on global supply chains and generate more high-paying manufacturing jobs.
- **Continued advances in novel biopharmaceutical therapies involving both small-molecule and biologics.**
- **Significant advances in process technologies to improve biopharmaceutical manufacturing** involving increased use of digital automation (Pharma 4.0).
- **Continued role of emerging venture capital-backed biotech companies as leading drivers for innovative drug discovery and development, often closely aligned with CDMOs to bring new therapies to market.**

Source: BCC Research

Why is this S&T Opportunity Area a Fit for Delaware?

Delaware today has a strong footing and diverse ecosystem in biopharmaceutical manufacturing and discovery industries, with potential forward-looking opportunities across both small molecule and biologic platforms. Nearly 10,000 workers are employed in Delaware across biopharmaceutical manufacturing and discovery companies, according to the Delaware BioScience Association and the Delaware Prosperity Partnership. This includes large pharma, emerging startups, life science discovery tools companies, CDMOs and CROs.

Additionally, Delaware has a growing base of basic, translational, and clinical research activities across its universities and healthcare systems. NIH research awards across universities, non-profit research institutes, and healthcare systems—considered the gold standard in biopharmaceutical-related research—reached $75.6 million in 2023 and increased by 15 percent from 2019 to 2023. University biopharmaceutical-related research—encompassing biological and biomedical sciences, health sciences, and bioengineering—rose an even faster 85 percent from 2019 to 2023, reaching nearly $80 million in 2023. Still, the overall level of academic biopharmaceutical-related research in Delaware lags behind the nation, with Delaware generating per capita NIH funding of $73 compared to $114 nationally and per capita university biopharmaceutical-related research funding of $77 compared to $170 nationally.

Delaware has benefitted from having access to specialized funding from NIH's Institutional Development Award (IDeA) program that seeks to broaden the geographic distribution of NIH funding by supporting faculty development and institutional research infrastructure enhancements in states that have historically received low levels of support from NIH. One critical element of IDeA funding is that it has enabled Delaware to bring together and advance multi-institutional collaborations through Delaware's IDeA Networks of Biomedical Research Excellence (INBRE). INBRE has focused its efforts on ensuring Delaware has the world-class laboratory infrastructure needed to advance biopharmaceutical-related research. INBRE-supported core facilities are found across UD, DSU, ChristianaCare, and Nemours Children's Hospital.

Another key element of NIH's IDeA program is support for Centers of Biomedical Research Excellence (COBRE) involving thematic, multidisciplinary research centers that develop faculty and institutional research capabilities. COBRE awards help to develop a critical mass of investigators. Several areas of biopharmaceutical-related research strengths stand out:

- **Chemical Biology:** This interdisciplinary field combines chemistry and biology to study biological systems at the molecular level. Research topics include the design and synthesis of chemical probes, biosensors, enzyme inhibitors, and therapeutic agents, as well as the study of biomolecular interactions and mechanisms.

- **Pediatric Research:** Delaware was the site for the first freestanding children's hospital that is part of Nemours Children's Health, which has grown to become one of the nation's largest integrated pediatric health systems, providing hospital- and clinic-based specialty care, primary care, prevention, and research and medical education programs aimed at improving the lives of children and families throughout the Delaware Valley. Nemours has two COBREs that are active in Delaware, and is a national leader in pediatric research, including areas such

as asthma and cystic fibrosis, cancer biomarkers and therapeutics, diabetes and obesity, and neurodevelopmental and musculoskeletal disorders.

- **Neurosciences:** The COBRE for the Delaware Center for Neuroscience Research has been in place since 2012 and has focused on supporting research aimed at understanding how thoughts, memories, feelings, and actions emerge from dynamic activities in the brain, and how brain functions change over time. Co-led by DSU and UD, it seeks to bring together a multidisciplinary group of neuroscientists and connects with the interdisciplinary Ph.D. neuroscience programs at both institutions.

- **Biotechnology:** INBRE has funded several core facilities involved in biotechnology, including the DNA Sequencing and Genotyping Center and the Pediatric Genomics Laboratory. Notably, both Christiana Care and Nemours are actively involved in applying biotechnology to human health:

    - At Christiana Care, its Gene Editing Institute is a worldwide leader in CRISPR gene editing technology and the only institute of its kind based within a community health care system in the U.S.
    - At Nemours, its Center for Applied Clinical Genomics (CACG) works to turn genetic information into tangible improvements in patient care.

- **Clinical and Translational Research:** For Delaware, a leading area of clinical and translational research is cancer. ChristianaCare's Helen F. Graham Cancer Center & Research Institute is a member of the National Cancer Institute's NCI Community Oncology Research Program (NCORP) that offers access to NCI-sponsored clinical trials and works on industry-sponsored clinical trials. Additionally, through the Cawley Center for Translational Cancer Research (CTCR) it focuses on breast cancer, colon cancer, radiation oncology, and tissue engineering. Nemours is also active in cancer-related clinical trials through its Nemours Children's Center for Cancer and Blood Disorders (NCCBD), a pediatric cancer center. Support through NIH's Institutional Development Award (IDeA) program has advanced two other clinical and translational research efforts in Delaware. One is the Delaware Clinical and Translational Research ACCEL Program and the other is the ECHO IDeA States Pediatric Clinical Trials Network, composed of research sites in 18 states that aims to enhance pediatric clinical trial access at state and national levels and to help carry out well-designed clinical trials in children.

It is important to note that while collectively Delaware's research activity is sizeable, innovation activity in the state is more industry-driven and often does not include coordination across university collaborators, creating a siloed ecosystem that stands in contrast to the more integrated adjacent life sciences hub in Philadelphia.

Given Delaware's critical mass of industry as well as a growing number of startups and research-driven initiatives, it is critical that the state be able to identify and focus on key markets where it is best positioned to drive growth in a competitive and fast-moving landscape that spans international markets. Based on the innovation being driven by Delaware's industry sector, the state has two unique opportunities to expand its competitive position: biopharmaceutical manufacturing and biopharmaceutical discovery.

Biopharmaceutical Manufacturing

Delaware has a mix of companies involved in biopharmaceutical manufacturing, with concentrations in small-molecule biopharmaceutical manufacturing and life science tools manufacturing.

In small molecule-based biomanufacturing, a longstanding anchor for Delaware is AstraZeneca with approximately 500 workers at its 570,000 square foot Newark facility involved in manufacturing, formulation, packaging, warehousing, testing and distribution of small molecule-based medicines. Delaware is also home to AstraZeneca's North American headquarters, with considerable focus on commercial operations for biopharmaceutical sales, marketing, and administrative functions. A more recent and significant small-molecule manufacturing operation located in Delaware is by WuXi, a world leading CDMO, with approximately 500 workers at its 600,000 square foot facility involved in the contract manufacturing and packaging of active pharmaceutical ingredients and solid dosage products along with testing laboratories. Delaware is also home to a number of mid-to-small sized companies involved more specialized intermediate product and materials used in small-molecule biomanufacturing, including for active pharmaceutical ingredients involved in opioid and antacids medicines and for specialized materials for packaging and sealants. Altogether these mid-to-small sized companies employ well over 500 workers in Delaware.

Looking to the future, Delaware is also well-positioned for supporting industry growth in large-molecule biologic manufacturing by leveraging the presence in Delaware of the National Institute for Innovation in Manufacturing Biopharmaceuticals (NIIMBL). NIIMBL is a Manufacturing USA Institute, established by the federal government, with the defined mission to accelerate biopharmaceutical manufacturing innovation and workforce development to enhance U.S. economic competitiveness. Since its founding in 2017, NIIMBL has grown to over 200 member organizations, including biopharma companies, research universities, small businesses, and government agencies. It plays a central role in shaping next-generation biopharmaceutical manufacturing technologies and workforce strategies, and aligns closely with UD's strong foundation in biologics production expertise and its emerging capabilities in advanced biomaterials for cell therapy and drug formulation.

UD is already generating a strong pipeline of graduate and undergraduate engineering talent to support the growing industry in biologics production. The university's ability to advance biologics process innovation and advancement of a technical talent will be greatly enhanced with the completion of the Strategic Advanced Biopharmaceutical Research & Education (SABRE) Center, an FDA-compliant Good Manufacturing Practice facility to bridge the gap between lab research and full-scale biologics production.

Another distinct area of biomanufacturing found in Delaware is a complex of life science tool companies advancing highly sophisticated instruments for new drug discovery as well as advancing diagnostic tools for disease detection. Many of these life science tool companies directly reflect the legacy of DuPont in its past biopharmaceutical focused on instrumentation and analytical chemistry. Among the largest life science tools companies in Delaware is Agilent's Chemistries Division, including its efforts in advancing and manufacturing liquid chromatography

columns used for separations analysis critical to drug discovery for both small-molecule and biologic therapies. Today, Agilent employs nearly 1,000 workers in Delaware across R&D, manufacturing, and commercial operations for its Chemistries Division. Delaware is also home to other key life sciences tools and instrumentation developers that support the biomanufacturing value chain, including:

- Developers of chromatography and advanced separations analysis tools, including SEPAX and Advanced Materials Technology.

- TA Instruments, another company closely related to DuPont's history and a leading tools developer for laboratories to test the physical properties of new medicines among other materials.

- Siemens Healthineers' diagnostics manufacturing facility employs over 1,300 workers, including 500 in manufacturing and technical positions, and is involved in reagent manufacturing for diagnostic assays along with instruments for blood analyzers and immunoassay systems as well as consumable production such as test cartridges, pipette tips, and sample tubes.

Biopharmaceutical Discovery

In biopharmaceutical discovery activities, Delaware has two unique opportunities: targeted small-molecule therapies and pre-clinical contract research services.

Delaware is now home to a growing number of drug discovery startup companies that share a focus on advancing targeted small-molecule inhibitors based on deep understanding of molecular pathways for leading diseases. These small-molecule inhibitors are widely used to treat diseases such as cancer, autoimmune disorders, infectious diseases, and neurological conditions. The oldest and most successful to date of these start-up companies is Incyte, which relocated to Delaware from California in 2002 and attracted a core group of researchers previously at DuPont Pharma to enable the company to shift from being a genomics company to a biopharmaceutical company focused on immunology and inflammation. Although it originally focused on small molecule compounds, today Incyte has evolved into a broader-based biopharmaceutical company with half its portfolio now focused on biologics development involving monoclonal antibodies and bio-specific antibody drug candidates.

Further evidence of the growing base of discovery activities includes three other fast-growing small molecule start-up companies, all of whom started with former Incyte scientists in leadership positions:

- Prelude Therapeutics was started in 2016 by former Incyte scientists to focus on novel small molecule therapies targeting key mechanisms in cancers. It raised a total of $453 million in venture capital financing before going public in 2021 based on the strength of having four targeted small-molecule therapies in clinical development.

- NiKang Therapeutics was started in 2017 and its success in discovering and developing a pipeline of small molecule medicines for difficult-to-drug oncology targets using insights

from molecular pathways and use of structure-based drug design has enabled it to raise $260 million in venture capital financing.

- A third start-up led by former Incyte scientists, Synnovation Therapeutics, was formed in 2021 and has raised $139 million in venture capital financing based on its lead program to advance a potentially best-in-class, potent, highly selective inhibitor to combat solid tumors and its second program that targets a selective inhibitor of a specific pathway that promotes tumor initiation and development.

In addition, the DTP@STAR Incubator, a state-of-the art incubation space created in 2016 on the UD STAR Campus that provides access to resources for early-stage companies to drive and accelerate their economic success, has helped scale a number of startup companies with four of them having gone public.

Delaware is also home to a number of contract research companies that support the discovery ecosystem, primarily focusing on pre-clinical drug discovery services. One CRO started in Delaware, Quest Pharmaceutical Services now known as QPS, has grown into a leading full-service global CRO supporting discovery, preclinical, and clinical drug development with more than 1,250 employees in the United States, Europe, India, and Asia. Another leading CRO started in Delaware is Wilmington Pharmatech, which specializes in chemical process research, analytical method development and validation, trace chemical analysis, and discovery studies for pharmaceutical and biotechnology industries. Other CROs based in Delaware include: ABS providing cell culture services, gene editing, human biospecimens, cell and tissue preparations and analyses, and samples storage; Adesis, focused on custom synthesis, hit-to-lead and lead optimization, and scaling up lead molecules for testing; Charles River's Accugenix® laboratory, offering contract testing services for rapid and accurate identification of environmental isolates; and Frontier Scientific, specializing in sample management, reformatting and distribution of screening compounds and building blocks for small molecule drug discovery, SAR studies, and lead optimization.

Implications for Future Growth

Delaware's diverse mix of activities across the biopharmaceutical manufacturing and discovery ecosystem positions the state to have sustained growth in future years. To help ensure Delaware's market position for future growth, several key issues were identified in conversations with key stakeholders that need to be addressed:

- **Biopharmaceutical Manufacturing and Discovery Talent:** Discussions with industry stakeholders reinforced the findings of the Delaware BioScience Association's (Delaware BIO) 2022 member survey underlining significant current and future industry needs to fill roles spanning advanced manufacturing, operations, management, biomedical technology, and product research and development. While bachelor's and advanced degrees are still very much in demand, there is a concern that most UD and DSU graduates are leaving the state. This raises the time and cost of recruitment of top talent for Delaware biopharmaceutical manufacturing and discovery companies by having to go out-of-state. At the same time, most companies have open technical and production roles that require a high school education, training certificate, or a 2-year associates degree. The concern is that Delaware is not generating the pipeline of talent with the technical skills required. DE Bio, UD, and the State of Delaware are working to address these concerns through a biopharmaceutical manufacturing training pilot, a new statewide program to retain STEM university graduates by supporting a portion of their college loan payments and launching a dedicated organization to serve as a hub for addressing current and future talent needs by furthering partnerships across industry, education, and government. Much is riding on the success and ability to scale-up these and other future talent development efforts.

- **Diversifying Delaware's Biopharmaceutical Manufacturing Base into Biologics:** A missing component of Delaware's activities in biopharmaceutical manufacturing is the lack of industry activities involved in large-molecule biologics production. This is surprising given the base of contract development and manufacturing organizations (CDMOs) in Delaware as well as the excellence of UD in biologics production expertise that enabled Delaware to become the home of NIIMBL, which plays a central role in shaping next-generation biopharmaceutical manufacturing technologies and workforce strategies for industry. Despite having significant industry collaborations as well as pilot facilities and other shared-use laboratories based at NIIMBL's facility in Delaware, no significant industry efforts in biologics production are taking place in the state today. Given that biologics manufacturing markets are growing fast, especially with advanced cell and gene therapies, this translates into Delaware missing realizing future growth drivers in biopharmaceutical manufacturing. Discussions with stakeholders suggest the opportunity for Delaware to assist existing biomanufacturing operations to diversify into biologics production, as well as collaborate with broader regional biopharmaceutical companies who are active in biologics therapies.

- **University Collaborations with Biopharmaceutical Manufacturing and Discovery Industry:** Delaware's biopharmaceutical manufacturing and discovery industry does not tap the variety of opportunities offered by Delaware universities through its participation in NIH's Institutional Development Award (IDeA) program. This includes access to student internships, use of core facilities, and broader research collaborations with university faculty. Additionally,

only a few industry partners are taking advantage of matching grant funding for applied research collaborations with Delaware university researchers through the state supported Advanced Technology Grant Program administered by UD's Biotechnology Institute. This need for stronger industry-university collaborations is recognized by key stakeholders, including Delaware BIO and UD. Together they have jointly funded a new position for connecting bioscience-related university faculty with entrepreneurs, businesses, and investors, and were successful in competing for funding support from the National Science Foundation's (NSF) inaugural Accelerating Research Translation (ART) program to invest in capacity-building resources that enhance research impact, with a focus on pursuing use-inspired research guided by industry input.

- **Clinical Trial Capacity:** While Delaware has clinical and translational research efforts underway at its universities and healthcare systems, it stands well behind other states in its level of clinical trials activities normalized for its population. An analysis by the Delaware Health Information Network concluded that Delaware is a clinical trials "desert" with just one clinical trial for every 3,333 residents compared to one clinical trial for every 278-649 residents in the surrounding states of Pennsylvania, Maryland, New Jersey, and Virginia. A recently released study prepared for PhRMA of the state-by-state impact of biopharmaceutical industry-sponsored clinical trials found that Delaware had a mere 56 active industry-sponsored clinical trials in 2023, with 371 enrollees and estimated industry funding of $13.4 million. Nationally, there were 5,288 active industry-sponsored clinical trials that generated $30 billion in industry funding.[37] Further investigation is needed to learn why Delaware is lagging so far behind in a substantial and growing component of biopharmaceutical discovery activities.

37 See https://phrma.org/blog/new-research-industry-sponsored-clinical-trials-contribute-billions-to-state-economies

Delaware Emerging Opportunity: BlueTech Innovation

Delaware is at a pivotal moment in developing applications within its Blue Economy, an economic sector encompassing marine science, ocean technology, offshore wind, aquaculture, and coastal resilience. While Delaware's research institutions have a long history of engaging in coastal and marine research, recent investments in autonomous marine technologies, offshore energy infrastructure, and sustainable fisheries position the state to expand its leadership in BlueTech innovation.

Unlike larger maritime hubs such as Rhode Island, Virginia, and the Gulf Coast, Delaware lacks a major naval installation or a large commercial port presence. However, the state's strengths in marine robotics, offshore wind science, and policy-driven coastal management create unique opportunities to attract industry partnerships and federal funding.

What is Driving This Emerging Opportunity Area for Delaware?

Delaware's geographic location, research capabilities, and recent Blue Economy investments are fueling the growth of BlueTech and ocean-driven industries. Several dynamics are accelerating this opportunity:

- **Research and Innovation Strengths in Marine Autonomy and Robotics and Coastal Monitoring:** Delaware is a national leader in marine robotics, ocean sensing, and environmental monitoring, driven by flagship initiatives such as Project ABLE (Autonomous and Blue Economy Laboratory for Exploration) that integrate autonomous systems, offshore research, and BlueTech workforce development. The Robotics Discovery Lab and Marine Operations Center at UD's Lewes Campus serve as testbeds for autonomous underwater vehicles (AUVs) and remote sensing platforms, and federal agencies such as NOAA, DARPA, and the Office of Naval Research have funded autonomous systems research in the state, positioning Delaware as a hub for ocean robotics. UD also plans to launch a federal-supported technology acceleration program aimed at bolstering the pipeline of state startups focused on applications in coastal resilience and other Blue Economy capabilities.

- **Offshore Wind Development and Marine Energy Deployment and Workforce Development:** Delaware researchers are exploring turbine optimization, offshore wind permitting, and environmental impact assessments—areas that could attract state and federal funding. UD and the Danish Energy and Climate Academy (ECA) have also jointly created an Offshore Wind Skills Academy (OWSA), which is preparing a workforce pipeline for wind turbine maintenance, environmental monitoring, and offshore operations. Delaware's extensive research activity in coastal resilience engineering and environmental monitoring makes it a strong candidate for other types of marine energy research, testing, and development, including wave and tidal power.

- **Emerging Aquaculture and Sustainable Fisheries Sector:** Delaware's research activity has continued to advance aquaculture applications for areas such as oyster hatcheries and sustainable fisheries management, helping reduce costs for local seafood producers. Ongoing development of aquaculture innovations, such as controlled-environment agriculture (CEA) models, could attract investment similar to ecosystems that other mid-Atlantic coastal states have developed.

- **Disaster Response, Coastal and Port Infrastructure, and Workforce Development and Training Opportunities:** Delaware's Blue Economy workforce opportunities span offshore wind, marine robotics, aquaculture, and environmental conservation, requiring specialized training programs and key job roles where Delaware could become a leading generator of "human capital" for the Blue Economy. Some areas of high demand where Delaware is positioned to support talent pipelines include wind turbine technicians, marine robotics engineers, aquaculture biologists, and hydrographers. Additionally, there is current research activity around modeling for the Port of Wilmington flooding and coastal infrastructure resilience that could serve as a model for broader commercial and public sector engagement, while even wider opportunities in disaster response and recovery policies could be supported by UD's role as an anchor for the NSF CoPe Coastal Hazards, Equity, Economic prosperity, and Resilience (CHEER) Hub, a major multi-institutional research initiative focused on disaster resiliency.

What is Needed to Grow This Opportunity Area in Delaware?

While Delaware has strong Blue Economy assets, this area is still emerging as a recognized industry cluster alongside other competitor regions and needs further scaling to fully develop a sustainable and competitive BlueTech ecosystem. Several key areas where the state can invest to grow this opportunity include:

- **Expanding Industry Partnerships and Investment in Applied Research:** Unlike other coastal states with Blue Economy opportunities, Delaware currently lacks more mature industry partnerships with large-scale maritime companies and offshore wind developers. Most research funding comes from basic science grants from federal sources rather than direct industry collaborations, limiting opportunities for commercialization. Establishing a state-supported Blue Economy testbed for Research, Development, Testing, and Evaluation (RDT&E), modeled after programs and investments in Virginia and Maryland, could attract industry investment in marine autonomy and offshore technology.

- **Building a Blue Economy Policy and Incentives Framework:** Unlike New Jersey, Rhode Island, and Maryland, Delaware has not yet created a comprehensive Blue Economy strategy to align research, economic development, and policy initiatives. Developing state tax incentives or grants to attract BlueTech startups, aquaculture firms, and marine energy companies would increase private-sector engagement, while streamlining offshore wind permitting and coastal resilience funding could accelerate investment in infrastructure and technology development.

- **Strengthening Workforce Training and Talent Retention:** Delaware has a major opportunity to expand BlueTech workforce training, including marine robotics certification programs, offshore wind technician apprenticeships, and aquaculture workforce pipelines. Without dedicated training programs in these areas, Delaware risks losing its leading position and talent to neighboring states with stronger workforce development programs. More applied, cross-disciplinary programs that play to the strengths of the state, such as UD's proposed Associate of Arts (AA) degree in Marine Studies, would help bridge workforce gaps in areas such as GIS, wind energy, and informatics as well as helping continue to attract talent.

- **Enhancing Blue Economy Infrastructure and Testing Facilities:** To fully realize the potential of this area, Delaware needs a dedicated Blue Economy Innovation Hub, combining marine technology R&D, incubator space for startups, and state-supported industry collaborations alongside access to the testbed capabilities noted above. Further leveraging the existing port infrastructure, offshore wind staging capabilities, and maritime logistics via a dedicated initiative would increase Delaware's attractiveness to marine technology firms, where Delaware has an opportunity to be competitive in offering U.S.-based demonstration and deployment "outpost" locations to international firms that have more mature technologies in this space as a first step to then establishing U.S. production and deployment operations.

Delaware Emerging Opportunity: Integrated Agriculture and Sustainable Food Production

Despite its more limited land area, Delaware has a rich history in agriculture spanning poultry farming, crop production, and agricultural research. The state's high productivity soils, moderate climate, and proximity to major East Coast markets have made it a key mid-Atlantic hub for agribusiness, with over $2.1 billion in agricultural cash receipts generated in 2022 and nearly 42 percent of the state's total land area used for farms.[38] Since the mid-20th century, Delaware has been home to one of the most concentrated poultry industries in the U.S., supplying major food distributors and retailers across the country. At the same time, the state's land-grant institutions, industry partnerships, and cooperative extension programs have continued to advance innovative research in crop science, livestock management, and food safety technologies. Given the state's agricultural industry base and its role in driving economic activity, there is an opportunity to strengthen the existing agricultural value chain leveraging the state's research strengths. However, the university's research enterprise has traditionally been more disconnected from technology translation and commercialization activities with the state serving more as a testing and demonstration site for larger agricultural companies as opposed to an innovation driver. To fully leverage Delaware's agbioscience research capabilities and attract large-scale agricultural industry R&D operations, greater coordination within the agricultural innovation ecosystem is necessary.

What is Driving This Emerging Opportunity Area for Delaware?

Several dynamics are driving activity across Delaware's research and industry base in agriculture across a set of key applications verticals that are not currently well-coordinated together:

- **Delaware's major research institutions are driving agricultural innovation across several precision agriculture technology verticals:**
    - **Crop Monitoring Tools and Systems:** DSU is utilizing AI, remote sensing, and robotics to enhance precision irrigation, automate nutrient management, and implement real-time monitoring systems for soil and crop health. This aligns with broader trends in precision agriculture, where technologies like drones and GPS tools are being used to optimize resource use and reduce waste.
    - **Sustainable Soil and Plant Health:** UD's College of Agriculture and Natural Resources (CANR) is conducting research on soil microbiome interactions, regenerative farming techniques, and climate-resilient crops to improve nutrient uptake, reduce chemical inputs, and increase soil carbon sequestration. This includes work at the Carvel Research and Education Center, which focuses on agronomic, vegetable, and fruit research.
    - **Smart Pest Control and Integrated Pest Management:** Researchers are developing biological control agents and bio-based pesticides to reduce reliance on synthetic chemicals while enhancing pest resilience. This approach is part of integrated pest management (IPM) strategies that combine multiple tactics for sustainable pest control.

38 Delaware Department of Agriculture, Delaware Agricultural Statistics Bulletin 2022-2023

- **Agricultural Automation:** Investments in autonomous farm equipment, drone-based crop monitoring, and AI-driven farm analytics are increasing efficiency in Delaware's grain and poultry farming systems. For example, UD is exploring the use of robots and AI for high-throughput plant phenotyping and precision agriculture.

- **Despite recent declines in wholesale value, Delaware's poultry industry represents a key economic driver and potential end user market:** Delaware hosts one of the largest poultry production clusters in the U.S., with major companies like Perdue, Allen Harim, and Mountaire Farms contributing over $1 billion to the state's economy and supporting approximately 8,500 jobs. This sector plays a crucial role in the state's agricultural economy, with the potential for additional use-inspired innovation opportunities:

  - **Next-Generation Poultry Vaccines and Disease Prevention:** UD's Avian Biosciences Center is advancing pathogen resistance research and developing innovative Marek's disease vaccines, enhancing biosecurity and disease management in poultry farming. This work aligns with broader efforts to improve animal health and reduce the use of antibiotics.

  - **Alternative Feedstocks and Nutritional Optimization:** Researchers are exploring alternative protein sources, probiotics, and precision-fed nutrients to reduce environmental impact and antibiotic use in poultry farming. This includes developing sustainable feed options that can help mitigate the environmental footprint of poultry production while maintaining animal health and productivity.

  - **Industrial Farming Automation:** Companies like Perdue Farms are investing in automation technologies, such as robotic processing and AI-driven monitoring systems, to enhance efficiency, improve animal welfare, and reduce labor costs in poultry production.

- **Demand for sustainable farming practices and emerging agricultural technologies continues to increase in Delaware:** Delaware faces significant challenges from sea level rise, with thousands of acres of farmland being converted into marshland. To address these issues, researchers are exploring innovative agricultural methods that can adapt to changing environmental conditions. For example, the Carvel Research and Education Center and the Center for Food Systems and Sustainability are advancing Controlled Environment Agriculture (CEA) using vertical farming and hydroponics to provide sustainable models for year-round fruit and vegetable production. Other emerging companies are leveraging AI, satellite technology, and precision agriculture techniques to improve farm efficiency, reduce environmental impact, and enhance rural development in the face of evolving climate trends.

What is Needed to Grow This Opportunity Area in Delaware?

Despite strong research capabilities and agricultural expertise, the state does not yet possess a coordinated agbioscience or agtech ecosystem with large industry partners and consistent commercialization activity. Stakeholders noted several thematic areas where further development and investment by the state could accelerate the pace of agricultural innovation and lead to further opportunities:

- **Strengthening Industry-University Collaboration and Commercialization Pathways:** Stakeholders noted that Delaware faces a disconnect between university-led research and on-the-ground agricultural technology adoption. Expanding extension services and farmer-university pilot programs could accelerate the deployment of new technologies, such as precision agriculture tools and climate-resilient farming practices. Unlike states with strong agricultural biotech industries, Delaware also lacks large-scale agribusiness industry partners driving commercialization. Exploring ways to build an agricultural innovation consortium could attract companies in bio-based materials, alternative proteins, and climate-resilient crops. This would help leverage Delaware's research strengths in areas like soil microbiome research and biopesticide development.

- **Investing in Next-Generation Agricultural Infrastructure and Testing Facilities:** UD and DSU require expanded testing grounds for climate-adaptive farming systems, including high-tech greenhouses, precision irrigation testbeds, and automated farming test sites. Developing a more strategic vision for a food processing and supply chain innovation "brand" would also help integrate logistics, packaging, and value-added processing capabilities, positioning Delaware as a regional hub for sustainable food innovation and enhancing its capacity for food processing and distribution across its existing anchor companies.

- **Addressing Talent Gaps in Agricultural Technology and Agribusiness Management:** Expanding certificate programs in agricultural data science, robotics, and supply chain analytics would help better align talent with industry needs, focusing on emerging technologies like AI, drones, and IoT sensors integrated into Delaware's agribusiness environments. Additionally, programs that integrate STEM skills with agribusiness education would help retain and develop local expertise, addressing the shortage of talent moving into management roles within Delaware's poultry and agribusiness sector.

- **Leveraging the Concept of "One-Health" Value Chain Initiatives to Expand Bio-Based Products and Climate Resilience:** Aligning soil microbiome research, biopesticide development, and plant-based therapeutics under a holistic framework that encapsulates the soil-crop-animal feed-food value chain could better scale to attract federal funding and industry partnerships. Furthermore, integrating resilience elements such as salt-tolerant crops and regenerative soil management practices is crucial for advancing climate-resilient agriculture in coastal regions facing soil salinity challenges due to sea-level rise, and could have broader applicability beyond Delaware.

Delaware Emerging Opportunity: Rehabilitation and Musculoskeletal Innovations

Rehabilitation and musculoskeletal treatments represent a broad spectrum of interventions focused on restoring function, reducing pain, and improving a patient's quality of life. The markets for these treatments are growing significantly due to an aging population, increasing sedentary lifestyles, and advancements in medical technology and delivery.

While rehabilitation and musculoskeletal treatments are highly interconnected, they each stand apart.

- Musculoskeletal disorders involve conditions affecting the muscles, bones, joints, tendons, and ligaments that may result from a variety of causes such as injuries, overuse, repetitive motions, or underlying diseases. Among common disorders are arthritis, tendonitis, carpal tunnel syndrome, rotator cuff and shoulder injuries, knee diseases, and back pain. Treatment options for musculoskeletal conditions are diverse—from rehabilitation treatments involving physical therapy and exercise programs to medications to treat pain and inflammation to regenerative therapies such as platelet-rich plasma injections and stem cell treatments to uses of minimally-invasive ultrasound and radiofrequency ablation treatments to surgical implants such as joint replacement and bone to prosthetics. The global musculoskeletal disorders treatment market size was valued at $186 billion in 2023 and is expected to grow at a compounded annual growth rate of 6.0 percent over the forecast period of 2024 - 2032.[39]

- Rehabilitation innovations, as noted above, are one key option for treating musculoskeletal conditions. However, rehabilitation serves as a treatment option for a wider range of conditions, including neurological and cardiovascular conditions. Rehabilitation treatments are primarily delivered through physical therapy involving exercise, manual techniques, and related-modalities to alleviate pain, enhance mobility, and strengthen affected areas. Alternative treatments such as acupuncture, chiropractic care, and massage therapy are also a part of rehabilitation treatments. The global market for rehabilitation services was estimated at $255 billion in 2023 and is expected to grow at a compounded annual growth rate of 6.1 percent during over the forecast period of 2024 to 2030.[40]

Innovations driving growth include home-based, personalized digital rehabilitation services, the use of data analytics to improve human performance, wearable technologies to monitor patient progress and facilitate personalized rehabilitation programs, advanced minimally invasive regenerative procedures, and advanced joint replacement implants.

39 Towards Healthcare, Musculoskeletal Disorders Treatment Market Size and Overview: 2024-2032, see https://www.towardshealthcare.com/insights/musculoskeletal-disorders-treatment-market-sizing?utm_source=chatgpt.com

40 Grandview Research, Medical Rehabilitation Services Market Size, Share, & Trends Analysis Report: 2024-2030, https://www.grandviewresearch.com/industry-analysis/medical-rehabilitation-services-market-report

What is Driving This Emerging Opportunity Area for Delaware?

Several dynamics are driving activity across Delaware's research base:

- **Leading National Graduate Research Programs:** Delaware is well-known for having one of the nation's top-ranked Physical Therapy and Kinesiology graduate programs, with U.S. News and World Report ranking UD as second in the nation in Physical Therapy and the National Academy of Kinesiology ranking UD as seventh in the nation. Additionally, UD's Biomedical Engineering graduate program is also highly ranked. UD's strategic integration of movement sciences led by its programs in Physical Therapy and Kinesiology with broader biomedical engineering to advance injury prevention, rehabilitation, and performance optimization through its Interdisciplinary Program in Biomechanics and Movement Science (BIOMS) is a unique asset.

- **Significant Strengths in Peer-Reviewed Publications:** Delaware research strengths in rehabilitation and musculoskeletal research are clearly demonstrated through its level of specialization in peer-reviewed publications, including:

    - Rehabilitation: Delaware is 226 percent more specialized in peer-reviewed publications than the national average, with 316 publications from 2019-2024.

    - Sport Sciences: Delaware stands 102 percent more specialized in peer-reviewed publications than the national average, with 308 publications from 2019-2024.

    - Orthopedics: Delaware stands 67 percent more specialized in peer-reviewed publications than the national average, with 353 publications from 2019-2024

- **Significant Presence of Research Centers and Labs:** Delaware has several leading centers of excellence in rehabilitation and musculoskeletal research.

    - Nemours stands out as a national clinical and research leader in Pediatric Orthopedics. Led by its Center for Orthopedics Research and Development (CORD), Nemours focuses on spinal deformities and dysfunction (i.e., scoliosis, kyphosis, and spondylolisthesis), cerebral palsy, skeletal dysplasia, sports medicine, and hip disorders. At any given time, Nemours is working on more than 100 orthopedic-related research projects and well over 50 clinical trials.

    - UD's Center for Biomedical Engineering Research (CBER) supports the design, characterization, validation, and marketing of surgical devices in collaboration with biomedical companies and entrepreneurs.

    - UD's Center for Musculoskeletal Research (DCMR) supports basic and preclinical research on the central theme of musculoskeletal health in an effort to identify potential therapeutic interventions. It has funded a range of projects focusing on osteoarthritis, cartilage repair, tissue engineering, and regeneration.

    - UD's NIH-funded COBRE in Cardiovascular Health brings a multidisciplinary research approach to understanding the mechanisms underlying the causes and consequences

of poor cardiovascular health and/or function and developing effective interventions for these conditions.

- UD's Departments of Physical Therapy and Kinesiology and Applied Physiology focuses on rehabilitation research to improve physical function and quality of life for those with low back pain and hip fractures, tendons/lower leg injuries, arthritis, and stroke recovery. Additionally, research labs are focused on biomechanics, including orthotics and prosthetics, falls research and mechanisms responsible for changes in gait due to age, pathology, injury, or exercise. There is also a growing emphasis on human performance relating to athletic training and sports medicine addressing issues such as concussions, neurologic and biomechanical aspects of injury proneness, and use of analytics and advanced technologies, such as wearables, by UD's Athletic Department to address imbalances in muscles, injury reduction, and improved conditioning and athleticism.

What is Needed to Grow This Opportunity Area in Delaware?

Despite strong research capabilities, the state does not yet possess either an industrial base or consistent commercialization activity. Stakeholders noted several thematic areas where further development and investment by the state could accelerate the pace of innovation and lead to further opportunities:

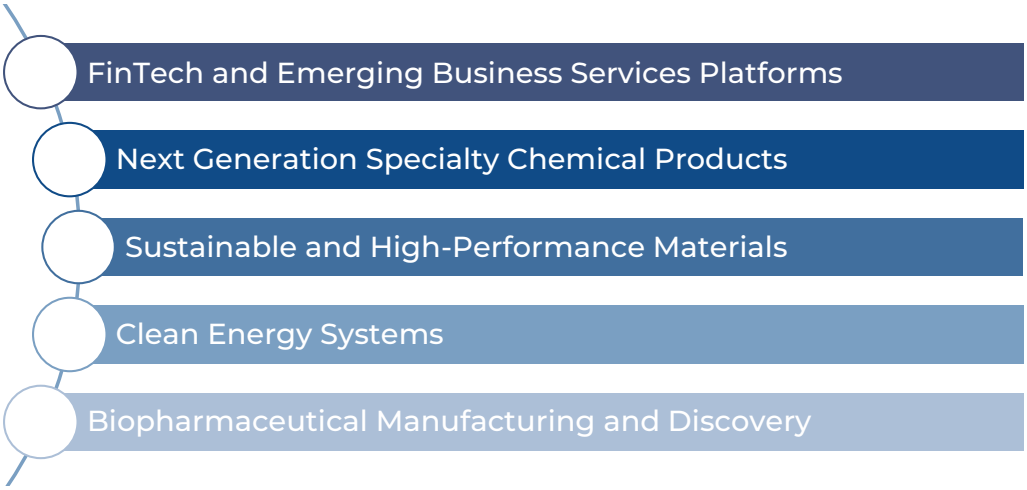
- **Stronger Clinical and Translational Research Capacities:** While Nemours offers Delaware a world-class capacity in clinical and translational research for pediatric-related treatments, there is not an equivalent strength for leveraging the extensive research expertise found in more adult related rehabilitation and musculoskeletal conditions. Over the years, there have been improvements in resources for clinical and translational research for academic researchers, particularly with pilot studies through the Delaware Clinical and Translational Research ACCEL Program and with patient recruitment through UD's Center for Human Research Coordination. Still, key aspects of clinical and translational research are lacking, including strong partnerships with orthopedic physician groups involved in clinical and translational research and gaps in infrastructure for clinical trials coordinators/specialists and data management. This may call for broader regional partnerships with academic medical centers and contract research organizations focused on rehabilitation and musculoskeletal devices and therapies.

- **Enhanced Acceleration and Industry Partnership Services to Promote Delaware as a Leading State:** Today, there is not a significant base of medtech firms based in Delaware to collaborate and partner in the commercialization of UD's significant strengths in rehabilitation and musculoskeletal research. This calls for stronger outreach to entrepreneurs across the globe as well as to regionally-based companies across the Delaware Valley and other nearby states to collaborate with and bring a market-driven focus on commercialization for rehabilitation and musculoskeletal innovations. Other communities have dedicated accelerators that go beyond their local pool of entrepreneurs to create new partnerships and collaborations leveraging their key assets for innovation. Discussions with stakeholders have indicated that there are potential commercial partners interested in this research. The state should consider an accelerator program that can attract industrial partners, serial entrepreneurs, or cohorts of startups from outside the state.

Conclusion

The S&T growth opportunities identified in this study represent a unique portfolio of Delaware's technology strengths and a potential playbook for the state's innovation-led future. **The five existing S&T growth opportunities** illustrated in Figure 26 are the areas in which Delaware is best positioned and primed to compete in innovation-led market opportunities that can help sustain the state's leading industry clusters in the near-term.

Figure 26. Delaware's S&T Growth Opportunity Areas



Source: TEConomy Partners, LLC.

In addition, three emerging S&T growth opportunity areas were identified that will require nurturing and longer-term investments as new market opportunities present themselves in the coming years. The three emerging S&T growth opportunity areas are:

- BlueTech Innovation,
- Integrated Agriculture and Sustainable Food Production, and
- Rehabilitative and Performance Enhancement Technologies.

Successfully seizing these opportunities will require intentional connections, investments, and a collaborative culture. As DPP looks to the future, these opportunity areas can serve as a guide to catalyze strategic partnerships, to inform future investments, to serve as a foundation for statewide innovation initiatives, to build awareness of the state's unique strengths, and to recruit and retain world-class innovators in Delaware.

Line-of-Sight Technical Appendix

Introduction

Given the importance of innovation as a critical driver for the future growth and development of Delaware's science and technology (S&T) industry clusters, an assessment of innovation-led growth opportunities for the state must be forward looking rather than retrospective. Traditional industry target analysis relies on examining in-depth trends and competitive position in industry activities that largely shed light on where an economy has been. This is helpful but not sufficient to understand tomorrow's development opportunities. It is equally important to understand where an economy has the capacity to grow and leverage comparative advantage, which is informed by an analysis of core industry-facing technology competencies.

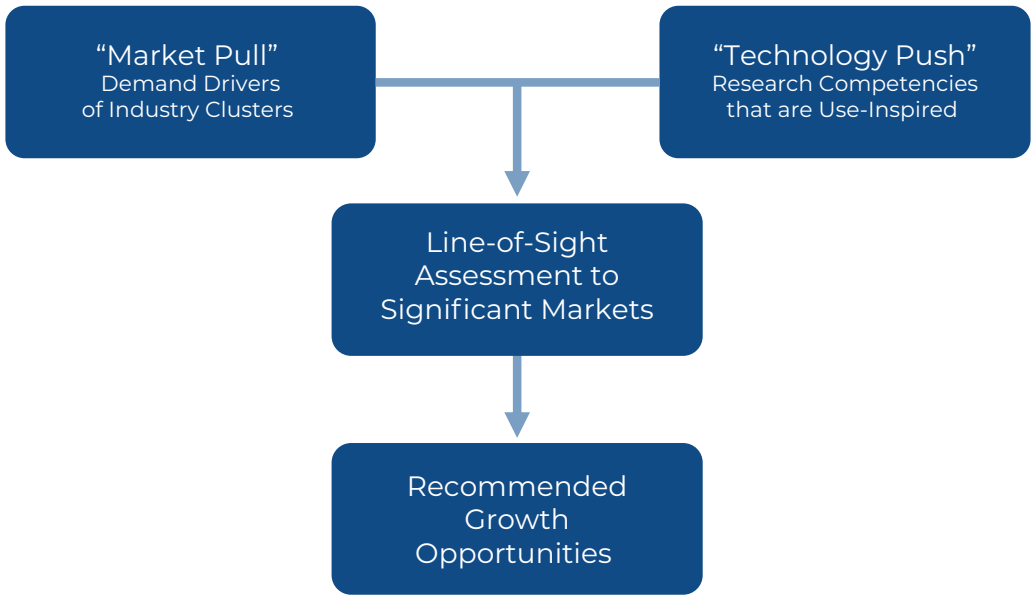
Growth opportunities must build on the foundation laid by existing core competencies and excellence present within a state. Delaware's strengths in innovative capacity reflect the core S&T-related technology competencies found in its industry and research institutions. The concept of core competencies is now widely understood as a critical factor for industries to be competitive. As defined by Gary Hamel and C.K. Prahalad in Competing for the Future, a "competence is a bundle of skills and technologies representing the sum of learning across individual skill sets and organizational units."[41] From a regional economic development perspective, core competencies represent a critical mass of know-how found locally. This critical mass exhibits industry expertise and creative activity across product development and process improvements, alongside the region's research strengths in scholarly activity, technology transfer, and specialized talent development.

For this assessment, emphasis was placed on identifying core competencies that can be considered "industry-facing," or primarily driven by the needs of industry in advancing innovation-led products and services to market. While direct efforts by industry in innovation and research are "industry-facing" by definition, not all university research activities are oriented towards business uses. For research institutional efforts to be industry-facing requires that they be focused on use-inspired and applied research activities, provide strong commercialization potential, involve industry collaborations, and/or offer shared-use facilities and capabilities that can be leveraged by industry. The translation of research to address specific industry and societal needs is what often allows universities to make a difference in driving innovation and economic growth.

41 Hamel and Prahalad, "Competing for the Future," Harvard Business Press, 1994.

To maximize the potential for economic development impact, it is critical to identify strategic areas that align Delaware's research assets and competencies with the needs and opportunities of its industry innovation drivers. The growth opportunities in which Delaware is best positioned to differentiate itself reflect the intersection of its current strengths in science and technology research and its capacity to link to its existing and emerging industries. As depicted in Figure A1, the convergence of core technology competencies and well positioned industry drivers can offer a "line of sight" to growing innovation-led opportunities that can help sustain Delaware's leading industry clusters as well as pursue emerging market opportunities. TEConomy's line of sight analysis identifies capabilities supported by both research institution and industry strengths, in which Delaware excels in both the "market pull" of innovation activities and growth trends of its existing industry clusters and the "technology push" of industry-facing core competencies where it has the know-how across its research institutions to advance future innovation and growth.

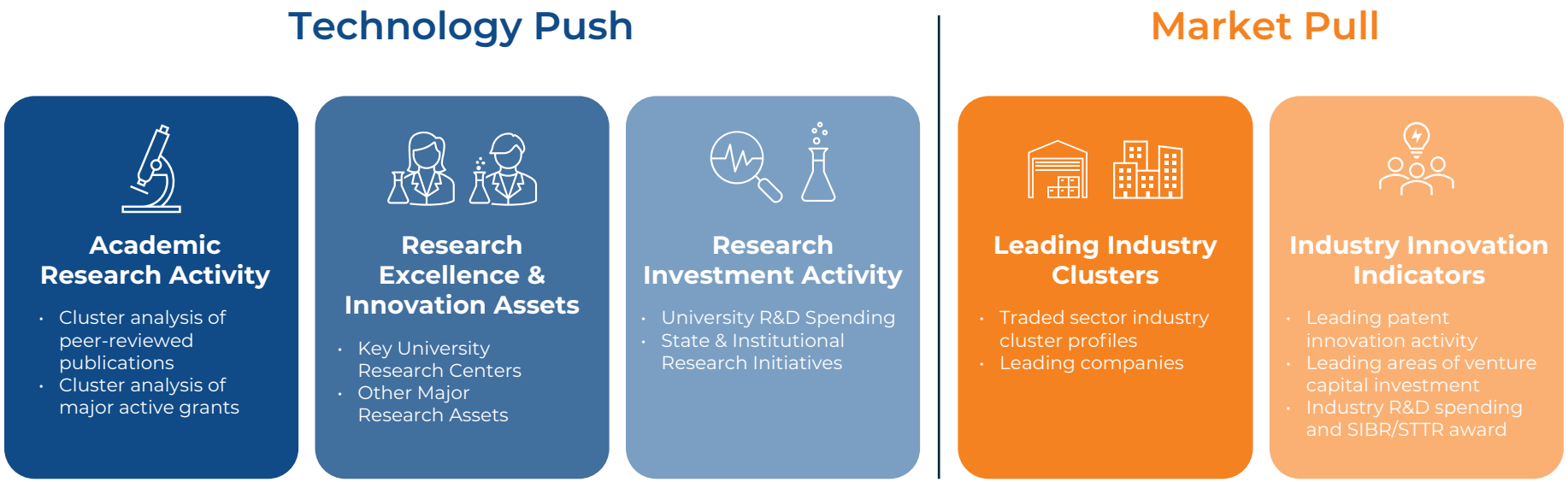
Figure A-1. Line of Sight Approach for Identifying Growth Opportunities in Delaware



Source: TEConomy Partners, LLC.

As depicted in Figure A2, identifying linkages between technology push and market pull capabilities involves analyzing a number of key indicators. Taken together, these can offer the line-of-sight to growing innovation-led market opportunities that help sustain the vibrancy of Delaware's leading science and technology industry clusters as well as position the state to respond to market opportunities in new industries that evolve in the future. Subsequent sections of this technical appendix outline the various analyses that were used to determine Delaware's core competencies and growth opportunity areas.

Figure A-2. Key Indicators and Analyses Leveraged for the Line-of-Sight Assessment of Delaware's Growth Opportunities



Source: TEConomy Partners, LLC.

Technology Push

This section summarizes TEConomy's quantitative assessments of Delaware's "technology push" activity, which use innovation and talent indicators to identify core competencies that drive research excellence. A variety of information was analyzed to provide insight into specific areas of technology and innovation strengths found in Delaware, identifying industry-facing capabilities where Delaware has the know-how and capacity across its academic institutions to advance innovation in growth-oriented markets.

TEConomy leveraged data sources documenting research activity to help identify underlying core competencies that directly support basic sciences and translational research for potential end markets, including:

- **Research publication activity and key themes**, which highlight areas of specialization across Delaware's institutions that are aligned with potential "use-inspired" research and application areas for translational research.
- **Current, active researcher-initiated grant awards**, which identify research projects with potential alignment with industry as well as reflect research expertise within institutions.
- **Industry-facing, "use-inspired" research centers** operating at Delaware's universities, which can serve as hubs of innovation and translational activity and identify investment in differentiated research capabilities as well as active collaborations with industry partners.
- **University R&D spending trends**, which highlight areas of focused investment supporting research applications.

Academic Research Activity

Delaware academic research activity demonstrates key areas of excellence that help identify the state's research core competencies. Research publications can help identify areas of critical mass, specialization, and potential application areas for translational research. Moreover, publication themes highlight research strengths that are aligned with potential use-inspired research. In addition, researcher-initiated grant award activity supplements information from publications activity by identifying research that has potential alignment with industry needs. These grants reflect institutional research expertise and thought leadership that drives innovation ecosystems and connects to potential end markets.

Delaware Research Publications

Research activity from publications is an important indicator of innovation activities and key capabilities that can drive economic growth. TEConomy leveraged the Clarivate Analytics Web of Science journal indexing database to analyze peer-reviewed scientific research publications from Delaware-based authors. The analysis was limited to research in non-humanities disciplines published from 2019 to the present. This approach identified 17,154 publications, most of which are generated by the UD, with DSU and Nemours Children's Hospital being other prominent institutions.

The leading discipline areas present in Delaware's research publications are detailed in Table A1. A specialization index value over one indicates that Delaware has specialized publishing activity relative to national trends in the corresponding field.

Table A1. Leading Discipline Areas for Delaware Research Publications Records, 2019-Present

Scientific Discipline Area	Record Count	% of Total Publications (n = 17,154)	Publication Specialization Index
Environmental Sciences	997	5.8	1.55
Materials Science, Multidisciplinary	986	5.7	1.25
Engineering, Electrical & Electronic	830	4.8	0.89
Astronomy & Astrophysics	742	4.3	2.07
Chemistry, Physical	737	4.3	1.60
Pediatrics	724	4.2	2.35
Chemistry, Multidisciplinary	711	4.1	1.33
Multidisciplinary Sciences	652	3.8	0.86
Physics, Applied	580	3.4	1.22
Oncology	474	2.8	0.83
Neurosciences	453	2.6	0.80
Engineering, Chemical	410	2.4	2.21
Biochemistry & Molecular Biology	408	2.4	0.67
Geosciences, Multidisciplinary	391	2.3	1.35

Scientific Discipline Area	Record Count	% of Total Publications (n = 17,154)	Publication Specialization Index
Nanoscience & Nanotechnology	389	2.3	1.13
Pharmacology & Pharmacy	389	2.3	0.96
Public, Environmental & Occupational Health	387	2.3	0.81
Orthopedics	353	2.1	1.67
Ecology	335	2.0	1.15
Computer Science & Information Systems	330	1.9	0.71
Clinical Neurology	329	1.9	0.70
Biotechnology & Applied Microbiology	322	1.9	1.69
Optics	321	1.9	1.24
Computer Science, Theory & Methods	317	1.8	0.62
Rehabilitation	316	1.8	3.26
Genetics & Heredity	312	1.8	1.21
Sport Sciences	308	1.8	2.02

Source: TEConomy's analysis of Clarivate Web of Science Publications

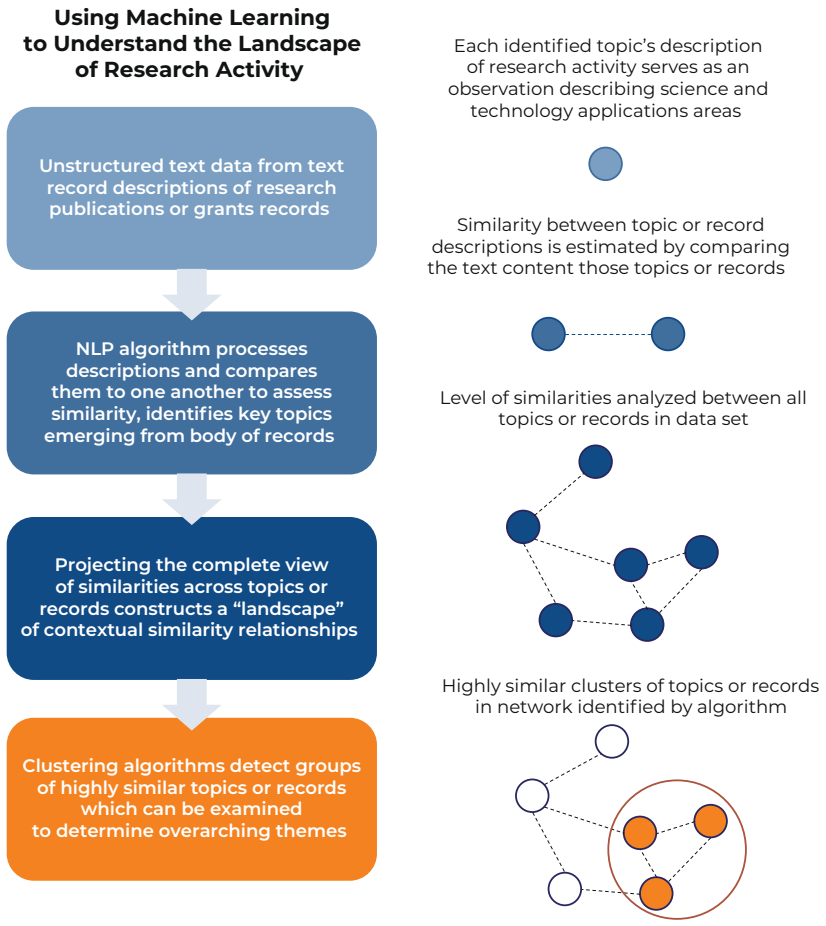
Delaware shows highly specialized levels of activity in rehabilitation, pediatrics, chemical engineering, astronomy & astrophysics, sport sciences, biotechnology and applied microbiology, orthopedics, physical chemistry, and environmental sciences.

While research disciplines can be illustrative of critical mass in key areas, summary totals do not fully capture the differentiated competencies of a specific ecosystem. To better understand the distinct strengths of Delaware's research base and extract further detail from the body of research publications, TEConomy conducted additional analyses of research activity that link individual publication records by the unstructured text content in their abstracts. This approach is also used for grant analysis and throughout various other technology "push" and market "pull" analyses to identify themes that emerge from key indicators of innovative activity, as outlined further in this appendix.

This text analysis is done using a topic modeling technique that employs natural language processing and machine learning clustering algorithms to generate detailed underlying topics present in the research text content. As illustrated in Figure A3, the model compares the text content between records and topics, creating groups of highly similar topics or records that can indicate underlying focuses within and across Delaware's body of academic research. Graphing topics or publications by similarity allows for visualization via a "landscape" that aids in understanding the structure of the thematic areas present.

The topic model analysis of Delaware publications identified 182 topics that span various science and technology areas with a potential line-of-sight to end markets, highlighted in Figure A4. Nearly 20 percent of the publications analyzed relate to clinical research for drug development and other treatments for cancer, heart disease, and other conditions. Additionally, almost 14 percent of publications relate to technology applications in ecology and conservation, such as climate risk modeling, biological control, and environmental monitoring. Other significant science and technology areas include machine learning and advanced computing, materials engineering and nanotechnology, protein structures and cellular systems, energy conversion technologies and materials, and neurological rehabilitation.

Figure A-3. Top Thematic Areas of Research Competencies Identified in Topic Modeling of Delaware Research Publications



Source: TEConomy's analysis of Clarivate Web of Science Publications

Figure A-4. Landscape Perspective of Broad Thematic Areas from Topic Modeling of Delaware Research Publications

Ecology and Conservation

- Climate change, climate risk modeling, and resilient infrastructure
- Parasitoid-based biological control
- Habitat and conservation dynamics
- Plant stress response and deep learning
- Remote sensing and environmental monitoring

Materials Engineering:

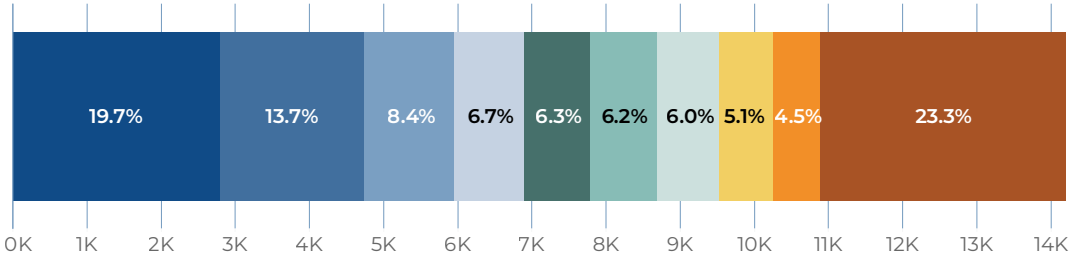
- Thin film technology and magnetic alloys
- Fibers, polymer composites, and colloidal rheology for manufactufing and biomedical engineering applications
- Nanotechnology and electronics manufacturing
- Materials development for photovoltaic modules

Protein Structure and Cellular Systems

- Proteomics: Protein annotation, protein interactions in antibodies, viral capsid structure, lipid dynamics, applications in pharmaceuticals
- Biomedical engineering of hydrogels for wound healing
- Cell biomechanics and chondrocyte signaling in cartilage

Clinical Trials & Studies Outcomes

- Cancer immunotherapy and pharmacogenetics
- Drug delivery and vaccine uptake
- Heart disease and cardiac arrest treatment and management
- Other conditions such as asthma, kidney disease, stroke, inflammation, and maternal health



Machine Learning and Advanced Computing

- Biomedical applications or deep learning: Medical segmentation, spectral imaging, diagnosis, health IT, cellular and molecular modeling
- Sensing satellite communications, and radar technology
- Blockchain and privacy technology
- Autonomous vehicles and infrastructure integrity

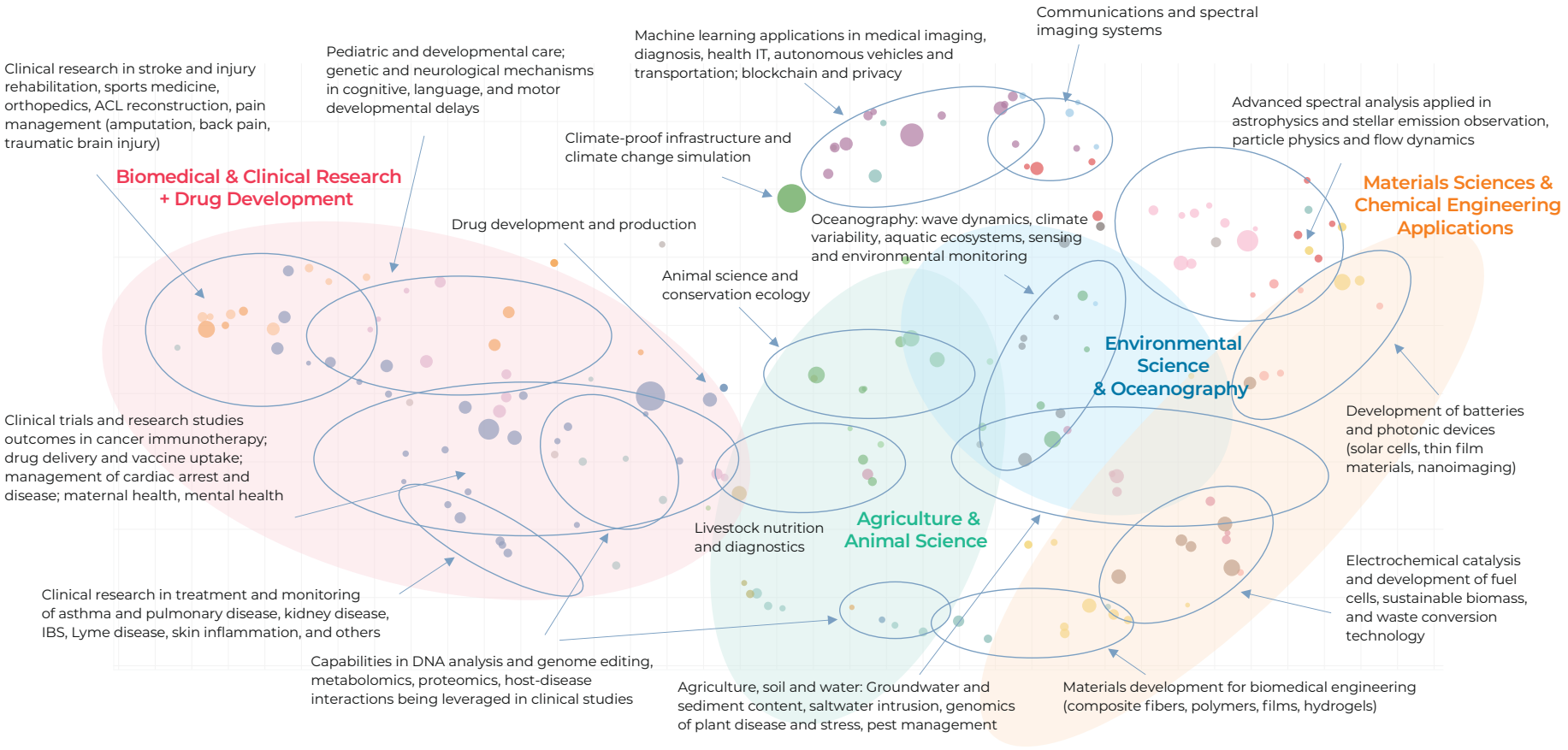
Source: TEConomy's analysis of Clarivate Web of Science Publications

Figure A5 illustrates the key themes identified across the landscape of Delaware research publications, with areas of critical mass appearing as more tightly grouped clusters. Each point represents a topic identified by the topic model, sized by the number of publications assigned to it. As shown in the landscape, ***Delaware's publications activity can be grouped into four large thematic areas that demonstrate potential core competencies:***

- **Biomedical and clinical research and drug development:** Demonstrates strength in "multi-omics" and bioinformatics as well as differentiated presence in drug development and production and rehabilitative medicine.
- **Agriculture and animal science:** Demonstrates strength in sustainable agriculture.
- **Environmental science and oceanography:** Demonstrates strength in marine science, coastal dynamics, and climate resilience.
- **Materials sciences and chemical engineering applications:** Demonstrates differentiated presence in composites, nanotechnology, materials for biomedical engineering, other advanced materials, and chemical engineering for electrochemical applications.

In addition to these four areas, it is worth noting that the landscape shows strength in data science and machine learning, with a variety of applications in areas such as medicine, blockchain, and AV.

Figure A-5. Landscape Perspective of Broad Thematic Areas from Topic Modeling of Delaware Research Publications



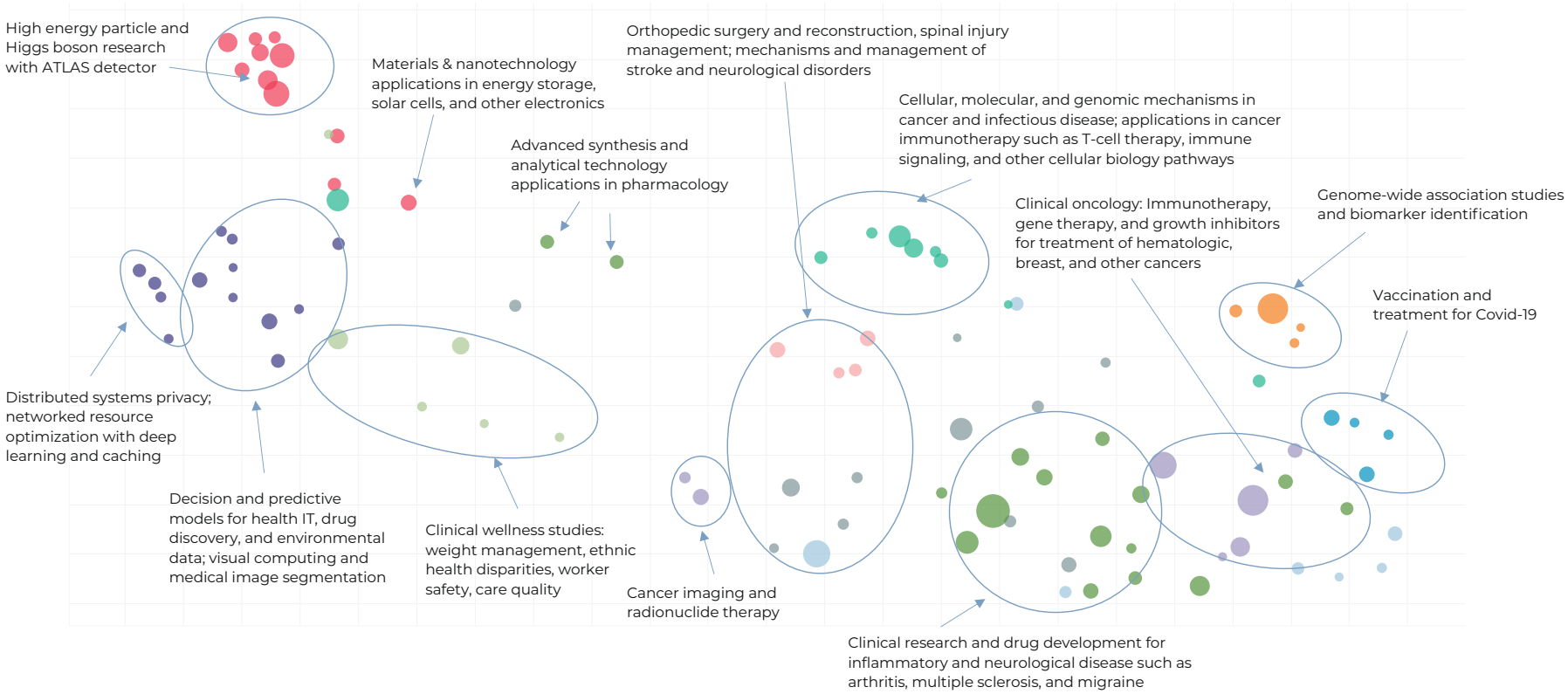
Regional Context: Philadelphia Research Publications

The vibrant life science ecosystem in Philadelphia complements and builds upon many Delaware institutional research strengths, potentially presenting additional opportunities for Delaware markets. Delaware's New Castle County, which includes UD and about 58 percent of the state's population, is part of the Philadelphia-Camden-Wilmington Metropolitan Statistical Area. As a result, interstate collaborations will likely be important for leveraging Delaware's core competencies. In particular, Philadelphia-based research activity where industry plays a collaborative role can identify opportunities for Delaware to further innovation commercialization. Research publications with co-authorship of research institutions and professionals in industry indicate areas where industry stakeholders are interested in documenting their research in publications, either as an investment in R&D that will advance the state of the science or due to industry applications that may result from commercialization of the ideas.

To focus on these opportunities, TEConomy conducted a similar topic model analysis on research publications with industry collaborations from the University of Pennsylvania, Temple University, Drexel University, and Thomas Jefferson University over the same time period. After identifying over 88,000 research publications from these Philadelphia universities, TEConomy removed approximately 1,800 publications that were already included in the Delaware analysis and then focused on the 4,389 publications that included industry authors. Major industry collaborators in this body of work include Janssen, Novartis, Genentech, Merck & Co, Regeneron, Pfizer, and Sanofi.

The topic model analysis identified 92 science and technology research topics. Figure A6 illustrates the key themes present in the landscape of Philadelphia industry-coauthored research publications. Philadelphia has strong research activity with potential to support Delaware's areas of excellence in materials science and nanotechnology, electrochemistry, data science and AI applications, clinical research, drug development, rehabilitative medicine, and bioinformatics and "multi-omics."

Figure A-6. Landscape Perspective of Broad Thematic Areas of Research Competencies Identified in Topic Modeling of Philadelphia Research Publications with Industry and Research Institution Collaboration



Source: TEConomy's analysis of Clarivate Web of Science Publications

Delaware Project Grants

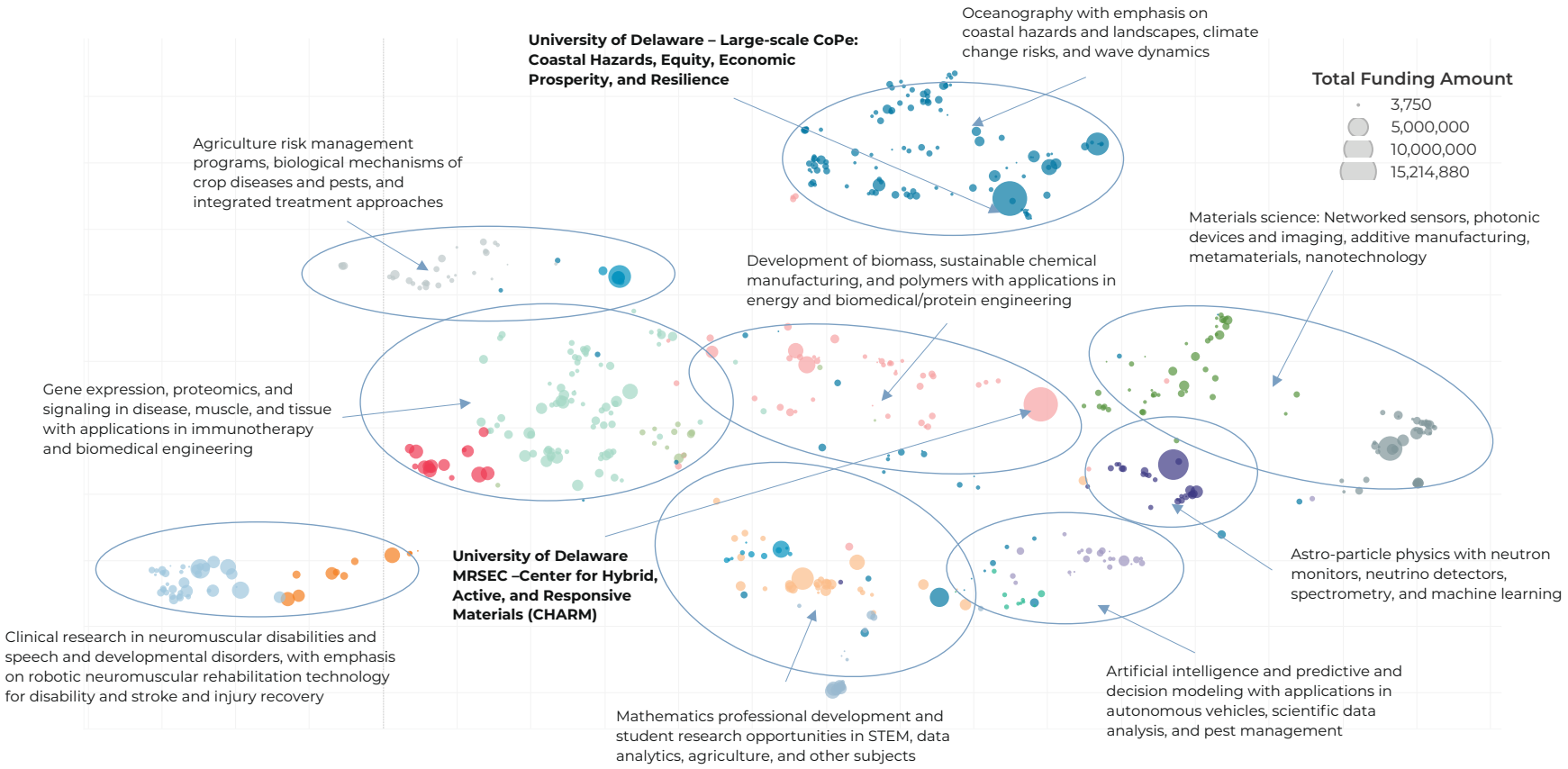
In addition to research publications, grant awards to Delaware project leaders and principal investigators provide another indicator of activity in enabling capabilities anchored by state research institutions. TEConomy examined researcher-initiated research project grants from major federal institutions, a definition closely aligned with R01-equivalent grants from NIH.[42] These types of project grants are often the most indicative of where researchers develop and invest in core competencies at an institution. TEConomy pulled active awarded grants from 2019 to 2024. from NSF, NIH RePORTER, USDA CRIS, and DoD DTIC data, identifying the following awards:

- 419 NSF awards totaling $243M in funding
- 111 NIH awards totaling $53.2M in funding
- 116 USDA awards totaling $58.8M in funding
- 129 DoD awards totaling $70.2M in funding

Figure A7 illustrates the key themes identified across the landscape of Delaware grant awards. As opposed to the prior topic landscapes for the publications analyses, the project grant landscape graphs individual awards, colored by topic and sized by their total funding amount. **The Delaware research project landscape indicates strong capabilities in composites and nanotechnology, advanced materials, chemical engineering, marine and coastal science, biomedical engineering, multi-omics, biomedical engineering, and rehabilitative technology.**

42 As per NIH's definition of the R01 series grant purpose, they are designed "To support a discrete, specified, circumscribed project…in an area representing the investigator's specific interest and competencies."

Figure A-7. Landscape Perspective of Broad Thematic Areas of Research Competencies Identified in Topic Modeling of Active, Researcher-led Project Grants at Delaware Institutions



Source: TEConomy's analysis of NIH RePorter, NSF, USDA CRIS, and DoD DTIC awarded grants data

Research Excellence & Innovation Assets

The presence of industry-facing university centers of excellence and other research assets highlights areas of focused investment in differentiated research capabilities and infrastructure as well as active collaborations with industry partners. These centers support and anchor core competencies and drive innovation, and they often represent key enablers of linkages to industry applications that form the basis for the line-of-sight to growth opportunities.

TEConomy identified several leading institutes through qualitative analysis of Delaware's major research universities. Tables A2 and A3 highlight industry-facing, use-inspired research centers at UD and DSU that span several broad thematic disciplines and can serve as hubs of innovation and translational activity. The research centers at both universities demonstrate a heavy focus in biomedical and agricultural research, while UD shows additional strengths in materials science, chemical engineering, catalysis and energy, data and computer science, and marine science.

Table A2. University of Delaware Industry-Facing Research Centers

Chemical Engineering and Materials Science (Estimated $132.1M in 2023)	Other Engineering and Computer Sciences ($71.1M in R&D)	Health and Biomedical Sciences ($66.8M in R&D)
Catalysis and Energy • Center for Catalytic Science and Technology • Center for Fuel Cell Research • Delaware Energy Institute • Institute of Energy Conversion • Catalysis Center for Energy Innovation **Materials Science and Chemical Engineering** • Center for Research in Soft Matter & Polymers • Center for Composite Materials • Center for Plastics Innovation • Center for Hybrid, Active, Responsive Materials • Advanced Materials Characterization Lab (Core)	**Data and Computer Sciences** • Data Science Institute • Center for Autonomous and Robotic Systems (CARS) • Center for Cybersecurity, Assurance and Privacy (CCAP) • AI Center of Excellence • Quantum Science and Engineering **Other Engineering** • Institute for Engineering Driven Health • Delaware Center for Transportation	**Biopharmaceuticals and Biotechnology** • National Institute for Innovation in Manufacturing Biopharmaceuticals • Delaware Biotechnology Institute • Center for Biomanufacturing Science and Technology • Biopharmaceutical Innovation Center **Other Biomedical Research** • Center for Musculoskeletal Research • Center for Biomedical Engineering Research • Center for Bioinformatics & Computational Biology (CBCB) • ADVANCE Institute

Agricultural Sciences ($34.2M in R&D)	Ocean, Marine, and Other Geosciences ($26.7M in R&D)	Physics and Astronomy ($16.3M in R&D)
• Carvel Center • Avian Biosciences Center • Center for Food Systems and Sustainability	• Center for Applied Coastal Research (CACR) • Center for Robotic Oceanic and Coastal Systems • Center for Environmental Monitoring and Analysis • Center for Research in Wind	• Delaware Asteroseismic Research Center • Bartol Research Institute • Center for Neutron Sciences

Source: TEConomy's analysis of NSF HERD and University of Delaware Webscan

Table A3. Delaware State University Industry-Facing Research Centers

Health and Biomedical Sciences ($12.8M in R&D)	Agriculture and Natural Resources ($6.7M in R&D)	Physics and Astrophysics ($4.3M in R&D)
• Delaware Center for Neuroscience Research • Delaware Clinical and Translational Research ACCEL Program • DELAWARE NUCLEOTIDE ANALYSIS (DNA) CORE CENTER • The Interdisciplinary Health Equity Research (IHER) Center • Delaware IDeA Network of Biomedical Research Excellence (INBRE)	• Environmental Cooperative Science Center • Living Marine Resource Cooperative Science Center (LMRCSC) • Center for Environmental Justice • Water Quality Testing Lab • Aquaculture Research and Demonstration Facility • Food Microbiology & Microbial Omics	• *OSCAR: The Optical Science Center for Applied Research* • Advanced Quantum Sensing Center

Source: TEConomy's analysis of NSF HERD and Delaware State University Webscan

In addition to the noted industry-focused R&D centers, Table A4 identifies additional UD research labs and institutes across five major disciplines. These additional facilities support the research competencies identified in the centers of excellence as well as facilitate additional industry collaboration.

Table A4. Other University of Delaware Research Labs and Institutes

Chemistry and Materials Research Centers	Biomedical Sciences	Data Sciences and Engineering	Agriculture and Environment	Finance, Business, Economics, Policy
• Catalysis Center for Energy Innovation	• National Institute for Innovation in Manufacturing Biopharmaceuticals	• Data Science Institute	• Delaware Environmental Institute	• Delaware Center for Transportation
• Center for Clean Hydrogen	• The Ammon Pinizzotto Biopharmaceutical Innovation Center	• Center for Autonomous and Robotic Systems	• Disaster Research Center	• Hospitality Associates for Research and Training
• Delaware Energy Institute	• Delaware Biotechnology Institute	• Center for Cybersecurity, Assurance and Privacy	• Center for Applied Coastal Research	• Institute for Financial Services Analytics
• Institute of Energy Conversion	• Center for Biomanufacturing Science and Technology	• Quantum Science and Engineering	• Center for Energy and Environmental Policy	• Institute for Global Programs and Services
• Center for Fuel Cells and Batteries	• Delaware Center for Musculoskeletal Research	• Center for Data-Intensive & Computational Science	• Center for Environmental Monitoring & Analysis	• Institute for Public Administration
• Center for Composite Materials	• Institute for Engineering Driven Health	• AI Center of Excellence (AICoE)	• Center for Food Systems and Sustainability	• JPMorgan Chase Innovation Center
• Center for Research in Soft Matter and Polymers	• Center for Biomechanical Engineering Research	• Computer Architecture and Parallel Systems Lab	• Center for Research in Wind	• Michael and Rosann Geltzeiler Trading Center
• Center for Plastics Innovation	• Center for Cardiovascular Health	• Applied Science and Engineering Laboratories	• Center for the Study of Pollutants in the Environment	• Mid-Atlantic Industrial Assessment Center
• Biomolecular Interaction Technologies Center	• Center for Disabilities Studies	• Center for Spintronics and Biodetection	• Delaware Geological Survey	• Weinberg Center for Corporate Governance
• Center for Catalytic Science and Technology	• Center for Drug and Health Studies	• Sociotechnical Systems Center	• Institute for Soil and Environmental Quality	• Marriott Center for Tourism and Hospitality
• Center for Hybrid, Active, and Responsive Materials	• Center for Health Assessment Research and Translation	• Pearson Hall Makerspace	• Mangone Climate Change Science and Policy Hub	
• Delaware Asteroseismic Research Center	• Delaware Center for Cognitive Aging Research		• Mid-Atlantic Regional Association Coastal Ocean Observing System	
• Bartol Research Institute	• Nurse Managed Primary Care Center		• OCEANIC- Ocean Information Center	
• Center for Neutron Science			• Water Resources Center	
• Bartol Research Institute (Physics)				

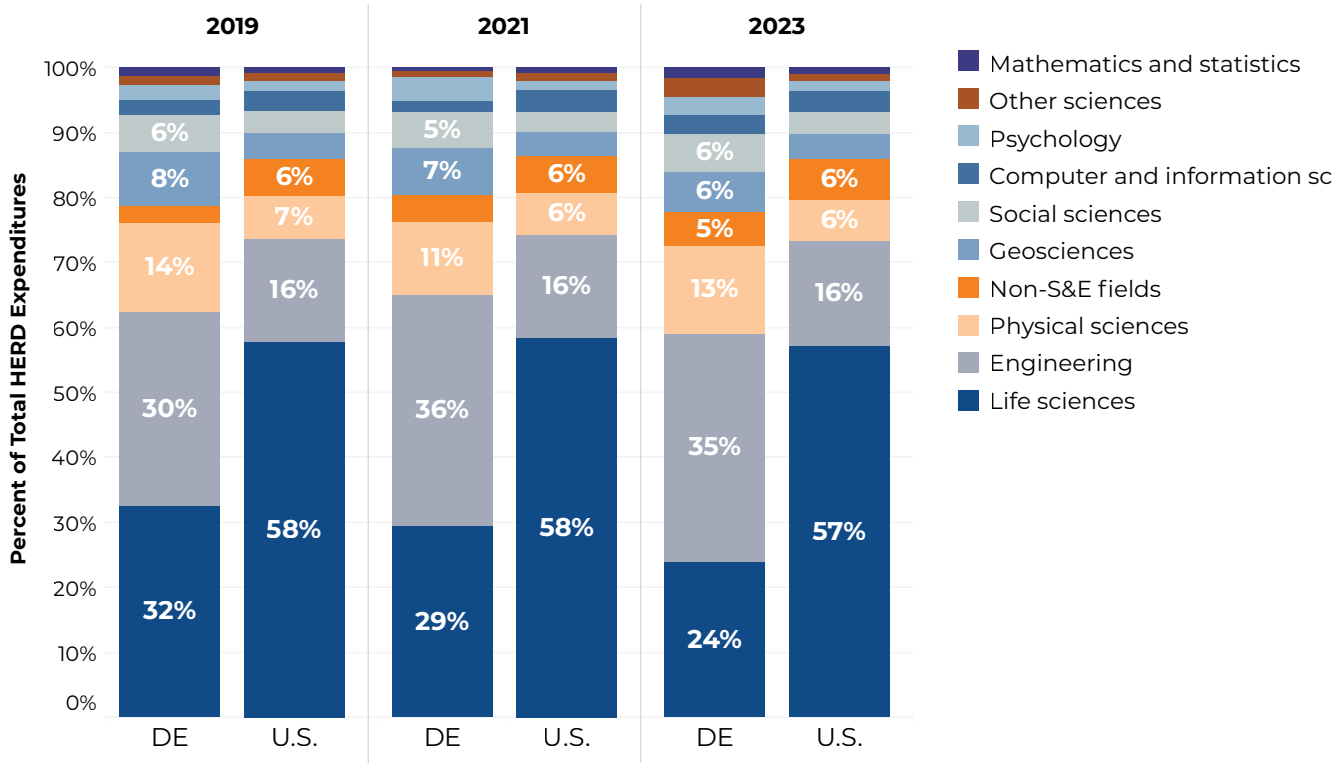
Source: TEConomy's analysis of Delaware university and research institution websites

Research Investment Activity

Academic research and development expenditure trends are another important indicator of investment areas supporting research applications with potential relevance to end markets. University research spending patterns highlight focused investments in differentiated research capabilities that drive regional specialization and core competencies. To track academic R&D output, the National Science Foundation conducts its Higher Education Research and Development Survey (HERD). This annual survey captures R&D output by academic discipline for institutions with $150,000 or more in total expenditures. Delaware's R&D expenditures are primarily driven by UD, but DSU is included in the HERD survey as well.

Figure A8 illustrates Delaware university R&D spending trends over 2019-2023 by academic discipline, relative to US trends over the same period. **Driven by UD, state academic R&D expenditures reached $461.6 million in 2023, growing by 108 percent since 2019. This has dramatically outpaced national growth of 23 percent, highlighting UD's substantial investment in expanding research output.** In addition, figure A8 highlights Delaware's areas of concentrated research and development by indicating each discipline's share out of total expenditures, compared to national shares. **Delaware holds a specialized concentration in seven of the ten broad disciplines displayed in figure A8, with Engineering (led in particular by Chemical Engineering) and Physical Sciences (led by Chemistry and Materials Science) among the state's largest research areas.**

Figure A-8. Delaware University R&D Spending Trends by Academic Discipline

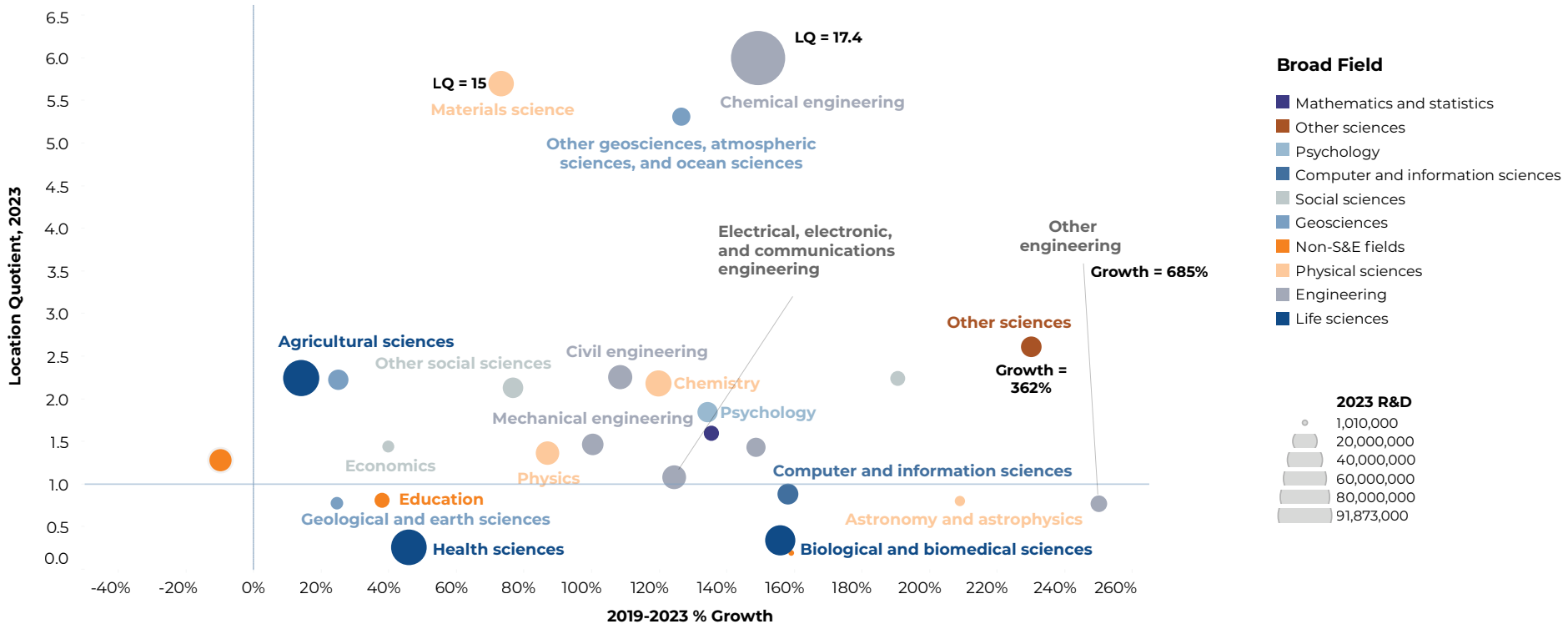


Source: TEConomy's analysis of National Science Foundation (NSF), National Center for Science and Engineering Statistics, Higher Education Research and Development (HERD) Survey

Figure A9 further breaks down R&D spending by discipline, graphing detailed fields within each broad field displayed in Figure A8 by location quotient and spending growth. The location quotients indicate state-level R&D concentration, with an LQ value over one indicating that Delaware has a specialized level of R&D concentration relative to national trends in that field. Each point represents a detailed field, sized by the volume of 2023 R&D expenditures and colored by broad field. Fields such as other sciences, other engineering, and other geosciences include subject areas that cannot be classified using the other disciplines listed, usually because they are highly interdisciplinary or multidisciplinary in nature.

Figure A9 reinforces the highly specialized role of chemical engineering and materials science demonstrated in Figure A8. **Chemical engineering and materials science are Delaware's most highly specialized R&D fields, with location quotients of 17.4 and 15 respectively. Additionally, chemical engineering has the largest amount of 2023 funding.** Other geosciences are also highly specialized, albeit with a relatively low overall funding amount. **All detailed fields have experienced investment growth since 2019, with the highest growth being in other engineering, other sciences, astronomy and astrophysics, computer and information sciences, and biological and biomedical sciences.**

Figure A-9. Delaware University R&D Spending Trends and Specializations by Detailed Academic Discipline



Source: TEConomy's analysis of National Science Foundation (NSF), National Center for Science and Engineering Statistics, Higher Education Research and Development (HERD) Survey

Conclusions from Technology Push

The quantitative analyses described in this section reveal a critical mass of activity driving several key use-inspired science and technology capabilities. **Delaware's academic research volume, supplemented by grant awards, investment activity, and industry-facing centers at the state's universities, is focused around nine thematic research competencies in technology areas such as medicine and biomedical research, materials and chemical engineering, agriculture, data science, and marine science.**

Table A5 summarizes the S&T-related core competencies emerging from research activity indicators across Delaware institutions analyzed in the "technology push" assessment. For each listed core competency, the table illustrates the level of support identified through each quantitative analysis outlined in this section. Analyses indicating a leading and differentiated presence, a strong presence, or some presence of a listed competency are highlighted.

Table A5. Summary of Delaware Core Competency Themes Across Indicators of Research Activity

●● = Leading, differentiated presence of core competency; ● = Strong presence of core competency; ○ = Some presence of core competency

Broad Thematic Research Competencies Emerging from Quantitative Analyses	Overall Presence of Leading Fields in Recent Research Publications Trends	Presence of Use-Inspired Themes in Topic Modeling of Research Publications Records	Presence of Active Researcher-led Project Awards Supporting Competency	Presence of Supporting Industry-Facing University and Federal Lab Research Centers	Significant Shares of University R&D Spending Relative to National Trends
Drug Development & Manufacturing	●	●●	●●	●●	
Bioinformatics & "Multi-omics" Diagnostics	●	●	●	●	
Rehabilitative Medicine & Biomedical Engineering	●●	●●	●	●	
Composites, Nanotechnology, & Other Advanced Materials	●●	●	●●	●●	●●
Chemical Engineering	●●	●●	●●	●●	●●
Sustainable Agriculture	●	●	○	●	●
Data Sciences & AI Applications	●	●	●	●	
Marine Science & Coastal/Climate Resilience	●●	●	●●	●●	●
Energy Science & Renewable Technologies	●	○	○	●●	

Source: TEConomy Partners, LLC

Market Pull

This section summarizes TEConomy's quantitative assessments of Delaware's "market pull" activity, which use industry innovation and emerging technology indicators to identify potential alignment of research excellence with markets. A variety of information was analyzed to provide insight into the innovation activities and growth trends of existing Delaware industry clusters, identifying leading sectors that the state is well-positioned to build upon.

TEConomy leveraged several sources of data on industry performance and emerging technology applications to help build a picture of the market landscape and demand for new innovations:

- **Traded sector industry cluster position and performance,** which identify leading S&T-driven industries with specialized activity, critical mass to advance innovative products and services, and potential for translation of research to end markets.
- **Leading companies and economic development targets,** which identify potential alignment with research strengths.
- **Venture capital investment in emerging companies,** which highlights entrepreneurial companies and emerging sectors advancing innovation-led market applications and developing new technologies and services that generate interest from investors.
- **Trends in industry-led patenting,** which indicate industry innovation and highlight areas of applied technology where companies are actively investing in intellectual property (IP) generation in anticipation of market activity.
- **Federal Small Business Innovation Research (SBIR) grant awards,** which highlight pipelines of small business-led R&D in emerging technology areas that can indicate commercialization activity and capacity.
- **Industry R&D investment,** which identifies areas of specialization and potential innovation-led industry sectors.

Leading Industry Clusters

Science and technology-driven innovation in Delaware is generated by the specific traded sector clusters or niches that represent existing capabilities and emerging opportunity areas across the state. TEConomy conducted an analysis of Delaware traded sector industry cluster profiles to understand areas of industrial strength and comparative advantage. This analysis is primarily focused on leading innovation-driven, STEM talent-intensive, and export-oriented industries, or what are known as "advanced industries" as identified by The Brookings Institution. High-performing traded clusters represent clear sources of demand for new technologies and innovation, making them important drivers of wealth generation and state economic development. This industry cluster analysis provides a starting point for the other market pull analyses in Delaware's line-of-sight assessment.

Traded sectors are industries that sell their goods or services to markets outside their local region. **These industries are critical for economic growth because they bring new wealth into the local economy and create significant "multiplier" effects.** Traded sectors tend to be more innovative and S&T-oriented due to several factors such as exposure to international competition and global supply chain integration, ability to drive geographic specialization and corresponding investment in new products and services and improved economic resilience that enables investment in long-term R&D and ideation. In contrast to traded sectors, local industries such as retail and healthcare are driven by population growth and primarily serve local residents.

To assess the performance of Delaware's traded sectors, TEConomy analyzed the following economic measures for each traded sector industry cluster:

- **Relative Concentration of Detailed Industries in Identified Clusters (location quotient analysis):** Measure of which detailed industries are specialized within an industry cluster relative to the nation.
- **Employment Changes for Detailed Industries in Identified Clusters (past growth analysis):** Measure of whether industry cluster is a job generator. This is best viewed over an entire business cycle (peak to peak) to ensure a thorough understanding of the business dynamics.
- **Projected Growth of Detailed Industries in Identified Cluster (future growth analysis):** Informs which detailed industries within an industry cluster are projected to grow in coming years, as opposed to losing competitive share amidst changing market and talent dynamics.

Table A6 displays Delaware traded sector cluster profiles, including information on share of state GSP, past and projected employment relative to national levels, and location quotient. Location quotients are included for the Philadelphia MSA as well to contextualize Delaware's markets in the broader region. Shaded cells indicate either outsized portions of Delaware's private sector industry mix, traded industry sectors that outperform overall past or future US growth trends, or highly specialized industry clusters with LQ values of at least 1.2. **Delaware's traded sector profiles indicate strong industry capabilities in financial and insurance services, food and natural resource processing, chemical manufacturing, corporate and business services, and transportation and logistics.**

Table A6. Profile of Traded Sector Industry Clusters in Delaware

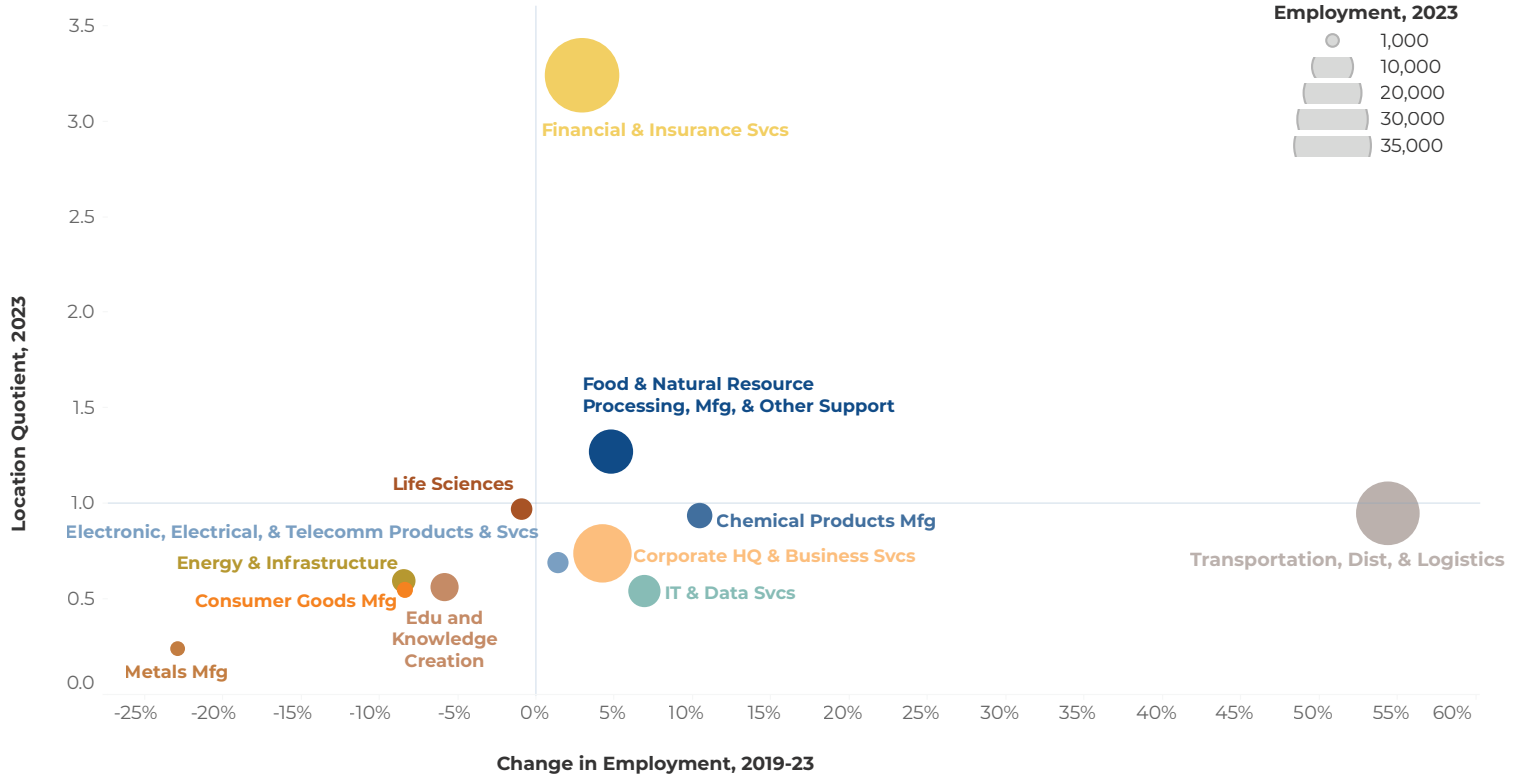
Industry Sector	% of Total DE GSP, 2023	Empl., 2023	Projected 2033 Empl.	DE Empl. Change 2019-23	U.S. Empl. Change 2019-23	Projected DE Empl. Change 2023-33	Projected U.S. Empl. Change 2023-33	DE Location Quotient 2023	Philly MSA Location Quotient 2023
Traded Sector Total	**48.7%**	**120,736**	**133,961**	**9.4%**	**6.5%**	**11.0%**	**9.8%**	**0.94**	**0.95**
Financial & Insurance Services	16.4%	34,262	38,186	2.9%	3.1%	11.5%	7.9%	3.24	1.30
Transportation, Distribution, & Logistics	7.0%	24,958	31,665	54.3%	11.5%	26.9%	8.8%	0.95	0.88
Corporate HQ & Business Services	6.5%	21,395	21,508	6.1%	7.3%	0.5%	11.8%	0.75	1.01
Food & Natural Resource Processing, Mfg, & Other Support	2.6%	12,073	12,977	4.7%	4.1%	7.5%	8.0%	1.27	0.62
IT & Data Services	2.2%	6,414	7,365	6.9%	18.1%	14.8%	23.4%	0.54	0.68
Education and Knowledge Creation	1.2%	4,887	4,021	-5.9%	10.0%	-17.7%	9.7%	0.56	2.14
Chemical Products Manufacturing	3.5%	3,997	4,599	10.7%	0.1%	15.1%	4.5%	0.94	0.89
Energy & Infrastructure	5.0%	3,390	3,279	-8.9%	-3.9%	-3.3%	7.1%	0.59	0.57
Electronic, Electrical, & Telecom Products & Services	1.1%	2,787	3,533	1.9%	4.6%	26.7%	14.6%	0.7	0.55
Life Sciences	1.4%	2,454	2,421	-15.1%	9.0%	-1.3%	10.6%	0.84	1.55
Consumer Goods Manufacturing	0.4%	1,528	1,432	-12.2%	-7.1%	-6.3%	-5.0%	0.53	0.63
Metals Manufacturing	0.5%	1,420	1,644	-18.9%	-3.0%	15.8%	2.5%	0.26	0.67
Production Technology and Heavy Machinery	0.7%	734	880	-1.9%	0.60%	19.9%	6.6%	0.24	0.64
Aerospace & Defense	0.1%	348	356	-46.7%	-0.3%	2.3%	7.0%	0.17	1.20
Vehicle Manufacturing	0.0%	88	94	-42.7%	2.7%	6.5%	-1.8%	0.03	0.25
Advanced Industries1	18.4%	29,552	31,055	1.3%	9.3%	5.1%	12.1%	0.62	0.88
Total Private Sector	**100%**	**404,158**	**434,423**	**3.9%**	**3.9%**	**7.5%**	**8.1%**	**1.00**	**1.00**

1) Denotes total employment in Brookings Advanced Industries definition. See https://www.brookings.edu/wp-content/uploads/2015/02/Advanced-Industries-Data-and-Methods-Appendix.pdf for further details.

Source: TEConomy's analysis of Lightcast data release 2023.2

Figure A10 provides additional visualization of the relative concentration and employment changes for Delaware traded clusters, graphing each cluster by location quotient and past employment growth. Points are sized by the 2023 employment figures. **Two of the traded sectors are highly specialized in Delaware, with location quotients exceeding 1.2: Financial & Insurance Services and Food & Natural Resource Processing, Manufacturing, and Other Support.** These sectors have both experienced employment growth since 2019 as well. **The Transportation, Distribution, and Logistics sector has grown the most rapidly during this recent period.** While less concentrated in Delaware than nationally, its location quotient will continue to increase if projected trends are realized. By contrast, **nine of the sectors displayed in Figure A10 have either experienced employment declines or lagged national growth by more than one percentage point.**

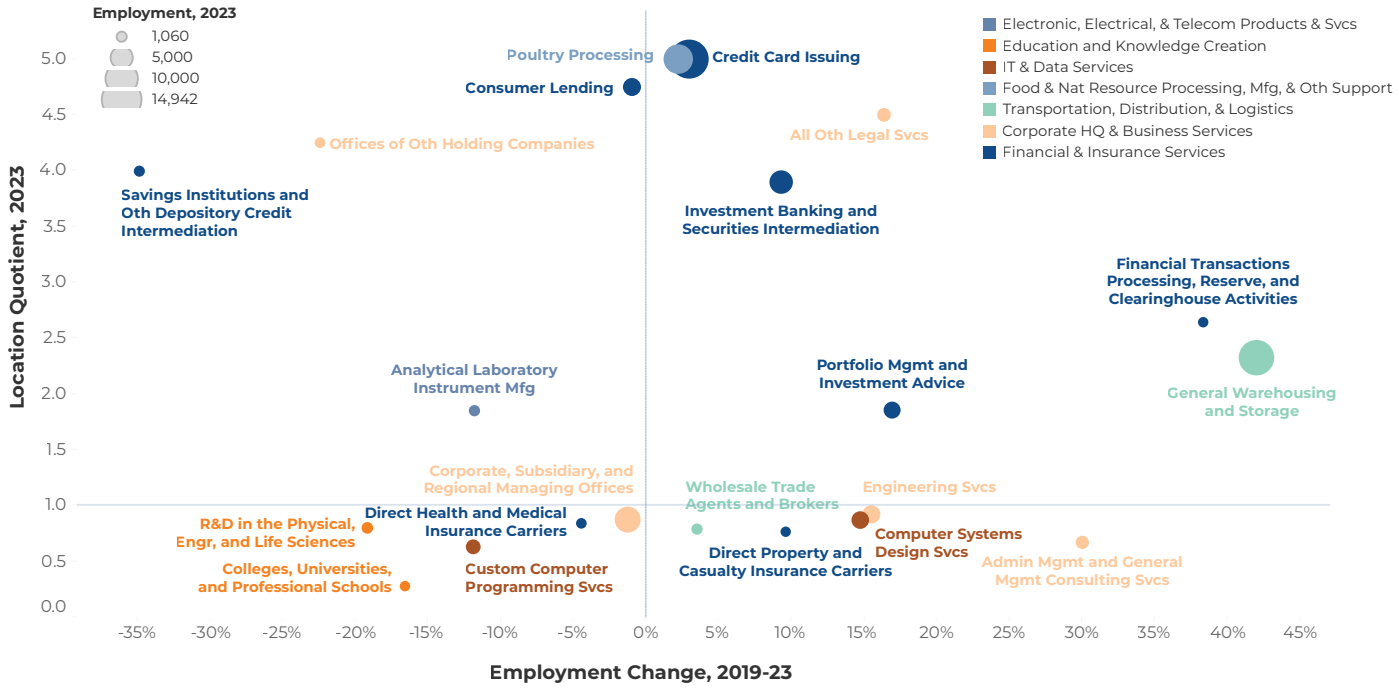
Figure A-10. Summary of Traded Sector Industry Cluster Trends in Delaware, 2019-2023



Source: TEConomy's analysis of Lightcast (datarun 2024.3)

Figure A11 illustrates specialization levels and employment change for the detailed industries within Delaware's identified traded sectors, as defined by 6-digit NAICS codes. Detailed industries are graphed by location quotient and growth, sized by 2023 employment, and colored by broad traded sector. **Among detailed industries with 2023 Delaware employment of 1,000 or more, seven segments are both specialized and growing, including Credit Card Issuing, General Warehousing and Storage, Investment Banking and Securities Intermediation, and Poultry Processing.** The traded sector **Financial & Insurance Services** comprises most of the detailed segments in Figure A11 that are either highly specialized, growing, or both, reflecting the importance of this sector as a major industrial strength in Delaware with continued growth potential. **Additionally, the traded sector General Warehousing and Storage leads all detailed industries in the state with growth of 153 percent since 2019.** Increased national demand for warehousing and geographic proximity to major markets have driven substantial investment by companies in this space within Delaware.

Figure A-11. Summary of Leading Detailed Traded Sector Industries in Delaware, 2019-2023 (6-digit NAICS with at least 1,000 jobs in 2023)



Source: TEConomy's analysis of Lightcast (datarun 2024.3)

To best inform a customized cluster strategy for Delaware, it is important to complement this traded cluster assessment by considering the targeted major growth industries identified by DPP, which include:

- **Manufacturing and Logistics:** Transportation equipment is noted as one of Delaware's largest manufacturing exports, valued at almost $900 million, consisting of products like aircraft parts, aerospace parts, and automotive materials. Other manufacturing companies focus on products like electrical equipment manufacturing, structural metals, and paper products.

- **FinTech, Business, and Financial Services:** Anchored by major financial services providers such as Bank of America, Barclays US Consumer Bank & Barclays Bank Delaware, Capital One, M&T Bank, Marlette Funding, WSFS Bank and JPMorgan Chase. Today, financial services are the state's largest traded sector with robust startup and innovation activity.

- **Biotech and S&T Industries:** Known for global leadership in chemical innovation due to anchoring companies such as DuPont, but also anchored by materials science companies such as W.L. Gore and increasingly by biotech companies like Incyte and Agilent that provide drug discovery and manufacturing services.

- **Education and Healthcare:** Operations of several healthcare systems located in state (Highmark, Christiana Care, Bayhealth, TidalHealth, etc.) in addition to major research universities.

- **Food and Agriculture:** One of the country's leading producers of broiler chickens, generating more than $1 billion in sales annually. Leading poultry processors such as Perdue, Allen Harim, and Mountaire have significant operations in the state.

Most of DPP's industry clusters align with and reinforce the strengths seen in the traded cluster industry analysis.

In addition, leading traded sector Delaware companies as identified by Inc 5000 and DPP help to anchor and drive innovation in the state's key existing industry clusters. They include:

- **Advertising and Marketing**
  - Hite Digital: digital marketing services
  - Brand IQ Group: digital marketing services
  - Tapp Networks: digital marketing services
  - Carvertise: rideshare advertising

- **Financial Services**
  - Best Egg: personal loan lender
  - RiversEdge Advisors: financial planning and investment advisory

- **Agriculture/E-Commerce**
  - Hatching Time: poultry care products

- **Business Services**
  - Placers: staffing firm

Industry Innovation Indicators

Delaware industry innovation indicators complement traded sector industry cluster analysis by demonstrating existing and emerging industrial research strengths and areas of innovation leadership. Indicators analyzed in this section include patent innovation activity, venture capital investment, industrial R&D investment, and federal Small Business Innovation Research grant awards. These indicators provide additional insight into industry performance and technology applications, highlighting growth opportunities across Delaware's market landscape.

Delaware Patent Innovation Activity

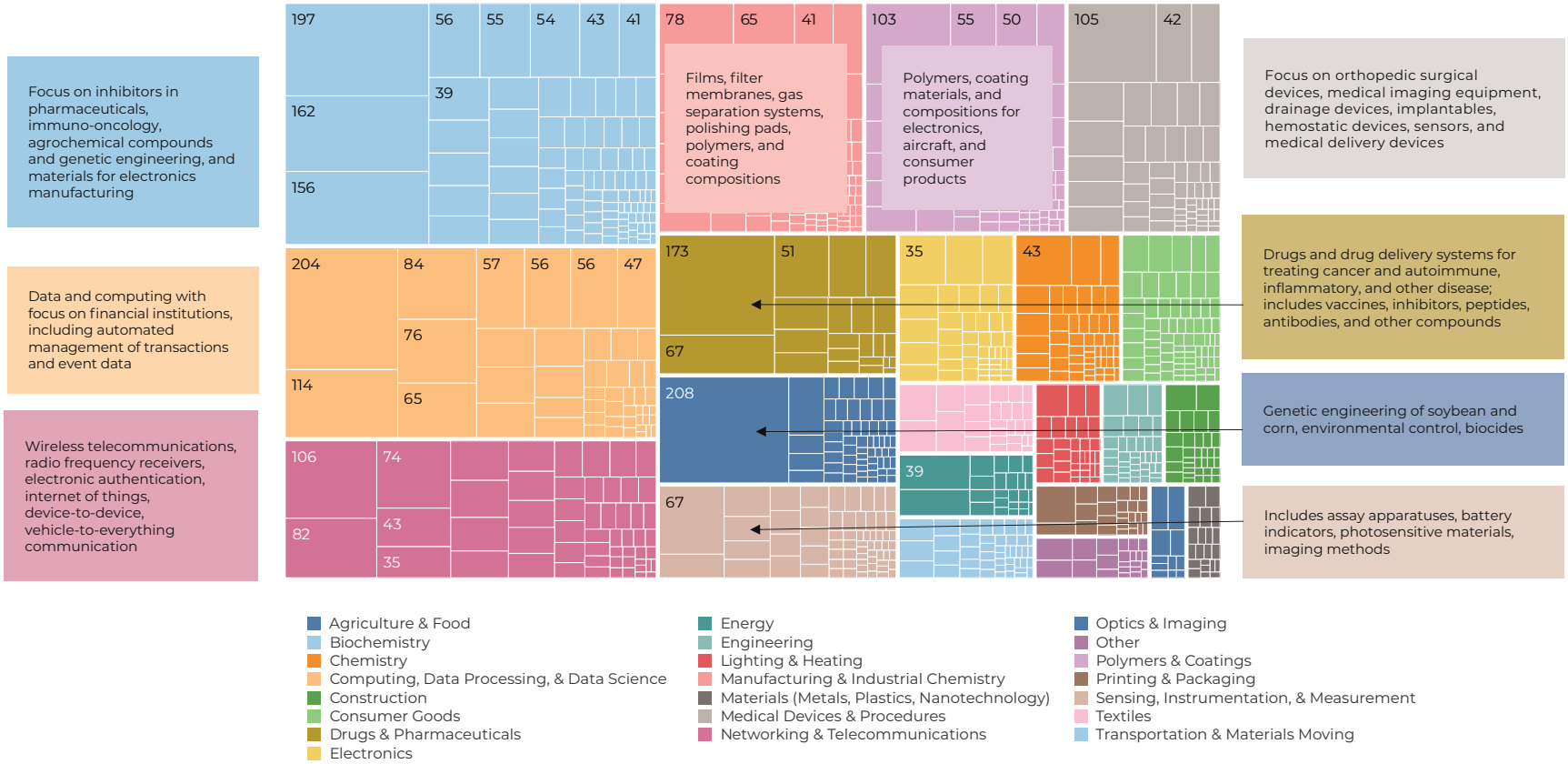
An important indicator of key industrial technology capabilities is patent innovation activity being generated within Delaware. Patents are a primary means for inventors to protect their product innovations from being replicated, and as such can be a good proxy for understanding the types of innovation where unique and specialized competencies are being demonstrated in a region. Although there are other forms of intellectual property protection through copyrights, trademarks, and trade secrets, patents are among the most widely used form of protection of novel technological inventions.

This analysis of patent innovation activity focuses only on patents invented by Delaware residents in order to best capture the context of innovation generated within the state rather than innovations that companies "import" from inventors in other regions. The analysis also includes only Delaware-invented patents assigned to industry rather than universities or other research institutions, highlighting the most industry-facing IP originating in Delaware. Patent applications are considered along with patent awards to provide an assessment of more recent innovation activities, since it can take several years for a patent award to be issued from the time of initial application.

Delaware inventors generated 8,060 industry-assigned U.S. patent records from 2019 to 2024, totaling 3,450 patent awards and 4,610 unique patent applications. Totals were adjusted for patent applications that eventually transitioned to awards during

this timeframe to prevent double counting. Figure A14 depicts these Delaware patents by the broad technology class listed in the patent records. These technology classes describe the various applications and combination technologies found within the intellectual property documented in the record. **The leading technology classes in Delaware-invented, industry-assigned patents highlight industry IP generation in life sciences, financial analytics, and data processing applications, with emphasis in biopharmaceuticals, agrochemical compounds, business management, telecommunications, and Internet of Things.**

Figure A-12. Leading Technology Classes in Delaware-Invented, Industry-Assigned Patents, 2019-2024



Source: TEConomy's analysis of USPTO data via Derwent Innovation

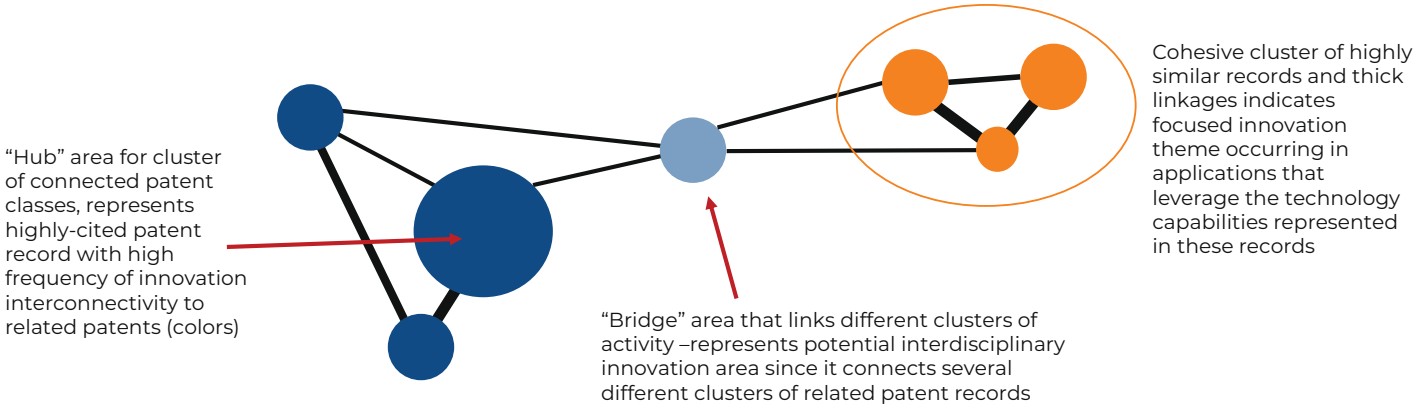
TEConomy leveraged these patent technology classes to further investigate themes within Delaware patent activity. In addition to the "primary" technology class listed in a patent filing, there are additional technology classes listed that describe the various applications and combination technologies found within the documented intellectual property. Examining these technology classes in the context of this "bundle" of cross-listed technologies can provide a more holistic and nuanced view of the ways in which innovative applications are being advanced.

The idea of convergent sets of technologies is a powerful concept for describing areas of critical mass where groupings of technologies are being leveraged together to create new products and services, with relationships between technologies forming a set of connections that can be considered together as network depicting the technology landscape of a set of patents. From economic literature describing healthy innovation ecosystems, the formation of such networks that leverage many technologies is one of the critical underpinnings of a robust innovation economy.

TEConomy used network analysis algorithms to visually construct a network of cross-disciplinary technology linkages based on the combinations of technology classes present in Delaware patent activity. This approach provides a way to depict the structure and emergent themes in the "landscape" of Delaware's innovative capabilities contained in patent records. To support the linkages found through technology classes, the unstructured data in the patent abstracts was also leveraged, similar to the approach used for topic modeling of publications and grants in the technology push assessment. TEConomy did not develop a full topic model for patents, but unstructured text similarities were calculated and combined with technology class linkages in a weighted average, giving technology classes an 80% weight and text similarities a 20% weight.

Figure A15 illustrates how these innovation landscape networks are constructed from patent data and interpreted to study Delaware innovation themes. The network nodes, denoted by circles, indicate individual patent records, sized by the number of forward citations. Highly-cited patents are impactful in terms of contributing to follow-on innovation since patents routinely cite prior patents as references in documenting their new intellectual property. Node colors indicate clusters of highly related patents connected by common co-occurring technology classes, as determined by network analysis algorithms. Lines connecting nodes indicate linkages between patents, with the thickness of lines indicating the volume of connections observed across the set of patent records based on the weighted average between technology classes and abstract text similarity.

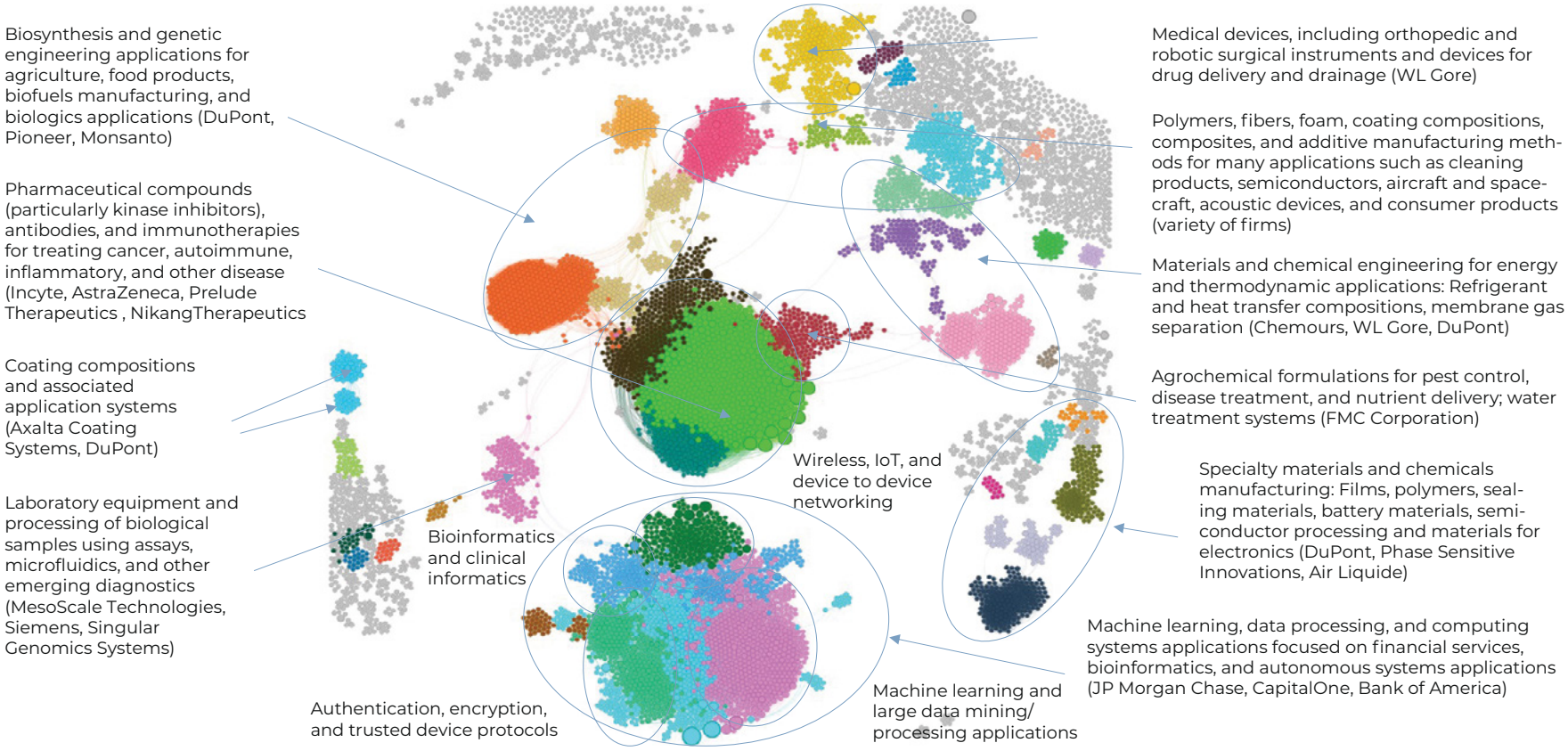
Figure A-13. Example of Network Formed by Patent Records Linked by Technology Class Areas



Source: TEConomy Partners, LLC

Figure A16 illustrates the main innovation themes identified across the network of Delaware-invented, industry-assigned patent records. **This network perspective indicates strong industry capabilities in chemical manufacturing, financial and insurance services, IT and data, life sciences, electronics and telecommunications, and food and natural resource processing.** In addition, Figure A16 points out leading firms generating IP in each cluster.

Figure A-14. Innovation Network Perspective of Delaware-Invented IP Generation by Industry



Source: TEConomy's analysis of USPTO data via Derwent Innovation

Expanding on the companies identified in the network landscape, Table A7 details the leading companies listed as assignees in Delaware-invented patent records over the period of analysis. All Delaware-invented industry-facing patents represent potential market opportunities for the state, but companies with Delaware offices are listed first in the table since they indicate stronger current industry presence. **Leading Delaware assignee companies are primarily focused on innovation in biopharmaceuticals, materials engineering, chemical manufacturing, electronics, financial technology, and wireless communications.**

Table A7. Leading Company Assignees in Delaware-Invented IP Generation by Industry

Primary Patent Assignee	Assignee Innovation Focus in Patenting	Patent Applications	Patent Awards	Total Patent Records	Delaware Office
Incyte Corporation	Small molecule drugs, primarily in oncology, including compounds, formulations, and processes	360	262	622	Yes
DuPont	Advanced materials, chemistry, agricultural biotechnology, and electronics	309	223	532	Yes
W.L. Gore & Associates	Advanced materials and membranes with applications in medical devices, textiles, and manufacturing	195	128	323	Yes
Chemours Company	Advanced electronics materials and industrial chemistry for water treatment and other applications	188	126	314	Yes
Bank of America	Financial technology and AI with applications in payments, information security, fraud detection	136	103	239	Yes
Monsanto	Genetically engineered disease-resistant corn and soybean varieties	107	103	210	Yes
Convida Wireless	Wireless communications, connectivity innovations, and Internet of Things	87	86	173	Yes
Rohm and Haas	Materials for electronics, water treatment, agriculture, coatings, and sealants	70	64	134	Yes
Capital One	Financial technology, AI, and blockchain with applications in digitalization and cybersecurity	64	50	114	Yes
Solenis	Chemical technologies for water treatment, paper production, oil refining, and other biotechnology	57	38	95	Yes
Phase Sensitive Innovations	Radio frequency-photonic technologies, including advanced receivers, antennas, and other components	45	34	79	Yes
Axalta Coating Systems	Coatings and paints for vehicles, buildings, and industrial applications	39	32	71	Yes
J.P. Morgan	Financial technology, digital banking, blockchain, banking systems, cybersecurity, and data analytics	216	148	364	No
Qualcomm	Wireless communications and semiconductor technologies	58	82	140	No
Air Liquide	Industrial gases, carbon capture and storage, hydrogen production and storage	70	52	122	No
FMC Corporation	Synthetic chemistry in agriculture, including insecticides, herbicides, and fungicides	70	45	115	No
Siemens	Imaging and AI-diagnostics, industrial automation and Internet of Things, and smart infrastructure	57	53	110	No
Boeing	Manufacturing, industrial automation, and computing with aerospace and defense applications	41	48	89	No
Universal Display Corporation	Organic light-emitting diode displays, including phosphorescent materials, device architectures, and manufacturing processes	47	20	67	No
Danisco	Food production, preservation, and additives; industrial enzymes and fermentation processes	49	12	61	No
AstraZeneca	Pharmaceutical compounds, drug delivery, and gene therapies	51	9	60	No
Apple	Consumer electronics including hardware, operating systems, software, and interface design	27	32	59	No
Pioneer Hi Bred	Agricultural biotechnology with applications in plant genetics and breeding and sustainability	33	24	57	No
Total		**4,610**	**3,450**	**8,060**	

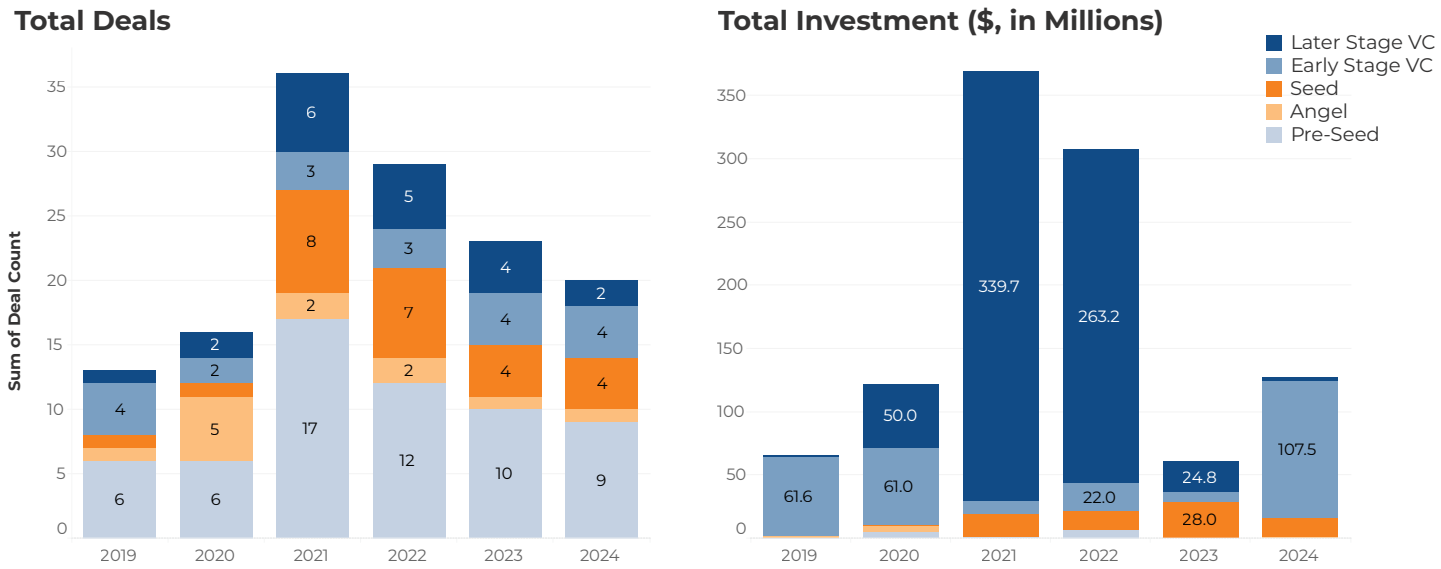
Source: TEConomy's analysis of USPTO data via Derwent Innovation

Delaware Venture Capital Investment

Risk capital investment in emerging companies is an especially relevant indicator of industry-facing innovation activity where capital is being actively deployed to fund promising products and services. Examining the leading industries associated with venture capital investment can highlight growing areas of critical mass in Delaware's markets. TEConomy used the PitchBook venture capital database to analyze venture funding in pre-seed, angel investor, seed, and early and later stage venture capital deals for every Delaware company receiving venture financing between 2019 and 2024. Only companies with operations in Delaware were considered (as opposed to companies incorporated in Delaware but operating elsewhere).

Figure A17 illustrates total venture capital deals and investment dollars by year and investment phase. Venture capital deal flow levels and investment totals in Delaware have receded from the peak in 2021, consistent with a steep national drop in venture investment levels over the last three years. Despite following the national trend, the rebound in Delaware investment in 2024 outpaces national growth from the prior year. Within the state, 65 percent of total investment is classified as later stage venture capital, which aligns with the broader national distribution of investment phases.

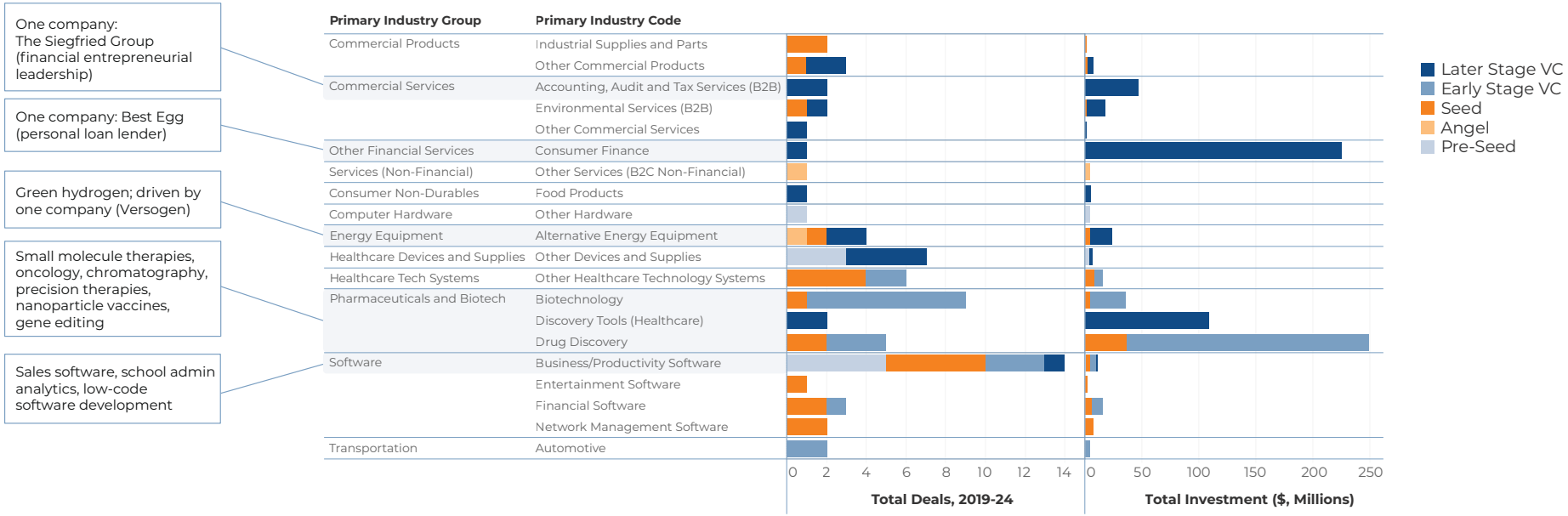
Figure A-15. Trends in Levels of Venture Capital Deal Flow and Investment in Emerging Delaware Companies, 2019-2024



Source: TEConomy's analysis of PitchBook data

Figure A18 graphs Delaware venture capital deals and investment totals by industry code in order to highlight emerging industry sectors that are advancing innovative market applications and generating interest from investors. The industry mix associated with recent venture capital investment in Delaware companies demonstrates particular emphasis on life sciences and financial and business services technology. Figure A18 also highlights industry groups whose venture capital investment is primarily driven by a single leading company.

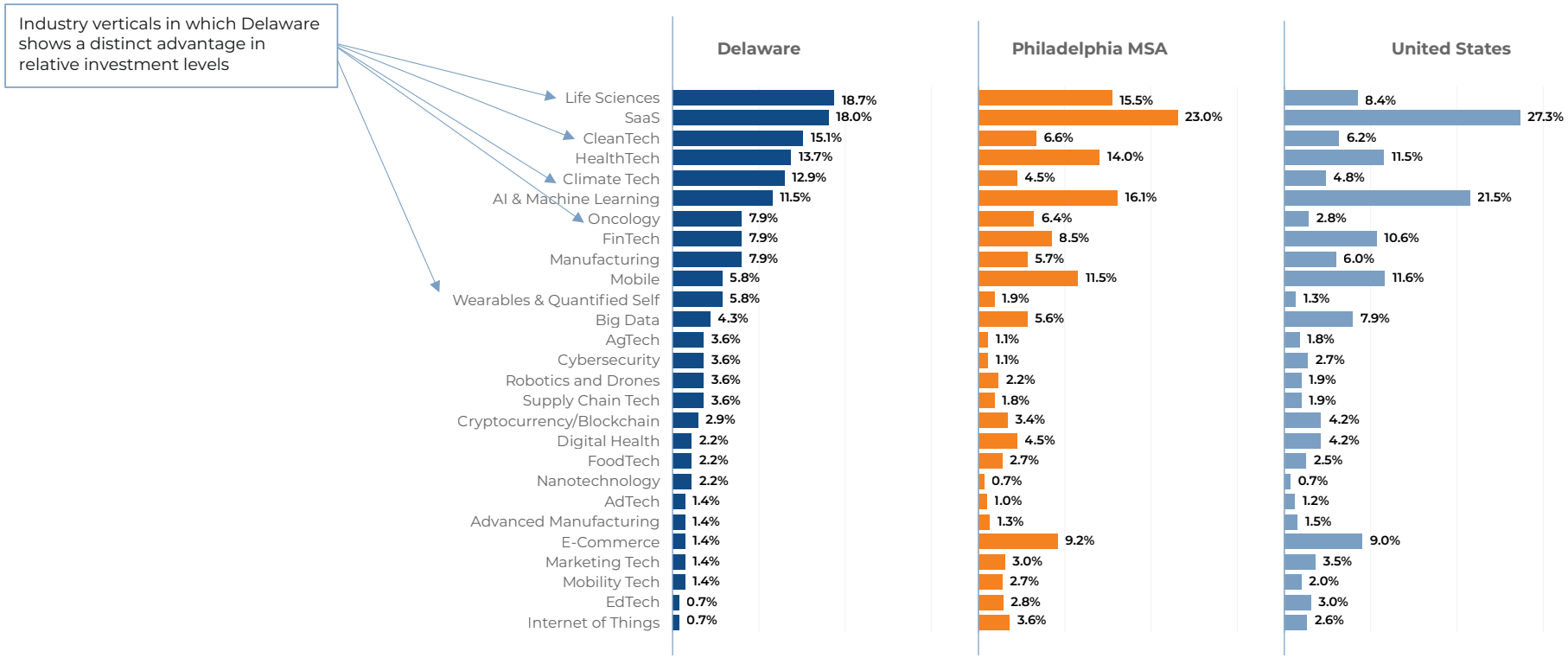
Figure A-16. Profile of Emerging Market Focus Areas from Recent Venture Capital Investment Activity in Delaware Companies



Source: TEConomy's analysis of PitchBook data

To further examine the industries associated with Delaware venture capital funding and to benchmark Delaware against the Philadelphia MSA, and the nation, Figure A19 breaks down venture capital investment for each region by key industry applications verticals, indicating each vertical's share of total funding. This analysis highlights Delaware's emphasis on venture capital financing in life sciences, SaaS applications in fintech and business services, and clean/climate tech. **Compared to the U.S. and the Philadelphia MSA, Delaware displays a distinct advantage in the life sciences, clean tech, climate tech, oncology, and wearables and quantified self industry verticals.**

Figure A-17. Investment in Key Industry Verticals as a Percentage of Total VC Deals, 2019-2024



Source: TEConomy's analysis of PitchBook data

Over 2019-2024, Delaware's industry verticals with the top venture capital shares had the following average deal values (in millions, with highest average deal values in bold):

- **Life Sciences: $24.8 (U.S. $17.3)**
- SaaS: $11.0 (U.S. $12.1)
- CleanTech: $2.0 (U.S. $10.3)
- HealthTech: $1.4 (U.S. $10.1)
- Climate Tech: $2.5 (U.S. $15.9)
- AI & ML: $0.9 (U.S. $12.6)
- **Oncology: $45.8 (U.S. $19.5)**
- **FinTech: $22.1 (U.S. $13.1)**
- Manufacturing: $0.3 (U.S. $6.8)
- Mobile: $1.3 (U.S. $10.1)
- Wearables & Quantified Self: $1.2 (U.S. $5.6)

Delaware Industry R&D Spending and Federal SBIR/STTR Awards

A key way that companies translate basic science and innovation into market-facing products and services is through investment in internal research. This represents a direct measure of the level to which companies are prioritizing innovative growth in their spending decisions. To assess research and development spending and growth over time in each of Delaware's industry clusters, TEConomy leveraged national survey data compiled by the National Science Foundation through its Business R&D and Innovation Survey (BRDIS) for 2019 through 2022. The survey examines a representative sample of privately held, non-farm businesses across the U.S. that performed $50,000 or more of R&D.

Table A8 summarizes the industry R&D spending levels and concentrations (measured by LQ) across Delaware's traded sectors and their corresponding detailed industries. **Biopharmaceuticals drive much of Delaware's industry R&D expenditures, while chemical product manufacturing and food production are the most highly specialized in R&D investment.**

Table A8. R&D Spending Amongst Leading Industry Sectors with >$5M in Spending in 2022

Traded Sector Industry	Detailed Industry	2022 Industry R&D ($M)	Share of DE 2022 Industry R&D Total	2022 R&D Concentration (LQ)	DE Change, 2019-2022	U.S. Change, 2019-2022
All Industries Total	-	**$2,874**	**-**	**-**	**100.10%**	**41.70%**
Life Sciences	Pharmaceuticals and medicines	$1,639	57.00%	3.31	286.60%	33.10%
Financial & Insurance Services	Finance and insurance	$319	11.10%	3.93	145.40%	93.20%
Food & Natural Resource Production	Food	$271	9.40%	8.51	-28.50%	71.00%
Chemical Products Manufacturing	Basic chemicals	$192	6.70%	15.35	111.00%	20.40%
Life Sciences	Electromedical, electrotherapeutic, and irradiation apparatus	$74	2.60%	3.95	2366.70%	27.00%
Electronic, Electrical, & Telecom Products & Services	Other measuring and controlling devices	$69	2.40%	3.67	35.30%	-9.50%
IT & Data Services	Computer systems design and related services	$31	1.10%	0.35	342.90%	2.60%
IT & Data Services	Data processing, hosting, and related services	$25	0.90%	0.11	-7.40%	63.40%
IT & Data Services	Software publishers	$25	0.90%	0.11	177.80%	53.20%
Life Sciences	Medical equipment and supplies	$11	0.40%	0.12	-38.90%	27.20%
Chemical Products Manufacturing	Plastics and rubber products	$7	0.20%	0.46	-56.30%	17.40%
Electronic, Electrical, & Telecom Products & Services	Semiconductor and other electronic components	$7	0.20%	0.03	600.00%	48.20%
Aerospace & Defense	Aerospace products and parts	$6	0.20%	0.09	500.00%	54.90%
Vehicle Manufacturing	Transportation equipment	$6	0.20%	0.03	100.00%	47.50%

Source: TEConomy's analysis of NSF Business R&D and Innovation Survey (BRDIS)

In addition to industry R&D, federal Small Business Innovation Research (SBIR) and Small Business Technology Transfer (STTR) grant awards are another important indicator of investment in industry research that can allow emerging companies to translate innovation into market-facing products and services. SBIR awards represent a significant milestone in the commercialization process where capital is being actively deployed by the federal government to fund industry innovation in budding businesses.

TEConomy examined SBIR/STTR awards given to Delaware companies between 2019 and 2023, identifying funding activity from the following federal agencies:

- Department of Health and Human Services (HHS): 38% of all awarded dollars
- Department of Defense (DoD): 36% of all awarded dollars
- Department of Energy (DoE): 16%
- National Aeronautics and Space Administration (NASA): 5%
- National Science Foundation (NSF): 4%

There were 81 Delaware-based companies receiving SBIR funding during the period of analysis. Table A9 displays the 22 companies that were awarded at least $1.5 million. These 22 companies comprise 56 percent of awards to Delaware companies and 80 percent of the total funding awarded. Award activity in these top Delaware companies is primarily focused on a variety of biomedical and materials-related technologies.

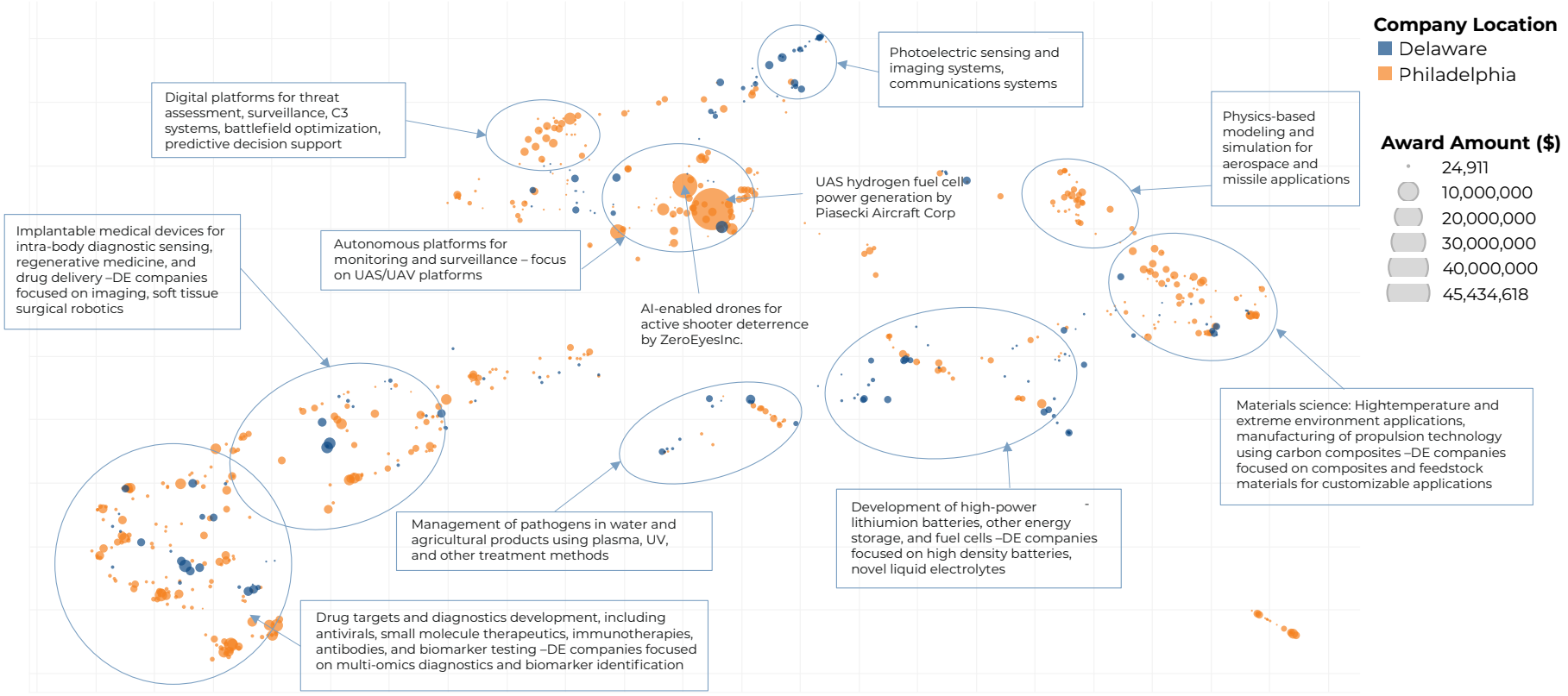
Table A9. Leading Delaware Companies in Recent Federal SBIR/STTR Award Activity

Company	Research Area	Awarding Agencies	Total Awards, 2019-2023	Sum of Award Amount ($, Millions)
Phase Sensitive Innovations	photonic devices	DOD, DOE, NASA	23	$12.86
IsoPlexis Corporation	proteomics - immune response and disease progression	HHS	5	$10.16
Optosurgical	technology for thyroid surgery	HHS	5	$9.48
Morgan & Mendel Genomics	functional genomics	DOD, HHS	4	$4.90
RiKarbon	renewable oils and products from bio-based carbon	DOE	4	$3.96
Composites Automation	advanced composite materials and process technologies	DOD, DOE, NASA	6	$3.92
Chip Design Systems	sensor development and testing	DOD	5	$3.82
Biomason	bio-based concrete	DOD	1	$3.82
STF Technologies	advanced materials - shear thickening fluid	DOC, DOE, NASA	7	$3.64
SHE BASH	DevSecOps	DOD	3	$3.36
En Solución	chemical-free food safety	HHS	3	$2.80
Talos Tech	advanced batteries	DOD, DOE, NASA	5	$2.57
The Amino Company	amino acids	HHS	2	$2.45
Applied Diamond	natural and synthetic diamonds	DOE	6	$2.39
Framergy	PFAS remediation and batteries	DOD, EPA	2	$2.17
Extreme Scale Solutions	data processing and cloud computing	DOE	3	$2.16
GlycoMira	innate immune system modulators for cancer	HHS	1	$1.98
Ballydel Technologies	advanced materials and manufacturing processes	DOD, NASA	5	$1.87
EM Photonics	GPU computing	DOD	5	$1.86
PedialyDx	analysis of baby crying acoustics	HHS	1	$1.83
Delux Advanced Manufacturing	multi-material 3D printing processes	DOD	3	$1.66
Einsenca	imaging of neuroinflammation in Alzheimer's disease	HHS	1	$1.65

Source: TEConomy's analysis of SBIR.gov data

To examine the distinct strengths and innovation themes in Delaware SBIR/STTR awards, TEConomy leveraged unstructured text in award abstracts and visualized a landscape perspective based on abstract similarities. This landscape analysis included both Delaware and Philadelphia-based SBIR awards in order to examine Delaware's activity within the context of broader regional markets. Figure A20 illustrates the key themes identified across the landscape of Delaware and Philadelphia MSA SBIR/STTR grant awards. Points representing individual awards are sized by total award amount and colored by Delaware or Philadelphia company base. **The regional SBIR/STTR award landscape indicates strong industry capabilities in electronics and telecommunications, biomedical and life sciences, aerospace and defense, chemical manufacturing, energy infrastructure, and data science.**

Figure A-18. Landscape Perspective of Thematic Areas Within Regional SBIR/STTR Awards, 2019-2023



Source: TEConomy's analysis of SBIR.gov data

Conclusions from Market Pull

The quantitative analyses described in this section reveal a critical mass of existing innovation-focused industry activity. Delaware's leading industry clusters as identified by the traded sector analysis, supplemented by business investment and R&D and IP generation, highlight several niche markets representing existing strengths or emerging areas of opportunity in Delaware. **The state's strongest sectors across all technology and innovation indicators include Life Sciences, Financial & Insurance Services, Food & Natural Resource Processing, Chemical Products Manufacturing, and IT & Data Services.**

Table A10 summarizes Delaware's S&T-related, market-facing areas of activity, as outlined by the traded sector industry cluster analysis and supported by other analyses in the "market pull" assessment. For each traded sector, the table illustrates the level of support identified through each analysis outlined in this section. The Leading Industry Position column reflects the economic measures included in Delaware's industry cluster analysis (location quotients, employment, and growth), while the subsequent columns summarize results from the other technology and innovation indicators examined. Analyses indicating a leading and differentiated presence, a strong presence, or some presence of a traded sector are highlighted.

Table A10. Summary of Delaware Industry Cluster Activity Across Indicators of Industrial Innovation, Specialization, and Growth

●● = Leading, innovation-driven traded sector cluster; ● = Strong presence of traded sector cluster; ○ = Some/emerging presence of traded sector cluster

Traded Industry Sectors	Leading Industry Position*	DPP Focus Industry with Existing Anchor Companies	Presence of Emerging Companies in VC Investment	Presence of Emerging Companies in SBIR Awards	Significant Shares of Industrial R&D Spending	Evidence of Significant IP Generation Activity
Aerospace & Defense				●	○	○
Chemical Products Manufacturing	●	●●		●	●●	●●
Consumer Goods Manufacturing		○				○
Corporate HQ & Business Services	●	●	○			
Education and Knowledge Creation	○	●				○
Electronic, Electrical, & Telecomms Products & Svcs	○			●●	●	●
Energy & Infrastructure	●		○	●		○
Financial & Insurance Services	●●	●●	●●		●●	●●
Food & Natural Resource Processing, Mfg, & Other Support	●●	●●	○		●●	●
IT & Data Services	○	○	●	●	●	●●
Life Sciences	●●●	●●	●●	●●	●●	●●
Metals Manufacturing		●				
Production Tech and Heavy Machinery				○		○
Transportation, Dist., & Logistics	●	●	○			○
Vehicle Manufacturing					○	

*Considers measures of employment size, recent growth in DE and relative to U.S., and concentration/specialization in DE relative to national averages (LQs).
**Leading life sciences companies in Delaware appear to be categorized under non-life sciences industry codes in QCEW data; as a result, significant employment base and specialization exists despite subpar industry position of "core" life sciences industries.
Source: TEConomy Partners, LLC

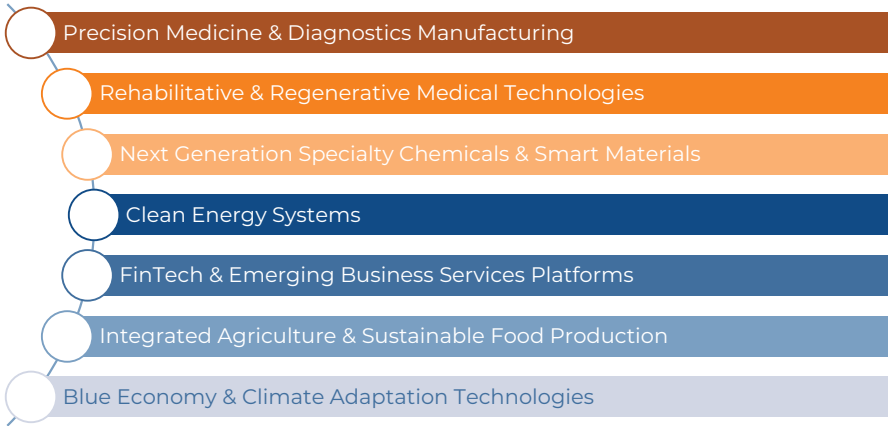
Conclusion

The technology push and market pull analyses together inform the line-of-sight assessment, which identifies growth opportunity areas where Delaware is best positioned to differentiate itself and sustain the state's leading industry clusters as well as advance emerging and future market opportunities. These innovation opportunities are centered around areas of technology and industry convergence, where Delaware's industry innovation drivers are aligned with the core technology competencies found across the state's research institutions. Strengths at this intersection indicate areas of specialization and critical mass that can allow Delaware to leverage a wide range of industry-facing assets.

TEConomy's quantitative analysis identified seven preliminary market opportunity areas where Delaware is advancing use-inspired, industry-facing innovation supported by key research assets within the state. The presence of major research activity and centers anchoring industry activity and innovative capacity makes these opportunities important potential drivers for translational research, commercialization, and economic development.

Figure A21 outlines these seven potential growth opportunity areas derived through quantitative analysis of Delaware research and industry activity.

Figure A-19. Potential Growth Opportunity Areas Indicated in Quantitative Analyses of Delaware Research and Industry Activity



Source: TEConomy Partners, LLC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