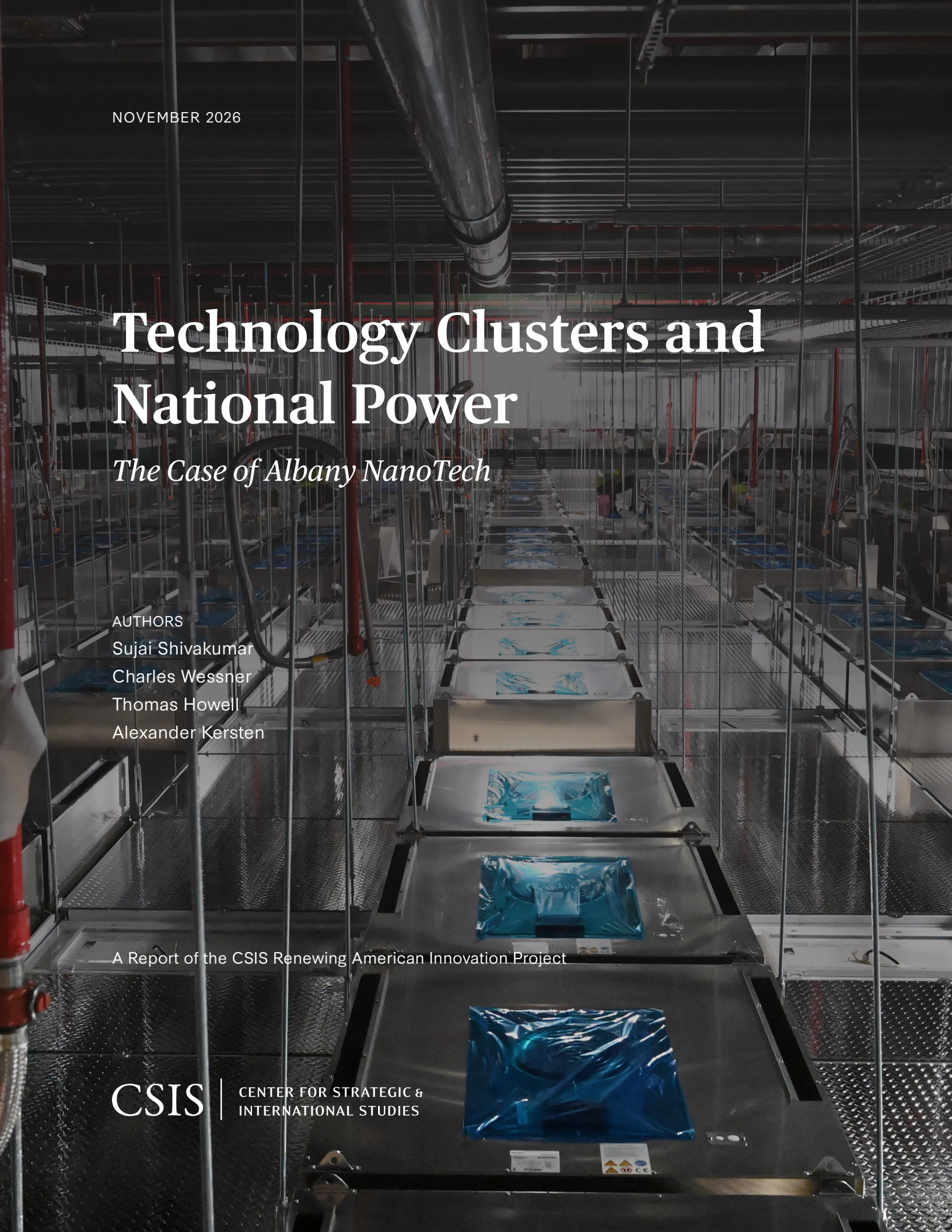


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Technology Clusters and National Power

The Case of Albany NanoTech

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A Report of the CSIS Renewing American Innovation Project

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Cover: Albany Times Union/Hearst Newspapers/Getty Images

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Executive Summary

Strategic competition between the United States and China has placed semiconductor leadership at the center of national power. Advanced chips are foundational to artificial intelligence, quantum systems, defense platforms, space technologies, biotechnology, medical devices, and high-performance computing. The capacity to conduct advanced semiconductor research and development (R&D) and manufacturing within the United States has become essential to supply-chain resilience, technological advantage, and long-term national security.

Semiconductor leadership, however, depends on more than the presence of individual firms or fabrication plants. It also depends on whether a region can organize many specialized assets into a working system: advanced research facilities that make experimentation possible, anchor companies that define technical needs and attract suppliers, universities and training providers that develop skilled workers, financing and public agencies that sustain long-term investment, and trusted domestic and allied partners that enable collaboration while protecting commercially sensitive knowledge.

In this regard, technology clusters perform several strategic functions. They concentrate scarce capabilities, lower the cost and risk of experimentation, accelerate knowledge exchange, support prototyping and scale-up, train specialized workers, and create durable networks for collaboration and resilience. Assessing such clusters therefore requires attention not only to their facilities and partners but also to the outcomes they generate, the risks they face, and their ability to adapt across successive technology cycles.

The Albany NanoTech Complex is presented in this paper as a case study in how strategic technology clusters are built, sustained, and translated into national capability. Operated by New York Creates, the Albany complex brings together advanced semiconductor research and innovation backed by exceptional infrastructure, public-private partnerships, and workforce programs. It has attracted commercial firms, supported the development of defense-relevant capabilities, and fostered international collaboration, all within a single applied research platform. Its success results not only from the scale of its unique commercial-level facilities but also from the institutional capabilities it has developed over more than 25 years to move evolving technologies from research and early prototypes to manufacturing processes.

This report situates the Albany NanoTech Complex within a broader framework for understanding how strategic technology clusters emerge, perform, develop networks of collaboration, and endure. It argues that a technology cluster's significance lies not in the scale of its facilities or the prominence of its partners but in the functions it performs. Albany's current capabilities span leading-edge semiconductor R&D in extreme ultraviolet (EUV) lithography, sub-2-nanometer process technologies, advanced packaging, heterogeneous integration, photonics, and quantum-related systems, but it serves an equally important role as a platform for coordinating public-private and allied collaboration. Albany links applied research to national security priorities through NORDTECH and AIM Photonics, while its partnerships with IBM, Japan's Rapidus, imec, Tokyo Electron, JETRO, and the government of Hokkaido—the Japanese prefecture where Rapidus is building its first advanced semiconductor fabrication facility—strengthen cooperation with allied semiconductor ecosystems. It also facilitates the development of specialized workforce pipelines and institutional resilience in a strategic sector. This report first develops a framework for assessing strategic technology clusters and then applies it to Albany's origins, governance evolution, current research partnerships, workforce systems, and broader policy implications for U.S. and allied semiconductor resilience.

Understanding Strategic Technology Clusters

A technology cluster becomes strategic when its capabilities matter not only for regional growth or firm-level competitiveness but also for national resilience, security, and geopolitical leverage. Ordinary technology clusters may generate innovation, jobs, startups, and productivity gains; strategic technology clusters do these things while also supporting trusted supply chains, defense-relevant applications, allied cooperation, and the ability to sustain critical technologies during periods of disruption or international competition. A strategic cluster serves as a platform for capabilities that the United States and its allies cannot easily replace.[1]

Recent scholarship suggests that high-performing technology clusters should be assessed less as static geographic concentrations than as dynamic innovation ecosystems: networks of firms, universities, public agencies, suppliers, investors, and workforce institutions that repeatedly exchange knowledge, share specialized infrastructure, and translate research into commercial or strategic capability. In this view, a successful cluster performs several core functions. It concentrates scarce technical assets, lowers the cost and risk of experimentation through shared facilities, accelerates knowledge spillovers and workforce formation, supports open but governed collaboration among firms and research institutions, and creates credible pathways from laboratory discovery to prototyping, pilot production, and scale-up. Recent work on innovation ecosystem indicators similarly emphasizes that performance should be measured across inputs, activities, linkages, and outputs—including human capital, R&D intensity, infrastructure, institutional quality, financing, innovation collaboration, employment, production, and commercialization outcomes.[2]

International examples help clarify both the promise and the risks of this model. Europe's semiconductor clusters—including Leuven/imec, Grenoble-Crolles, and Dresden—show different combinations of cooperative R&D, manufacturing density, supplier specialization, and public support, but they also reveal vulnerabilities when cluster activity is fragmented or insufficiently connected to scale-up pathways.[3] In Taiwan, Hsinchu demonstrates the importance of dense knowledge exchange, talent circulation, and institutional adaptation over successive technology cycles; that said, recent research cautions that spatial concentration alone does not guarantee resilience, observing that larger and more deeply integrated clusters appear better positioned to withstand shocks than looser agglomerations.[4]

Consequently, the strength of a tech cluster should be evaluated by a practical set of criteria: whether it sustains advanced shared infrastructure; attracts and retains anchor partners; generates usable process and product innovations; supports joint R&D, prototyping, and pilot production; trains the necessary workforce; protects sensitive knowledge; creates trusted domestic and allied supply-chain options; and remains institutionally resilient in the face of market, technological, geopolitical, and policy shocks.

Table 1: Strategic Functions of Semiconductor Technology Clusters: Albany in Comparative Perspective

Critical cluster function	Albany NanoTech	Hsinchu	Leuven/imec5	Grenoble-Crolles6	Dresden/Silicon Saxony
Shared advanced infrastructure	Very strong: 300 mm research fabs, EUV/high-numerical aperture (high-NA) EUV pathway, advanced packaging, and photonics assets	Strong: dense infrastructure linked to TSMC and Taiwan's broader, globally competitive semiconductor manufacturing base	Very strong: world-leading shared precompetitive microelectronics R&D infrastructure	Strong: CEA-Leti and STMicroelectronics support applied R&D and pilot-line capabilities and serve as an important part of the French defense posture	Strong: manufacturing and supplier infrastructure anchored by major fabs and equipment/materials firms
Anchor firms and institutional leadership	Very strong: NY Creates, IBM, TEL, Applied Materials, Micron, ASML, and state government provide durable anchors	Very strong: TSMC, UMC, ITRI, and National Tsing Hua University anchor the national ecosystem	Very strong: imec partners with multiple global firms, has strong links with universities, and benefits from sustained support from public stakeholders	Strong: CEA-Leti, STMicroelectronics, and regional institutions provide technical leadership backed by sustained central government support and linked universities	Strong: GlobalFoundries, Infineon, Bosch, Fraunhofer institutes, and regional networks provide anchors
R&D-to-scale pathway	Strong: proven lab-to-fab transitions, including IBM 2 nm process work, Rapidus training, and Wolfspeed's SiC process transfer	Very strong: tight coupling between research, engineering talent, suppliers, and high-volume fabrication	Strong: excels in precompetitive R&D, though scale-up depends on industry partners outside imec itself	Strong: focused on applied research, prototyping, and industrial transfer through Leti and STMicroelectronics	Strong: benefits from close proximity to production fabs and specialized suppliers
Workforce and talent formation	Strong: a growing number of apprenticeships, NNME Northeast, K–12 programs, veterans training, and university/community college pathways	Very strong: long-standing talent circulation among firms, universities, and public research institutes	Strong: attracts global research talent and trains engineers through university and industry networks	Strong: embedded in France's leading engineering, research, and applied technology institutions	Strong: supported by Germany's vocational, university, and applied research systems
Strategic resilience and security relevance	Very strong: supports trusted domestic R&D, defense microelectronics, development, allied cooperation, and supply chain resilience	Very strong: central to global chip production but geopolitically vulnerable to cross-strait risks	Very strong: in leading R&D capabilities, strengthens European R&D sovereignty and allied innovation networks	Strong: contributes to European technology autonomy, especially in R&D and specialized manufacturing	Strong: provides European manufacturing depth but remains exposed to energy, market, and policy shocks

Note: These institutions and regional ecosystems operate in different national and economic contexts and perform distinct functions. The comparison is therefore illustrative rather than strictly equivalent—particularly in the case of Hsinchu, which represents a much larger manufacturing ecosystem than the Albany NanoTech Complex.

Source: CSIS.

The comparison suggests that Albany is strongest where shared infrastructure, institutional leadership, and applied R&D combine to create strategic relevance. By bringing together advanced facilities, specialized technical capabilities, anchor firms, universities, public agencies, workforce programs, and allied partners, the Albany NanoTech Complex illustrates key elements of an active strategic technology cluster.

Technology Cluster Origins and Institutional Resilience

Strategic technology clusters rarely emerge fully formed or follow a single developmental path. Some begin with an anchor capability—a major firm, university, public laboratory, specialized facility, or defense requirement—that concentrates expertise and attracts complementary assets; others emerge more organically as firms, universities, suppliers, investors, and skilled workers gradually form reinforcing relationships within a region. In either case, the value of a cluster lies in repeated interaction through shared infrastructure, applied research, training, prototyping, financing, commercialization, and external market or technology linkages, in addition to co-location.

Recent work on innovation ecosystems and place-based innovation policy underscores that outcomes are highly contingent on a cluster's ability to build on latent regional capabilities, address concrete bottlenecks, involve sustained commitments by multiple stakeholders, and adapt over time as technologies and markets change.[7] For this reason, the policy lesson is that governments can improve the odds of success when they reinforce genuine capabilities, reduce coordination failures, sustain investment, ensure effective governance, and connect regional assets to national and international technology networks.

Accordingly, the evolution and current operation of the Albany NanoTech Complex can be understood along two related dimensions. The first is in terms of regional development: how a regional strategy that began in 1997 with a focus on industrial retention, public investment, and university-linked research evolved into a durable, globally recognized cooperative research platform. The second is functional: how the resulting cluster should be assessed—by the capabilities it produces over time—and the important ramifications for U.S. security and resiliency.

The Albany NanoTech Complex developed pragmatically from New York State's effort to retain IBM, preserve advanced semiconductor and nanotechnology capabilities, and ensure that key research facilities would remain anchored in the state even if corporate priorities shifted. Locating a university-linked nanotechnology research center on a New York campus allowed the state to sustain IBM's research presence while placing core assets under a form of public stewardship.[8] This transformation depended on institutional innovation as much as financial investment.

The key innovation was an operating model that let Albany function less like a conventional academic unit and more like an industry-facing research consortium. Nonprofit entities affiliated with the SUNY Research Foundation enabled flexible contracting, shared access to costly tools and cleanrooms, the protection of proprietary information, intellectual property (IP) management, and project-based collaboration among university, government, and corporate partners. These arrangements helped Albany move at industrial speed while giving firms confidence to conduct

precompetitive and applied R&D in a shared facility. As the platform grew, however, this flexibility also required stronger oversight, setting the stage for successive leaders of the nano complex to establish new governance structures.

Alain Kaloyeros, an innovative and later controversial SUNY Albany professor, helped establish nonprofit entities under the SUNY Research Foundation that gave the emerging College of Nanoscale Science and Engineering greater flexibility in working with semiconductor devices, equipment, and materials companies. This operating model allowed Albany to attract major research partnerships and gave the cluster an institutional form suited to fast-moving technology development that characterizes the semiconductor industry.[9]

The same institutional flexibility also exposed risks. Those risks included blurred accountability between academic, economic-development, and facility-management functions; dependence on a single entrepreneurial leader; limited transparency in contracting and project selection; exposure to conflicts of interest; and the appearance that rapid dealmaking was outpacing public oversight. These weaknesses did not erase the value of Albany's model, but they made clear that flexibility had to be paired with strong governance.

At Kaloyeros's recommendation, CNSE was separated from SUNY Albany in 2014 and merged with the Utica Institute of Technology to form SUNY Polytechnic Institute. His subsequent role in Western New York economic development ended in bid-rigging charges, an indictment, and his resignation in 2016, after which several SUNY Poly projects stalled. Yet the Albany platform proved resilient. New York State reaffirmed its commitment through the Empire State Development Corporation, overhauled the management structure, and restored operations under stronger oversight. The resulting institutional reset preserved the Albany NanoTech Complex's core capabilities while preparing the ground for a more durable governance model.[10]

The years that followed showed the depth of that commitment. In 2018, New York and Applied Materials announced plans for an $880 million semiconductor materials center at the Albany NanoTech Complex. In 2019, IBM and New York disclosed plans for a $300 million project to develop component technologies for artificial intelligence (AI), also housed at the complex.[11] That same year, the state nonprofit New York Center for Research, Economic Advancement, Technology, Engineering, and Science (NY Creates) was formed to take over management of the complex from SUNY Poly, while CNSE was separated from SUNY Poly and reintegrated with SUNY Albany, where it focuses on academic programs.[12]

In 2022, New York appointed an experienced semiconductor executive, David Anderson, as president of NY Creates. Anderson had been part of the original staff of Sematech, the semiconductor research consortium created in 1987 that successfully restored U.S. chip manufacturing competitiveness relative to Japan. He is supported by Dr. Douglas Grose, former CEO of GlobalFoundries and now chair of the NY Creates board. Under their leadership, the Albany NanoTech Complex has become operationally self-sustaining, relying on public support primarily for major capital expansions rather than routine operations.[13]

This leadership matters because NY Creates is not simply a landlord for expensive equipment; it performs the coordinating functions that make Albany a strategic technology platform. It manages shared facilities, aligns public investment with industry needs, sustains partner confidence, supports capital planning, and provides the governance needed to keep applied R&D, workforce training, and commercialization connected. Those functions are especially important when federal policy shifts because they allow the complex to maintain continuity even as national programs change.

In October 2024, the National Center for the Advancement of Semiconductor Technology—then operating through Natcast under the Department of Commerce—designated the Albany NanoTech Complex as the site of its EUV lithography accelerator, with a proposed $825 million in federal support under the CHIPS and Science Act. In August 2025, however, Commerce Secretary Howard Lutnick announced that the department would void broader Natcast R&D funding and shift operational responsibility for the National Semiconductor Technology Center to the National Institute of Standards and Technology. That decision created uncertainty about the federal role in NSTC-related R&D programming at Albany, but it did not affect the separate acquisition and installation of the high-NA EUV system itself, which New York State had already committed to fund as part of its $1 billion investment in the NanoFab Reflection facility and related equipment.[14]

Since then, New York has remained committed to the EUV R&D effort, while industry partners who pledged roughly $9 billion have given no indication that those plans have changed.

This does not mean that all technology clusters necessarily require public finance. Some clusters can emerge primarily from private entrepreneurship, market demand, talent movement, or the cumulative advantages of proximity, notably to leading-edge universities. But in strategic semiconductor technologies, the case for public support is stronger because the required infrastructure is exceptionally capital-intensive, the benefits of shared research and workforce formation spill across firms, and the national security value of trusted domestic capability exceeds what any single company can ensure. Albany therefore illustrates a narrower point: Public finance is not a universal precondition for cluster formation, but it is often essential when the policy objective is to build and sustain shared capital-intensive capabilities with national strategic value. It is equally important that the public support be sustained.

Albany's Strategic Functions

The Albany NanoTech Complex's origins point toward the next question: how to assess whether a strategic cluster's institutional resilience translates into concrete performance, measurable capabilities, and national semiconductor advantage.[15] In Albany's case, the complex lowers the cost and risk of advanced experimentation and prototyping, enables joint R&D, supports transitions to commercial production, trains specialized workers, protects sensitive knowledge, and connects domestic and allied semiconductor capabilities. The following points apply that functional framework to the specific ways Albany converts institutional and technical capacity into national semiconductor advantage.

- **Advanced research infrastructure:** Albany's first strategic contribution is its concentration of advanced semiconductor research and manufacturing infrastructure. Its equipment is not that of a research center but of a manufacturing facility with commercial-grade equipment. The complex is the only public-private facility in the United States conducting applied R&D with state-of-the-art EUV lithography tools, including the capabilities required for work at the 2-nanometer node and below. These capabilities are pathways for the next generation of AI, high-performance computing, and other strategically important applications. Because the tools, cleanrooms, process integration expertise, and engineering talent required for this work are prohibitively expensive for most individual firms to replicate, Albany provides an invaluable service with a shared platform that enables industry, universities, and government partners to conduct research and test designs at commercial wafer scale.
- **Defense and national security applications:** The complex also supports defense-relevant microelectronics through partnerships such as the Northeast Regional Defense Technology Hub (NORDTECH) and the American Institute for Manufacturing Integrated Photonics (AIM Photonics). These initiatives help address a critical need in the U.S. innovation system: the ability to prototype and produce specialized chips, photonic devices, and quantum-related technologies for defense and intelligence applications. Many defense-relevant devices require small-batch development and production on advanced 300-millimeter fabrication lines, tasks that commercial fabs are often reluctant to undertake. Albany's applied research model allows such work to proceed in a trusted, domestic environment.
- **Allied semiconductor cooperation:** The Albany NanoTech Complex's role extends beyond domestic capability. Through IBM, NY Creates, and partners such as Belgium's imec, France's Leti, and Japan's Rapidus, the complex is central to allied efforts to develop and diversify the supply of advanced semiconductors. The Rapidus initiative in Japan, supported by IBM technology developed at the Albany Complex, seeks to establish secure, commercially viable production of leading-edge chips at the 2-nanometer node. If successful, it will provide the United States and its allies with an additional source of advanced logic beyond the highly concentrated production facilities in Taiwan and South Korea. In this way, Albany contributes directly and importantly to supply-chain resilience and allied industrial coordination.
- **Quantum and emerging technology development:** Based on its unique facilities, the complex is also becoming an important platform for quantum-related research and other emerging technologies with commercial and defense applications. NY Creates and its partners are pursuing work in quantum photonics, superconducting qubits, sensing, secure communications, and advanced packaging. These activities align with federal and defense priorities that regard quantum technologies as strategically important for national security, critical infrastructure capabilities, navigation, biotechnology, and more powerful computing systems.
- **Facilities, workforce, and operating model:** As noted, the capabilities that support these missions are substantial. The Albany NanoTech Complex operates five interconnected 300-millimeter research wafer fabs in roughly 200,000 square feet of Class 1–capable cleanroom space. It maintains advanced lithography, packaging, heterogeneous integration, and production-management capabilities, including systems that allow operators to monitor,

track, document, and control processes certified by the International Organization for Standardization (ISO). This work is carried out by NY Creates' roughly 900 scientists and engineers, while on-site research partners bring the total workforce to approximately 3,000.

It is worth noting that these strategic functions are not abstract claims about Albany's potential; they are visible in the specific partnerships, facilities, and programs operating at the complex today. The next section turns to the research collaborations that put its role into practice, showing how shared infrastructure is used to advance applied R&D, prototype new technologies, support manufacturing readiness, and connect semiconductor innovation to support U.S. and allied priorities.

Current Research Collaborations

NY Creates' current research collaborations illustrate the breadth, depth, and strategic relevance of the Albany NanoTech Complex. These partnerships span leading-edge semiconductor manufacturing, photonics, advanced packaging, defense-related microelectronics, and quantum technologies, bringing together major firms, universities, and government agencies in a shared innovation ecosystem. Collectively, they show that the complex functions as a national platform for technology development, manufacturing readiness, workforce training, and international cooperation.

By documenting Albany's capabilities, it is possible to describe how the cluster performs the strategic functions identified above. This section proceeds through the principal domains in which those functions are visible: (1) the EUV Lithography Center and IBM AI Hardware Research Center, which demonstrate Albany's role in leading-edge process development, (2) the Rapidus, Tokyo Electron (TEL), Applied Materials, and Wolfspeed partnerships, which show how the complex supports allied cooperation and lab-to-fab transitions, and (3) NORDTECH, AIM Photonics, CSR, SQFab, and PsiQuantum, which illustrate its role in defense microelectronics, photonics, and quantum-related technologies. Taken together, these examples show how shared infrastructure, anchor firms, applied research programs, workforce initiatives, and allied collaborations interact to convert institutional capacity into concrete outputs: manufacturable processes, trained personnel, trusted prototyping environments, and pathways from research to production.

Extreme Ultraviolet Lithography Center ("EUV Center")

On July 1, 2025, NY Creates' EUV Center became operational at the Albany NanoTech Complex. The center is a public-private partnership among the Albany complex, New York State, and industrial partners including IBM, Micron Technology, Tokyo Electron, and Applied Materials. It is North America's only nonprofit R&D center designed to use high-NA EUV lithography on 300-millimeter manufacturing lines to support sub-2-nanometer technology development. This newest and most sophisticated class of semiconductor manufacturing tool is expected to become operational in late 2026.[16]

- Numerical aperture measures a lithography tool's ability to focus light; a higher NA enables sharper resolution and smaller features. High-NA systems use laser-driven plasma and precision optics to produce chips with greater computing power and lower energy consumption.
- The center's lithography tool, ASML's TWINSCAN EXE:5200B, illustrates the extraordinary scale and technical complexity of high-NA EUV manufacturing. The system weighs more than 200 tons and must be shipped disassembled in 250 crates, requiring 5 cargo planes and 20 semi-trucks. It generates plasma heated to 220,000 degrees centigrade—roughly 40 times the temperature of the surface of the sun—and enables the production of semiconductor chips with circuit line widths smaller than 2 nanometers. Chips at this scale can contain tens of billions of transistors, and high-NA EUV is expected to push miniaturization still further.

As noted above, without federal support, New York State has committed $1 billion to acquire the ASML lithography system and construct the NanoFab Reflection (NFR) building that will house it. The new facility includes 50,000 square feet of ISO 5 cleanroom space and supports R&D for the world's most advanced semiconductors, including AI graphics processing units, chips for large language models, high-performance computing devices, and specialized defense applications. Workforce training is also central to the center's mission, reflecting the need for people as well as tools to regain and sustain U.S. leadership in advanced semiconductor manufacturing. This project is the first expansion at the Albany NanoTech Complex since 2015, when the 356,000-square-foot Zero Energy Nanotechnology (ZEN) facility was established.[17]

IBM AI Hardware Research Center

Although IBM has divested its semiconductor manufacturing facilities, it remains deeply engaged in semiconductor process research and product development. Its AI Hardware Center operates at the Albany NanoTech Complex in partnership with NY Creates, Applied Materials, Tokyo Electron, Rensselaer Polytechnic Institute, SUNY, and other organizations. The center develops process and device technologies with applications in IBM servers and mainframes, among other systems. IBM's 2-nanometer silicon transistor technology based on gate-all-around nanosheets was demonstrated on a 300-millimeter wafer line at the complex.

As of late 2024, IBM had 700 people working at Albany NanoTech and planned to add 100–150 more, including visiting engineers from Rapidus. To accommodate the new personnel, IBM agreed with NY Creates to lease an additional 30,000 square feet in the ZEN building, bringing its total square footage at the Albany complex to 100,000. IBM executive Mukesh Khare commented in

2024 that "all of our semiconductor research and development goes through Albany. This is the headquarters for IBM semiconductor research and development."[18]

In addition to anchor tenants IBM, TEL, and Applied, NY Creates partners with leading semiconductor companies including Micron, ASML, LAM Research, SCREEN, and KLA. Collaborating research partners include DARPA, Rapidus, NoMIS Power, NIST, PsiQuantum, Rensselaer Polytechnic Institute, SUNY Albany, and the National Science Foundation (NSF).[19] These partnerships establish Albany's role at the leading edge of logic and process technology. They also provide the foundation for a second function: using Albany's capabilities to support allied industrial strategy and the equipment, materials, and process transitions needed for future technology nodes.

The Rapidus Initiative

Rapidus is a Japanese chipmaking facility backed by eight leading Japanese companies and supported by the government of Japan. Its goal is to help Japan return to the leading edge of semiconductor manufacturing by developing the capacity to produce highly specialized chips at the 2-nanometer node and below, comparable to the capabilities of current world leaders such as TSMC and Samsung. To pursue this goal, Rapidus is collaborating with IBM Research and Belgium's imec to establish semiconductor manufacturing facilities in Japan based on IBM's gate-all-around nanosheet technology, which was developed at the Albany NanoTech Complex. The effort reached an important milestone in July 2025, when Rapidus successfully formed 2-nanometer transistor structures on a wafer at its Chitose fabrication plant in Hokkaido. In an exceptional cooperative arrangement, Rapidus has also dispatched some 135 engineers to Albany for two years of training to learn to produce IBM's 2-nanometer technology at the Rapidus fab in Hokkaido. Rapidus Chairman Tetsuro Higashi described their return as a sign of growing technical confidence, observing that they could now stand alongside engineers who had worked with IBM.[20]

Underlying the Rapidus enterprise is the strategic risk posed to the Western allies by overreliance on TSMC, the producer of the world's most advanced semiconductors. Based in Taiwan, TSMC is exposed to Chinese pressure as well as geological risks. The founders of Rapidus concluded that "TSMC had no intention of building cutting-edge facilities outside of Taiwan."[21] In light of this reality, CEO Atsuyoshi Koike stressed the "importance of establishing a [secure] cutting-edge facility in Japan in collaboration with the United States as a strategic countermeasure to geopolitical risks."[22] If successful, the Rapidus project will create a second source for allied procurement of the world's most advanced semiconductors at a site in Japan that is not exposed to the same risks that TSMC faces from an aggressive nearby China or that Samsung faces from North Korea.

As research ties between New York State and Japanese companies deepen, a broader policy framework is emerging to support semiconductor cooperation between Albany and Japan. In December 2024, NY Creates signed a strategic partnership agreement with the Japan External Trade Organization (JETRO) to promote advanced semiconductor R&D, technology alliances, and workforce development across New York's Capital Region and Japan. JETRO reportedly saw New York's sustained bipartisan support for the Albany NanoTech Complex as a model, noting that state policies supporting the chip industry continued unabated across gubernatorial transitions.

This cooperation was reinforced by an August 2024 agreement among New York's Empire State Development Corporation, NY Creates, and the government of Hokkaido. That agreement aims to foster partnerships in semiconductor R&D and workforce development, while Hokkaido policymakers have described New York's Tech Valley as a model for building not just fabs but a broader ecosystem of related companies, technical expertise, and workforce training.[23]

TEL Technology Center America (TTCA)

Japan-based TEL is one of the foremost producers of semiconductor manufacturing equipment in the world. Its research center, TTCA, has been operating at the Albany NanoTech Complex since 2003. TTCA features 16,000 square feet of cleanroom space, 18,000 square feet of office space, and 80 TEL chipmaking tools with full-flow integrated processing and patterning capability. At present, TEL is supporting the scaling of complementary metal-oxide-semiconductor (CMOS) processes and device features to their atomic limits and exploring quantum engineering, new materials, and neuromorphic structures, which are designed to mimic the functioning of the human brain.[24]

TEL has been collaborating with IBM for over two decades in joint semiconductor R&D, a partnership which has yielded, among other things, a new laser debonding process for producing 300-millimeter wafers for 3D chip stacking. At present, TEL is developing deposition, coating, and development methods to support high-NA EUV lithography, refining its state-of-the-art coater/developer equipment to be compatible with chemically amplified resists and spin-on metal-containing resists for higher resolution and etch resistance at small nodes. Its processing modules improve uniformity and throughput in the lithography process, which is essential to enable scaling to high-NA EUV. TEL holds a nearly 100 percent global monopoly in coater/developer equipment designed specifically to support high-NA EUV.[25]

Together, Rapidus and TEL illustrate Albany's international dimension: The complex supports allied semiconductor resilience while serving as a site where global equipment makers refine the processes needed for future technology nodes. That same applied-research model also supports domestic lab-to-fab transitions in materials engineering and compound semiconductors.

Materials Engineering Technology Accelerator ("META Center")

The META Center, operated by Applied Materials—the largest U.S.-based maker of semiconductor manufacturing equipment—is a novel facility that seeks to accelerate the prototyping of new processing techniques, materials, and devices. META Center engineers test and prove these innovations in a pilot manufacturing environment to speed up their transition to manufacturing at scale. At present, the META Center is evaluating a novel magnetic random-access memory (MRAM) with potential applications in chips for the Internet of Things, high-density working memory, and low-power, nonvolatile code storage.[26]

Wolfspeed

In a collaboration between NY Creates and Wolfspeed (formerly Cree) to develop the world's first 200-millimeter silicon carbide (SiC) fab in Marcy, New York, Wolfspeed utilized processing equipment at the Albany NanoTech Complex to develop the 200-millimeter SiC process.[27] SiC devices have applications in environments that operate at high temperatures and/or high voltage, such as electric vehicles and locomotives, renewable energy equipment, and communications. When the Marcy fab was completed, the NY Creates equipment and its 200-millimeter process were transferred to the Marcy site, significantly accelerating the ramp to production at the new fab.[28]

These examples show how Albany helps move process innovations from shared research infrastructure toward production environments. The same lab-to-fab logic carries into Albany's defense and photonics programs, where the emphasis shifts from commercial scaling to trusted prototyping, specialized manufacturing, and national security applications.

Northeast Regional Defense Technology Hub (NORDTECH)

NORDTECH is a coalition of public and private sector entities with microelectronics expertise in and around New York State. Its five founding members are NY Creates, IBM, Rensselaer Polytechnic Institute (RPI), Cornell University, and the University at Albany's College of Nanotechnology, Science, and Engineering. It is part of the Microelectronics Commons, a network of U.S.-based prototyping innovation hubs established by the Pentagon to reduce U.S. reliance on foreign semiconductors and supply-chain risks. Between 2022 and 2024, NORDTECH received roughly $80 million in federal funds for research projects primarily focused on quantum computing. NORDTECH engages in statewide networking activities with companies, universities, and research organizations in support of work underway at NY Creates and other New York research hubs. These efforts enable the rapid formation of project teams drawn from multiple organizations to support defense-oriented R&D at the Albany NanoTech Complex, which is a key element of the hub's network of cutting-edge facilities. In effect, these efforts resemble the activities of Germany's Fraunhofer-Gesellschaft in rapidly mobilizing ad hoc teams from the German science base to address specific technological challenges.[29]

NORDTECH's Lab-to-Fab (LIFT) program focuses on short-duration projects that can be executed in less than a year and uses its facilities to develop proof-of-concept data that can lead to additional research and funding. These projects must align with the Microelectronics Commons' mission of accelerating lab-to-fab technology transitions and contribute to NORDTECH's mission areas: prototyping, packaging, workforce development, and sustainability.[30] NORDTECH Technical Director Dr. Nicholas Fahrenkopf sees the organization as a regional innovation network that mobilizes collective technical capabilities to support chip reshoring and technological advances.[31]

AIM Photonics

The AIM Photonics program at NY Creates' Albany NanoTech Complex and the Test, Assembly, and Packaging (TAP) facility in Rochester, NY, operate the first U.S.-based publicly accessible

300-millimeter facility for integrated silicon photonics. The facility develops photonic integrated circuits (ICs), which utilize light rather than electrons to form functioning circuits. The AIM Photonics Multi-Project Wafer team deploys an extensive toolset and deep expertise to assist customers in designing, building, testing, and packaging photonic device prototypes on a cost-effective basis.[32]

AIM Photonics was established in 2015 as one of nine research institutes launched by the Department of Defense (DOD) under the federal Manufacturing USA initiative, with an initial $110 million DOD grant and $250 million in New York State funding. The Air Force Research Laboratory later contributed additional support, including $165 million in 2021 and $321 million in 2024, to programs designed to ensure the manufacturing readiness of advanced photonics technologies for national security needs. The institute links wafer fabrication research facilities in Albany with Test, Assembly, and Packaging facilities in Rochester, creating a distributed platform for integrated photonics development from design and fabrication through testing, assembly, and packaging.[33]

The institute is closely aligned with national priorities and projects of strategic significance to the United States, including defense-critical technologies in advanced sensing, laser-guided systems, high-speed communications, quantum photonics, and novel packaging. By developing and scaling secure domestic manufacturing for critical photonics components, AIM Photonics is able to both strengthen the U.S. industrial base and reduce reliance on foreign suppliers. This photonics platform also provides a bridge to quantum-related work, where integrated photonics, secure communications, sensing, and advanced packaging converge with emerging defense and commercial needs.[34]

AIM Photonics is engaged in a number of projects to develop integrated photonics platforms and manufacturing capabilities for quantum technologies in cooperation with U.S. research organizations and government agencies.[35]

- The QUPICS project, in partnership with Cornell University and several other team members, has received funding through the NORDTECH Microelectronics Commons initiative and seeks to develop an accessible 300-millimeter foundry for quantum photonics technologies, ranging from ultraviolet through infrared wavelengths. The ultimate purpose is to enable the prototyping and mass manufacturing of quantum photonics chips with applications in cryptography, sensing, networking, quantum computing, and position, navigation, and timing for commercial and defense uses.[36]
- The CHIQPI project seeks to surmount barriers to the manufacturing of quantum photonic ICs by developing hybrid integration platforms and foundry processes.[37]
- AIM is developing quantum dot laser technology for integration into its silicon photonics platform in conjunction with semiconductor companies, universities, and federal initiatives. If successful, this effort will enable improvements in scalability and energy efficiency, and it will enhance the capabilities of quantum sensing, communications, computing, and AI.[38]

Center for Semiconductor Research (CSR)

CSR is the primary 300-millimeter operation at the Albany NanoTech Complex. It integrates several cleanrooms and reflects a 20-year partnership with industry-leading companies that have included IBM, Applied Materials, TEL, and ASML. CSR's 300-millimeter facilities are fully managed by NY Creates staff and integrate device design, fabrication, modeling, testing, and pilot manufacturing across a broad range of technologies. Projects include AI hardware, graphene-based devices, sensors, novel memory structures, neuromorphic computing, and quantum devices.[39]

The Improved Materials for Superconducting Qubits with Scalable Fabrication (SQFab) Project

The SQFab project is a DOD-funded effort led by NY Creates and centered at the Albany NanoTech Complex. The project is intended to demonstrate scalable quantum error correction using new materials, qubit control schemes, and innovative quantum circuits. NORDTECH is collaborating with major companies and research organizations in support of this project, including Cornell University, New York University (NYU), D-Wave, Quantum Circuits Inc., the Air Force Research Laboratory-Information Directorate, Princeton, and Syracuse University.[40]

Collaboration with PsiQuantum

Reflecting its unique capabilities, in 2023, NY Creates entered into a collaboration with PsiQuantum, a Palo Alto–based quantum computing company, pursuant to which the partners will use the Albany NanoTech Complex to integrate PsiQuantum's silicon-based integrated photonics technology with novel materials such as barium titanate, which can enable ultra-high-performance optical switching with applications in large-scale quantum circuits. PsiQuantum is currently mass-producing its Omega photonic quantum chips at GlobalFoundries' wafer fabrication facilities in Malta, NY, with NY Creates providing the research and engineering infrastructure needed to enable rapid innovation cycles. The ultimate goal is to build large-scale, error-corrected quantum computers that can be employed in commercial applications by 2027.[41]

Taken together, these programs show how the Albany NanoTech Complex deploys shared research infrastructure to generate strategic capabilities. The complex supports leading-edge process development, accelerates transitions from laboratory concepts to manufacturable technologies, connects applied research to defense and allied priorities, and creates a platform for collaboration across firms, universities, and government agencies. Yet these capabilities cannot be sustained by equipment and partnerships alone. They depend on a specialized workforce able to operate advanced tools, translate research into reliable processes, support prototyping and scale-up, and adapt as semiconductor and quantum-related technologies evolve. The next chapter therefore turns from Albany's research collaborations to the workforce systems that make those collaborations durable.

Workforce Development

Workforce development is not an ancillary activity at Albany; it is the mechanism that allows the complex's research partnerships and advanced facilities to produce lasting strategic value. NY Creates operates a substantial set of programs designed to align local and regional education and training systems with semiconductor workforce needs. These efforts reach high school students, community college and university students, veterans, apprentices, faculty, and incumbent workers. They are central to the report's argument because advanced semiconductor capacity depends not only on tools and facilities but also on the technicians, engineers, instructors, and institutions capable of operating, improving, and sustaining them.[42]

National and Regional Pipeline Coordination

- The SEMI Foundation recently announced the launch of the first four Regional Nodes of the National Network for Microelectronics Education (NNME), an important step toward a coordinated national infrastructure for semiconductor workforce development. Funded by the NSF in collaboration with the U.S. Department of Commerce and supported by $900,000 in New York State Empire State Development funding for New York–focused workforce efforts, NNME is designed to address talent pipeline gaps across the microelectronics ecosystem. NY Creates leads the NNME Northeast Regional Node, serving New York, Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, Pennsylvania, Rhode Island, Vermont, and Virginia.[43]

Apprenticeships and Technician Training

- NY Creates and Micron have begun a strategic workforce development partnership to expand the regional pipeline of skilled technicians needed to support Micron's planned domestic memory manufacturing expansion in Clay, New York. The apprenticeship program draws on NY Creates' Albany NanoTech Complex and existing workforce-development programs. With support from the Center for Economic Growth (CEG) and the Manufacturers Association of Central New York (MACNY), apprentices gain hands-on experience in applied settings and develop skills relevant to technician roles in Micron fabrication facilities.[44]

Curriculum Development and Education Pathways

- The Northeast Advanced Technological Education Center (NEATEC) is a joint NY Creates/SUNY program, which operates through a network of nearby community colleges, universities, and companies to develop and disseminate curricula addressing the essential technician competencies required in the semiconductor and nanotechnology workforce. This program was launched in 2019 with a $6 million grant from the NSF.45
- NY Creates is collaborating with the National Institute for Industry and Career Advancement (NIICA) to implement the Registered Apprenticeship Program (RAP) to train current NY Creates employees, with eventual recruitment of students from local educational institutions who will train within the Albany NanoTech Complex facilities. Hudson Valley Community College (HVCC) in nearby Troy, New York, is developing the Related Technical Instruction (RTI, or coursework) for this program.46
- The NY Creates/Raytheon Workforce Training Program offers an 80-hour course focused on the engineering skills that are essential in the semiconductor industry, including mechanical assembly, pneumatics operation, sensor technology, and basic electronics components.47
- EASEL Faculty Technical Development Workshops connect community college faculty with technicians and engineers at NY Creates and its industry partners to enhance faculty knowledge of chip fabrication, enabling them to teach the necessary technical skills for chipmaking. Related EASEL Student Technical Development Workshops are designed to enhance technical knowledge, build practical skills, and connect students with professionals in the field, helping to prepare students for careers in the semiconductor industry.48
- The Learning by Experience through Advanced Research in Nanotechnology (LEARN) program offers internships to college undergraduates who benefit from hands-on training and experience in advanced silicon wafer fabrication, preparing them for careers in semiconductor manufacturing.[49]
- The Vet Semiconductor Training & Experience Program (Vet S.T.E.P.), hosted by NY Creates and funded by the NSF, offers veterans a 10-week training program to prepare them for careers in the semiconductor industry, featuring themes such as manufacturing, electronics, and pneumatics, followed by an eight-week internship at a semiconductor company.[50]

- Tech Valley High School is located on site at the Albany NanoTech Complex, enabling students to earn college credits for completion of nano-related coursework and gain practical experience at the site.51
- NY Creates operates K-12 programs to engage local students, offering group tours of the fabrication and characterization facilities at the Albany NanoTech Complex and hands-on activities in nanoscale technology, including semiconductor fabrication. This program engages over 1,000 students annually.52
- The New Visions/Emerging Technologies initiative was developed by NY Creates and the Capital Region Boards of Cooperative Educational Services (joint activities by two or more school districts), a curriculum directed at high school seniors involving both theoretical knowledge and hands-on experience with respect to themes such as cleanroom protocols, hydrogen safety, electrical and mechanical systems, automation, pneumatics, and troubleshooting.[53]

IC Design, Photonics, and Specialized Training

- NY Creates is partnering with NYDesign, a nonprofit seeking to democratize access to tools and expertise for New York residents to design, verify, and produce their own ICs. Under the partnership, NY Creates provides strategic guidance and support to NYDesign's efforts to establish design and enablement centers across the state to provide IC design training, streamline the design process, and provide access to tools and IP.54
- AIM Photonics provides online training in photonic integrated circuit (PIC) design and direct training in design and packaging in its PIC fab, developing PIC training hardware and education courses, and participating in regional and national consortia to disseminate PIC training content. Among other initiatives, it offers eight-to-ten-week internships that expose participants to PIC design, fabrication, testing, and packaging. Interns are paired with engineers and researchers at the Albany NanoTech Complex for mentoring, skill development, and project-based learning.[55]

Workforce Intelligence and Security Skills

- NORDTECH convened a Workforce Development Summit at the Albany NanoTech Complex in October 2025. At the summit, it presented the findings of its Workforce Needs Assessment with respect to microelectronics and semiconductor manufacturing workforce requirements, released in June 2025.[56] The study identified talent pipeline and microelectronics training program gaps and offered a road map and recommendations for closing those gaps. More generally, NORDTECH engages educational institutions in initiatives across New York, such as a collaboration with NYU to train students in the security-related aspects of microelectronics, including cybersecurity and protection of open-source designs from insertion of backdoor and Trojan elements.[57]

Taken together, these workforce programs show both the promise and the limits of workforce development in strategic technology clusters. What works is the integration of training with real

facilities, employers, and applied research: Apprenticeships, internships, faculty externships, community-college curricula, and regional nodes such as NNME help align education pathways with the practical skills needed in cleanrooms, fabs, photonics facilities, and design environments. Recent workforce studies emphasize that this alignment is especially important in semiconductors, where technician shortages, retention challenges, faculty capacity, infrastructure access, and the need for portable industry-recognized skills can become binding constraints.[58]

Albany can build on this foundation by deepening coordination across employers and training institutions, keeping curricula aligned with successive technology nodes, expanding successful programs to meet fab demand, and broadening the regional pipeline of technicians and engineers. Its workforce advantage is that training occurs within an active research and prototyping platform, closely connected to industry practice. Sustaining that advantage will require continued attention to outcome measurement, curriculum renewal, instructor and technical-mentor capacity, access to specialized equipment, and stronger links among training, hiring, career progression, and long-term worker retention.

Policy Lessons and Strategic Implications

The Albany NanoTech Complex case illustrates that strategic technology clusters should be judged not simply by the scale of their inputs or the proximity of their assets but by the functions they perform and the outcomes they generate. Indeed, public and private investment, anchor firms, universities, facilities, skilled labor, and access to capital are all necessary foundations of technology clusters. But the more decisive question is whether those assets generate a multiplier effect, involving sustained activity in joint R&D, prototyping, pilot manufacturing, supplier development, workforce training, standards setting, and sustained international collaboration. Successful clusters convert such activity into durable results—including patents, technology demonstrations, trained workers, startups, scale-ups, manufacturing transitions, and follow-on private investment. In strategic technologies, the test is broader still: Successful clusters can strengthen supply-chain resilience, support defense-relevant innovation, diversify regional economies, and remain technologically current across successive generations as a result of sustained investment and successful collaboration.

Viewed against this framework, the Albany NanoTech Complex features many of the attributes of a successful strategic technology cluster. It is not a conventional university research center or a real estate development, but an applied research and prototyping platform organized around extremely expensive shared infrastructure, robust industrial partnerships, and long-term state support from New York governors drawn from differing parties. Its 300-millimeter wafer facilities, EUV and advanced packaging capabilities, photonics assets, workforce programs, and relationships with firms such as IBM, TEL, Applied Materials, Micron, ASML, Lam Research, SCREEN, and KLA

give it the institutional density and technical relevance associated with a small number of globally significant semiconductor clusters.

The Importance of Sustained Public Support

Albany's experience offers a broader lesson for technology policy. Strategic capacity is not invented; it is built, maintained, and renewed through institutions capable of enduring political change, mobilizing private investment, and translating innovation into industrial capability. The success of the Albany NanoTech Complex required entrepreneurial leadership, sustained support from the business community, and effective public-private partnerships among leading companies and New York State. Most notably, this effort has continued for more than 25 years across multiple governors and periods of institutional instability. That continuity has enabled the growth of advanced facilities, the attraction of new partners, and the emergence of a regional technology platform with national significance.

Albany is not unusual in this respect. Other successful strategic technology clusters—notably imec in Belgium—also rest on long-term public commitments that provide patient capital, institutional continuity, and a trusted platform for precompetitive collaboration. In 2023, imec reported annual revenue of €941 million, with 75 percent supplied by industry partners and the remainder by the government of Flanders, the European Union, and other public programs.[59]

Public support matters because leading-edge semiconductor R&D requires equipment, cleanrooms, workforce systems, and technical expertise that are too expensive and risky for most individual firms to sustain alone, while the benefits spill across companies, regions, and allied technology networks. Sustained support can give firms and research partners the confidence to invest, collaborate, and remain engaged through successive technology cycles.

This public-private model also clarifies the role that renewed federal funding could play at Albany. Federal participation would not replace New York or industry investment; it would complement those commitments by sustaining shared research infrastructure whose benefits extend beyond any single firm or state. Such support would help preserve a national capability proportionate to the strategic challenge posed by China's state-led semiconductor investment, which has exceeded $150 billion since 2014.[60]

A Focal Point for Coordination and Growth

The range of activities at the complex—cutting-edge semiconductor research, full-flow prototyping, large-scale industrial cooperation, workforce development, and major international collaborations—underscores its strategic importance. It has become a magnet for new investment, including Micron's decision to build next-generation memory fabs in New York. Its cooperation with Rapidus supports efforts by like-minded countries to diversify the supply of leading-edge chips. Importantly, its photonics and quantum-related capabilities are now contributing to New York's emerging quantum ecosystem and complement regional strengths in places such as Colorado, Illinois, Maryland, and New Mexico. These functions strengthen the domestic technology base for AI and

defense applications, reduce reliance on vulnerable foreign supply chains, and position Albany as a trusted partner for U.S., Japanese, and European firms developing next-generation chips.

The Tech Hubs program offers a useful governance analogy. Its notice of funding opportunity treated governance as a core project function, not an administrative afterthought, and emphasized the need for cross-sector consortia to coordinate technology maturation, workforce development, infrastructure, commercialization, and national security objectives.[61] One practical expression of this model is the regional innovation officer, a catalytic role responsible for aligning firms, universities, workforce institutions, public agencies, and investors around a shared technology strategy while also accounting for security, supply-chain, and trusted-partner considerations. Albany already performs many of these coordination functions through NY Creates, suggesting that strategic clusters benefit from an identifiable institutional actor able to integrate regional growth with national technology and security priorities.

Risks and Long-Term Viability

Albany's strategic importance also exposes several risks that require a long-term policy response. Its continued success depends on sustained public support for capital expansion, policy continuity across administrations, strong governance, partner commitment, cybersecurity, resilient infrastructure, and a reliable supply of skilled workers. Because so much unique U.S. capability in advanced lithography, packaging, photonics, and quantum-related research is concentrated at a single site, disruptions in funding, governance, infrastructure, or workforce supply could have outsized national consequences. The relative uniqueness of the complex is therefore both a source of national strength and a potential vulnerability requiring appropriate protection.

For the United States, the Albany complex holds a distinctive position as a trusted public-private research and prototyping platform for advanced semiconductor technologies, defense applications, workforce development, and allied cooperation. A sensible strategy should therefore reinforce Albany's distinctive role as a national applied research platform while building complementary capabilities across the United States. A national strategy focused on greater resilience could, and indeed should, use Albany as an anchor for a more robust semiconductor research and production network. In this respect, this complex should be understood as a leading source of the institutional capacity required to translate R&D into manufacturing, while strengthening both domestic and allied capabilities, keeping in mind that these capabilities are foundational for the security of the United States and its allies.

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