

2021-2026 Science & Innovation Strategic Plan

Developing an Innovation Economy in Oklahoma



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EXECUTIVE SUMMARY

The Oklahoma economy is at an inflection point. Disruptive technology is changing the face of every industry and forcing all states to reassess how best to compete and remain relevant in a knowledge-based innovation economy. In this strategic plan, we examined three states that have been successful at developing an innovation economy: Texas, Ohio, and Massachusetts. These three states invested early and aggressively in creating an innovation ecosystem to compete with Silicon Valley, the birthplace of innovative startups. Ohio invested \$2.3 billion, Massachusetts invested \$1.6 billion, and Texas invested over \$1 billion. These three states have been able to transform and modernize their economy by embracing a host of common principles including:

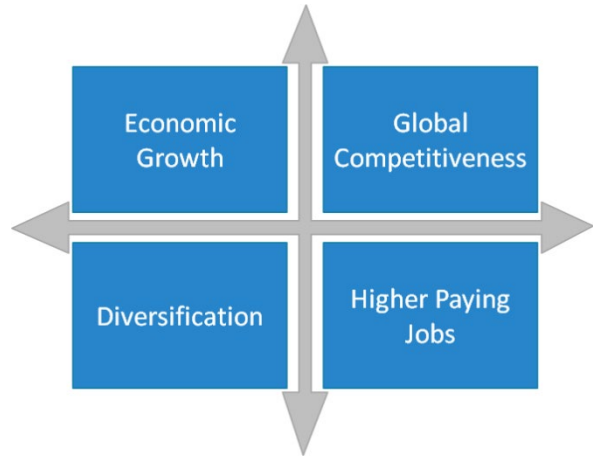
- Long-term state investments in research, education, and innovation infrastructure;
- Visionary leadership of regional leaders who aggressively pursued state and federal investments in strategic research, including federal research centers;
- Presence of top research universities that produce world-class research outputs, as well as a highly skilled workforce;
- Industry investments in research;
- Concentration of pioneering, research-intensive companies;
- Strong collaboration among state, philanthropy, industry, and academia; and
- Established infrastructure for high tech entrepreneurship including early-stage and late stage capital, incubators and accelerators for startup companies, and programs to support technology transfer and commercialization of research.

Oklahoma should leverage on the experiences of Texas, Ohio, and Massachusetts to create a roadmap to develop an innovation economy in Oklahoma. At present, Oklahoma ranks in the bottom 10th percentile with respect to innovation. The Milken Institute's 2020 State Technology and Science Index ranks Oklahoma #45 with respect to innovation, placing us in the bottom 10th percentile. This strategic plan puts forth a number of recommendations to alter Oklahoma's innovation trajectory and catapult us to the forefront of the innovation revolution. It outlines the necessary steps that Oklahoma should take to create an economy that is ready and able to compete with other states for capital, businesses, and jobs. While Oklahoma has a multitude of industry sectors in need of investments, leadership must prioritize our limited resources and allocate them to three targeted strategic areas where we will have the greatest probability of generating maximum return while leveraging on our existing strengths. These three areas are biotech/life sciences, aerospace and autonomous systems, and energy diversification. Oklahoma should coalesce its resources to bolster and grow these three strategic industry areas.

The time is now to invest heavily in and plan long-term for Oklahoma's future. The Texas, Ohio and Massachusetts models show that it can take anywhere from 20 to 30 years for innovation to generate a return on investment, but the upside is undeniably substantial. The executive and legislative leadership in Oklahoma must have the political will to invest big and bold in innovation and to make this multigenerational commitment. They must also have the discipline to stay the course for the long haul. With vision, discipline, focus and determination, Oklahoma can transform our state economy to an innovation economy that reflects the pioneering, entrepreneurial and resilient spirit of our state.

WHY INNOVATION MATTERS

Innovation is the key driver of economic growth and prosperity. Innovation matters to Oklahoma's future. Our state must invest in innovation for four principal reasons: to grow our state economy, accelerate our state's competitiveness, diversify our state economy, and create large scale, high paying jobs for Oklahomans.



- 1. Economic Growth.** Oklahoma lags other states in growing our economy. From 2015 - 2019, Oklahoma's GDP grew by 1.8%, for an annualized rate of .4%. In contrast, the U.S. economy expanded by 9.8% for an annualized rate of 1.9%, growing 375% faster than Oklahoma's economy. Neighboring states also outpaced Oklahoma in GDP growth for that same period: Colorado's annualized rate of growth was 3.48%, Kansas' was 1.81%, Texas' was 1.65%, Missouri's was 1.3%, New Mexico's was .95%, and Arkansas' was .80%. As innovation's role in driving economic growth continues to amplify, Oklahoma risks falling further behind unless we take decision actions to change the trajectory of our state economy and modernize it to reflect the changing economic and technological trends.
- 2. Competition.** Competition is the basis of a capitalist market economy. States compete with each other to attract investments by creating a favorable environment for business investments. Oklahoma must compete to retain existing companies and to attract new companies and private capital to Oklahoma. States compete for businesses by offering economic incentives, creating business-friendly policies, and leveraging on their resources such as natural resources, human capital, and research assets. As demonstrated recently by Oklahoma's efforts to recruit Tesla and Saab to Oklahoma, Oklahoma must outcompete other states to attract high tech and advanced manufacturing businesses to Oklahoma. Oklahoma is an excellent state to do business. Our state ranks 1st among other states in terms of cost of living. We also rank 2nd best in terms of cost of doing business. We also have low-income tax rates ranking 6th in the nation for tax burden per capita. However, where we are less competitive is in education and research. The Milken Institute's 2020 State Technology and Science Index ranked Oklahoma dead last in education at #50. In terms of research, Oklahoma ranks #36 based on data collected by the National Science Foundation for total research and development expenditures in 2017.
- 3. Diversification.** The collapse in oil prices that took place in 2014 and that occurred again in 2020 has underscored Oklahoma's over dependence on oil and gas as the crux of our state economy. Oklahoma's GDP hit an all-time high of \$209 billion in 2014 and tumbled to \$188 billion by 2016 due to the downturn in the oil and gas industry, a decline of 10%. The mining industry's share of Oklahoma's gross domestic product (GDP) increased to 14% in 2018, compared to just 4.6% in 1997, a rate that is now one of the highest in the nation, surpassing those of Texas (9%) and New Mexico (12%). Furthermore, as the global auto industry moves away from fossil fuels, Oklahoma state leaders need to be mindful that petroleum-powered vehicles will decline over time, reducing the demand for oil and gas. While oil and gas has been and will continue to be a pillar of Oklahoma's economy for some time, Oklahoma needs to plan long-term and diversify our state economy to be less dependent on the oil and gas industry.

4. **Higher Paying Jobs.** The innovation economy currently drives high paying job creation and depends on a consistent and steady flow of STEM workers. According to the U.S. Department of Commerce STEM Jobs 2017 Update, employment in STEM occupations grew much faster than employment in non-STEM occupations over the 2000 – 2010 period (24.4% versus 4%, respectively), and STEM occupations are projected to grow by 8.9% from 2014 to 2024, compared to 6.4% growth for non-STEM occupations. STEM jobs also command higher wages, earning 29% more than their non-STEM counterparts in 2015. With a median household income of \$54,449 based on 2019 Census data, Oklahoma has one of the lowest median household incomes in the nation ranking at #44, putting us in the bottom 15th percentile. Median household income is a strong indicator of a state’s populace’s spending power and economic status. By investing in an innovation economy, Oklahoma can help raise the state’s median household income and average annual wages through the creation of higher paying STEM jobs.

OKLAHOMA'S CURRENT CHALLENGES IMPEDING INNOVATION

To develop a roadmap to create an innovation economy, it is important to understand current challenges impeding Oklahoma's ability to create an innovation economy. To assess what measures need to be put into place to create an innovation economy, it is important to evaluate Oklahoma's current standing in the following four key areas that are critical to the creation of an innovation economy:

- Education and human capital;
- Research;
- Integrated support systems; and
- Startup capital and financing.

1. **Education and Human Capital.** Talent is one of the key assets of an innovation economy. A state's innovation economy is tied to the quality of its educational systems from primary and secondary schools to colleges and universities. High tech companies require access to a skilled labor force. One of the reasons why Austin and Boston have become epicenters for innovation is due to their abundance of readily available talent from high-quality public-school systems to excellent private and public colleges and universities. Companies often cite the strengths of a state's well-educated workforce as one of the qualifying reasons for their site selection. Unfortunately, Oklahoma's standing in education is poor. The Milken Institute's 2020 State Technology and Science Index ranked Oklahoma dead last in human capital investment at #50. There have been several instances where corporations have passed Oklahoma over as a place to invest due to concerns about the local workforce. In 2021, startup Firehawk Aerospace chose north Texas over Oklahoma to establish R&D facilities, citing access to aerospace engineers as the driving reason. In 2020, Tesla chose Austin over Tulsa, a city where 46% of the adult population have at least a bachelor's degree compared. In 2019, the Saab Group chose Indiana over Oklahoma City due to concerns over its ability to access a highly skilled workforce to staff its plant in Oklahoma City. Companies have repeatedly expressed serious concerns about workforce challenges in Oklahoma.
2. **Research.** Scientific research conducted at our universities is vital for developing new discovery that leads to groundbreaking innovations. These innovations drive our state's economy, creating new products, processes, and services to enhance the quality of life of Oklahomans. Strong research programs also provide educational opportunities for students and attract high caliber faculty. The amount of research and development (R&D) taking place is an indicator of a state's ability to generate new knowledge and to attract research funding to develop innovative products and services. In 2017, Oklahoma ranked #36 in the nation in total R&D expenditures according to data collected by the National Science Foundation. With the exception of Arkansas, neighboring states outcompeted Oklahoma in R&D expenditures with Texas at #3, Missouri at #21, Colorado at #22, New Mexico at #24, and Kansas at #29. State, federal, university and industry make up the main sources of R&D funding with the bulk of R&D activities conducted by industry and universities.
3. **Integrated Support System.** Oklahoma currently lacks an integrated system to support innovation activities and an overarching organizing structure to develop, coordinate and oversee startup and track research activities. At present, pockets of innovation and entrepreneurship activities exist throughout the state, operating in silos and not cross pollinating or creating

synergy which is critical to fostering innovation. Small scale incubators are scattered throughout the state with few making any significant traction. Accelerators are practically non-existent and business plan competitions are confined largely to the university setting targeting primarily student entrepreneurs. The state’s top research universities also lack an efficient and functioning framework to partner with industry to conduct research, transfer technology and commercialize research. As a result, efforts at developing an innovation economy in Oklahoma are uncoordinated, fragmented, and ineffective. To successfully build an innovation economy, stakeholders in government, academia, industry, and philanthropy need to work together to build a cohesive and comprehensive innovation ecosystem to nurture high tech startups and innovative enterprises.

4. **Startup Capital and Financing.** To transform innovative ideas and technology into market opportunities, innovative businesses need access to capital in the form of grants, loans, angel investment, venture capital and private equity. Currently, Oklahoma is not competitive in seeking early-stage funding. The number and value of Small Business Innovation Research (SBIR) and Small Business Technology Transfer (STTR) awards that go to Oklahoma’s businesses are good indicators of the ability of the R&D in Oklahoma to attract proof-of-concept capital. SBIR/STTR programs are federal grant programs that offer small technology companies some of the broadest forms of early-stage capital. Participants in the SBIR/STTR programs can use the credibility and experimental data developed through research to design commercial products and to attract strategic partners and investment capital. From the 2013 – 2017 period, Oklahoma ranked #35 in the number of SBIR/STTR grants awarded, averaging 17.8 awards each year.

Start-ups in Oklahoma experience difficulty in accessing venture capital in Oklahoma. The National Science Foundation maintains a database of venture capital disbursed by state and compares across states by measuring the amount disbursed per \$1 million of state GDP. In 2018, Oklahoma ranked #36 in disbursing venture capital. Over the 2010 – 2018 period, Oklahoma ranked last among surrounding states for venture capital disbursement.

Table 1: Average Venture Capital Disbursed per \$1 million of State GDP³

	1995-1999	2000-2009	2010-2018
Oklahoma	\$11	\$174	\$228
Arkansas	\$38	\$64	\$343
Kansas	\$26	\$230	\$526
Louisiana	\$99	\$69	\$395
Missouri	\$725	\$472	\$931
New Mexico	\$237	\$909	\$700
Texas	\$581	\$1,819	\$1,445
Oklahoma Rank	7 of 7	5 of 7	7 of 7
US Average	\$399	\$1,214	\$1,712

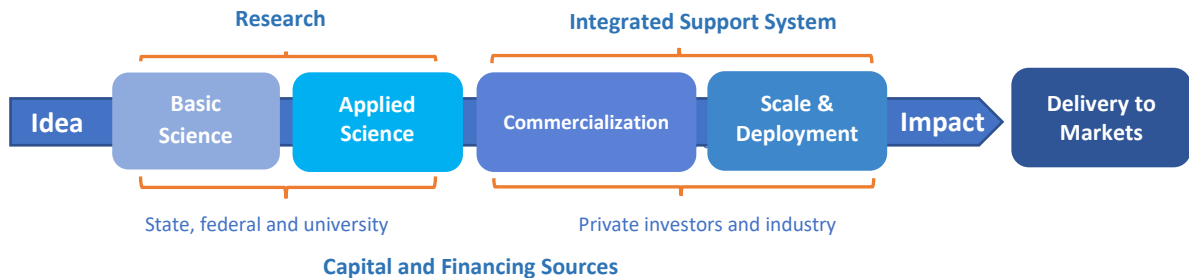
Source: National Science Foundation

Oklahoma has made efforts to grow its venture capital base through the creation of the Oklahoma Capital Investment Board and i2e. The Oklahoma Capital Formation Act was passed in 1991 and created the Oklahoma Capital Investment Board (OCIB). The mission of OCIB is to mobilize equity and near-equity capital for investment to create jobs and diversify and stabilize the economy of the State of Oklahoma. OCIB does not directly fund any company or business but invested in other venture capital funds that demonstrated a commitment to serving

entrepreneurs within Oklahoma. OCIB has the authority to raise capital and sold \$100 million in transferrable tax credit to raise funds. Unfortunately, due to poor returns and lack of strategic direction, tax credits authorized for use by OCIB expired on July 1, 2020, and no action was taken to continue to fund OCIB, allowing it to be gradually phased out.

The State of Oklahoma funds i2e through passthrough appropriations via OCAST. i2e is a private not-for-profit corporation that invests in entrepreneurs who are building high growth companies in Oklahoma. i2e works with entrepreneurs, researchers, and companies to help them commercialize their technologies, launch, and grow new businesses, and access capital. It is difficult to measure the impact of i2e in helping to grow the state’s startup capital base due to lack of data and tracking of its investments. Oklahoma also has several emerging boutique venture capital firms. However, our state lacks the critical mass of capital needed to launch and grow capital-intensive startups from idea to impact.

Innovation Pipeline: from Idea to Impact



5. **OCAST.** The Oklahoma Center for Advancement of Science & Technology (OCAST) was established in 1987 as a technology-based economic development agency and is the only agency focused on the development, transfer, and commercialization of technology. OCAST is tasked with creating an innovation pipeline for Oklahoma. Saddled with the statutory requirement to fund eight programs on a modest annual budget of \$14 million, OCAST has struggled to make a meaningful impact on the state economy since its inception. While there are anecdotal success stories over the past three decades, OCAST has been unable to lead the charge in creating large-scale high paying, high tech jobs for Oklahomans and in developing and commercializing research on a consistent and scalable basis. For OCAST to be successful and to fulfill its intended goal, its mandated scope will need to be restructured to allow for nimbleness and agility and its investment in research need to be more strategic, focused, disciplined, and meaningful.

PATHWAY TO INNOVATION: RECOMMENDATIONS

To create a strategic plan for building an innovation economy in Oklahoma, we examined the successes of Texas, Ohio and Massachusetts and compiled the following recommendations.

Recommendation #1 – Establish the Office of Science and Innovation

Given the critical role that innovation plays in the future of Oklahoma’s economy, the Governor and the Oklahoma Legislature should establish the Office of Science and Innovation (S&I Office) and fund it appropriately with an annual budget of \$800K to allow for staffing, programming, and marketing. The Governor should designate the Secretary of Science and Innovation to lead the development of innovation-friendly policies and statewide strategies to drive innovation and economic growth. The S&I Office would facilitate the development of meaningful collaborations across industry, academia, government, and nonprofits to create an integrated support system to stand up incubators and accelerators, hosting business plan competitions, and partnering on research endeavors. This Office would also be responsible for creating a system to collect innovation-pertinent data which is currently non-existent). Data that should be tracked include:

- Number of new high-tech companies founded in Oklahoma
- Number of new high-tech companies coming out of public universities in Oklahoma
- Number of new high-tech companies founded on university-originated patents and licenses
- Number of faculty and graduates from Oklahoma universities who have founded high tech companies. Number revenue generated, jobs created, and amount of venture capital investment received by start-ups in Oklahoma.
- Amount of venture capital received by industry sectors, by stages (seed, early, expansion and late) and by exits (IPO or M&A)
- Return on investment for any state investments in start-ups via i2e, OCAST or any other state-supported agency

Additionally, a data analytics team would need to be established to collect, analyze, provide data-driven updates, and make data-driven recommendations to the Governor and Oklahoma Legislature. An annual operating budget of \$800K would allow for \$475K in staffing (an executive director and five support staff members – one administrative assistant and four program managers (to carry out each of the four recommendations listed below), \$125K in programming, and \$200K in marketing.

Recommendation #2 – Identify Strategic Industries for Large Scale, Focused Investments and Partnerships

As we look to position Oklahoma to advance to a top 10 state in innovation and economic growth, science and technology investment in the state’s higher education, technology transfer of university R&D, public/private partnerships for workforce and technology development, venture capital ecosystem for emerging technologies, and infrastructure to accelerate early-stage companies, is critical. While we have a multitude of industry sectors worthy of investments, we must prioritize our limited resources and support industry sectors with the greatest probability for large scale job creation and maximum return on investment. Oklahoma can leverage on three key technology areas where our state already has established significant infrastructure and know-how and where a top 10 ranking can be achieved. These three areas are aerospace and autonomous systems, biotechnology/life sciences, and energy diversification.

Aerospace and Autonomous Systems. Research and development activity related to aerospace has been underway for decades in the state, and in the most recent decade for unmanned systems. Oklahoma’s legacy of aviation leadership includes aviation pioneers like Clyde Cessna and Wiley Post,

and it was leadership from Oklahoma U.S. Senator Mike Monroney that led to the creation of the Federal Aviation Administration (FAA) in the 1950s. Today, Oklahoma is home to the FAA's Mike Monroney Aeronautical Center, one of the largest FAA organizations and sites outside of Washington D.C. The state is also home to Tinker Air Force Base and the Sustainment Headquarters of the United States Air Force and to many large and small aviation, aerospace, and cyber-related companies. Oklahoma prides itself in having one of the nation's eight spaceports -- the Oklahoma Air & Space Port with a corridor that stretches 152 mile-long and 50-mile wide. Aviation is now – and has always been – an important part of the Oklahoma economy. Leveraging this, with Oklahoma's leadership in weather and atmospheric research at the National Weather Center in Norman, OK, provides much-needed weather information and data to enable research and public safety to support this technology/industry area. The State of Oklahoma has research and development strengths, and most importantly – the vision and leadership to emerge as a leading region for growth of the autonomous systems and aerospace industry.

Biotechnology/Life Sciences. As in aerospace, Oklahoma has had significant biotechnology research and development activity underway for decades. Home to the University of Oklahoma with a comprehensive health system and NCI Cancer Center, Oklahoma State University with human and animal schools of medicine and a focus on a One Health approach (human, animal, agriculture), numerous other Universities/Colleges with life science curriculum, the Oklahoma Medical Research Foundation (OMRF), the Oklahoma Blood Institute (OBI), The Noble Research Institute, and many biotech and life science related companies, provide Oklahoma with a firm foundation for growth in this sector. Additionally, like the establishment of the National Weather Center, Oklahoma has recently announced the opening of the Oklahoma Pandemic Center for Innovation and Excellence (OPCIE). This center is the first of its kind in the US for public health response and education for human, animal and environmental pathogens and looks to establish public and private partnerships across all areas of biotechnology to address its mission. Oklahoma is poised to emerge as a leading state for the biotechnology industry.

Energy Diversification. Oklahoma has a long and rich history as a leader in oil and gas research and exploration. The state continues to lead the way in these areas. As the need for energy consumption and the environmental concerns around it continue to grow globally, the State has increased its focus on efficient and environmentally friendly methods and alternative energy solutions to support the changing needs of the globe. These efforts span the state's higher education institutions and the many energy companies that already exist within the state ecosystem. The OSU Discovery Center (previously the Baker Hughes Energy Innovation Center) will allow researchers and students to collaborate with industry experts to innovate and advance key technologies in engineering for the field. Oklahoma's energy expertise extends well beyond traditional energy to geothermal, solar and wind and is leading the way with a diverse energy plan. Currently, the state ranks #3 in installed wind capacity and has >40% of Oklahoma's electricity generated from renewable resources. Along with having one of the lowest electricity rates in the country, in 2019, the state became #1 in the nation for electric vehicle charging. Focusing more resources on these and other energy diversification areas will help the State develop and maintain leadership across all areas of energy.

Recommendation #3 – Establish Centers of Excellence in Research

Research universities play a central role in the innovation process. The Governor and the State Legislature should invest in Oklahoma's research universities. State investment in research is essential to Oklahoma's economic competitiveness and leadership. Investments should be made to the three strategic areas (aerospace and autonomous systems, biotechnology/life sciences, and energy diversification) and sustained in a consistent manner to achieve effectively long-term goals.

Oklahoma needs to rethink its approach to funding scientific research. Funding sources for research originate from five principal sources: federal, state, university, industry, and nonprofits. To encourage increased investments in research, Oklahoma should replicate Texas' funding research model. In 2018, total R&D expenditures in Texas equaled \$5.6 billion compared to Oklahoma's \$517 million. The State of Texas alone appropriated \$847 million to fund research in 2018. Texas has established a number of university-earmarked research funds that receive annual appropriations from the Texas Legislature. Oklahoma should consider replicating three Texas funds which are structured to offer incentives for universities to secure research dollars – The Texas Research Incentive Program (TRIP), the Governor's University Research Initiative (GURI), and Performance-Based Research Operation. TRIP provides state matching funds to encourage universities to secure private gifts and endowments to enhance research activities. GURI awards matching grants to assist in recruiting distinguished researchers such as Nobel Laureates from institutions outside of Texas with the goal of enhancing Texas' national and global economic competitiveness. The Performance-Based Research Operation offers a base match according to the average annual research expenditures and a tiered performance incentive match over the increased expenditures over the previous biennium. The State of Oklahoma needs think creatively on how best to offer incentives for Oklahoma universities to be more competitive in seeking federal and private research dollars by leveraging state investment. In addition to increasing funding for research, Oklahoma also needs to offer incentives for universities to partner with industry and establish a legal framework to commercialize research seamlessly. Both OU and OSU should operate on a standard set of rules with respect to IP ownership, technology transfer, and revenue-sharing agreements that is conducive for growing public-private research partnerships.

Key performance indicators for this recommendation include:

1. Increase in state R&D expenditures
2. Growth in university research faculty numbers in key strategic investment areas
3. Growth in number of university faculty members invited to join nationally touted academies such as the National Academy of Medicine, National Academy of Sciences, and the National Academy of Engineering
4. Growth in university investments in high-tech infrastructure
5. Percentage in state GDP growth coming from the high tech industry
6. Growth in the number of venture-backed deals
7. Growth in the total amount of federal research dollars in key strategic investment areas

Recommendation #4 – Create Superclusters of Innovation and Support Systems

Superclusters of innovation are economic hot spots with high concentrations of new technologies in particular fields germinating at a rapid rate and where pools of capital, expertise, and talent foster the development of new industries and new ways of doing business. Silicon Valley, Austin and Boston are examples of super clusters of innovation. Superclusters tend to share the following ingredients: excellent universities, successful entrepreneurs, a pool of talent, access to financing and shared resources like incubators and accelerators. Once super clusters are formed, entrepreneurs, companies' capital and talent will gravitate to these clusters to gain better access to specialized knowledge high paying jobs, supply chains, and new products and ideas. Oklahoma needs to develop a comprehensive strategy to create an innovation ecosystem to nurture new concentrations of growth industries centered on the three strategic areas of investment: aerospace and autonomous systems, biotechnology/life sciences, and energy diversification. We recommend the following investments to create vibrant innovation clusters:

- As the highest priority, innovation clusters that span all three strategic areas should be developed in the most densely populated centers: Oklahoma City and Tulsa. Oklahoma City's cluster should leverage the OKC Innovation District and the nearby OSU Discovery and OU Research Park infrastructure. Tulsa's cluster should leverage the Tulsa Innovation Labs, the burgeoning medical corridor, and Tulsa operations of both OU and OSU (Schusterman Center, OSU Medicine, Helmerich Research Center, etc.).
- As the next priority, several single-sector clusters should be developed in conjunction with key state assets/investments, such as FISTA/Fort Sill in Lawton (defense technologies), the OPCIE in Stillwater (One Health), and the Oklahoma Space Port in Burns Flat (commercial space flight).
- In addition to resources deployed directly at the cluster sites, the economic development and commercialization infrastructures at both OU and OSU should be resourced to collaborate on additional services to the clusters. Likewise, the respective research parks at OU Norman and OSU Stillwater can serve as both supports to, and overflow from, all the clusters.

Once a strategy is developed, state agencies, corporate leaders, higher education, charitable foundations, and nonprofits should coordinate and pool their resources and organize their programs within the framework of the overarching strategy to build shared facilities for manufacturing prototyping, wet labs for experiments and testing, incubators, and accelerators. In addition to shared facilities, Oklahoma must also nurture a risk capital community that is supportive of early-stage as well as later-stage financing for start-ups to ensure that emerging firms can grow and scale in Oklahoma. Lastly, state leaders should liaise with our congressional delegation to determine if funding is available from the U.S. Departments of Energy, Commerce, Defense, Agriculture, Labor, and Education to support regional innovation clusters.

Key performance indicators for this recommendation include:

1. Total amount of federal funds (e.g., SBIR, STTR, etc.) secured by Oklahoma companies supported by the clusters
2. Total number of R&D contracts between companies supported by the clusters and Oklahoma research institutions
3. Total number of jobs created by companies supported by the clusters
4. Total amount of capital from private partnerships

Recommendation #5 – Establish a Federally Funded Research Lab

Innovation regions are often anchored by federally supported research lab such as a Federally Funded Research and Development Center (FFRDC) or a University Affiliated Research Center (URAC). Silicon Valley has the Lawrence Berkeley National Laboratory and the SLAC National Accelerator Laboratory. Boston has the Lincoln Laboratory. Texas has NASA which receives close to \$2 billion in federal dollars annually to fund operations, programs, and research in Houston. Texas also has U.S. Department of Defense and Human and Health Services district labs and research units, which combined bring in another \$2 billion in federal dollars to Texas. Oklahoma should work with our federal delegation to develop proposals to develop a federally funded research lab based on the three strategic investment areas -- aerospace and autonomous systems, biotechnology/life sciences, and energy diversification. Possible federal partnerships could be formed with the U.S. Department of Defense for unmanned aerial systems and aerospace, the Defense Advanced Research Projects Agency, the U.S. Department of Energy for energy diversification, the U.S. Department of Health and Human Services for opioid research and the National Institutes of Health. Oklahoma should also leverage on our military installations (Tinker

Air Force Base, Fort Sill Army Base, Altus Air Force Base, and Vance Air Force Base) to forge research and innovation partnerships with federal agencies.

To achieve the goal of establishing one or more federally supported research labs in Oklahoma, Governor Stitt should create an Energy Diversification Council and a Life Sciences/Biotech Council similarly to the already established Aerospace and Autonomous Systems Council. The Energy Diversification Council should be charged with the goal of landing a U.S. Department of Energy-funded research center focused on clean energy. The Life Sciences/Biotech Council should be charged with the goal of landing a U.S. Department of Health and Human Services or National Institutes of Health funded research center. All three of the envisioned Councils (Energy Diversification Council, Life Sciences/Biotech Council, and Aerospace and Autonomous Systems Council) will be responsible for securing federal grants in their respective area.

Key performance indicators for this recommendation include:

1. Amount of federal and non-federal funding
2. Number of patents, publications
3. Creation of Student/workforce training opportunities
4. Amount of entrepreneurial investment and commercialization of products
5. Usage of traditional energy vs. clean energy
6. Number of jobs created, average salary compensation, and percentage in population growth
7. Number of companies recruited to Oklahoma

Recommendation #6 – Invest in Education, Workforce Development, and Internship Programs

One area that our state will need to shore up to develop an innovation economy is to increase investments in education in every segment of the from K-12 to post-secondary education (vocational, undergraduate, and graduate education). Access to an educated workforce is a critical component of an innovation economy. Being ranked #50 in the nation for education by the Milken Institute's 2020 State Technology and Science Index serves as a deterrence for innovative companies looking to relocate to Oklahoma. Texas' and Massachusetts' education funding models serve as good examples for Oklahoma. In 1854, the Texas Legislature had the foresight to create the Texas Permanent School Fund (PSF), \$2 million endowment to benefit public schools and public higher education systems in Texas. In 1876, legislators stipulated in the Texas Constitution stipulated that certain lands belong to the PSF and proceeds from the sale and mineral-related rental of these lands including royalties belong to the PSF and would form the corpus of the PSF. As of August 2020, the Texas Permanent School Fund had a market value of \$48.3 billion, providing a predictable stream of revenue to support public education and higher education in Texas. Massachusetts which ranks #1 by the Milken Institute for overall in innovation and for education decided to double down on its investment in education. In 2019, Republican Governor Charlie Baker signed landmark legislation to strengthen public education by boosting investments in public schools by \$1.5 billion annually for the next seven years. The State of Massachusetts realized that its vast pool of talent is what fuels its innovation economy.

The envisioned Office of Science and Innovation would work with the Science and Innovation Council to develop a long-term strategic plan and sustainable funding model to address Oklahoma's educational shortfalls. Cutting up and redistributing pieces of the pie cannot be the solution. The size of the pie for education in Oklahoma needs to grow if we want to grow our economy and transform it into an innovation fueled economy. Oklahoma could dedicate a portion of incoming federal funds to establish a

substantial Permanent School Fund and identify additional revenue streams. The Fund should be structured similarly to TSET's funding formula and safeguards to deter the State from tapping into the Fund in the event of budget shortfalls. Additionally, a statewide apprenticeship program with corporate partners should be established. Lastly, Oklahoma needs to develop a strategy to encourage more students to pursue STEM degrees, offering incentives for community colleges and regional and research universities to graduate more students in STEM. Oklahoma could also expand the number of STEM workers by replicating talent recruitment programs like Tulsa Remote where the state offers financial incentives for STEM workers to relocate to Oklahoma.

Key performance indicators for this recommendation include:

1. Legislation passed to create a Permanent School Fund and apprenticeship program
2. Legislation passed to increase in public education funding per student
3. Legislation passed to increase funding for post-secondary education (career tech and higher education)
4. Increase in academic achievement as measured by performance in science and math 4th and 8th grade testing
5. Number of corporate partners participating in the apprenticeship program
6. Increase in the number of STEM degrees awarded by Oklahoma institutions

Recommendation #7 – Secure Public and Private Financing to Fund Recommendations

A number of states have invested billions of dollars into modernizing their state economy and transforming it to meet the challenges of a technologically driven global economy. Ohio invested \$2.3 billion, Massachusetts invested \$1.6 billion, and Texas invested over \$1 billion. More recently, the State of Indiana was one of the more recent states to invest massively in innovation by creating a 10-year, \$1 billion innovation initiative to jumpstart its innovation economy. Oklahoma should assemble a 6-9-person task force made up of legislators, academic experts, and industry leaders to perform a 6-month assessment to determine the level of investment needed and identify potential public and private funding sources to implement these recommendations with at minimum a 10-year commitment to funding. The cost to implement this strategic plan could be substantial. However, the price of not investing is even higher. Failure to invest substantially in the three strategic industries will lead to Oklahoma falling further and further behind in growing our state economy.

APPENDIX: CASE STUDIES – TEXAS, OHIO, AND MASSACHUSETTS

Texas Case Study: Diversifying and Expanding the Texas Economy Through Innovation

For the last 3 decades, the Texas economy has been gradually changing from a resource-based economy to a knowledge-based economy. Due to thoughtful and intentional long-term planning, Texas has become a state known not only for oil and gas production and cattle ranching, but also for its concentration of high-tech companies. The high-tech sector has been one of the fastest-growing segments of the Texas economy since the 1990s. Since the oil crash of the 1980's, Texas has been diversifying its economy to reduce the impact of the oil industry's volatility on the state's economy. In 1982, the oil sector's share of state GDP was 19%. In 2018, the oil and gas industry accounted for only 9% of the Texas GDP. As a result of government leadership, the Texas economy has evolved from one overly dependent on oil and gas to one that boast one of the most diversified state economies in the nation. Today, with 57 companies with corporate headquarters in Texas, Texas is home to the 2nd highest number of Fortune 500 companies with high tech giants like Tesla, Oracle, and Hewlett-Packard re-locating to the Lone Star State. How has Texas managed to transform and diversity its state economy?

In the mid 1990's, Texas took a number of important steps to grow its high-tech industry. In 2003, the Texas state legislature established the Texas Enterprise Fund (TEF) with an initial investment of \$295 million. Through TEF, Texas committed \$25 million to attract a new Center for Advanced Diagnostic Imaging in Houston, which hastened the development of new commercially marketable biomedical imaging technologies and create 2,200 new jobs. In 2005, under the leadership of former Governor Rick Perry and with support from the state legislature, Texas created a \$200 million Texas Emerging Technology Fund (TETF) to invest in research, development, and commercialization of emerging technologies. The goal of TETF was to create jobs and develop the Texas economy. Legislative sessions in 2007 and 2009 increased investments to the fund bringing the total amount of funds under management to approximately \$500 million. TETF focused on three main investment areas:

1. *Incentives for Commercialization Activities*: early-stage technology investment funds designed to assist companies in transforming ideas, concepts, and prototypes into commercially viable products.
2. *Research Award Matching*: funds create public-private partnerships which leverage the unique strengths of universities, federal government grant programs, and industry.
3. *Acquisition of Research Superiority*: funds for Texas higher education institutions to recruit the best research talent in the world.

Texas places a top priority on research investments. In 2019, Texas higher education institutions recorded \$5.6 billion in total research expenditures, ranking third in the nation in R&D in total investments behind California and New York. Federal research dollars accounted for 40% of the research expenditures, with 20% coming from industry, and another 17% from state and local funds. From 2009 through 2015, the Texas Legislature has invested hundreds of millions of dollars in research by creating several funds to support university-generated research, some of which are:

- Texas Research University Fund (TRUF) provides funds to Texas' two top research universities: The University of Texas at Austin and Texas A&M University to recruit and support faculty to ensure excellence in instruction and research. The average annual funding for TRUF is \$70 million.

- Core Research Support Fund (CRSF) provides funds to emerging research universities in Texas to support and maintain educational activities that promote increased research capacity. The CRSF Fund allocates \$59 million each year to eight emerging research universities.
- Texas Research Incentive Program (TRIP) provides matching funds to assist emerging research universities in leveraging private gifts for the enhancement of research productivity and faculty. Matching funds are awarded based on private gifts and endowments to enhance research activities. From FY 2010 through FY 2021, the TRIP provided a total of \$361 million in matching funds to Texas universities.
- Governor’s University Research Initiative (GURI) provides matching grants to public universities and health-related institutions to assist in recruiting distinguished researchers, such as Nobel laureates and National Academy members, from institutions outside of Texas to enhance the state’s national and global economic competitiveness. As of 2020, \$54 million has been invested in GURI.
- Texas Comprehensive Research Fund (TCRF) provides funds to Texas public institutions that are neither research nor emerging research universities. \$7 million is made available annually to 25 institutions.
- National Research University Fund (NRUF) provides funds to Texas emerging research universities seeking to achieve national prominence as major research universities. The average annual funding per institution is \$8.3 million.

Texas views its talent pool as an economic strategic asset. High-tech firms are re-locating to Texas to tap into the vast pool of skilled labor clustered in Austin and the Dallas-Fort Worth area. The availability of a skilled labor pool is often ranked as the most important factor for a firm’s decision to relocate to Texas. Because high-tech companies are expanding in Texas, skilled workers from other regions are attracted to Texas in search of high paying jobs, thereby further expanding the state’s skilled labor pool. Texas has adopted innovative educational programs to ensure that its public schools produce an abundance of talent for technical and STEM careers such as:

- **Early College High School.** This program blends high school and college coursework to provide students who are at risk of not graduating, students who are historically underserved, and students who wish to accelerate their learning with the opportunity to earn an associate degree and/or 60 hours of college credit tuition free. Early college opportunities include the Pathways to Technology Early College High Schools (P-TECH) program, an open-enrollment program that provides students with work-based education. In the 2017–18 school year, 198 schools were designated early college high schools, including P-TECH.
- **Texas Science, Technology, Engineering, and Mathematics Initiative (T-STEM).** This initiative creates secondary schools that focus on improving instruction and academic performance in science and mathematics–related subjects and increasing the number of students who study and enter STEM careers. In the 2017–18 school year, 132 campuses were designated a T-STEM Academy.
- **Industry Cluster Innovative Academies.** Launched in 2017, this program provides opportunities for work-based learning and college course credit within targeted industry clusters and focuses on graduating students with industry certifications and 60 hours of college credit and/or an associate degree. There are 18 Industry Cluster Innovative Academies scattered across Texas.

The Texas public school system and public universities also benefit from a steady stream of funding. In 1854, the Texas Legislature had the foresight to create the Texas Permanent School Fund (PSF) with a \$2 million endowment to benefit public schools and public higher education systems in Texas. In 1876, the

Texas Constitution stipulated that certain lands belong to the PSF and proceeds from the sale and mineral-related rental of these lands including royalties belong to the PSF would form the corpus of the PSF. As of August 2020, the Texas Permanent School Fund had a market value of \$48.3 billion, providing a predictable stream of revenue to support public education and higher education in Texas.

The relocation of large tech firms to Texas such as Apple and Google have had a rippling effect on the Texas venture capital ecosystem. In 2019, Austin made it into the top 10 venture markets bringing in more than \$1.8 billion in venture capital funding. Austin also ranked #7 in the number of deals in 2019. Tech savvy individuals and entrepreneurs are flocking to Austin to work for startups or to start their own. Innovative companies such as Capital Factory have helped make Texas a destination of choice for high tech entrepreneurs. Capital Factory was founded in 2009 when Austin's startup scene was still nascent. It offers an accelerator program and access to venture capital. Its strength lies in its ability to build bridges among startups, funding sources, corporate partners, and government agencies and to create a supportive community where entrepreneurs can work near each other and share best practices and challenges.

The availability of a highly educated labor force, quality education, access to capital, a favorable tax and business environment, and relatively low cost of living has made Texas an in-demand location for high tech firms, professionals, and entrepreneurs.

Ohio Case Study: Rebuilding Ohio's Economy Through Innovation

During the first half of the 20th century, Ohio's economy was buoyed by its steel, auto, rubber, and aerospace industries. By the 1970s, many of these key manufacturing industries faced growing competition from abroad and increased automation. At the same time, Ohio failed to invest sufficiently in the university infrastructure and in emerging industries such as electronics and biomedicine. The industrial decline in Ohio resulted in job and population losses and stagnant economic growth. During the recession of 2009, Ohio lost 376,500 jobs and suffered some 89,000 housing foreclosures. Ohio became one of the clusters of midwestern states negatively branded as part of the Rust Belt, with rust referring to deindustrialization, economic decline, population loss, and urban decay.

In 2002, the state government took decisive action to reverse Ohio's economic decline by rebuilding its economy and shedding its attachment to the old economy way of doing business. The state created the Ohio Third Frontier, an unprecedented \$1.6 billion bond commitment by the state and passed by voters to create an "innovation ecosystem" that supports the efficient and seamless transition of great ideas from the laboratory to the marketplace. In 2010, Ohioans voted to increase funding for the Third Frontier by another \$700 million and extend it for another five years, bringing the state's total investment in the Third Frontier to \$2.3 billion. The \$2.3 billion initiative has supported applied research and commercialization, entrepreneurial assistance, early-stage capital formation, and expansion of a skilled talent pool that can support technology-based economic growth.

Ohio's Office of Technology Investments administers the Third Frontier programs, which provides funding to state-based, technology-oriented companies, universities, and non-profit research organizations to create new companies, industries, products, and jobs. Amendments to the state constitution approved by Ohio voters lifted a constitutional ban on state investments in private business with respect to the Third Frontier program. Furthermore, the Third Frontier program has been the largest contributor to the Ohio Research Scholars Program, which funds university efforts to attract researchers who bring with them federal research dollars to Ohio. State legislation was also passed to allow university faculty to become stakeholders in startups to commercialize their research findings. This change in legislation led to an increase in university start-ups.

Philanthropic organizations in Ohio also stepped to help turn the states' economy around. Philanthropic foundations pooled their resources to create Fund for Our Economic Future with a \$20 million investment to back small nonprofit economic development organizations that function as catalysts for innovation-based economic revitalization, forming innovation clusters and establishing incubators and accelerators.

One highly successful nonprofit economic development organization is the BioEnterprise Corporation, a business formation, recruitment, and acceleration initiative established in 2002 through a collaborative partnership among the Cleveland Clinic, University Hospitals and Case Western Reserve University and supported by government, private and foundation sources. BioEnterprise houses a life science incubator that provides clients with access to wet and dry lab space and state of the art laboratory equipment. It also provides its clients with workstations, office space and conference rooms. By 2004, start-ups supported by BioEnterprise had raised \$62 million in capital. By 2009, BioEnterprise had supported 89 biomedical companies in Ohio raising \$859 million in capital and generating 1,900 jobs.

Today, Ohio has experienced an innovation-based economic turnaround. The state's unemployment rate which peaked at 11% in 2010 dropped to 4.8% in 2018. Ohio also added 540,100 private sector jobs from 2011 – 2018.

Ohio continues to build upon its investment in innovation with particular emphasis on research. Over the span of a year from March 2020 – March 2021, the state established three innovation districts: the Cincinnati Innovation District in March 2020, the Cleveland Innovation District in February 2021, and the Columbus Innovation District in March 2021. Each innovation district will focus on a specialty in partnership with local universities and health systems.

- The Cincinnati Innovation District which will receive \$100 million in state funding is a partnership between the state, the University of Cincinnati, and the Cincinnati Children's Hospital Medical Center to focus on increasing 15,000 STEM graduates and developing and commercializing research focused on pediatric diseases.
- The Cleveland Innovation District, which will receive \$265 million in state funding, is a partnership between the state, the Cleveland Clinic, Case Western Reserve University, Cleveland State University and University Hospitals to focus investments on researching infectious diseases and pandemics. The goal is to create 20,000 jobs in Ohio over a 10-year period, capitalizing on Cleveland's academic and clinical care assets.
- The Columbus Innovation District is a \$1 billion collaboration between the state, Ohio State University and Nationwide Children's Hospital. The state will invest \$100 million with Nationwide Children's Hospital contributing \$350 million and Ohio State University contributing \$650 million. The focus of the Columbus Innovation District is to develop gene and cell therapies and conduct cancer research.

Ohio's investments in innovation over the past two decades demonstrates its commitment to embrace a knowledge-based economy. Its state leadership is willing to be bold by-passing innovation-friendly legislation, investing in partnerships with universities to advance cutting edge research, and committing substantial state dollars to create an innovation ecosystem.

Massachusetts Case Study: Leveraging Innovation to Be a Global Biotech Hub

In 2008, Massachusetts set its sight on competing with Silicon Valley to become the world's leading biotech hub by launching the Mass Life Sciences Initiative (MLSI). Through MLSI, the state committed to investing \$1 billion over 10 years in the life sciences sector. In 2018, Governor Charlie Baker reauthorized the initiative. He committed an additional \$623 million to drive education, research and development and workforce training in the life sciences industry.

The \$2.3 billion funding to grow the state's life sciences sector is managed by the Massachusetts Life Sciences Center (MLSC). The MLSC is an economic development investment agency dedicated to supporting the growth and development of life sciences in Massachusetts. MLSC supports innovation, research, commercialization, and manufacturing activities in the fields of biopharma, medical device, diagnostics, and digital health. MLSC makes these investments through a combination of grants, loans, capital infrastructure investments, tax incentives and workforce programs.

Massachusetts has made a concerted effort to create a biotech supercluster to compete head on with Silicon Valley. In Boston and Cambridge, a high concentration of hospitals, leading universities, and private companies exist in a small geographic area. State leaders leveraged on this concentration of top tier universities from Harvard to MIT and world-renowned hospitals such as Massachusetts General Hospital, Dana-Farber Cancer Institute and Brigham & Women's Hospital to create the Kendall Square biotech supercluster. Kendall Square, which has been labeled "the most innovative square mile on the planet," has over 120 biotech and life sciences companies and research institutions, including Moderna, Biogen, Amgen, Novartis, and Pfizer.

Massachusetts has been incredibly successful at creating the necessary infrastructure for biotech start-ups to launch and thrive. In Boston alone, there are more than 50 biotech and life sciences incubators and accelerators, some of which received operating grants from the state's Collaborative Workspace Program which awards over \$1 - \$2 million annually to organizations that fuel community-based innovation. In February 2021, MLSC announced a partnership with Thermo Fisher Scientific, Waters Corporation, and Astellas to create LabCentral, a fully functional life sciences laboratory with a focus of helping more advanced stage start-ups scale-up bio-manufacturing. Massachusetts state leadership continues to spearhead innovative initiatives to sustain and grow the state's life sciences sector.

The nonprofit sector has played a significant role in fueling Massachusetts' aspiration to become a life sciences juggernaut. The Massachusetts Biotechnology Council (MassBio), a nonprofit trade association, was founded in 1985 by six start-ups, Biogen, Genzyme, BioTechnica, Genetics Institute, Damon BioTech, and Integrated Genetics to help make Massachusetts home to the world's leading life sciences supercluster. Today, MassBio has over 1,100 members comprising of biotech companies, academic institutions, disease foundations, and hospitals. In addition to providing networking opportunities for entrepreneurs, business leaders, and scientists, MassBio also offers its members value-added services. For example, through its MassBio Edge, MassBio pools the buying power of its member companies to purchase goods and services, such as lab and office supplies, that biotech and life sciences companies need to do innovative work and develop new therapies.

University leadership is one of the primary reasons for Massachusetts phenomenal biotech success. Kendall Square is home to two of the world's leading research universities -- Harvard and MIT. In addition to conducting cutting edge research and producing biotech talent, both MIT and Harvard play an active role in making Kendall Square a biotech supercluster. Both universities operate incubators and

accelerators. In particular, MIT has been at the helm in the creation of Kendall Square. Starting in the 1960's, MIT grew its real estate portfolio by purchasing surrounding properties around the Kendall Square area. Kendall Square was formerly an abandoned industrial area adjacent to the MIT's campus. In 2013, MIT embarked on a massive \$1.3 billion redevelopment plan to transform 26 acres of property that the university owned around Kendall Square into commercial, residential and laboratory spaces to support the area's burgeoning biotech sector and affluent employees.

Federal research dollars have also been a key building block in Massachusetts' innovation economy. Massachusetts consistently ranks #2 behind California in the total amount of federal research dollars received, taking in a \$28 billion haul in 2018. The state is home to five of the top hospitals in the country that receive the most National Institutes of Health (NIH) funding. That track record is significant because NIH is the largest public funding source of biomedical research worldwide. In 2019, Harvard University alone received \$560 million in federal research dollars. MIT is also home to Lincoln Laboratory, a federally funded research and development laboratory sponsored by the Department of Defense. The Lincoln Laboratory has an annual operating budget of \$1 billion, the bulk of which is funded by federal dollars, and employs over 3,500 MIT employees. Lincoln Laboratory supports a division dedicated to biotech and human systems research.

Since 2010, the Milken Institute has ranked Massachusetts #1 in its State Technology and Science Index, powered by the state's strong R&D inputs and aggressive human capital investments. The state consistently ranks #1 or #2 in public education by the U.S. News & World Report and WalletHub, spending \$17K per pupil. However, Massachusetts continues to invest in public education to protect its pole position in educational strength. Recognizing that the availability of a highly educated workforce in Massachusetts is the state's most valuable asset in maintaining its economic competitiveness, Governor Baker signed into law landmark legislation in 2019 to commit an additional \$1.5 billion over seven years to fund the state's public education system.

From investing in public education to collaborative partnerships between government, academia, health systems, and the private sector, state leaders have transformed Massachusetts into the world's top biotech hub. And their targeted investments have paid off handsomely. In 2012, venture capital firms poured in \$900 million into Massachusetts. In 2020, Massachusetts-based biotech companies raised a record-breaking \$5.8 billion in venture funding. Furthermore, 21 Massachusetts biotech companies had IPOs, raising an additional \$3.9 billion in public equity.

Massachusetts serves as model example of the incredible gains that can be made when government, industry, and universities collaborate towards a shared vision. Many attribute Massachusetts overwhelming success in spurring on innovation to the state government's leadership and commitment to partnering with industry, academia, and nonprofits to advance the state's biotech aspirations and in its commitment to funding education.

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