



BUILDING AN ECONOMY OF THE FUTURE:

Indiana's Strategy for
Advancing GDP Growth
and Economic Prosperity

Phase II: Strategy and Action Plan

Prepared for:

Bradley B. Chambers
Secretary of Commerce, State of Indiana
CEO, Indiana Economic Development Corporation

Prepared by:

TEconomy Partners, LLC. with support provided by
the Central Indiana Corporate Partnership



TEconomy Partners, LLC (TEconomy) endeavors at all times to produce work of the highest quality, consistent with our contract commitments. However, because of the research and/or experimental nature of this work, the client undertakes the sole responsibility for the consequence of any use or misuse of, or inability to use, any information or result obtained from TEconomy, and TEconomy, its partners, or employees have no legal liability for the accuracy, adequacy, or efficacy thereof.

CONTENTS

Executive Summary	i
Economy of the Past.....	i
Economy of the Future	i
I. Introduction.....	1
Indiana's Economic Performance	3
A Time of Change	4
A Need to Strategize and Invest Wisely.....	5
II. Overview of Strategic Plan.....	7
Strategies and Actions Summary.....	10
III. Strategy 1: Advancing World-Class Education and Workforce Training	13
Action 1.1: Increase graduate retention through financial incentives in strategic fields of study	20
Action 1.2: Address projected supply-demand imbalances in sub-baccalaureate technical positions	28
Action 1.3: Create strategic industry workforce training and development centers.	30
Action 1.4: Advance industry-student connectivity during education	35
Action 1.5: Enhance mechanisms to support increased workforce participation	36
Action 1.6: Develop a marketing initiative to tell the Indiana story and encourage increased population and workforce growth	38
Action 1.7: Continued investment in the built environment, communities, and quality of life to encourage population retention and growth.....	38
IV. Strategy 2: Accelerating Productivity Via Business 4.0	41
Action 2.1: Significantly increase funding for the Manufacturing Readiness Grant program.....	43
Action 2.2: Expand the MRG program with a parallel Business 4.0 Readiness program that will support digital transformation in strategic nonmanufacturing sectors of the economy.....	46
Action 2.3: Attract automation companies and consultancies.....	46
V. Strategy 3: Focusing on Strategic Sector Evolution & Development.....	47
Action 3.1: Strategic Cluster Foci.....	50
Action 3.2: Capturing a new strategic industry.....	52

Action 3.3: Onshoring and strategic recruitment to reinforce cross-cutting technology competencies	56
VI. Strategy 4: Completing the Economic Development Ecosystem	59
Action 4.1: Focus the legislature and state agencies on economic development.....	59
Action 4.2: Develop and communicate a renewable and affordable energy roadmap for the state	60
Action 4.3: Secure a portfolio of strategic sites in the state suited to major projects	61
Action 4.4: Increase entrepreneurial activity and supports.....	61
VII. Conclusions.....	65
Appendix A: Memorandum from TEconomy Summarizing Competitive Analysis	67
Conclusions	89
Appendix A1: Development Functions and Programs	91
Appendix A2: Summary of State Economic Development Expenditures and Other Indicators (2020)	91
Appendix A3: Average, Maximum, and Minimum Economic Development Expenditures Across Functional Areas (FY2016-2020).....	93
Appendix B: Selected Companies Active in Hydrogen Technologies.....	95
Appendix C: Largest Companies Active in IoT Development and Systems	99
Hardware.....	99
Platform, Software, and Service Providers.....	99
Other U.S.-Based IoT Engaged Companies.	100
Appendix D: Summary from CEO Interviews—Identified Strengths, Weaknesses, Opportunities, Threats, and Needs.	103
Strengths.....	103
Weaknesses	103
Opportunities.....	104
Threats	104
Needs.....	105
Appendix E: Companies Engaged in Industry 4.0 Implementation and Integration Services.....	107

EXECUTIVE SUMMARY

Economy of the Past

Across the past decade, and relative to other states, Indiana has had a “middle of the road” economy. Across the 2010-2019 timespan, Indiana ranked 20th among the 50 states and the District of Columbia (DC) in terms of its average annual GDP growth rate of 1.99%. This decadal growth in GDP places Indiana just inside the second quintile of U.S. states and below the national average GDP growth rate. Under Governor Eric Holcomb, the state's performance has improved, but challenges remain as the state seeks to move to the next level of economic growth. Notable among challenges observed are:

- Only recent implementation of a clear and concise strategy to guide economic development investments that will take time to produce results.
- Underinvestment in economic development by the state. Indiana has significantly underspent its ten direct competitors annually for decades.
- Workforce availability and skills are lagging due to population growth headwinds and underperformance in terms of attraction or retention of well-educated and in-demand vocationally trained people.
- Multiple key industries in Indiana are and will continue to face significant changes due to disruptive technologies and shifting market trends.
- Productivity growth in many Indiana industries has lagged, with Indiana underinvesting in productivity-enhancing digital technologies.

At the direction of Secretary of Commerce Brad Chambers, TEconomy Partners, supported by the Central Indiana Corporate Partnership (CICP), was tasked with specifically addressing the first bulleted item above—

working to develop a strategy for the economic component of Secretary Chambers' "5e" vision for Indiana. The strategy seeks to address Indiana's economic challenges and advance Indiana to a rank in GDP growth and GDP per capita that exceeds its rank among the states based on population (16th). Doing so necessitates urgency, bold actions, and investments, as it requires advancing Indiana from its current 20th rank in GDP growth rate and 31st place in GDP per capita.

Economy of the Future

This report outlines an ambitious strategy and action plan for Indiana and the Indiana Economic Development Corporation (IEDC). It is designed to:

- Advance productivity and business growth by addressing needs for an available and appropriately skilled workforce and investment in advanced business technologies.
- Focus on strategic sector expansion and attraction, both in key existing industries and in new opportunity sectors.
- Increase new business development and entrepreneurship in Indiana rooted in R&D and innovation.

The specific strategies and actions recommended include:

Strategy	Actions
1. Advancing World-Class Education & Workforce Training	<p>Action 1.1: Increase graduate retention through financial incentives in strategic fields of study.</p> <p>Action 1.2: Address projected supply-demand imbalances in sub-baccalaureate technical positions.</p> <p>Action 1.3: Create strategic industry workforce training and development centers.</p> <p>Action 1.4: Advance industry-student connectivity during education.</p> <p>Action 1.5: Enhance mechanisms to support increased workforce participation.</p> <p>Action 1.6: Develop a marketing initiative to tell the Indiana story and encourage increased population and workforce growth.</p> <p>Action 1.7: Continued investment in the built environment, communities, and quality of life to encourage population retention and growth.</p>
2. Accelerating Productivity Via Business 4.0	<p>Action 2.1: Significantly increase funding for the Manufacturing Readiness Grant (MRG) program.</p> <p>Action 2.2: Expand the MRG program with a parallel Business 4.0 Readiness program that will support digital transformation in strategic nonmanufacturing sectors of the economy.</p> <p>Action 2.3: Attract automation companies and consultancies.</p>
3. Focusing on Strategic Sector Evolution & Development	<p>Action 3.1: Strategic cluster foci:</p> <ul style="list-style-type: none"> • Mobility Systems, Power, and Propulsion • Life Sciences • Insurance and Insurance Innovations <p>Action 3.2: Capturing new strategic industries:</p> <ul style="list-style-type: none"> • Semiconductors and Advanced Microelectronics • Hydrogen Systems and Electric Battery Systems and innovations <p>Action 3.3: Onshoring and strategic recruitment to reinforce crosscutting technology competencies.</p>
4. Completing the Economic Development Ecosystem	<p>Action 4.1: Focus the legislature and state agencies on economic development and competitive annual funding for IEDC.</p> <p>Action 4.2: Develop and communicate a renewable and affordable energy roadmap for the state.</p> <p>Action 4.3: Secure a portfolio of strategic sites in the state suited to major projects.</p> <p>Action 4.4: Increase entrepreneurial activity and supports.</p>

Implementing these strategies and actions requires a significant commitment by the state and its key stakeholders, together with increased investment in economic development (including funding for IEDC). Programs outlined in the strategy require a long-term commitment of financial resources, with major funding needed for:

- IEDC's operational budget—which should be at least doubled to bring it in line with competing states.
- Advancing retention of graduates in strategic STEM-degree disciplines in Indiana after their graduation (a circa \$52 million net cost program for the state operating over five years).
- Investment in a Bioscience Industry Workforce Training and Development Center (an estimated \$60 million), and a similar investment in several distributed workforce training and development centers focused on Industry 4.0 skills development, co-located with Ivy Tech core campuses.
- Significantly enhanced funding for the successful Manufacturing Readiness Grants (MRG) program, increasing funding to \$50 million in 2023 and to \$100 million a year for a subsequent four-year period (sunsetting thereafter). Plus investment in a Business 4.0 Readiness Grants Program, at a smaller scale, to encourage digital and Internet of Things (IoT) investments in nonmanufacturing sectors of strategic importance, such as the insurance sector and the logistics and distribution sector.
- Continued investment in the Regional Economic Acceleration and Development Initiative (READI) program, strategic sites program, state marketing program, and other related initiatives supporting the advancement of enhanced quality of place statewide.

Because of the scale of changes coming to industries, the scale of investment needed to adapt, and extreme competition for the people who enable successful business transformation to occur, Indiana's leadership, the IEDC, and key stakeholders recognize the inflection point at which the state now stands. To borrow a term from the business literature, Indiana needs to move from “good to great” in terms of its ability to conduct advanced economic development. The strategies outlined herein are designed to help accomplish that.

Indiana's state legislature and executive administration have performed very important work over the past decade by being fiscally responsible, building a AAA bond rating, and accumulating a budget surplus. Now is the time to put that capital base to work—to invest at a significant level over the next several years to set the stage for powering Indiana's economy and economic growth forward.

I. INTRODUCTION

Economies at a state level are immensely complex. While we may boil down economic performance to some basic metrics (such as unemployment rate, economic output, and gross domestic product), the fact is that each of these measures is derived from the sum actions and decisions of millions of individual people and many thousands of employers. These, in turn, are impacted by multiple factors, including global market conditions, government policies and trade agreements, emerging disruptive technologies, evolving consumer preferences, and a host of other, often interrelating, factors.

In our free-market, capitalist economy, we assume that commercial market forces shape our economic trajectory. Although that is true, it is also true that the actions of government have a robust influence on those market forces—in both directions. Governments (at federal, state, and local levels) play an extremely important role in the overall market economy ecosystem. They set many of the rules that govern the operation of markets (such as trade agreements and anti-trust policies), hold regulatory sway over business operations and products (via FDA, OSHA, EPA, CPSC, etc.¹), impact the flow of capital (via the SEC², taxation, monetary policy, and other means), fund and perform R&D on a large-scale, and, perhaps most importantly, operate a very large part of the education system that provides the educated workforce to power the economy.

At a state level, government actions matter...they matter a great deal:

- If they are consistent, predictable, and well-reasoned, they contribute to business confidence and a willingness to make long-term investment plans and commitments of capital.
- They impact the bottom-line net income of firms through rates of taxation, and thus the level of business income available for reinvestment and rewarding employees.
- They impact the cost of labor via unemployment compensation rates, workers' compensation rates, health care regulation impacts on costs, etc.
- They affect the performance and operation of the K-12 education system and have a major role in public higher education with community colleges and public four-year colleges and universities.
- They support innovation through public universities, state R&D funding, and R&D tax credits.
- They directly regulate the operation of large sectors of the economy (healthcare, insurance, utilities, etc.) and set the rules that govern environmental and consumer protection.

1 FDA = Food and Drug Administration, OSHA = Occupational Safety and Health Administration, EPA = Environmental Protection Agency, CPSC = Consumer Products Safety Commission.

2 SEC = Securities and Exchange Commission

- They develop, maintain, and operate critical infrastructure, such as highways and airports.
- They play a key role in public safety, law and code enforcement, and the operation of the legal system that, in part, governs market behavior and the rules of business.
- They operate professional license systems and permitting systems to assure baseline qualifications are met for important occupational functions.
- They provide support for public health, thereby working to sustain quality of life, limit healthcare costs, and maximize the availability of a work-ready population.
- They provide financial and other incentives to enhance the attractiveness of the state to targeted industries and help key industries adapt to forces of change and invest in the future.
- They influence population growth through policy, regulation, and the level of investment in the built environment, housing, arts, and culture (in addition to the aforementioned).

Because state government is so interwoven into the operation of the economy, having an effective and predictable government that develops and deploys well-reasoned policies matters greatly. Businesses certainly favor lower costs, preferring low business taxes all things being equal, but they also benefit from having a state that strategically invests in education, workforce development, infrastructure, public health, and other factors that greatly influence business operations. Talk to corporate CEOs and they will tell you that low business taxes and a fair regulatory regime matter, BUT they are only part of the state equation in creating a truly business-friendly and growth-promoting environment. Employers are concerned with each of the bulleted factors on the previous page and above, and for companies

The IEDC Notes the Following:

Our programs and initiatives offer business support and expertise to companies that are investing and creating jobs in Indiana. We're working to improve our quality of place, infrastructure, available development sites and regulatory assistance to build economic strength and opportunity that grows and attracts new business and talent.

From decreasing permitting time, to streamlining application processes, pre-certifying shovel-ready sites and increasing access to training and skills, we're focused on creating new high-wage, high-skill opportunities for the next generation of Hoosiers. We place special emphasis on the automotive, life sciences, energy, and national security industry sectors, and support companies involved in advanced manufacturing, logistics, information technology and research and development.

Indiana also provides financial assistance to qualified high-tech firms and small businesses and offers a variety of programs to support new business start-ups and business expansion and growth.

Source: <https://www.iedc.in.gov/programs>

that have large-scale investments to make, considerable care goes into examining business factors and government policies at a state and local level that will impact success and operational stability. When a company builds a factory or office building, invests in state-of-the-art technology and capital equipment, and uses time and resources to train a skilled workforce, the company does so with a clear eye on the long-term payback expectations for their investment—and, as discussed above, government clearly plays an important role in establishing and operating an environment that significantly impacts commercial return on investment.

Thus, for Indiana's economy, the actions and operations of state government matter greatly. Indiana needs to be strategic in assuring the ongoing devel-

opment and evolution of a favorable business climate, and that involves far more than marginal adjustments to business tax rates. The Indiana Secretary of Commerce has overall responsibility for the business ecosystem in the state, and for guiding state actions in support of a favorable business climate. Under the leadership of the Secretary of Commerce, the Indiana Economic Development Corporation (IEDC) is the organizational entity with day-to-day responsibility for much of this critical mission (see sidebar). The IEDC is not alone, however, in this mission, with multiple state agencies directly or indirectly influencing many components of the economy—for example, the Indiana Department of Education, Department of Labor, Department of Workforce Development, Department of Agriculture, Department of Transportation, Utility Regulatory Commission, etc. Communication and strategic planning between and across Indiana State Government departments is thus essential to fully engaged economic policy and successful economic development for the state.

Current Commerce Secretary Brad Chambers and IEDC leadership understand the critical importance of state government in assuring Indiana has the fundamentals in place to assure a growing and globally competitive economy and an improving quality of life for all Hoosiers. To this end, the IEDC, in collaboration with the Central Indiana Corporate Partnership (CICP), retained the services of economic development experts at TEconomy Partners to develop an economic strategy and action plan to guide IEDC's focus on building an economy of the future and in advancing Indiana's economy over the next decade. TEconomy has been a key partner with CICP in research and strategic planning to guide the successful development and functional mission activities of CICP initiatives and has been engaged in economic development planning across multiple Indiana regions. As an informed third-party organization, working nationally and internationally in advanced economic development, TEconomy also brings perspectives from competing locations that serve to inform Indiana's strategic planning and competitiveness.

TEconomy's work for IEDC has been divided into two phases. The first phase was diagnostic in nature, serving to characterize the macroeconomic trajectory that Indiana's economy has demonstrated. The first phase also examined the recent performance of individual sectors of the Indiana economy, particularly traded and advanced industries central to building a high-performance economy.³ The second phase, reported herein, focuses on a deeper dive into key elements of the economy and recommends a series of specific strategies and actions designed to advance Indiana toward the top echelon of states in terms of GDP growth by 2031.

Indiana's Economic Performance

Figuring out a more dynamic and growth-oriented pathway forward is critically important for Indiana because, as Phase I found:

Across the past decade, and relative to other states, Indiana has had a “middle of the road” economy. Overall, across the 2010-2019 timespan, Indiana ranked 20th among the 50 states and the District of Columbia (DC) in terms of its average annual GDP growth rate of 1.99%. This decadal growth in GDP places Indiana just inside the 2nd quintile of U.S. states, and below the national average GDP growth rate.

Another key measure that allows meaningful comparison between states, and against the national average, is “GDP per capita” (using 2019 GDP divided by population—the usual benchmark used to evaluate “standard of living”). On this measure Indiana is further down the table in terms of its position among U.S. states. Indiana's GDP per capita was \$50,455 in 2019, versus \$58,164 for the national measure (i.e., Indiana's GDP per capita was only 86.7% of the national level)... Based on the 2019 performance Indiana resides in the 4th quintile of states and would need to increase its GDP per capita by \$345 (0.68%) to move into the 3rd quintile, by \$6,246 (12.38%) to

3 “Indiana's Economic Future. An evaluation of economic performance, key economic drivers, trends, and ambitious opportunities for the future. Phase I — Situational Assessment Report.”

enter the 2nd quintile, and by \$12,100 (23.98%) to make it into the top quintile of states.

As these data suggest, Indiana has been slipping in terms of its comparative economic position in the nation—this despite state government having taken decisive and laudable steps to secure low business taxes and a favorable regulatory environment for business operations. The data suggest that low taxes and limited regulation cannot alone advance Indiana’s business environment to global competitiveness. Rather the market is placing increasing emphasis on areas such as education, work-ready labor availability, innovation advancement, entrepreneurship supports, capital access, quality of life investments, and policy and other key business location factors. Indiana has accomplished important work in creating a favorable tax and regulatory environment, but as we will see, in an era of extensive and intensive business change, other factors need urgent attention.

A Time of Change

Multiple reports have noted the impact or potential impact of disruptive technologies and changing business trends on major sectors of the Indiana business economy.⁴ Indiana has large clusters of business activity in automotive products, power and propulsion technology, biopharmaceuticals, medical devices, warehousing and logistics, insurance, and multiple other sectors that face significant change and disruption associated with new technologies. These changes present both threats and opportunities for Indiana—threats in terms of businesses not being able to adapt to changing technologies or market forces and losing their competitive edge, along with opportunities for businesses to take advantage of forces of change to advance new products and technologies to meet market needs and gain market share. Companies such as Subaru, Cummins, Toyota, Allison

Transmission, and General Motors face significant changes on the horizon as the automotive sector advances electric powertrains, hydrogen power, and autonomous vehicle operations. The pharmaceuticals sector is similarly seeing significant changes in products and their manufacturing processes as the majority of new drugs move from chemically-based pills to organically-based biologics, necessitating more complex manufacturing processes and many more specially-skilled production employees. Manufacturing in general is being reshaped by new capabilities contained in Industry 4.0 technologies, which integrate digitally enhanced and informed processes across the production and supply chain into smart production systems. Even agriculture, Indiana’s first industry and still very important to the economy statewide, is being remade by advanced technologies in precision and digital agriculture with autonomous agriculture on the horizon. Across almost every sector, industries are being reshaped by integrated digital technologies—technologies that span and connect multiple manufacturing and business functions, together with supply chains, and deploy business analytics to achieve high productivity and business efficiency. These are the technologies inherent in the term Industry 4.0 (a.k.a., Manufacturing 4.0 and Business 4.0), reflecting advancement into a fourth industrial revolution that sees digital technologies operating as holistic smart systems.

A characteristic of this fast-moving environment of change is that there are highly significant investment capital requirements for businesses investing in Business 4.0. The new business paradigm is not about adding a manufacturing robot here or there, it is far more dramatic and transformational, requiring investments in multiple digitally connected systems and the advanced analytics capabilities to operate complex systems-of-systems. **The capital required for doing this, the complexity of doing it, and the need for special talent with the skills to do it, are extraordinary—and even**

⁴ See, for example, the following TEconomy reports for CICIP and its initiatives: “Clusters & Disruptors: Envisioning Central Indiana’s Economic Future in a Time of Change,” “Artificial Intelligence and Advanced Analytics in Indiana: An Initial Discussion of Industry Needs and University Capabilities,” and “Indiana’s Economic Future. An evaluation of economic performance, key economic drivers, trends, and ambitious opportunities for the future. Phase I — Situational Assessment Report.”

large-scale business enterprises have expressed concern about having the financial and human capital resources to execute the necessary actions at scale. Similar large-scale transformation challenges and capital investment issues exist for many major industries that are adapting to disruptive technologies.⁵ Indiana State Government needs to become a partner with its strategic industries by engaging proactively in supporting industry transformation and working to help strategic industries adapt and benefit from changes and new opportunities.⁶ If Indiana does not engage strategically, other states and locations will.

“Business as usual” is unlikely to work in an economic development environment that is seeing such revolutionary levels of business and sector transformation. Companies need to see their state economic development agencies as supportive partners, working with them to advance strategic sites and infrastructure, access to investment capital, and, especially, access to educated and trained human capital able to implement and operate modern business systems and technologies.

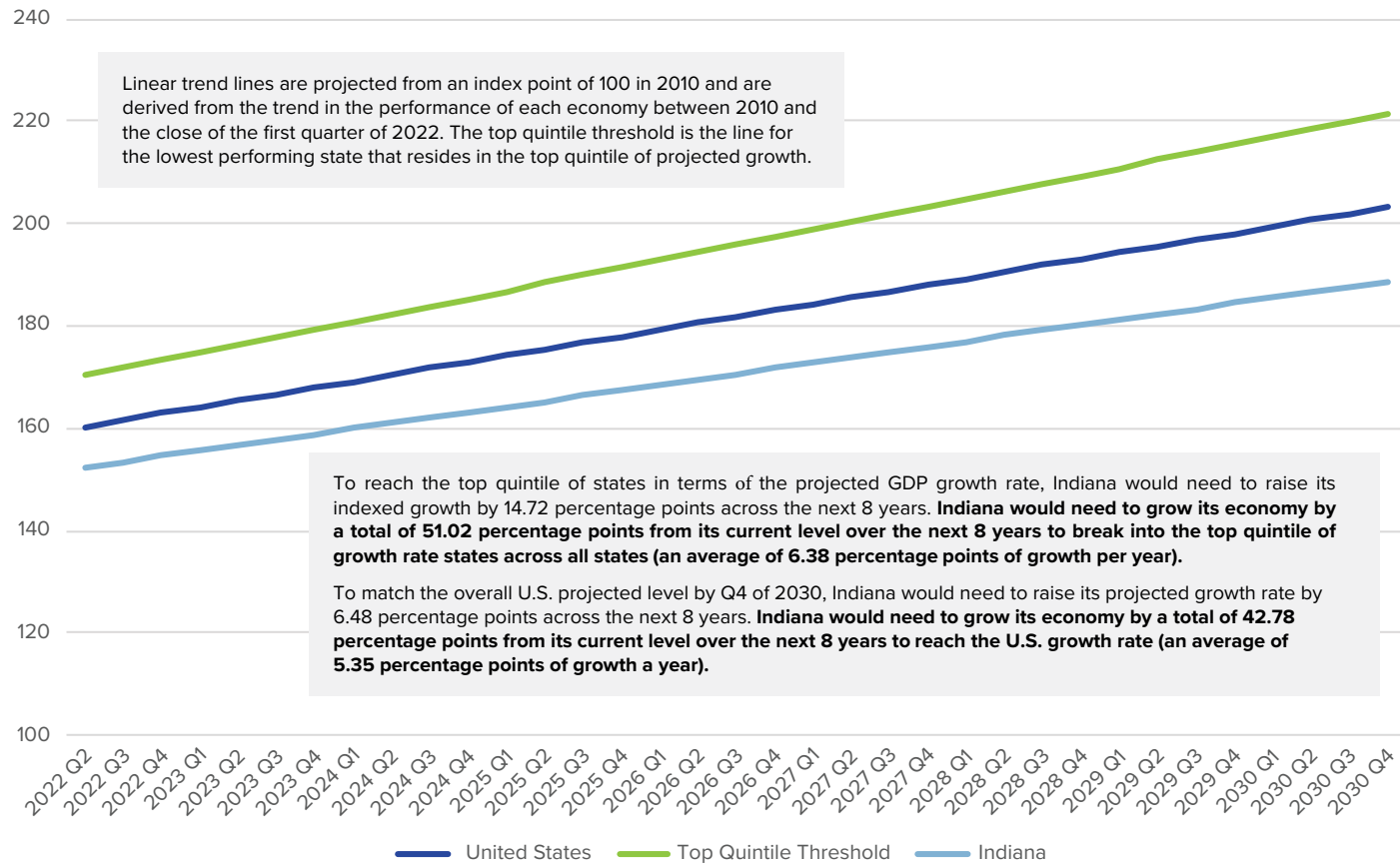
A Need to Strategize and Invest Wisely

Because of the scale of possible industry disruption, the scale of investment needed to adapt, and the extreme competition for the people who enable successful business transformation to occur, Indiana’s leadership, the IEDC, and key stakeholders such as CICP recognize the inflection point at which the state now stands. To borrow a term from the business literature, Indiana needs to move from “good to great” in terms of its ability to conduct advanced economic development, and IEDC recognizes that it needs a strategy to do so. Secretary Chambers rightly is seeking to advance Indiana into the upper quintile of states in terms of GDP growth rate by 2031 — an ambitious goal (Figure 1). Achieving this clearly requires pivoting state economic development actions to the realities of building the Business 4.0 economy and assuring that the key factors that matter to businesses in their ongoing operations and new operation location decisions are well-met in Indiana. This report outlines an ambitious strategy and action plan for doing so.

5 Illustration of the scale of the investment challenge for one industry adapting to disruption, automotive, is provided in a recent report by McKinsey, titled “McKinsey Quarterly: Can the automotive industry scale fast enough?” May 12, 2022.

6 An example of this in an adjacent state is the Critical Industry Investment program funded in Michigan with a \$1 billion appropriation from the Michigan legislature. Key investments made have supported the attraction of billions in investment in battery and electric vehicle manufacturing plants. See, for example: <https://www.michiganbusiness.org/press-releases/2021/12/tji-whitmer-signs-economic-development-bills-into-law/>

Figure 1: Moving Indiana into the Upper Quintile of State GDP Growth Rates by 2031. Current Projected Trajectory of GDP Growth for Indiana, the U.S., and the Top Quintile of States.⁷



⁷ Baseline data for GDP growth by U.S. Bureau of Economic Analysis. Linear trendline calculations by TEconomy partners. Actual growth rates may vary considerably from projections and these projections are made only to illustrate the magnitude of growth required.

II. OVERVIEW OF STRATEGIC PLAN

Analysis and input received across the project has provided clear direction for strategy development, identifying a need for strategic actions that will:

- **Increase Productivity** in key economic clusters. Leveraging the new opportunities contained in Manufacturing 4.0 and its associated technologies to substantially increase Indiana's manufacturing productivity and cement Indiana as a specialized hub for advanced, 21st Century high-performance manufacturing and business operations. Also, there is a need to advance opportunities to leverage IoT, AI, and other 4.0 digital technologies to increase productivity and output in nonmanufacturing sectors of strategic significance to the state.
- **Focus on Strategic Sector Expansion and Attraction.** Multiple industry sectors have expanded in Indiana during the past decade, with life sciences, information technology, and insurance as key examples. Sustaining growth in these sectors is important, as is developing a position in emerging sectors that may have a line-of-sight to growth in Indiana.
- **Help Indiana adjust to Disruptive Technologies.** Rapid technology changes and evolution in markets will significantly impact existing Indiana industries and present opportunities for early adoption and position building. Previous work by TEconomy for CICP⁸ identified many of the areas of challenge and opportunity associated with disruptions, and it is clear that technologies in robotics, artificial intelligence (AI) and autonomous systems, electric and hydrogen power

and propulsion, personalized and regenerative medicine, etc. hold promise for adoption to empower Indiana economic growth.

- **Advance R&D and Innovation.** Both academic and industry R&D play an important role in Indiana's economy by driving innovations for commercialization and helping industries improve existing products and services. It is imperative that Indiana is able to innovate, advance existing industries, establish a robust foothold in emerging industries, and connect related academic and industry R&D competencies.

Crosscutting each of these is a distinct need to assure the availability of a well-educated and appropriately skilled workforce. Advancing Business 4.0 processes, expanding businesses, attracting new businesses to the state, adopting new technologies, and performing R&D and innovation activities each depend on having access to a demand-meeting supply of capable people. ***Solving the human capital equation for Indiana is perhaps the defining challenge for the next decade.*** It is the business factor that is absolutely of most concern to the multiple CEOs of major Indiana enterprises interviewed in the course of performing the strategic plan development. Access to workforce is not a unique challenge for Indiana; it is generally a shared challenge in all states, but **the challenge is uniquely acute in Indiana because population growth is, while moderately positive, a constant challenge. Further educational performance and higher education attainment for Indiana's population is comparatively low, and**

⁸ TEconomy Partners. "Clusters and Disruptors: Envisioning Central Indiana's Future in a Time of Change."

the growing demand for skilled people to enable Business 4.0 and other transformations is very high.

The first phase of TEconomy’s research for IEDC and CICP provided input to the development of Figure 2, which provides a graphic overview of areas in need of particular attention in development of the strategic economic

development plan. The figure shows macro focus areas as the inner ring, and the outer rings detail the key constituent elements to work on.

Figure 2: Strategic Focus Areas Identified.



The development of specific strategies and actions to address these focus areas has used multiple informational and input resources. Primarily, these inputs have included:

- Time-series data analytics and the use of industry-targeting analysis to evaluate the decadal performance of Indiana's individual business sectors. The analysis highlighted sectors that are established or emerging strengths for the Indiana economy and those that demonstrate opportunities for growth. The results of this analysis are in the Phase I report.
- Assessment of levels and growth in productivity across key Indiana industry sectors that identify high-performing sectors as well as those that may require assistance in achieving meaningful productivity gains.
- Review of recent studies of Indiana's economic development performance and population projections, together with detailed existing reports on Indiana business clusters, the threats and opportunities associated with disruptive technologies and emerging business trends, and reports on specific business factors such as workforce development.
- In-depth interviews with CEOs and presidents of large and midsize business enterprises headquartered, or having major business operations, in Indiana. These interviews focused on opportunities to advance the economy, challenges to address, and the comparative rating of Indiana on multiple key business location factors. These interviews were surprisingly uniform in terms of their situational assessment of Indiana's strengths, weaknesses, opportunities, and threats (summarized in Appendix D).
- Review of economic development programs and activities in competing states, and reference to TEconomy's knowledge base regarding advanced economic development practices and what works to move the needle in economic performance.

Although the analyses and input to the process have been complex, and the challenge of pivoting Indiana to a new high-performance economic trajectory ambitious, the work performed can be summarized in **six key strategic conclusions:**

1. **Workforce availability and skills represent crucial concerns for Indiana and are the primary rate-limiting factor for economic growth.** The challenge is multi-dimensional and spans issues with slow population growth, overall performance in K-12 education, the percentage of the population seeking to achieve higher education credentials, and the retention and attraction of personnel with in-demand educational credentials and occupational skills. Indiana's ability to address each of the other strategic conclusions, in part, depends on solving the workforce availability and skills challenges across the state.
2. **Indiana's industry productivity and productivity growth rate are not where they need to be.** Given population constraints, which limit workforce availability, Indiana is unlikely to be able to boost GDP through the traditional pathway of putting more people to work; rather it needs to improve productivity with the workforce it has. In today's environment, this largely means investing in Business 4.0 technologies, processes, and widespread deployment.
3. **Indiana has several very large and important business sectors, or industry clusters, that are facing both opportunities and threats associated with major disruptive technologies.** These industry clusters are large enough that missteps in their adaptation to change, as well as disruptive technologies, will have a profound effect on Indiana's economic performance. A significant component of Indiana's economic development efforts needs to be focused on helping these strategic industries evolve and excel over the next decade.
4. **Indiana has some gaps, or areas of weakness, in its business sector structure that need to be addressed through recruitment and new**

business development and expansion. For the most part, these represent gaps in technologies and technology services that have a crosscutting impact on the operations and supply chains of other sectors in the Indiana economy.

5. **The State of Indiana is not competitive in its budgetary commitments and spending on economic development compared to competing states and needs to be more strategic in terms of its funding and structuring of economic development activities.** Specifically, Indiana has underspent by hundreds of millions annually compared to its 10 most direct competitors (See Appendix A, Figure 1).
6. **A series of additional specific challenges must be addressed for the Indiana economy to be optimally positioned for the future.** Needs here are quite diverse and relate to multiple business location factors including job-ready site development, utility rates and energy generation mix, and other public-policy-associated issues that impact business outlook.

Strategies and Actions Summary

TEconomy's review of these issues, and work to identify strategies and actions to address them, has resulted in a strategic action plan comprising four high-level strategies and 17 associated specific action recommendations. The four key strategies are shown in Figure 3, with associated actions further summarized in Table 1.

Figure 3: Four Strategies for Advancing Indiana's Economic Performance



Table 1: Topline Summary of Strategies and Actions.

Strategy	Actions
<p>1. Advancing World-Class Education & Workforce Training</p>	<p>Action 1.1: Increase graduate retention through financial incentives in strategic fields of study.</p> <p>Action 1.2: Address projected supply-demand imbalances in sub-baccalaureate technical positions.</p> <p>Action 1.3: Create strategic industry workforce training and development centers.</p> <p>Action 1.4: Advance industry-student connectivity during education.</p> <p>Action 1.5: Enhance mechanisms to support increased workforce participation.</p> <p>Action 1.6: Develop a marketing initiative to tell the Indiana story and encourage increased population and workforce growth.</p> <p>Action 1.7: Continued investment in the built environment, communities, and quality of life to encourage population retention and growth.</p>
<p>2. Accelerating Productivity Via Business 4.0</p>	<p>Action 2.1: Significantly increase funding for the Manufacturing Readiness Grant (MRG) program.</p> <p>Action 2.2: Expand the MRG program with a parallel Business 4.0 Readiness program that will support digital transformation in strategic nonmanufacturing sectors of the economy.</p> <p>Action 2.3: Attract automation companies and consultancies.</p>
<p>3. Focusing on Strategic Sector Evolution & Development</p>	<p>Action 3.1: Strategic cluster foci:</p> <ul style="list-style-type: none"> • Mobility Systems, Power, and Propulsion • Life Sciences • Insurance and Insurance Innovations <p>Action 3.2: Capturing new strategic industries:</p> <ul style="list-style-type: none"> • Semiconductors and Advanced Microelectronics • Hydrogen Systems and Electric Battery Systems and innovations <p>Action 3.3: Onshoring and strategic recruitment to reinforce crosscutting technology competencies.</p>
<p>4. Completing the Economic Development Ecosystem</p>	<p>Action 4.1: Focus the legislature and state agencies on economic development and competitive annual funding for IEDC.</p> <p>Action 4.2: Develop and communicate a renewable and affordable energy roadmap for the state.</p> <p>Action 4.3: Secure a portfolio of strategic sites in the state suited to major projects.</p> <p>Action 4.4: Increase entrepreneurial activity and supports.</p>

TEconomy's perspective is that **the state must go bold in its programming and investments if it is to significantly move the needle on its GDP growth goals. The challenge ahead is significant, and so the recommended strategies and actions outlined herein are both bold and ambitious in response.** The state legislature and executive administration have performed “yeoman's work” over the past decade, being fiscally responsible, building a AAA bond rating, and accumulating a budget surplus. ***Now is the time to put that capital base to work***—to invest at a significant level over the near term to set the stage for powering Indiana's economy and economic growth forward.

III. STRATEGY 1: ADVANCING WORLD-CLASS EDUCATION AND WORKFORCE TRAINING

Of all the resources that a state can possess, the most important is human capital. Having an available supply of educated, work-ready, occupationally qualified talent is a fundamental need across all sectors of the economy. This supply is particularly important for Indiana's economy, which has an above-average concentration of manufacturing and advanced industries (and thus specialized skills demands). As new digital technologies and integrated smart systems increasingly penetrate the workplace, the need for science, technology, engineering, and mathematics (STEM) educated workers, at multiple skill levels, will be particularly acute.

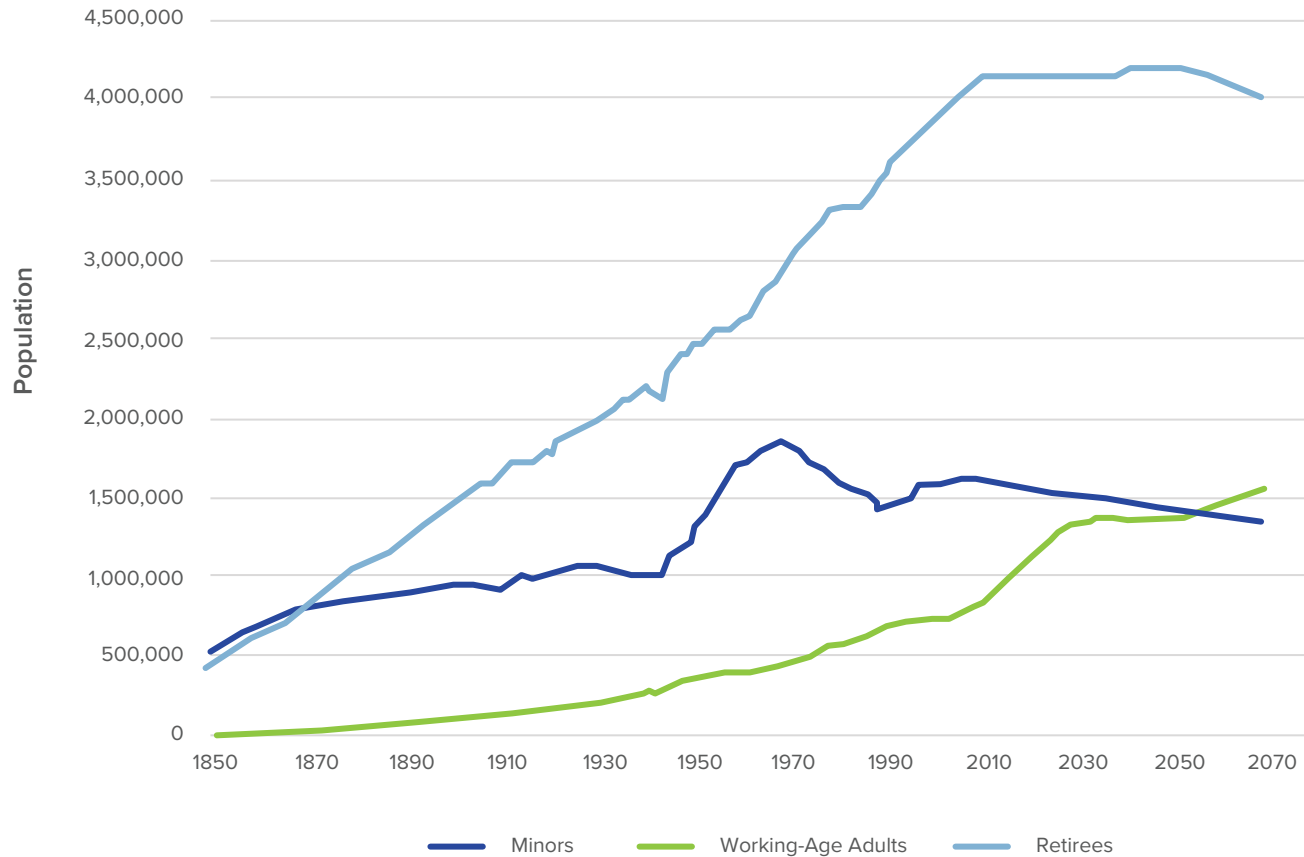
Indiana has a multi-dimensional workforce challenge currently and projected forward into the foreseeable future. As noted in the Phase I report, while the state ranks 18th in GDP⁹, its share of prime, working-age population (adults 25 to 64 years of age) places the state at 38th in the nation. Indiana ranks even lower in the percentage of its working-age population with higher education credentials (an associate degree or higher): 43rd in the nation. Further complicating the challenge are projections for relatively flat population growth in Indiana overall, and particularly flat projections for the working-age population (see Figure 4).

Advanced Industries in Indiana (Brookings Analysis — State of Renewal)

The sector comprised 10.5% of statewide employment in 2019—or 323,600 workers, with 268,400 in advanced manufacturing and 54,600 in advanced services—giving Indiana the third-highest sector share in the nation, behind only Michigan and Washington.

9 Data cited are for pre-pandemic, 2019.

Figure 4: American Enterprise Institute Analysis of Indiana's Historic and Projected Population by Age Category.¹⁰



¹⁰ Lyman Stone. "Time to Choose. Indiana's Decade to Decide its Demographic Future." American Enterprise Institute. November 2020. Graphic data sources cited as "US Census Bureau Population Estimates Program; decennial censuses; state and territorial censuses; author's imputations and calculations; IPUMS USA query of American Community Survey and historic censuses; and population model outputs."

It is notable that the state has a high proportion of its economy in advanced industries, yet ranks only 31st in terms of “STEM occupations as a share of all jobs.” This seems counterintuitive because the state has an outsized advanced-industries footprint. The low ranking is likely indicative of Indiana’s advanced industries not yet being well-entrenched in digitalization and the high-productivity technologies that demand a specialized STEM workforce. In other words, Indiana’s advanced industries are at the lower end of advanced manufacturing and business systems adoption, and this is reflected in a lower STEM workforce penetration. This is reflected in Brookings’s “State of Renewal” report,¹¹ where the authors note that:

Underlying Indiana’s productivity challenge are digital challenges. Information technology (IT) adoption is an increasingly important influence on productivity patterns given the “digitalization of everything” in the COVID-19 economy. And yet, digitalization has been proceeding too slowly in Indiana, to the detriment of productivity growth. For one thing, Indiana ranks in the bottom third of states on Brookings’s basic measure of economywide digitalization as reflected by the average digital intensity of its occupations. In addition, information on Indiana firms’ capital expenditures depicts significant underinvestment in IT. Specifically, firm-level data from the tech-industry market research company Harte Hanks shows that in 2016, Indiana ranked just 37th among states for both its advanced industry sector and whole-economy annual per employee IT spending. Those levels—\$12,300 and \$7,400, respectively, compared to \$25,000 and \$11,100 nationally—ranked fifth and sixth among Indiana’s peer states.

With the current comparatively low level of educational attainment across Indiana’s working age population, and working-age population trends predicted to remain flat, it is not surprising that **industry in Indiana is sounding alarms**. In TEconomy’s recent interviews with CEOs at leading industry employers across Indiana, the issue of workforce constraints comes through loud and clear. Figure 5 shows the scores given by CEOs on a 1 through 5 scale¹² across key location factors pertaining to business and the economy. Evident in the scoring provided is the constrained performance of Indiana’s business environment in terms of “workforce availability” and “higher education attainment.”

Having a supply of well-educated, occupation-ready workers is a substantial concern for Indiana business and is the number one issue of concern that CEOs wish to see IEDC and associated state agencies work to address. Comments from CEOs serve to highlight this:

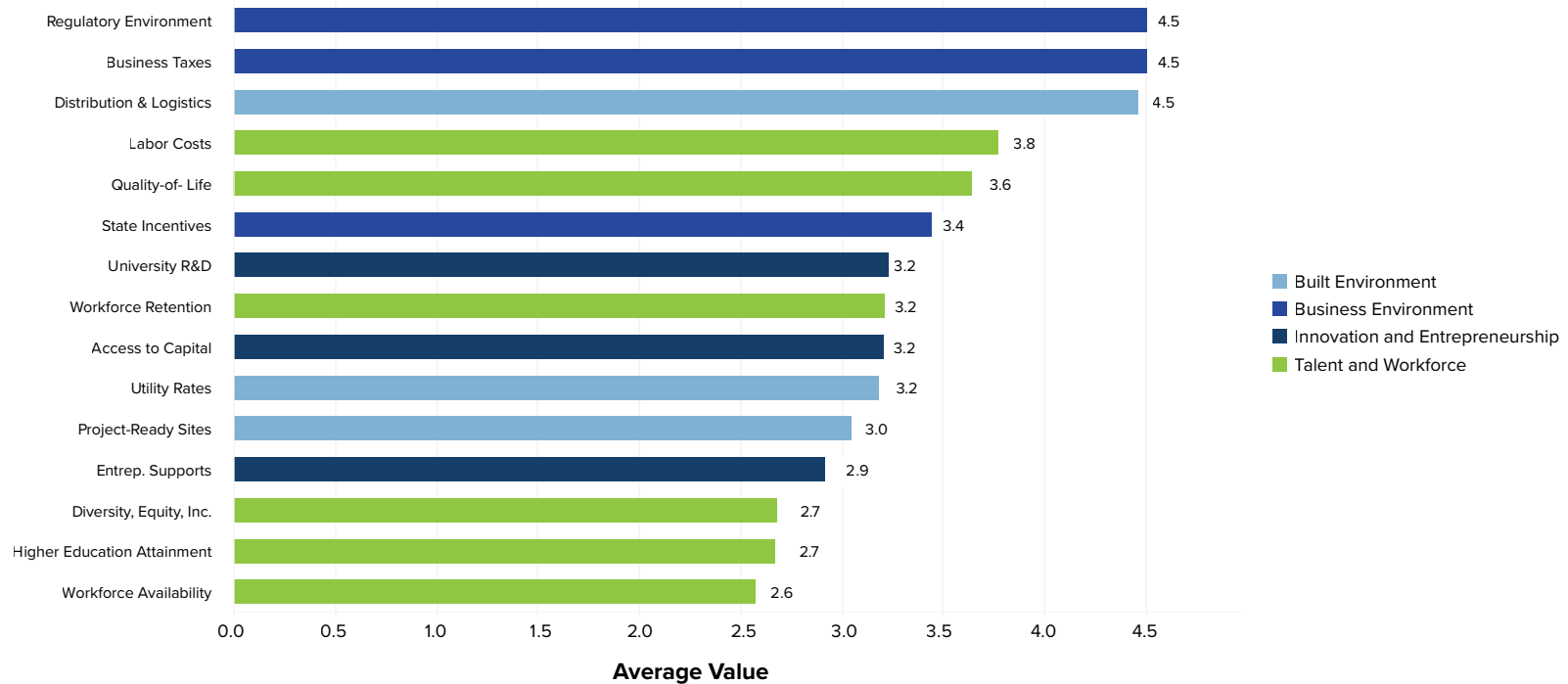
- “Labor is our biggest issue of all, and the challenge is evident at all skill levels.”
- “Honestly, we just need workers of any stripe. We just need workers to show up and we will train them in-house. We have even dialed-back drug testing because of the urgent worker need.”
- “Everything is a challenge currently, but the biggest barrier is talent able to support our digital transformation. We need personnel with expertise in AI, digital transformation and process engineering.”
- “We could contribute a lot more to GDP by producing more if only we could find workers.”
- “We need people with domain expertise in our sector. We cannot find them in Indiana.”

11 Mark Muro, Robert Maxim, and Jacob Whiton with Yang You, Eli Byerly-Duke, and Monica Essig Aberg. “State of renewal: Charting a new course for Indiana’s economic growth and inclusion.” Metropolitan Policy Program at Brookings. February 2021.

12 1 = very poor, 2 = poor, 3 = fair, 4 = good, 5 = very good.

- “The top two problems we see are availability of a workforce, and a lack of housing to support attracting more workers.”
- “We have a talent and assets mismatch. The biggest issue is in tech (talent) to meet the needs of our industries.”
- “Educational attainment and school quality are a clear issue for our state.”
- “Illiteracy is a real problem in our state, and we’ve seen nothing accomplished to address this in 60+ years.”¹³
- “We’ve chosen to select locations outside of Indiana for recent projects partly because of labor availability.”
- “Our education system is not functioning well; we have a lot of talent that is going to waste.”
- “We need to invest more in the people we have in the state....their upskilling.”

Figure 5: Rating Indiana Business Location Factors. Scoring by CEOs at Major Indiana Employers (2022)



¹³ Approximately 8% of the Indiana population is classified as illiterate. <https://worldpopulationreview.com/state-rankings/us-literacy-rates-by-state>

The deep concerns from Indiana employers regarding education in the state and the availability of qualified, work-ready people across Indiana is understandable—borne-out by reference to data regarding educational outcomes

and attainment statistics for the state. Across the board, from early childhood education through K-12 and onwards into higher education, Indiana is underperforming on many measures (for examples see Table 2):

Table 2: Examples of Educational Challenges in Indiana

Educational Level	Indiana Challenges
Early Childhood/ Pre-K	Indiana ranks last in WalletHub's ranking of states for early childhood education opportunities: It is noted that: <i>"Indiana's 51st place ranking was driven by its poor showing in several of the metrics: Lowest share of 3- and 4-years olds enrolled in Pre-K and Head Start programs (47th); lowest total spending on child enrolled in preschool (46th, tied for last with five other states); overall access to early childhood education (51st); and total resources and economic support (48th)."</i> ¹⁴
K-12 System	The percent of Indiana students passing both Math and English Language Arts sections of ILEARN (grades 3-8 combined) was just 37.1% in 2018-19 and dropped precipitously for 2020-21 (in the pandemic) to 28.6%. For Hispanic and Black students, the proficiency levels are considerably lower still, at 24.2% in 2018-19 for Hispanic students and just 8.1% for Black students. ¹⁵ While Indiana's high school graduation rate has been increasing, to 85% overall statewide, this includes a substantial 8% of students receiving waivers because otherwise they would not meet graduation requirements. ¹⁶
Higher Education	The percentage of Indiana residents enrolled in higher education one year after their high school graduation has been trending downward over the past decade (see Figure 6). It has declined from 65.8% in 2009-10 to 58.42% in 2018-19. ¹⁷ Among students enrolling in public higher education institutions (tracked as a longitudinal cohort starting in 2012-2013), of 34,383 enrolled, 25,820 persisted to a 2-year level, and 18,118 completed college. ¹⁸ Meaning that only slightly over half (52.7%) completed their higher education.

14 Dan McCaleb "Indiana ranks last in new study on early education." The Center Square. August 18, 2020. Reporting results of a nationwide comparative analysis by WalletHub. https://www.thecentersquare.com/indiana/indiana-ranks-last-in-new-study-on-early-education/article_6830b520-e15a-11ea-9f6d-3f7e4898ea8b.html

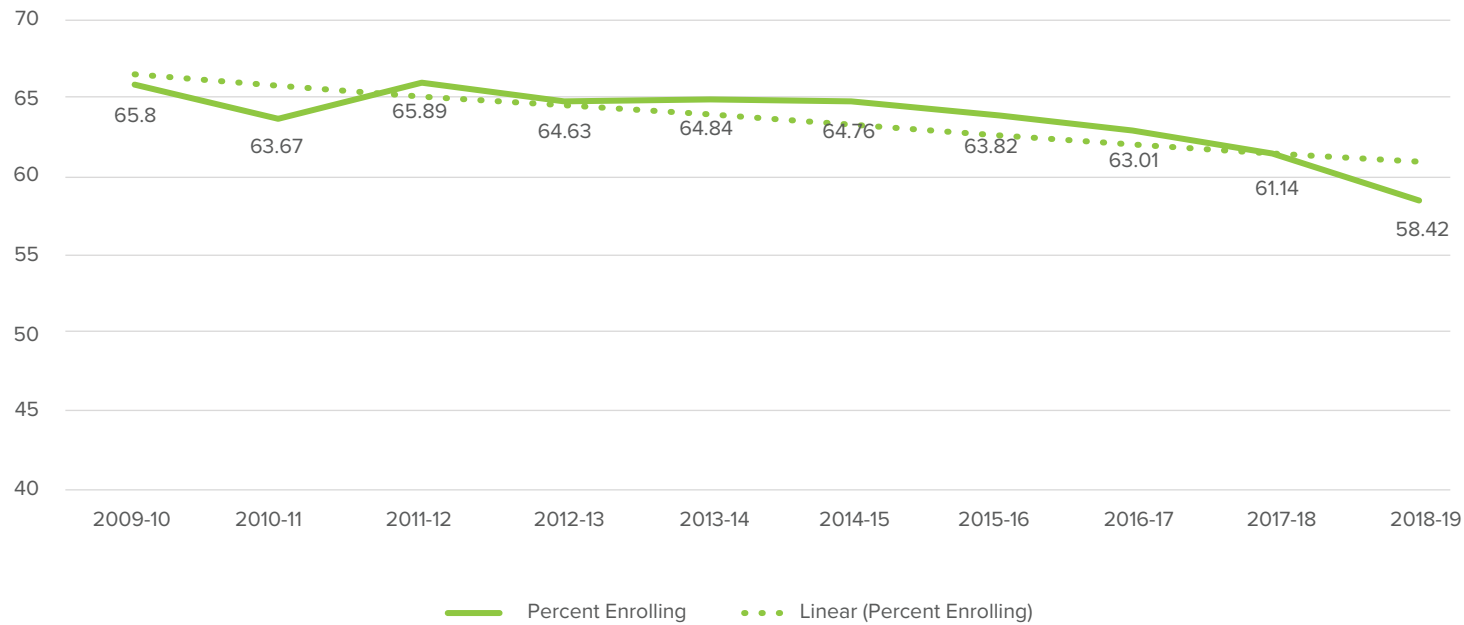
15 Indiana Department of Education. Summarized at: <https://businessequityindy.com/priorities/learning-and-talent/> slide 10.

16 Shaina Cavazos. "Plans for a single Indiana diploma advance with new rules that raise the bar for graduation waivers". Chalkbeat Indiana. Jan 23, 2018. <https://in.chalkbeat.org/2018/1/23/21104206/plans-for-a-single-indiana-diploma-advance-with-new-rules-that-raise-the-bar-for-graduation-waivers>

17 Indiana Commission for Higher Education. "College Readiness Report". Summarized and accessed at: <https://businessequityindy.com/priorities/learning-and-talent/> slide 20. Note: numbers reflect students who enrolled in an institution within one year following high school graduation.

18 Cohort count from Indiana Management Performance hub, all other data from Indiana Commission for Higher Education. "College Readiness Report". Summarized and accessed at: <https://businessequityindy.com/priorities/learning-and-talent/> slide 37.

Figure 6: Indiana, Percent Enrolled in Higher Education One Year After High School Graduation



Not expanding its population, underperforming in early childhood, struggling in K-12 as shown in ILEARN testing performance, and increasingly less likely to see its high school graduates successfully participate in and complete higher education, Indiana is going in the wrong direction if it seeks to meet the demands for a future well-educated labor force. IEDC's goal of substantially increasing Indiana GDP growth and seeing a meaningful improvement in GDP per capita will not be possible to achieve if educational attainment remains significantly sub-par in the state.

An economic development strategy is unable alone to address all aspects of a complex, multi-dimensional demographic and educational attainment challenge for Indiana. It can, however, recommend specific actions designed to address immediate needs for advancing a workforce prepared to meet the needs of strategic industries that power Indiana's economic future. Indiana needs a strategy that will enable it to build world-class education and workforce training capabilities. It is the most pressing concern voiced by employers, and without a substantial number of actions to enhance workforce development in the state, the GDP growth goals for the state simply will not be met.

To position Indiana to achieve GDP growth, several things must happen from a workforce development perspective:

- Indiana needs to increase the percentage of its workforce with meaningful higher education credentials, as well as retain a higher percentage of students in-state after their graduation from Indiana higher education institutions. In 2020, Indiana's population percentage with an associate degree or higher stood at 36.1%, a level significantly below the national average of 48.1%.¹⁹ Based on these data, Indiana is undersized in its associate degree and above population by 538,918 adults. Indiana's immediate goal should be to target U.S. national average.
- Indiana needs to develop workforce training programs geared to the specialized needs of key advanced industry sectors, providing assured pipelines for employers with expanding and evolving workforce needs.
- Indiana must increase awareness of occupational opportunities in the state and build connectivity between employers and students significantly prior to graduation. Engagement with industry helps students see the relevance of their coursework and provides an incentive to stay engaged in their program of study. Indiana-student-to-Indiana-industry relationship-building provides a means to retain higher numbers of graduates in-state after their graduation.
- Multiple advanced industry jobs, including robust family-sustaining wage jobs, require technical and trade skills that can be acquired through education below the baccalaureate level. Currently there is a mismatch between the demand for certificate-trained STEM and trades personnel and workers with many of the needed credentials.

Indiana needs to boost participation and graduation rates in this type of education and training by an estimated 10% over the next decade to meet demand (see Table 6). However, because of the specific credentials needed for certain occupations, considerable variability is present in the sectors and locations where the supply/demand shortfalls exist.

- Indiana's population is expanding only moderately while the labor participation rate has been declining. Indiana needs programs to support higher levels of participation in the workforce to assist in achieving economic growth. The May 2022 seasonally adjusted participation rate for Indiana was 62.9%, in contrast to several states with rates in the high 60s (e.g., Minnesota 68.4%, Colorado 69.4%).²⁰ Nebraska's May 2022 rate was 70%, a labor force participation rate that Indiana last saw in 1995 (Indiana's high was 70.8% in March 1995). Based on Indiana's current participating labor force of 3.3 million²¹, each additional percentage point of participation boosts the available workforce by 33,000 people.
- Indiana needs to supplement its home-grown talent with a steady influx of well-educated, occupationally skilled migrants into the state (both domestic and international). For this to occur, Indiana needs to be viewed as a welcoming location that strongly desires in-migration and for newcomers to succeed.

TEconomy's recommended actions under this strategy are designed to address the needs identified above and help resolve multiple challenges evident in the education-to-workforce pipeline in Indiana. Recommended actions are summarized in Table 3:

19 U.S. Census Bureau, American Community Survey estimates 2020. <https://www.census.gov/data/tables/2020/demo/educational-attainment/cps-detailed-tables.html>

20 <https://fred.stlouisfed.org/release/tables?rid=446&eid=784070>

21 Alexandria Burris. "Indiana could be seeing plateauing labor force participation." Indianapolis Star. June 17, 2022.

Table 3: Actions Recommended Under Strategy 1.

Strategy	Actions
1. Advancing World-Class Education & Workforce Training	<p>Action 1.1: Increase graduate retention through financial incentives in strategic fields of study.</p> <p>Action 1.2: Address projected supply-demand imbalances in sub-baccalaureate technical positions.</p> <p>Action 1.3: Create strategic industry workforce training and development centers.</p> <p>Action 1.4: Advance industry-student connectivity during education.</p> <p>Action 1.5: Enhance mechanisms to support increased workforce participation.</p> <p>Action 1.6: Develop a marketing initiative to tell the Indiana story and encourage increased population and workforce growth.</p> <p>Action 1.7: Continued investment in the built environment, communities, and quality of life to encourage population retention and growth.</p>

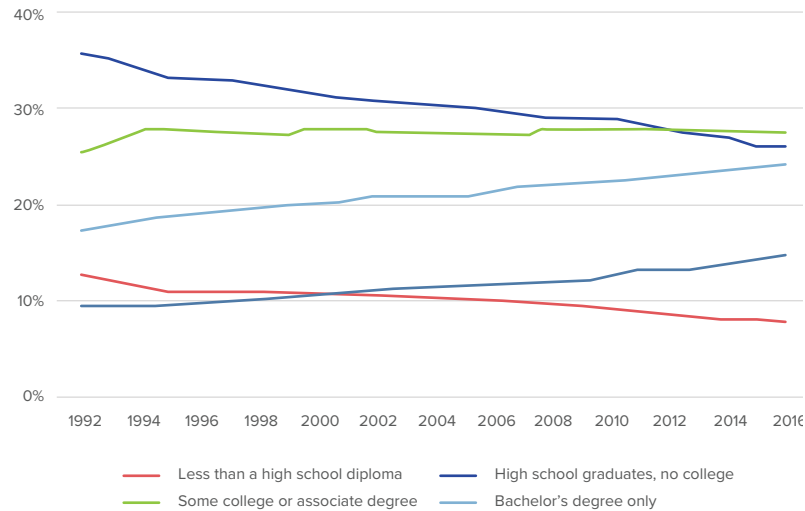
Action 1.1: Increase Graduate Retention through Financial Incentives in Strategic Fields of Study

Increasing GDP growth in Indiana requires, by definition, an improvement over the status quo. Achieving meaningful change in an advanced economy requires advancing modern production and business technologies and innovating to improve new product development and services. It also requires a robust supply of well-educated, occupationally qualified people to perform work, implement and operate new technologies, and advance innovation. In terms of the workforce, there is increasing demand for college-educated personnel (see Figure 7), particularly those with STEM degrees. In 1992, 26.5% of jobs were held by workers having a *bachelor's degree or higher* (Figure 7).²² This greatly expanded by 2016 to 38.9% of jobs, and it is likely to continue to gain in importance into the future. In contrast, the red and dark blue lines on Figure 7 represent workers without higher education, and their share of the labor force has diminished over time. **Indiana needs to boost the**

percentage of its population with 4-year degrees and above, currently at 17.3%, to meet projected employer demands and to boost the incomes of Hoosiers. Just to reach parity with the national average of workers with a 4-year degree or higher, Indiana needs more than 273,000 additional 4-year graduates and more than 189,000 with a graduate degree or more. This requires boosting the percent of the population with a bachelor's degree from its current 17.3% to a national average of 23.4%, and for graduate degrees from 9.9% to 14.1%. Again, those increases would only get Indiana to average.

²² <https://www.bls.gov/spotlight/2017/educational-attainment-of-the-labor-force/home.htm>

Figure 7: Percentage of Labor Force by Educational Attainment, 25 Years and Over, 1992-2016 Annual Averages



(Source: US BLS)

Recent statistics show the benefit of achieving progressively higher levels of educational attainment in Indiana as reflected in higher median earnings at 1 year, 3 years, and 5 years after graduation (Table 4).

Table 4: Median Annual Earnings by Level of Education in Indiana (2018-19)²³

Qualification	1 year	3 years	5 years
High School Diploma	\$14,871	\$20,597	\$29,059
Certificate	\$20,575	\$25,328	\$34,086
Associate	\$29,998	\$35,303	\$38,255
Bachelor's	\$33,045	\$42,463	\$46,793
Master's	\$45,659	\$52,536	\$56,256

One of the issues facing Indiana in its pursuit of a more highly educated labor force is the **loss of graduates to out-of-state locations after they graduate from Indiana institutions.** *The net leakage of Indiana students to out-of-state jobs is substantial, with data showing that one year after graduating from public post-secondary education in Indiana, only 46% of graduates will be working in Indiana. By year three this drops moderately to 43%, and by year five it is 41%.²⁴ It is almost certainly an even higher leakage for students from private higher education institutions, such as Notre Dame, where more students are from out-of-state to begin with. As reported in analysis undertaken by Emsi²⁵, summarized by Emsi in Figure 8, Indiana again shows up in the 40-50% retention rate classification. It is interesting to note that each of Indiana's neighboring states is in a higher classification (50-60%). The top-performing states (Texas, California, Georgia, Washington,*

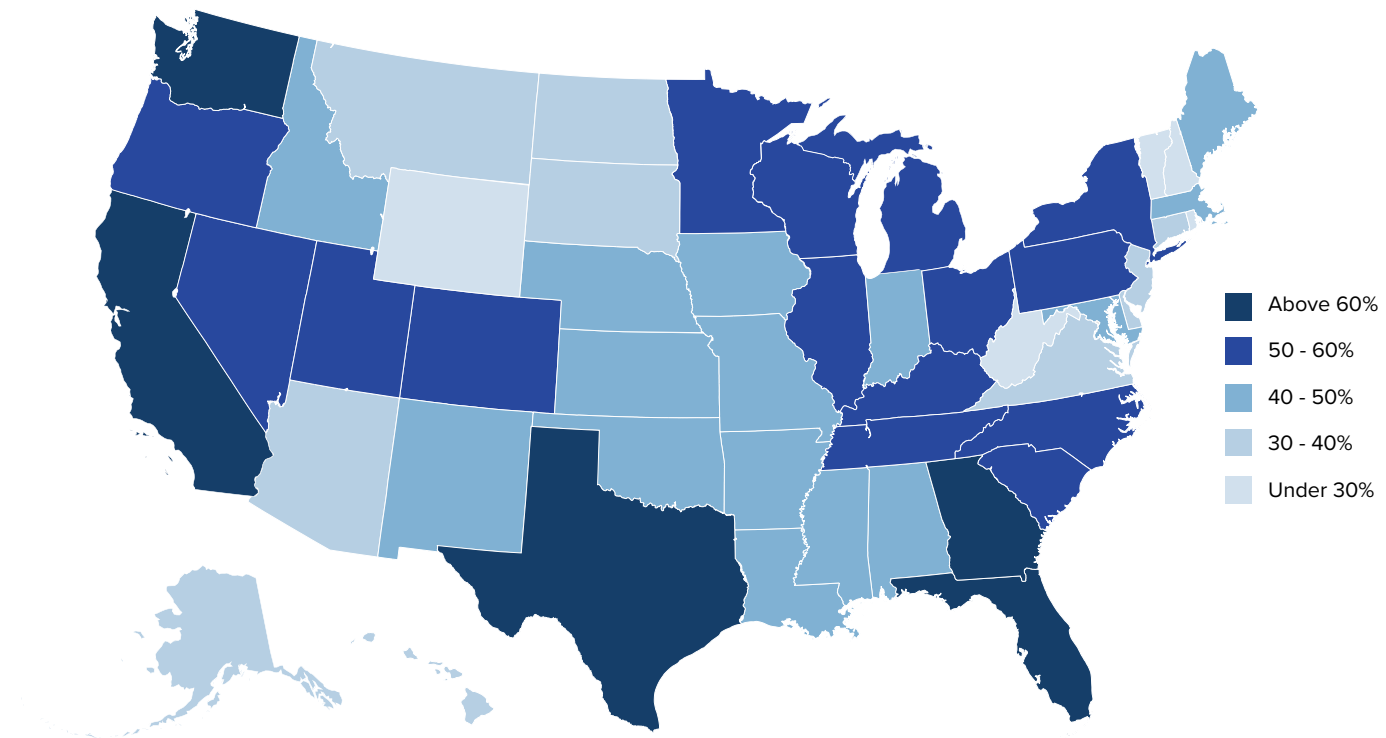
23 There is significant variation across Indiana's public institutions in terms of 5-year post graduation median earnings. High is Purdue University-Polytechnic Statewide at \$67,186, followed by Purdue-West Lafayette at \$60,748 and IUPUI at \$56,497. Lowest is Ivy Tech at \$38,439 which has many students graduating from two-year or certificate programs.

24 Source = Indiana Performance Management Hub. Data summarized at: <https://businessequityindy.com/priorities/learning-and-talent/Slide 38>.

25 <https://www.economicmodeling.com/how-your-school-affects-where-you-live/>

and Florida) each are above 60% retention. Based on these data, **Indiana needs to retain a significantly higher percentage of its college graduates to perform in line with regional peer states.**

Figure 8: Retention of Students in the State in Which Their Graduating Institution is Located



In part, the challenge of graduate retention may be addressed through building better connectivity between students while they are in college in Indiana and potential Indiana employers. This will work to build relationships and help students envision and plan for an Indiana-based career. This need for connectivity building is addressed in Action 1.3.

It should be noted that the pursuit of higher education may be undertaken for multiple reasons, including personal growth and expansion of knowledge and perspective, and that all degrees have worth in an informed and educated society. That said, many degrees are pursued with the goal of achieving educational credentials that qualify the student for specific occupations, such as engineers, teachers, scientists, legal professionals, healthcare professionals, and a host of other rewarding careers. **In terms of impact on the economy and GDP, certain educational disciplines and associated careers have a higher level of impact in that they support work in traded and advanced industries fundamental to sustaining a strong economy. Fields of study leading to these high-impact jobs for the economy may be termed “strategic” for Indiana when they support key industries that the state seeks to leverage and build upon for growth.** Although not exclusively the case, these strategic degrees tend to be in STEM disciplines.

For the 2019-20 academic year, state data show that **19.1% of degrees completed by public post-secondary students in Indiana were in STEM fields.** A further 19% of degrees were in health disciplines, which typically also have STEM content in their curriculum. Indiana needs to encourage higher levels of enrollment and degree completions in strategic STEM disciplines—especially those that align with demands in key target sectors (discussed under Strategy 3) in:

1. Vehicles, mobility, power, and propulsion
2. Life sciences (biomedical and agricultural)
3. Insurance and financial services
4. Emerging and crosscutting technology sectors (in integrated automation systems and robotics, software and software engineering, cybersecurity, electrical and electronic components, AI/advanced analytics, alternative energy, and others).

The question this action seeks to address is **how can Indiana significantly increase college enrollment in strategic fields of study and then retain the graduates of these programs in state?** It will take bold action and require the state and employers in Indiana to partner in incentivizing enrollment in Indiana’s higher education institutions. Helping the cause is certainly the fact that Indiana is home to world-class universities, including highly ranked institutions in STEM fields. The strong reputation of Indiana’s higher education institutions is very helpful to the cause but is not a solution in and of itself. Higher education has risen steeply in its cost, and a student in the U.S. now graduates with an average of \$28,950 owed in student loans. The burden of college debt is very much in the national dialog, and while higher education generally brings a long-term robust payoff in lifetime earnings, paying back student debt is a significant drain on graduate resources and very much in the minds of students and their families. Cost concerns may well be contributing to the declining percentage of high school graduates enrolling in higher education in Indiana (shown previously in Figure 6).

It is therefore recommended, under Action 1.1, that **Indiana develop a novel approach to support the cost of education for students pursuing and completing degrees in strategic disciplines with a rider attached to this support requiring the student works in Indiana for a minimum of three years upon graduation.** Because the retention of students in strategic disciplines is of direct importance to employers and the overall state economy, a **“Strategic Degree Support Program”** should be developed using both public and private funds.²⁶ **To gain significant, immediate attention in the marketplace, the degree of funding support provided will need to be significant with a suggested support level of 50% of the cost of tuition and fees for student education at Indiana higher education institutions.**

The defining of “strategic disciplines” should be established through advisory boards established by IEDC, with participation from the Indiana Department of Education, the Department of Workforce Development, the Commission for Higher Education, the Governor’s Workforce Cabinet, and senior industry human resources executives who can advise on their future workforce and occupation training needs. These advisory boards would work to identify degree programs in Indiana across three categories:

- **Strategic STEM**—linked to specific STEM degrees likely to be in high demand in support of Indiana strategic industries.
- **Strategic Non-STEM**—selected non-STEM degrees relevant to the development of strategic Indiana industries (for example, actuarial degrees for the insurance sector and operations research degrees for manufacturing sectors).

- **Non-Strategic STEM**—degrees in STEM not specific to strategic industry needs but potentially relevant to R&D, innovation, education, and other important state activities that relate to economic development.

Cost and potential yield of the proposed action

It should be noted that operating such a program comes with a significant financial price attached to it; however, the costs to Indiana’s economy and constraints on business growth if the degreed STEM workforce is inadequately retained in the state have the potential to be far higher still. What would such a program potentially cost the state? If the goal were to support the retention of 5,000 in-state student graduates from Indiana public higher education institutions in targeted strategic STEM degrees annually, the anticipated costs would be as follows:

Variable	Definition	Value
N	Number of students supported	5,000
C	Average cost per year for tuition and fees at a public Indiana 4-year institution, for in-state students (half to be reimbursed through the program) ²⁷	\$8,878 ²⁸ (See Figure 9)
Y	Years of education reimbursed through program per graduate	4
D	Duration of program operation to boost strategic degreed workforce	5

$((N \times C) \times Y) \times D \times 0.5 = \$443,900,000$ total five-year cost for program

26 The suggested program would be unique for a state (TEconomy has not identified any other state doing this), although there are multiple examples nationally of large corporations providing tuition reimbursement (although typically only for existing incumbent personnel pursuing further education to enhance their credentials).

27 The program may be geared to support of in-state students only but could allow out-of-state student participation with reimbursement only provided for the equivalent of in-state student tuition and fee levels.

28 <https://www.collegetuitioncompare.com/images/charts/statistics/indiana-colleges-undergraduate-program-average-tuition-fees-chart.jpg>

It should be noted that a study by the Indiana Business Research Center²⁹ found that 47.3% of public higher education graduates typically remain in Indiana to work after graduation. Because it is not possible to determine which graduates will remain post-graduation, 47.3% must be subtracted from the 5,000 supported through the program to derive a net gain of graduate STEM workers through the proposed program, equaling 2,635 net new retained per year (13,175 over five years of the program, for a cost of \$443.9 million total, equating to \$33,693 per net new retained STEM graduate).

Given the challenge of finding personnel and the high costs associated with recruiting candidates for jobs from outside of the state, there may be potential for employers to contribute significantly to the costs of the program. Assuming the 3-year Indiana job tenure required for reimbursement under the proposed program, an employer supporting half of the program cost would contribute \$16,847 total over the three years, equivalent to \$5,616 per year. Assuming a \$70,000 per year salary per graduate³⁰, that represents a less than 8% premium for recruiting through the program (a cost likely more than offset by the reduced challenges of recruitment and a likely higher level of retention of these students given their existing connection to Indiana). Recruitment costs have become significant in the competitive hiring environment for STEM graduates. Software Guild, for example, notes that for software engineers and developers, the cost of undertaking in-house recruitment typically is 12% of the recruit's salary, rising significantly to 22% on average if a recruitment agency is used.³¹ It is highly likely, therefore, that participating in the program through supporting the recruit's education cost reimbursement at 50% (for Indiana students graduating from public higher education institutions) would actually **result in a net cost savings for**

the participating employers. If employers are covering 50% of the cost of the program, then the five-year program cost for the state would be \$221,950,000 (however, as shown in Table 5, a significant amount of this will return to the state through income taxes).

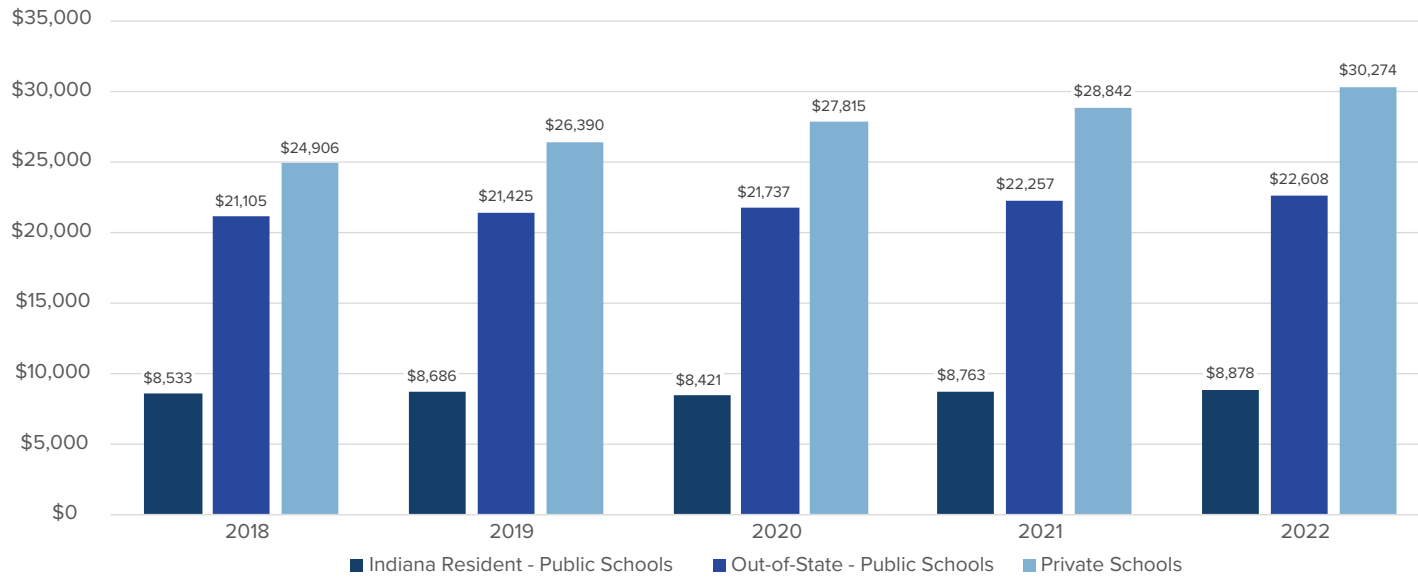
29 Allison Leeuw, Charles Baer, Timothy Zimmer "Indiana's STEM Pipeline: A Surplus of Graduates." 2014. Indiana Business Research Center at Indiana University's Kelley School of Business. <https://www.incontext.indiana.edu/2014/july-aug/article2.asp>

30 "The average median wage for a STEM-related job is almost double the median wage for all Indiana occupations, \$60,956 vs. \$31,740." <https://www.incontext.indiana.edu/2014/july-aug/article2.asp>. The data cited are for 2010 and have been inflated to \$70,000 for estimation purposes herein.

31 <https://enterprise.thesoftwareguild.com/recruit-developer/#:~:text=According%20to%20PayScaleopens%20in,12%25%20of%20salary%20on%20average>

32 <https://www.collegetuitioncompare.com/images/charts/statistics/indiana-colleges-undergraduate-program-average-tuition-fees-chart.jpg>

Figure 9: Indiana Colleges Undergraduate Programs Average Tuition & Fees Changes (2018-2022 at 4-year or higher institutions)³²



The state’s net cost of the program would be reduced by the amount of state taxes paid by the retained-graduate population. At a 3.23% flat state income tax rate, assuming a \$70,000 per year salary per graduate, total income for the 5,000 graduate cohort would equal \$350 million and the tax returned directly to the state would be \$11,305,000 in the first year, effectively compounding to generate a total estimated income tax revenue for the state over the five years of the program of \$169,575,000 (Table 5). Total

revenue back to the state would likely be higher, given the high employment multiplier effect likely associated with these high-pay and high-impact jobs (generating induced tax increase effects within the economy), and employee pay would likely progressively increase above \$70,000 over the course of their tenure at their Indiana employers. Also, it is likely that many participants in the program would stay employed in Indiana beyond the five years modeled, thus increasing associated state income tax revenues further.

Table 5: Estimated Income Tax Generation Through the Five-Year Program

	Year 1	Year 2	Year 3	Year 4	Year 5	Total Tax to State over 5 Years
New Added Each Year	5000	5000	5000	5000	5000	--
Existing from Previous		5000	10000	15000	20000	--
Total Program Workforce	5000	10000	15000	20000	25000	--
Pay @ \$70,000 per	\$350,000,000	\$700,000,000	\$1,050,000,000	\$1,400,000,000	\$1,750,000,000	--
State Income Tax Generated @ 3.23%	\$11,305,000	\$22,610,000	\$33,915,000	\$45,220,000	\$56,525,000	\$169,575,000

Based on these parameters, the estimated net cost to the state of operating the program for 5 years for the State of Indiana would be \$52,375,000 (equivalent to \$2,095 per participant for the 25,000 total five-year cohort).

While certainly not an inexpensive program to operate, the benefits for Indiana are likely to be considerable:

- It can be retroactive for students already enrolled and approaching graduation. **It therefore can be implemented rapidly and have an almost immediate effect on contributing to increased retention of graduates in key strategic disciplines.**
- By targeting the program initially to in-state students at Indiana public institutions, Indiana is leveraging its existing investment in the education of these students and is more likely to see success in increased marginal retention of these domestic Indiana students

through the program. The program is likely to be particularly beneficial to lower-income students concerned with the costs of their education and associated student loans.

- In targeting in-state students, the program supports those with higher connectivity to the state who are more likely to commit to a long-term future of working in the state.
- The program can be leveraged by Indiana employers through building relationships with students in Indiana degree programs (as outlined in Action 1.4). Major strategic sector employers will be engaged in the advisory boards designed to designate eligible degrees specifically relevant to their critically important Indiana industries.
- The program is designed to sunset. It is not intended to be a permanent program, but rather a 5-year commitment to provide a near-term supply-side boost to the skilled STEM workforce retention issue

in the state. That said, if the program proves to be highly effective, it is scalable—able to be extended or allow participation of larger cohorts of STEM and other high-priority strategic discipline students.

Most importantly, the cost of not working aggressively to boost the in-state retention of strategic STEM graduates likely will be high—felt in terms of constrained economic output and GDP growth, the leakage of new projects by employers seeking this talent at out-of-state locations that can supply them (as recently seen in the capture by other states of projects by Indiana firms), and reduced ability to recruit new strategic projects to the state.

Without this talent, the ability to strategically invest in new technologies and productivity-enhancing processes in Indiana (the focus of Strategy 2) also will be constrained significantly.

In 2014, the Indiana Business Research Center noted:

While there is always an argument to augment or expand higher education, the first step within Indiana may be to retain and employ the current Hoosier STEM pipeline.³³

This observation is even more relevant today and will continue to be for the foreseeable future. The proposed action represents a bold initiative designed to rise to the challenge and proactively demonstrate to Indiana employers the state's commitment to meeting their highly skilled graduate STEM workforce needs.

Action 1.2: Address Projected Supply-Demand Imbalances in Sub-Baccalaureate Technical Positions

As Figure 7 illustrates, demand is increasing significantly for workers with post-high school education and training, especially workers with a four-year or advanced degree. In contrast, job opportunities for those with only a high school diploma or less are declining substantially. Figure 7 also illustrates that the highest proportion of jobs in the U.S. economy is in the category requiring “some college or an associate degree.”

Within Indiana's advanced industrial economy, especially the manufacturing economy, employers are expressing concern over the availability of work-ready workers, in particular workers with technical job skills for advanced manufacturing jobs. Many of these latter job types are relatively high-paying, family-sustaining wage jobs that require specialized education and training at a certificate or associate degree level. Table 6 shows multiple examples of technical job categories that have a median pay level three years into the job in Indiana that is above the median earnings for an individual with a bachelor's degree 3 years after graduation (\$42,463). Indeed, several of the job categories in Table 6 have median pay above the median pay for master's degree graduates three years post-graduation (\$52,536) in Indiana.

³³ <https://www.incontext.indiana.edu/2014/july-aug/article2.asp>

Table 6: High Median Wage Job Classifications in Indiana Requiring Certificate or Associate Degree Training, But Less Than a Bachelor's Degree.

Certification	Indiana Median Pay @ 3 Years	Combined Certificates or Associates 2020-21 Academic Year	10 Year Supply Projection (Based on 2020-21 Year)	Demand Projection for 2021-2031 (Replacements for Retirements and New Openings)	Supply and Demand Balance
Sheet Metal Technology/Technologist	\$74,330	78	780	2,359	-1,579
Energy Management and Systems Technology/ Technician	\$69,182	42	420	139	+281
Industrial Mechanics and Maintenance Technology	\$63,708	208	2,080	2,046	+34
Industrial Technology/Technician	\$62,905	330	3,300	187	+3,113
Manufacturing Engineering Technology/Technician	\$56,793	336	3,360	187	+3,173
Mechanics/Repairers, General	\$54,213	120	1,200	1,354	-154
Machine Tool Technology/Machinist	\$53,856	51	510	5,929	-5,419
Medium/Heavy Vehicle and Truck Technology/Technician	\$52,136	136	1,360	2,194	-834
Computer Numerically Controlled (CNC) Machining Technology/CNC Machinist	\$51,669	69	690	709	-19
Totals		1,370	13,700	15,104	-8,005

Sources: Indiana Management Performance Hub (median wage data); Emsi Datarun 2022.2 (projected job openings); National Center for Education Statistics, Integrated Post-secondary Education Data System (IPEDS; certificates/degrees awarded); TEconomy Partners analysis. NOTE: Bachelor's Degree median earnings for Indiana at 3-years after graduation \$42,463 and master's degree median earnings for Indiana at 3-years after graduation \$52,536.

Evident in Table 6 is an overall projected supply shortfall of over 8,000 trained personnel through 2031 across just the nine aggregate jobs listed. The shortfall is not uniform, however, and that some of the occupation categories are well-met or even over-supplied by current programs in Indiana. The critical challenge areas appear in the “Machine Tool Technology/Machinist” and “Medium/Heavy Vehicle and Truck Technology/Technician” positions.

Balancing supply and demand across multiple occupation categories is a complex challenge, but it is essential that Indiana rise to the challenge, especially for meeting the needs of strategic industries for appropriately educated and trained workers. To this end, **TEconomy recommends that IEDC encourage a statewide collaborative, cross-sector effort to develop a detailed profile of projected supply and demand across key strategic associate degree and certificate-level occupations within Indiana.**

Particular attention needs to be paid to technical manufacturing jobs and to jobs in other strategic industries as profiled under Strategy 3. The supply and demand analysis should then be used to appropriately structure certificate and associate degree programs at a scale to meet demand. These training programs should be operated at Ivy Tech locations proximate to where the geographic pockets of demand are likely to occur, based on the spatial distribution of industry.

It should also be noted that the advancement of Industry 4.0's importance within the Indiana economy (discussed under Strategy 2) will also require approaches suitable to the **upskilling of the incumbent workforce** across manufacturing and other strategic sectors. TEconomy has noted this in recent major projects for the states of Iowa and Maryland, noting in the Maryland strategy that:

Upskilling the existing manufacturing workforce requires practical and flexible approaches, primarily short-duration education/training. The state should embrace and adopt 4.0-focused micro-credentialing approaches, certificates, and other "stackable" credentials, particularly for middle-skilled incumbent workforce and consider incentivizing data science-related cross-training for Engineering, Scientific, and Tech professionals.³⁴

Indiana high schools also have a role in providing solutions to the sub-baccalaureate educated technical workforce challenge. In the 2022-2023 school year, Indiana will launch a "Next Level Programs of Study" initiative that incorporates newly designed high school secondary career and technical education courses made up of 66 programs of study. Manufacturing is a focus for many of the programs of study and a new **Education Readiness Grants** program has been established by the Governor's Workforce Cabinet, in collaboration with Conexus, to provide up to five schools with \$100,000 in

grant support for industry-facing hardware and/or software to facilitate and add relevance to advanced manufacturing/Industry 4.0 instructional content. As noted by Conexus "grant recipients will be Indiana secondary schools who demonstrate a direct connection with local advanced manufacturers and graduate job-ready students with experience and credentials that apply to local employers." **IEDC should track the progress of the Education Readiness Grants program to understand its economic impact on regions throughout the state and assess whether an expanded program would support the state's broader economic development goals.**

Action 1.3: Create Strategic Industry Workforce Training and Development Centers.

Advanced industry operations can present a challenge for workforce training and development because these industries will often use special production environments and complex production processes and technologies that require specialized worker training. Placing inexperienced workers into such specialized environments is often not a feasible or effective approach, yet finding recruits with prior working experience specific to these specialized environments is a constant challenge. On-the-job training can only go so far in such environments (where mistakes can be costly or endanger workers), and it would be better if there were training sites that can readily duplicate or simulate the type of operations and working environment that trainees will enter. This offsite specialized training center approach has been successfully adopted in a few U.S. locations that have industry cluster specializations needing specific worker training. For Indiana, TEconomy sees a need for such centers focused on the life sciences and industry 4.0 technologies and production environments.

A Bioscience Industry Workforce Training and Development Center

Because Indiana has specialized strategic industry clusters in biopharmaceuticals and associated specialized biomedical products, there is intrinsic

³⁴ TEconomy Partners. "The Future is Now, Realizing the Promise of Industry 4.0: A Strategic Plan to Ensure a Competitive Future for Manufacturing in Maryland." April 2022.

demand for workers skilled in bioprocessing and aseptic/GMP drug and diagnostic manufacturing, as well as for training in up-and-coming advanced manufacturing modalities in the biopharmaceutical sector. Recently Eli Lilly announced a major investment in manufacturing in North Carolina, and the decision was evidently prompted, in part, by assurances of workforce training facilitated by North Carolina's BioNetwork, which is the life science training initiative of the North Carolina Community College System. BioNetwork's training system is supported by the Golden LEAF Biomanufacturing Training and Education Center (BTEC) on North Carolina State University's Centennial campus in Raleigh, which contains industry-grade good manufacturing practices (GMP) facilities, clean rooms, lab operations, etc. that simulate the environment in which trainees will be employed. The BTEC facility hosts the Capstone Center of BioNetwork that provides workforce training courses taught by industry experts with a specific focus on biomanufacturing skills sets including GMP, aseptic manufacturing, operations in biotechnology processes, industrial microbiology, good laboratory practices (GLP), HPLC, and validation. BTEC is also used by NC State for the training of undergraduate and graduate students in industry-facing skills, and for the training and upskilling of existing workers in North Carolina's large and expanding biopharmaceuticals sector.

North Carolina has experienced significant success in purposefully building a robust presence in the biopharmaceuticals and biotechnology sector. Shepherded by the state-funded North Carolina Biotechnology Center across multiple gubernatorial administrations, North Carolina has been able to sustain its commitment to building the life sciences industry in the state and meeting the specific workforce development needs of industry as it is attracted and scales-up. The BTEC facility was originally funded by the State of North Carolina and through State Tobacco Settlement dollars administered by the NC Goldenleaf Foundation.

As noted by BTEC:

Founded to help establish, attract and expand biomanufacturing in North Carolina and thus drive innovation and job creation, BTEC is located on North Carolina State University's Centennial Campus in Raleigh. It operates under the auspices of the university's College of Engineering (COE). BTEC operates two facilities: the 77,700-gross-square-foot main building and the approximately 5,000-gross-square-foot BTEC Annex in the Keystone Science Center. The two facilities feature more than \$18 million of industry-standard equipment and a simulated cGMP (current Good Manufacturing Practice) pilot plant facility capable of producing biopharmaceutical products using cell growth and expression, recovery, and purification processes. Undergraduates, graduate students, and working professionals come to BTEC for hands-on learning with the latest biomanufacturing technologies.

As mentioned previously, the North Carolina Community College System also operates the Capstone Center which utilizes the BTEC facility for general bioprocessing workforce training and for customized job training.

TEconomy is very familiar with BTEC and has a long-standing relationship with the North Carolina Biotechnology Center, evaluating the economic impact of the sector on the state. The Wikipedia entry for BTEC provides a solid overview of the Center and of the work performed there:³⁵

In 2003, North Carolina's Golden LEAF Foundation provided almost \$39 million to build BTEC, as part of a larger grant to establish a statewide public-private partnership now called NCBioImpact. The State of North Carolina provided funds for process equipment and supports the operation of the facility. The NCBioImpact partnership now includes BTEC, BRITE (Biomanufacturing Research Institute

³⁵ https://en.wikipedia.org/wiki/Golden_LEAF_Biomanufacturing_Training_and_Education_Center

and Technology Enterprise) at North Carolina Central University, North Carolina BioNetwork of the North Carolina Community College System, NCBIO (North Carolina Biosciences Organization), the North Carolina Biotechnology Center, and the Golden LEAF Foundation. It was created to provide workforce training and development for the biotechnology industry, thereby fostering the growth of this economic sector in the state.

BTEC collaborates with industry partners to design, develop, and deliver courses that provide professionals working for biomanufacturing companies, equipment vendors, or regulatory agencies with continuing education opportunities. Open-enrollment courses are offered throughout the year and are available to all interested parties. BTEC also regularly delivers courses customized to meet a client's specific needs for training.

BTEC delivers undergraduate and graduate courses to North Carolina State University students. Academic programs include the following: undergraduate certificate; undergraduate minor; post-baccalaureate certificate; graduate minor; a master's program offering two Professional Science Master's degrees, a Master of Science in Biomanufacturing (MS) and a Master of Biomanufacturing (MR). The curriculum for these certificates and degrees was created with extensive input from industry professionals, and most courses include substantial hands-on laboratory work. Most BTEC courses are offered in a half-semester (eight-week) format, which enables students to complete a series of courses in one academic year.

TEconomy considers the North Carolina system of workforce development for the biotechnology and biopharmaceuticals sector to be a best practice, with BTEC a centerpiece of the system.

Every two years, TEconomy updates its analysis of the life sciences sector in North Carolina, and the economic development success for the state is readily evident in the documented results:³⁶

- Total jobs supported by the life science sector in NC have grown **33%** from 2008 to 2018
- Total economic impact of the sector grew **82%** in that same time, from \$45.8 billion to \$83.3 billion
- The state's life science sector generated nearly **\$2.2 billion** in state and local government revenues in 2018, up from \$1.4 billion in 2008
- In terms of the Drugs and Pharmaceuticals strategic sector, North Carolina has risen to #3 in the nation, generates \$56.4 billion in economic activity, and supports 132,507 jobs earning \$9.6 billion in labor income.

Indiana, through BioCrossroads, covers much of the activity that in North Carolina is undertaken by the NC Biotechnology Center. The key missing element of a North Carolina-style ecosystem in Indiana is the BTEC training and workforce development element. Indiana would be well-served by duplicating the BTEC component of the NC system, covering training for traditional bioprocessing and incorporating new and expanding bioprocessing and advanced pharmaceutical manufacturing technologies that are increasingly seeing deployment. In this latter regard, work by TEconomy for Pharmaceutical Research and Manufacturers of America (PhRMA) found five key new technology spaces in pharma manufacturing likely to need training attention:³⁷

³⁶ TEconomy Partners. "2018 Evidence and Opportunity: Impact of Life Sciences in North Carolina" Available at <https://www.ncbiotech.org/transforming-life-science/why-nc/2018-teconomy-report>

³⁷ TEconomy Partners, LLC. "Biopharmaceutical Manufacturing in the U.S.: Making Cutting-Edge Medicines Today and Leading the Way on Medicines of Tomorrow." April 2019. Prepared for Pharmaceutical Research and Manufacturers of America (PhRMA).

- Continuous Manufacturing
- Single-Use Systems
- High-Volume Cell Processing Advances
- Advanced Purification Technologies
- Cell Preservation, Distribution and Handling Methods.

TEconomy recommends that IEDC and BioCrossroads form a scoping committee with representatives from biopharmaceutical, diagnostics, and contract manufacturing companies in Indiana to discuss their anticipated future needs in terms of production processes and the implications for equipping a BTEC-style center and developing curricula responsive to anticipated industry needs. It is anticipated that a facility developed and equipped along the lines of the NC BTEC would require a budget of at least \$60 million to establish³⁸, with it recommended that the opportunity be examined for public/private investment in an Indianapolis-based center using state funds, philanthropic funding, and industry donated/supported equipment contributions.

An Advanced Manufacturing/Industry 4.0 Workforce Training and Development Center

IEDC has already recognized the need to advance a center focused on education, training, and innovation focused upon Industry 4.0. The in-development Smart Manufacturing Studio Lab is intended to provide “lab space and access to state-of-the-art smart manufacturing equipment, allowing companies to train employees, validate technologies for their business models and conduct third-party pilot manufacturing.”³⁹ The IEDC notes that it will partner with industry stakeholders to “develop a project scope for the lab, mapping out

next steps and a plan to source and supply the equipment.”⁴⁰ Total funding allocated to developing the Smart Manufacturing Studio Lab is \$3 million.

The Ongoing (and Widening) Skills Gap in U.S. Manufacturing

Indiana manufacturers are not alone in their workforce challenges—the industry as a whole is experiencing serious difficulty in finding the right talent and filling open positions. In recent years, Deloitte and The Manufacturing Institute have surveyed manufacturers to understand and project national skills gaps and other labor force dynamics within and across the industry.

Their latest survey of more than 800 U.S. manufacturers found:

- The skills gap in U.S. manufacturing is expected to leave 2.1 million jobs unfilled by 2030.
- This potential gap could result in a \$1 trillion economic impact (cost) to the nation's economy.
- 77% of companies surveyed expect ongoing difficulties in attracting and retaining workers through 2021 and beyond.
- Finding talent is 36% harder than it was in 2018.

Manufacturers increasingly have difficulty hiring middle-skilled workers, including CNC machinists, welders, and maintenance technicians—all areas identified by Deloitte, as well as in interviews with Indiana manufacturers. The study recognizes the implications for Industry 4.0 that are likely to exacerbate the existing challenges, noting that: “As digital transformation in the manufacturing industry continues to develop, the skills needed to do the jobs in the smart factory will likely be different from skills used today. But today's manufacturing workforce does not possess many of these skills.”

Deloitte and The Manufacturing Institute. “*Creating pathways for tomorrow's workforce today: Beyond reskilling in manufacturing.*” May 2021.

38 TEconomy contacted the original project architects for the BTEC facility, Flad Architects, to get a ballpark estimate for such a facility duplicated in today's dollars in the Indianapolis environment. 2006 was the project year for the original project and the 96,000sf BTEC Building was \$27M with an equipment budgeted at \$9.3M (with significant donated equipment also). Normalizing these costs to Raleigh NC today generates an estimate of \$54.54M or \$568/square foot (note this is without equipment costs). Adapting this to the different cost of construction in Indianapolis, derives an estimate of \$58.95M or \$610/square foot (note this is without equipment costs).

39 <https://www.iedc.in.gov/program/economic-activity-stabilization-and-enhancement/overview>

40 Ibid

Relevant TEconomy Findings from Interviews with Iowa Manufacturers in Developing Iowa's Manufacturing 4.0 Strategy

Implementing Manufacturing 4.0 technologies is fundamentally changing the nature of work and job functions in the modern “smart” factory. To achieve its goals and benefits and compete in this environment, digital and “hybrid” skills are vital, learning must be continuous and lifelong, and preparation for modern manufacturing careers takes on a new context. Iowa's manufacturers embracing digital technologies require existing employees to be regularly and periodically “up-skilled.” Workforce development is both a major barrier and an enabler of Manufacturing 4.0 technology implementation, and how quickly and efficiently training and upskilling can occur is a significant factor in how Iowa competes into the future.

Interview and focus group discussions with Iowa manufacturers found:

- A broad consensus on the need to invest in digital skills and raise baseline Manufacturing 4.0 knowledge across nearly all occupational groups and levels.
- Among Iowa's small- and mid-sized manufacturers, there were many instances of IT, Analytics, and/or Technician personnel “wearing multiple hats” with respect to their roles in implementing Industry 4.0 technologies. These individuals often rely on informal training in-house and many do not have advanced degrees. This trend is driven by their valuable knowledge of unique production processes, so employers decide they would prefer to train and grow this talent internally, regardless of an individual's educational or digital training background.
- Concern among some companies that the technical training and expertise available at the state's community colleges—a focal point of much of Iowa's current workforce training/re-training programs—are lacking in Industry 4.0 technologies and advanced analytics.

Specific Industry/Manufacturing 4.0 skill sets in-demand that were consistently raised by manufacturing leadership include: Embedded electronics and software knowledge and the need for crosscutting skills such as Mechanical Engineers with software expertise; Industrial IoT specialists; Cybersecurity professionals and expertise; Middleware skills to integrate systems in large enterprise environments; and Technical Project Management overseeing cross-functional teams.

In general, there is a need for investments in adult or “nontraditional learner” upskilling programs in areas including IT, digital operations, supply chain management/ logistics analytics, and related areas.

Among the Iowa manufacturers engaged in project interviews and focus groups, there is an emerging consensus that implementing Manufacturing 4.0 technologies is not likely to require significant new hires, but instead will require upskilling existing workers.

“SEIZING THE MANUFACTURING 4.0 OPPORTUNITY: A STRATEGIC PLAN FOR IOWA'S MANUFACTURING INDUSTRY.” Prepared For: Iowa Economic Development Authority. Prepared By: TEconomy Partners, LLC. JANUARY 2021.

TEconomy would note that funding of \$3 million is probably a good level of initial seed funding for establishing a small center, but the scale of need in workforce training for Industry 4.0 and advanced manufacturing and logistics industries will likely require a significantly larger funding commitment over time. Given the widespread geographic distribution of industry across Indiana experiencing demand for a technically trained workforce, the solution is likely to be satellite Smart Manufacturing Studio Lab training centers at multiple Ivy Tech/public college locations.

Action 1.4: Advance Industry-Student Connectivity During Education

Indiana's world-class research universities and other higher education institutions represent a robust talent asset for the state. The website Educationdata.org's **2020 data**⁴¹ show Indiana hosting **422,906** students enrolled in Indiana colleges and universities, comprising 71.5% state residents and 28.5% nonresidents. 63.0% of enrolled students in Indiana are enrolled at public higher education institutions, and 37.0% at private colleges and universities. Indiana ranked 18th in the nation in 2020 in total annual number of individual graduates from its higher education institutions.⁴² This places college graduate production in line with the state's GDP rank in 2020, which was also 18th.

The issue for Indiana is less in terms of graduate production volume and more in terms of graduate retention. As noted in the Phase I report, the share of Indiana's population aged 25-64 having an associate degree or higher is low, with the state ranked 43rd in the nation. This discrepancy in graduate production ranking and percentage of population with a degree ranking is a rather clear indicator that there is very much an issue retaining Indiana college graduates in the state. Part of the issue may be that Indiana generally pays lower wages than many other states, and thus graduates are attracted to employers elsewhere who offer higher pay (even though cost of living may be higher in other states). TEconomy found, however, while performing a recent project for CICP and interviewing students that those students **had generally low levels of awareness of job opportunities and types of employers hiring in Indiana.** Interviews with highly in-demand students in advanced analytics programs at Purdue University served to highlight that the students by their Junior or Senior year had already been significantly engaged in dialog or internships and relationship-building experiences with out-of-state employers, whereas they had had very little or no engagement with Indiana companies or employers. TEconomy concluded that:

Realigning talent flows also requires more active relationship-building on the part of industry, which more coordinated relationships can help activate. Indiana's skilled graduates with AI-related backgrounds are typically being attracted away in a competitive market rather than choosing to leave due to perception of a lack of opportunity, meaning a key aspect of coordinating relationship-building will be increasing awareness of in-state opportunities for meaningful careers and better communicating the value proposition of the

41 <https://educationdata.org/college-enrollment-statistics>

42 <https://educationdata.org/number-of-college-graduates>

*state's brand. Over time, the creation of a highly innovative community of practice based around regional in-state hubs will build centers of gravity that retain cohorts of talent with varying specializations. Significantly boosting retention in the short term, however, may require significant use of incentives and active marketing efforts on the part of industry stakeholders with sizable needs.*⁴³

Based on these findings, TEconomy recommends that IEDC collaborate with intermediaries to develop a program to communicate with strategic employers in the state the need to engage with students in strategic disciplines early and often in their higher education in Indiana. Provision of state financial support for internships and other relationship-building experiences should be examined in supporting strategic industry engagement with students in strategic fields of study.

Action 1.5: Enhance Mechanisms to Support Increased Workforce Participation

June 2022 Bureau of Labor Statistics data estimate Indiana's workforce participation rate at 62.6%, ranking Indiana 23rd among all U.S. states.⁴⁴ Nationally, the workforce participation rate has been slowly declining, dropping from circa 67% in 2001 to 63.2% in 2019.⁴⁵ Indiana has also trended downward, but to a somewhat lesser degree than the nation, dropping from 68% in 2001 to 64.4% in 2019.⁴⁶ For states gaining population, a declining workforce participation rate presents a manageable challenge—providing an ability to still meet employers' needs through newcomers to the state. However, **for Indiana, with a flat-to-moderately-declining projection for the working-age population through the forthcoming decade (see Figure 4),**

any parallel reduction in workforce participation rate creates significant challenges for employers and the economy.

Several mechanisms exist for public policy to influence workforce participation rates; some are likely to have immediate benefits, while others require a more long-term approach. Options for IEDC and the State of Indiana to consider include:

- **Encouraging immigrants to choose Indiana as their state of residence.** As noted by the Bureau of Labor Statistics, in 2021 the labor force participation rate of the foreign-born was 64.7% while the labor force participation rate of the native-born was 61.0%.⁴⁷ Over the longer term, the Indiana federal delegation should seek to encourage immigration reform that will enable more immigration, particularly of high-skilled workers. Action 1.6 could assist in attracting immigrants to Indiana.
- **Increasing access to early childhood education** has a dual benefit of improving school readiness and future academic performance for Indiana's children and providing an ability for parents of young children to be able to work while their child is engaged in the early childhood program. It has also been noted that "employers also benefit because if parents know their children are receiving quality care in a healthy environment, they are more likely to stay in the workforce, and are more productive and focused at work."⁴⁸

43 TEconomy Partners, LLC. "Artificial Intelligence and Advanced Analytics in Indiana: An Initial Discussion of Industry Needs and University Capabilities." January 2020.

44 <https://www.bls.gov/web/laus/alfprderr.xlsx>

45 <http://www.hoosierdata.in.gov/MonthlyBriefing/LMI-Nov2019.pdf>

46 Ibid.

47 <https://www.bls.gov/news.release/pdf/forbrn.pdf>

48 North Carolina Department of Commerce. "First in Talent. Strategic Economic Development Plan for the State of North Carolina. Goals, Strategies, and Tactics for the New Economic Landscape". July 2021.

- **Enhance state financial support for childcare subsidies for working families and for expanding childcare facilities and programs state-wide.** Indiana participates in the Child Care and Development Fund (CCDF), which is a federal program helping low-income families obtain childcare so that they can work or attend job training and education courses. Helping to increase the availability, affordability, and quality of childcare, the CCDF program is administered through the Indiana Family and Social Services Administration in the Office of Early Childhood and Out-of-School Learning. Expanding the program further to allow more persons to qualify for the support and provide increased availability of professional childcare facilities and services providers would help increase the ability of parents to participate in the workforce.
- **Improving public health is a longer-term pathway to increasing labor force participation.** The Indiana University School of Medicine notes that Indiana is 41st in the nation in overall health, ranks 42nd when it comes to mental health, and is 48th in funding for public health.⁴⁹ In TEconomy's interviews with CEOs of major Indiana employers, issues with public health in the state and the effect on workforce participation and overall healthcare costs were voiced as concerns by several leaders. Poor public health leads to enhanced levels of disability that reduces workforce participation and is also associated with increased levels of absenteeism and reduced on-the-job productivity.
- **Assisting ex-offenders in pursuit of work** may also be beneficial to increasing the labor force. The Brennan Center for Justice reports that the "number of Americans with a criminal history has risen sharply

over the past three decades" such that "today, nearly one-third of the adult working-age population has a criminal record."⁵⁰ The majority of employers use criminal record checks, and a 2009 Justice Department study found that a past criminal conviction of any sort reduced the likelihood of a job offer by 50%⁵¹ Indiana's 2013 "Second Chance Law" which provides expungement/record sealing has been helpful, but clearly there are further economic benefits to be realized and further workforce participation advantages that could be achieved through criminal justice reform, including reviewing the criminal code for opportunities to decriminalize minor infractions. A statewide "ban the box" law, to moderate criminal background checks and questions early in hiring practices, would also be helpful. It should be noted that there is a GDP effect associated with criminal records because the earnings potential of people with convictions is significantly reduced. The average annual earnings loss for a misdemeanor conviction nationally is 16%, for felonies with no prison time, 22%, and for those formerly imprisoned, 52%.⁵²

- **Efficient and available public transit** is also an important component in providing affordable access to geographic employment clusters and is particularly important for lower-income individuals seeking to participate in the workforce.

49 <https://medicine.iu.edu/expertise/indiana-health#:~:text=Indiana%20is%2041st%20in%20the,Mental%20Health%20in%20America%202019>.

50 <https://www.brennancenter.org/our-work/analysis-opinion/just-facts-many-americans-have-criminal-records-college-diplomas>

51 Devah Pager and Bruce Western. "Investigating Prisoner Reentry: The Impact of Conviction Status on the Employment Prospects of Young Men." October 2009. <https://www.ojp.gov/pdffiles1/nij/grants/228584.pdf>

52 Priya Mahadevan. "Indiana's 'Second Chance Law' Seals Criminal Records. But Fines And Fees Can Stand In The Way." WFYI Indianapolis. April 21, 2021. <https://www.wfyi.org/news/articles/indianas-second-chance-law-seals-criminal-records-but-fines-and-fees-can-stand-in-the-way>

Action 1.6: Develop a marketing initiative to tell the Indiana story and encourage increased population and workforce growth

Given the population growth projections previously cited, there should be little doubt that **it will be important to make Indiana as welcoming as possible for the attraction of newcomers.** While Indiana's K-12 system and world-class universities can play an important role in developing talent in high-demand areas such as in STEM disciplines, they alone cannot be the solution to extreme competition for talent. Often employers need skilled personnel with some years of experience—positions unlikely to be filled with new graduates of Indiana's universities. The specialized talent to power Business 4.0 transformation and develop and implement new technologies are in extremely high demand and can be selective in where they choose to work and live. Indiana employers must compete hard to attract talent, often from out-of-state, and **they need Indiana to project an open, welcoming, and friendly image to the outside world.**

It is recommended that Indiana communicate and brand the best features of Indiana as a destination for technical talent. The branding and associated campaign could be either holistic or could be narrower in focus, specifically targeted toward technical talent demographics.

While TEconomy is politically neutral and working in almost every U.S. state, and economic development is very much a bipartisan goal for the nation and every state, it is professionally necessary to point out the potentially serious ramifications for Indiana associated with today's highly charged, partisan identity politics that can create an atmosphere or outside impression that is the antithesis of a campaign intended to encourage in-migration. If skilled and talented people of color or international origin feel that they may be unwelcome in Indiana, that belief has a very real economic downside. If Indiana is viewed as intolerant of diversity, unwelcoming of LGBTQ people,

or making moves that alienate talented women or other sub-populations, the state needs to be aware that **the chances of reaching its GDP growth goals could be seriously hampered.** At a minimum, it behooves legislators to always consider the economic ramifications of their actions and legislative proposals, in addition to any political goals, especially because **the trajectory of the Indiana economy impacts everyone in the state, no matter their political persuasion.** It should be noted that concerns surrounding the image of the state and the atmosphere being created for diverse populations were voiced quite strongly in TEconomy's interviews with CEOs of leading Indiana employers, and as Figure 5 illustrates, Indiana's performance on diversity, equity, and inclusion was rated low.

Action 1.7: Continued investment in the built environment, communities, and quality of life to encourage population retention and growth

When it comes to retaining population and increasing in-migration of people and businesses, the quality of place and perceived quality of life matters. Although both quality of place and quality of life are somewhat intangible metrics, various rankings of states have been attempted by researchers and media publications. Each of the various "best state" rankings approach their ranking scheme differently, with pros and cons to each approach, but there is a relative consistency evident in Indiana's comparative ranking across various sources. Table 7 summarizes Indiana's ranked position across five such ranking systems:

Table 7: Indiana Ranking in “Best State” Ranking Systems

U.S. News: “Best States 2021” ⁵³	WalletHub “Best States to Live, 2021” ⁵⁴	USA Today “Adapted Human Development Index, 2019” ⁵⁵	American Dream Prosperity Index ⁵⁶	CNBC “Life, Health & Inclusion” 2022 ⁵⁷	Average Rank Across Five Systems
32	29	40	35	43	36

As Table 7 shows, although there is variability in Indiana’s score across these five ranking schemes, they average to a composite score of 36th in the nation (as compared to Indiana’s population rank which is 16th).

The challenge for the IEDC is that the agency does not have jurisdiction over many of the variables that impact quality of life. It is a composite of factors covering areas such as economic opportunity, public health, safety and crime, education, quality of infrastructure, governance and fiscal stability, housing availability and affordability, aesthetics and functionality of the built environment, the natural environment, and recreational and entertainment assets. Recognizing that improving quality of life is important and that this somewhat intangible factor varies across Indiana’s geographic regions, the State of Indiana has been forward-thinking in terms of developing a program that supports individual Indiana regions in crafting strategies that fit the needs and characteristics of their individual locations.

Under Governor Holcomb, Indiana launched the Regional Economic Acceleration and Development Initiative (READI) which focuses on advancing quality of life, quality of place, and quality of opportunity. READI is noted by the IEDC to be:

A bold, transformational initiative that will dedicate \$500 million in state appropriations to promote strategic investments that will make Indiana a magnet for talent and economic growth. Through this initiative, the state will encourage neighboring counties, cities and towns to partner to create a shared vision for their future, mapping out the programs, initiatives and projects that are critical for them to retain talent today and attract the workforce of tomorrow. READI is expected to attract an impressive \$9 billion of local public, private and philanthropic match funding that will propel investment in Indiana’s quality of place, quality of life and quality of opportunity.⁵⁸

53 <https://www.usnews.com/news/best-states/rankings>. The U.S. News systems uses more than 70 metrics.

54 <https://wallethub.com/edu/best-states-to-live-in/62617>. WalletHub ranking is based on 52 key indicators of livability.

55 <https://www.usatoday.com/story/money/2019/11/07/best-worst-us-states-to-live-in/40544227/>. This is the most simplistic of the four systems examined, using just three primary variables.

56 <https://www.americandreamprosperity.com/rankings/state-by-state>. The American Dream Prosperity Index consists of three domains measured through 11 pillars, built upon 48 actionable policy areas (elements), and underpinned by over 200 indicators.

57 CNBC. “America’s Top States for Business 2022: The full rankings.” Ranking for the “Life, Health & Inclusion Category.” <https://www.cnbc.com/2022/07/13/americas-top-states-for-business-2022-the-full-rankings.html>. CNBC rates states on livability factors like per capita crime rates and environmental quality, and looks at inclusiveness in state laws, including protections against discrimination of all kinds, as well as voting rights. Health care quality, outcomes, preparedness, and public health spending are also key drivers in this category.

58 <https://www.iedc.in.gov/program/indiana-readi/overview>

READI is a great example of the state working to leverage its financial resources, together with local stakeholder knowledge, to provide effective financing for regional initiatives designed to meet READI goals. Although the outcomes of READI are yet to be seen, the program has been well-received by Indiana's regional leadership, providing an impetus and means for neighboring communities statewide to collaborate in developing actionable programs that, when implemented, will ideally serve to enhance the attraction, development, and retention of talent. With IEDC set to award up to \$50 million per region through the READI program, the program is of a scale that is suited to enabling meaningful advancement to occur in quality of place and quality of life investments.

In terms of action, READI is supported as a component of the IEDC 5e strategy as a suitable core program for state efforts to enhance regional quality of place/life and enhance the attraction and retention of skilled human capital.

IV. STRATEGY 2: ACCELERATING PRODUCTIVITY VIA BUSINESS 4.0

Computers and digital information have long been part of the American business ecosystem. From early development and adoption of mainframes and mini-computers to the rise of the personal computer in the 1980s, information technology (IT) has been increasingly integrated as a tool across almost all sectors of the U.S. economy. What has been termed Industry 3.0 saw the widespread use of IT and computer technologies to automate individual processes in manufacturing and associated industries, with the goals of increasing productivity and production quality/consistency. The penetration of digital technologies and IT has been far broader than just manufacturing, however, and is integral to the operations of almost every business.

The past decade has seen the rise of integrated and connected digital technologies as the next evolution of IT, whereby digital technologies are increasingly integrated into smart systems, or systems-of-systems, with computation and business process automation at the core. Driven by the power and increasing speed of network interfaces, broadband communications technology, advanced sensors, and machine learning (up to and including artificial intelligence) the term **Industry 4.0** has arisen. Industry 4.0 describes the development of intelligent or “smart” processes and control systems that integrate and automate multiple steps in the production process and enable refined, digitally informed, and controlled operations business-wide. Industry 4.0 can reach upstream of manufacturing production into the automation of supply chains and the management of inputs to production, through to automation of major manufacturing processes, and onwards into smart warehousing, logistics and delivery systems.

Industry 4.0 (see sidebar) describes a “smart” technology systems paradigm with application to manufacturing industries, their supply chains, and their logistics. As noted above, however, the smart systems paradigm is

The IUPUI Kelley School of Business and Conexus Indiana introduce Industry 4.0 as follows:

Indiana AML industries are firmly established in Industry 3.0, which can be characterized as using information and computer technologies to automate processes. Today, many companies automate processes, but the machines they use for automation (such as CNC machines) require a great deal of human interaction and are used primarily for increased capacity and product quality.

Industry 4.0, sometimes referred to as Smart Manufacturing, further integrates digital technologies, such as the Internet of Things (IoT), cloud computing and analytics, and artificial intelligence and machine learning into company-wide operations and manufacturing processes. Outcomes of Smart Manufacturing are potentially increased production and flexibility/agility, real-time visibility into equipment performance, and responsiveness to customer demand. Smart Manufacturing also leverages data to a significant degree for outcomes like predictive maintenance, self-optimization of process improvements, and increased production efficiencies. In short, companies aligned with Industry 4.0 are highly connected, digitized, agile and more autonomous than those entrenched in Industry 3.0.

Report: The First Signpost on the Road from Early Adoption to Widespread Application of Industry 4.0 Technologies.

also applied more broadly across the economy, with business sectors such as finance and insurance, healthcare, retail, and more leveraging IoT, advanced analytics, automated decision-making, and control (via AI and ML) into the core of their business operations.

For the advancement of Indiana's economy this almost across-the-board integration of "smart" systems is best termed **Business 4.0**—intended as a holistic term in this strategy document encompassing the digital transformation of business operations across multiple manufacturing and nonmanufacturing sectors alike.

As noted in a recent progress evaluation by IUPUI Kelley School of Business and Conexus:⁵⁹

The advanced manufacturing and logistics (AML) industries are the backbone of Indiana's economy, employing more than 500,000 Hoosiers and contributing more than any other industry sector to Indiana's gross state product. We make and move products that fuel the global economy—from automobiles to jet engines, medical devices and medicines.... The global advanced manufacturing and logistics industry sectors, however, are at a crossroads—challenged to adopt smart technologies, automation and data analytics to increase competitiveness, productivity and profitability. How Indiana's advanced manufacturers and logistics companies respond to the advent of Industry 4.0 impacts every aspect of the Hoosier economy as well as the global economy.

The State of Indiana via IEDC has been an early leader in responding to the transformational promise contained in Industry 4.0. Given the outsized importance of manufacturing and logistics industries across

Indiana, particular attention has been paid by IEDC working with Conexus, in collaboration with the IUPUI Kelley School of Business, to understanding the adoption of Industry 4.0 into Indiana industry, the challenges and opportu-

STATE OF INDIANA MANUFACTURING READINESS GRANTS

Operated in partnership with Conexus Indiana, the State of Indiana provides matching grants to "companies committing to modernizing their operations or integrating smart technologies and processes in order to improve capacity, speed and quality."

Investment: Up to \$200,000 (Minimum 1:1 matching basis)

<https://www.iedc.in.gov/program/economic-activity-stabilization-and-enhancement/overview>

nities presented, and to developing an innovative program—**Manufacturing Readiness Grants (MRG)**—to financially assist companies in accelerating their investments in smart technology integration. As is discussed further in this "Strategy 2" section, the MRG has received national recognition as an innovative, forward-thinking program and research by IUPUI and Conexus shows that the program is having a real, measurable effect on building Industry 4.0 momentum statewide.

Business 4.0 holds promise to boost business productivity in Indiana and thus advance improvement in the GDP growth rate. Importantly, it is a path to accomplishing GDP growth without requiring an expansion of the state pop-

59 IUPUI Kelley School of Business and Conexus Indiana. "The First Signpost on the Road from Early Adoption to Widespread Application of Industry 4.0 Technologies: 2021 Industry 4.0 Technology Adoption Survey Report"

ulation or the overall size of the workforce. However, that does not mean that it can be accomplished completely independent of the workforce; as noted under Strategy 1, the implementation of 4.0 technologies requires specialized personnel for the design, installation, maintenance, and other operations that enable smart systems to function. Workforce development and technology investment very much go hand-in-hand on the pathway to Industry 4.0's widespread impacts being positively felt across the Indiana economy.

Given the power and promise of Business 4.0, TEconomy recommends a series of specific actions for IEDC and its key partners to pursue in accelerating Indiana's adoption of smart systems across strategic business sectors. These actions are summarized on Table 8 and detailed further in this chapter.

Table 8: Recommended Actions for Accelerating Indiana's Business Productivity Via Business 4.0 Adoption.

Strategy	Actions
2. Accelerating Productivity Via Business 4.0	<p>Action 2.1: Significantly increase funding for the Manufacturing Readiness Grant (MRG) program.</p> <p>Action 2.2: Expand the MRG program with a parallel Business 4.0 Readiness program that will support digital transformation in strategic nonmanufacturing sectors of the economy.</p> <p>Action 2.3: Attract automation companies and consultancies.</p>

Action 2.1: Significantly increase funding for the Manufacturing Readiness Grant program

The previously cited 2021 Industry 4.0 technology adoption survey found significant progress recently made in Indiana in terms of Industry 4.0 recognition, intent to engage, and actual investment. That said, there is still much to do before Industry 4.0 reaches its full transformational potential across the large, advanced manufacturing and logistics (AML) sectors in Indiana. The topline conclusions of the IUPUI and Conexus study authors from the 2021 adoption survey are highlighted in Table 8.

Table 8: Topline Findings in the IUPUI Kelley School of Business and Conexus Indiana 2021 Industry 4.0 Technology Adoption Survey Report

Key 2021 report findings:⁶⁰

- Indiana companies are increasing implementations of Industry 4.0 technologies. In 2020, about 20% of respondents had successfully implemented or piloted an Industry 4.0 technology. The figure more than doubled this year with 43% of companies successfully implementing or piloting an Industry 4.0 technology.
- More companies are dedicating resources to Industry 4.0 technology adoption at a strategic/company-wide level. The number of companies with technology adoption budgets rose from 16% to 29% year-over-year, and those with strategic roadmaps for technology adoption rose from 12% to 23%, nearly doubling in both cases.
- Additive manufacturing, collaborative robots (cobots), and machine vision are making big moves on the adoption curve. Both large and small companies are reporting rapid adoption of these Industry 4.0 technologies, and their benefits are becoming increasingly apparent.
- Budget restriction is no longer the standout obstacle to technology adoption. And there is hope that budget restriction will continue to fall with the expansion of Indiana's Manufacturing Readiness Grants program in 2021. Within the survey population, several of the companies received matching grant funding to execute a technology adoption project and credited the grant with either enabling (34%), accelerating (26%) or expanding the scope (34%) of the project.
- Big data and analytics, augmented/virtual reality, artificial intelligence (AI) and machine learning (ML) are still emerging, but are expected to be implemented in the next 5 years.
- Most Hoosier manufacturers (68%) are collecting some data, but nearly two-thirds (65%) reported only a 'basic' data infrastructure with manufacturing data available to a limited number of personnel or departments. In other words, companies are collecting manufacturing data but are not yet capturing its full value.
- Hoosier companies are preparing for digital plant initiatives and agile manufacturing capabilities. Machine vision, big data and analytics, additive manufacturing, sensor technology, Internet of Things (IoT), and cobots round out the top six technologies expected to be implemented in the next 5 years.
- Enhancing/optimizing productivity is still the top strategic objective and key driver of Industry 4.0 technology investments at Hoosier companies.

The headline finding from the [previous] 2020 report was that only 16% of companies had a budget for technology adoption, with budgetary restrictions by far the biggest obstacle inhibiting progress. This year, 29% of companies have a budget for technology adoption, nearly double the percentage for 2020. And while budget restrictions remain a top obstacle in 2021, our study indicates that it is no longer an insurmountable obstacle for most manufacturers.

⁶⁰ Ibid

The uptake and interest across the AML sectors in the MRG program clearly have been significant. Conexus shared with TEconomy that 269 applications have been funded with grants valued at \$22.9 million. Moreover, the total investments made in Industry 4.0 eligible projects by the grant recipients have **greatly exceeded the 1:1 match goal with total project budgets reaching \$194.9 million.** The average grant size has been \$85,000. The program has been especially important in supporting Industry 4.0 initiatives across Indiana's large base of small and midsize AML operations—evidenced by the fact that the average size of a participating company is 177 employees.⁶¹ The program is also demonstrating a truly statewide footprint in terms of funded projects, and the participating companies report a 5% net wage growth across their operations. **TEconomy, in developing recent strategies for advancing Industry 4.0 in Maryland and Iowa, has specifically referenced the Indiana MRG program as a best practice in effective modern economic development program innovation.**

The high demand for the MRG program, and the significant technology investment journey that the AML sectors overall in Indiana are embarking on, point to both demand and need for increasing the funding to the MRG program. As noted earlier in this strategy document, Indiana needs to make bold moves and significant funding commitments to considerably advance its GDP growth rate goals. The MRG program is now a proven and effective program for helping advance productivity-increasing technology adoption across Indiana's critically important, traded AML sectors. It is also a scalable program, with the demand for the program indicative of significant additional demand (and the associated technology investment leverage and productivity benefits) being available across the AML sectors in Indiana if the program were to be provided with a larger total pool of available state funding.

To assess the “right-sizing” potential for scaling up the MRG program, TEconomy approached program management at Conexus to discuss their direct experience in administering the program, the demand for the program, and the realistic scalability. **The conclusion is that a right-sized annual target for funding available through the program should be \$100 million.** As noted by Conexus to TEconomy:

The success of MRG just scratches the surface of the manufacturing base in the state of Indiana. The program, as defined today, places sizable constraints on the full population of manufacturers. In fact, with approximately 8,500 manufacturers in the state, 269 awards represent just over 3% of this critical sector.

A stepwise approach to achieving the \$100M goal might be in order (e.g., initially \$50M, then building to \$100M), corresponding with very critical steps taken by the state, Conexus and other partners to develop a plan to operationalize, market, measure and appropriately fund such an important “MRG+” initiative.

The MRG's track record of funding leveraged through the program has been impressive. Given the previously cited experience of \$22.9 million in awards supporting a total investment of \$194.9 million, that is a **leverage of 8.5 to 1.** By scaling the program to \$100 million per year, it would be reasonable to anticipate circa \$850 million in Industry 4.0 investment spurred in the state through the program—a level of investment likely to drive significant productivity gains across Indiana manufacturing and advancing the state closer to its GDP growth goals.

61. Source: Slides provided by CICP, prepared by Conexus.

Action 2.2: Expand the MRG program with a parallel Business 4.0 Readiness program that will support digital transformation in strategic nonmanufacturing sectors of the economy

The application of IoT technologies and of the advanced analytics and AI capabilities that IoT and big data enable will not only be confined to manufacturing. These Business 4.0 technologies are change agents for almost all sectors of the economy and will absolutely impact significant and important sectors of Indiana's economy in both traded sectors (such as distribution and logistics, and insurance and finance) and non-traded sectors (such as health-care and retail sectors). Particularly for those sectors of the economy that are strategic growth opportunities (see Strategy 3), **there is a need to assist companies in making the Business 4.0 transition in the same way as for advanced manufacturing sectors. As such, it is recommended that IEDC consider expanding the MRG program with a parallel program providing support for digital/Business 4.0 transition in nonmanufacturing strategic industries.** The program will not need to be at the scale of the MRG program because there are fewer companies in Indiana within designated nonmanufacturing strategic sectors.

Action 2.3: Attract automation companies and consultancies

With talent to implement Industry/Business 4.0 in very high demand and short supply, and with IEDC working hard to provide industries with resources to start their Industry 4.0 investment journey, there will likely be a significant supply and demand challenge for talent to assist in implementation. The typical solution in such situations where internal talent is in short supply is outsourcing to contractors. It is obviously beneficial for Indiana if the outsourcing can be accommodated as much as possible with in-state contractors. Still, there is not a broad base of these types of firms servicing the growing Industry 4.0, IoT, and advanced analytics demands of companies. **IEDC needs to implement a short-term initiative to identify leading organizations that consult and contract in Industry 4.0 deployment and develop an attraction campaign to get them to establish or expand operations in Indiana.** Some of the leading companies engaged in this space are highlighted in Appendix E.

Reference to the types of companies and the initial projects engaged in by MRG recipients (captured in the information collected by Conexus) may be beneficial in identifying the types of capabilities that may need to be supplemented via contracting. A key element is likely to be with firms with expertise in robotics and automation planning and development.

V. STRATEGY 3: FOCUSING ON STRATEGIC SECTOR EVOLUTION & DEVELOPMENT

At the outset of this project, one of the expressed goals of the IEDC for the strategy was to have clear recommendations for strategic sectors that IEDC should pursue for significant growth and enhanced business recruitment. Industry-targeting analysis and other analytical methods were used in Phase I to segment the recent performance of all Indiana industries; these analyses contributed to developing a refined understanding of sectors that have, and should continue to have, an outsized impact on Indiana's economy and GDP trajectory.

Manufacturing was shown, overall, to be a clear current strength of the Indiana economy and a powerful driver of state GDP. Within manufacturing, several advanced industries were identified as being core to the ongoing growth and development of the Indiana economy; most notably:

- **Motor vehicle and motor vehicle parts and components manufacturing**—a diversified sector covering both passenger and commercial vehicles, major component systems, and powertrains. The sector in Indiana includes major Indiana-headquartered multinationals, such as Cummins and Allison Transmissions; large-scale vehicle and component assembly plants of Subaru, GM, Honda, Stellantis (Chrysler), and Toyota; a robust cluster of recreational vehicle manufacturers; the acknowledged U.S. hub for advanced racecar engineering; and a diverse base of small and midsize companies in Indiana across the vehicle supply chain.
- **Power Systems and Propulsion** stands as both a subsector of the above motor vehicle parts and components manufacturing sector and a broader strength for Indiana that expands significantly beyond on-road or off-highway motor vehicles. Cummins, for example, is a leading supplier of advanced power systems used in railway locomotives, marine transportation, and stationary power generation and recently acquired Meritor, a leader in axle and brake technology for advanced propulsion systems in a \$3.7 billion transaction. Indianapolis is home to large-scale operations of Rolls-Royce, with more Rolls-Royce products built in Indianapolis than anywhere else in the world including advanced engines used in military and commercial aviation and marine applications. Caterpillar performs engineering and manufacturing of its large marine engines at its Indiana Lafayette Large Engine Center.
- **Life Sciences - Biopharmaceuticals and Diagnostics**—Indiana has a storied history in pharmaceuticals as the home of Eli Lilly & Company. Eli Lilly is the largest company in Indiana's life sciences sector, but it is far from alone, with the industry comprising major operations of AstraZeneca, Baxter, Catalent, Elanco, Endocyte, Evonik, Mead Johnson, Novo Nordisk, Roche Diagnostics, and many other smaller biopharmaceutical and diagnostics OEMs and contract manufacturers. Biopharmaceuticals stands as a “current strength” sector for the state, defined as specialized, growing, and gaining share versus the industry overall in the United States. The life sciences sector has also seen significant recent growth, with BioCrossroads noting that “in 2021, Indiana's life sciences industry experienced strong growth in the attraction and expansion of companies across the state. Twenty-three companies

committed to invest over \$500 million and hire 2,100 employees. Of those 23 companies, nine committed to invest over \$10 million each and two others will invest over \$100 million in new Indiana facilities.”⁶² In addition to the biopharmaceuticals sector, life sciences in Indiana also sees a concentration in “Medical Equipment and Supplies Manufacturing,” which contributed an additional \$3.6 billion to Indiana’s GDP in 2020. A key component of this sector is **medical devices**. It should be noted that **agricultural life sciences** are also an important sector in Indiana, with global multinational company Corteva headquartered in the state, and a growing cluster of innovative companies expanding and emerging in plant sciences and agtech (precision and digital agriculture).

While manufacturing overall is a key sector for Indiana, it is not alone in terms of important sectors contributing to Indiana’s GDP. Several other sectors were identified in Phase I as high-performance sectors for the Indiana economy:

- **Insurance**—Insurance carriers represent a significant sector for Indiana, with \$6.1 billion in GDP contribution for 2020 and 23,385 jobs. In particular, Indiana has a robust position in the operations of mutual insurance companies. The cluster represents the largest of the “emerging” sectors within the Phase I industry-targeting analysis.
- **Logistics, Warehousing and Distribution**—Built upon Indiana’s geographic position as the “crossroads of America” together with intrinsic demand for services generated by Indiana’s diverse manufacturing industry, the state has a significant specialization in distribution and logistics. The sector is large, comprising close to 10% of Indiana’s private sector workforce. From a “moving the needle” perspective on overall state economic performance, it is an interesting sector by

virtue of being an early adopter of automation and robotics (as part of a national sector trend) and being supportive of efficient operations for Indiana’s critically important manufacturing sector. From a wage perspective, there is, however, considerable variability across subsectors, and automation may lead to employment levels declining. Many of the larger wholesale distribution NAICS, in terms of employment, do pay above the Indiana total private sector average annual wage, but many of the logistics-support jobs are not high-paying, and pay in courier jobs (e.g., FedEx, UPS, etc.) is trending down. From an IEDC perspective, Indiana’s inherent geographic advantages may bring projects and jobs to Indiana without the state needing to target it as a prime recruitment sector. Its size and support for the manufacturing sector does, however, make it a sector to which IEDC should pay attention.

There are thus four core clusters that TEconomy recommends as a central focus for attention in the work of IEDC and associated state agencies:

- **Vehicles, Power/Energy Systems, and Propulsion**
- **Life Sciences—Drugs, Diagnostics, and Vaccines (Biopharmaceuticals for Human and Animal Applications) and Agbioscience**
- **Medical Devices**
- **Insurance Carriers**

It should be noted that each of these clusters contain a mix of existing core competencies and sub-sectors. There are multiple emerging technologies that impact them. Each of the above industries or clusters are undergoing changes generated by disruptive technologies that present opportunities for new investment in Indiana, but also threats and challenges for the industries if they fail to adapt to changing technology and market realities. Disruptive technologies and changing trends pertaining to Indiana industry clusters

62 <https://www.prnewswire.com/news-releases/pharmaceutical-investments-lead-2021-life-sciences-growth-in-indiana-301474097.html>

have been reported in detail in TEconomy’s previous “Clusters and Disruptors” report for CICP.⁶³ Readers of this strategy document are encouraged to familiarize themselves with the key findings and conclusions from that previous report. In terms of the key strategic clusters recommended for focus, some of the top takeaways from that report can be found in Table 9.

Table 9: Disruptive Technologies and Recommended Strategic Clusters for Indiana

Cluster	Examples of Current and Pending Disruptives/Major Technology /Process Changes
Motor Vehicles, Power/Energy Systems and Propulsion	<ul style="list-style-type: none"> • Electric power and propulsion (battery power or fuel cells) • Hydrogen power (direct combustion or fuel cells) • Autonomous vehicle systems (high level of electronics and software integration required)
Biopharmaceuticals and Diagnostics	<ul style="list-style-type: none"> • Continuous Manufacturing • Single-Use Systems • High-Volume Cell Processing Advances • Advanced Purification Technologies • Cell Preservation, Distribution and Handling Methods
Agbioscience and AgTech	<ul style="list-style-type: none"> • Advanced gene-editing and transgenic plant transformation • Precision and digital agriculture • Farm robotics and agricultural processing and food processing automation
Medical Devices	<ul style="list-style-type: none"> • Connected and networked devices • Regenerative medicine
Insurance	<ul style="list-style-type: none"> • AI/Machine learning automated decision-making for underwriting and risk analysis • Big data analytics • Connected devices and telematics • Blockchain technology

63 TEconomy Partners “Clusters and Disruptors: Envisioning Central Indiana’s Economic Future in a Time of Change.” For the Central Indiana Corporate Partnership. November 2018. <https://www.cicpindiana.com/wp-content/uploads/2018/11/FINAL-CICP-ClustersandDisruptors-Executive-Summaryfinal.pdf>

It should be noted, of course, that the IEDC needs to be ready to service the needs and expressed interests of any major employer or inquiring business sector with a mobile business location decision to make. A focus on strategic clusters does not mean a sole focus on those industries to the exclusion of other opportunities. **Specific opportunities for additional, new Indiana industries are identified under Action 3.2.**

Strategic thinking about crosscutting sectors and technologies supportive of progress in multiple sectors across the Indiana economy is vital. As businesses adapt and change under the forces of Business 4.0, most sectors will experience demand for contracted services or building in-house capabilities in a range of supporting fields, including (but not limited to):

- Computer programming and software engineering
- Legacy IT systems integration with smart technology systems
- Cybersecurity
- Advanced analytics, up to and including machine learning and artificial intelligence
- Renewable energy integration
- And, for those companies in manufacturing—integration of electrical and electronic components, automation systems, cobots, and autonomous robotic systems.

Assuring Indiana's ongoing growth and the attraction of business ventures focused on these crosscutting sectors will be important to ensure Indiana is positively equipped to adapt to the changes and opportunities presented by Business 4.0 across all sectors of the economy.

TEconomy's recommended actions under this strategy are focused on advancing the IEDC, and Indiana's targeted economic development, relevant to strategic sectors (Table 10):

Table 10: Recommended Actions Under Strategy 3

Strategy	Actions
3. Focusing on Strategic Sector Evolution & Development	<p>Action 3.1: Strategic cluster foci.</p> <p>Action 3.2: Capturing new strategic industries.</p> <p>Action 3.3: Onshoring and strategic recruitment to reinforce crosscutting technology competencies.</p>

Action 3.1: Strategic Cluster Foci

As noted above, a series of industries should be considered strategic for Indiana because of their distinctive base of in-state core competencies, large-scale employment, significant GDP footprint, line-of-sight to growth opportunities, evolving associated technology opportunities, and the ability of state economic development engagement to move the needle in Indiana's favor. It is notable that during TEconomy's work to develop this strategy, clear momentum was evident when IEDC won new large-scale and high-profile projects for Indiana in several of the clusters. TEconomy did not have advance notice that these projects were forthcoming; thus, the new projects may be seen as evidence that the clusters selected truly are opportunities for the state.

It is fair to say that under the vision, leadership, and focus established by Secretary of Commerce Brad Chambers, Indiana through the IEDC has experienced unprecedented success in securing major projects for what are herein designated as strategic clusters. The strategic focus around industry of the future generating higher wages has resulted in \$17 billion of capex in just the first 6 months of 2022 (representing an over 300% increase over 2021's record) at wages 20% higher than previous years.

Some of the notable strategic cluster-related projects announced include:

- Stellantis NV, in a partnership with Samsung SDI, announced a decision to invest \$2.5 billion in a 3.3 million square foot battery manufacturing plant in Kokomo. The plant is expected to open in 2025, employing 1,400 people.
- In the power and propulsion sector, Rolls-Royce North America announced it will invest \$400 million in a major modernization of engine test facilities in Indiana.⁶⁴
- Eli Lilly and Company announced the selection of the LEAP (Lebanon Innovation and Research District) in Boone County as the location for a \$2.1 billion investment in new manufacturing facilities for active ingredients and new modalities such as genetic medicines. The new facility is anticipated to employ 500 personnel.
- Evonik announced a major \$220 million expansion of its pharmaceutical production facility in Lafayette, which is anticipated to add 80 jobs.
- MediaTek, a global leader in fabless semiconductor design and engineering, selected West Lafayette for its first Midwest semiconductor chip design center. Co-located at Purdue University, the MediaTek operation is anticipated to house 30 engineers by 2025.

For Indiana moving forward, TEconomy's research leads to the following key strategic sectors for advancing Indiana's economy and GDP growth over the next decade:

Mobility Systems, Power, and Propulsion

- On-road and off-road vehicles, passenger, commercial, and recreational
- Alternative and renewable power systems (mobile and static) and propulsion (electricity, hydrogen, and hybrid powertrains)—light and heavy-duty applications
- Battery systems
- Advanced automotive systems and components
- Autonomous systems
- Aircraft/aerial propulsion systems
- Marine propulsion systems
- Motor sport technologies

Life Sciences

- Small and large molecule pharmaceuticals and biologics, including human and veterinary application
- Diagnostics
- Vaccines
- Medical devices and connected systems
- Agriscience

Insurance and Insurance Innovations

- Mutual insurance companies
- Health insurance innovations
- Specialized technologies and services for insurance

64 <https://www.rolls-royce.com/media/press-releases/2022/17-03-2022-rr-north-america-invests-400-million-dollar-in-indiana-test-facilities.aspx>

In addition to the above existing sector concentrations, Action 3.2 addresses new sector opportunities for Indiana.

Action 3.2: Capturing a new strategic industry

Building on existing strengths and working to support the evolution of key strategic sectors in new technologies is central to Indiana's economic growth. However, there is also an opportunity to think boldly about new sectors, or new-to-Indiana sectors, that may be logical targets for the state—ideally in sectors that have an opportunity to be large-scale, new industry opportunities. IEDC has identified semiconductors and advanced microelectronics as one such industry, while a second is in the emerging hydrogen economy.

Semiconductors and Advanced Microelectronics as an Opportunity

IEDC has targeted “Advanced Microelectronics Production and Development” as a strategic industry development target for Indiana. IEDC has formed the Accelerating Microelectronics Production & Development (AMPD) task force focused on strategizing approaches for the state to become a leader in the semiconductor industry. The anticipated approach not only focuses on industry attraction but also on accelerating and supporting microelectronics research and domestic innovation in Indiana by securing commercial semiconductor and federal funding opportunities.

IEDC notes that:

Comprised of industry experts, Indiana's leading universities and public institutions, AMPD will leverage Indiana's advantages to attract significant investments by connecting semiconductor companies with local resources and assets, including skilled talent, prime real estate and competitive investment packages. The IEDC has seeded the initiative with \$2.7 million of state funding for the task force to design and execute a strategic outreach and marketing plan to secure commitments from established sector leaders and disruptive companies over the next two years to create a vibrant cluster in Indiana.

IEDC has retained two leading global strategic consulting groups to ensure AMPD is equipped with the best information and strategy for engaging the industry.

TEconomy suggests that IEDC consider integrating Internet of Things (IoT) devices as a potential component of the AMPD task force if it is not already doing so. Microelectronics/chips are critical enabling components of the extremely fast-moving IoT technology space. IoT technology is, of course, central to the deployment of Industry 4.0 (discussed herein) and the attraction and development of companies in IoT chips and microelectronics, sensors, etc. will reinforce the manufacturing ecosystems' ongoing evolution in Indiana. It is a fast-moving emerging market space, with market researchers

The IoT is a concept used to define a network of interconnected things and devices that are embedded with or connected through sensors, software, network connectivity, and the necessary electronics that enable the collection and exchange of data over the Internet, making the data and devices remotely accessible and automated.

BCC Publishing, "The Internet of Things." August 2021.

at BCC Publishing noting that it “is expected to grow from \$370.5 billion in 2021, at a CAGR of 27.6%, to reach \$1.3 trillion in 2026.”⁶⁵

TEconomy has accessed its market research subscriptions to develop a preliminary list of companies and their technology spaces in IoT which is included in Appendix C herein. It is separated into the largest hardware providers and the largest platform, software, and services providers. Major semiconductor companies are significant players in the hardware space of IoT systems.

Hydrogen Systems

A second major opportunity is in hydrogen. Electric vehicles powered though the electric energy stored in on-board batteries are breaking-through as a key platform for alternatively fueled vehicles for personal use. Electric propulsion is a disruptive technology in that it is changing major components (powertrains, removal of emission control and fuel components, etc.) and thus remaking supply chains in the manufacturing of new vehicles. Indiana is increasingly finding itself in the running as a site for investment around electric vehicles, building on its track record as a major automotive manufacturing state. The above cited Stellantis/Samsung decision to build a new automotive battery manufacturing plant in Kokomo is a testimony to the promise of new projects and jobs contained in electric power and propulsion. That said, while Indiana will now be a significant player in the electric vehicle supply chain, many other major electric vehicle investment projects have occurred across the nation and there is no single location or state that could be said to dominate the industry or seems likely to do so⁶⁶. It is a technology space that Indiana absolutely needs to excel in and that the state must aggressively pursue, but it is not going to see the type of individual state identity cluster built around it in Indiana that has been achieved with medical devices in Warsaw, for example.

There is, however, another opportunity in the power and propulsion space that does provide a potential pathway to building a dominant industry presence in Indiana. The opportunity lies in hydrogen as an alternative fuel. Hydrogen holds significant promise as a key component of a future sustainable energy ecosystem, having multiple characteristics in its favor as a renewable fuel:

- Hydrogen may be used directly as a fuel for use in appropriately designed internal combustion engines or may be used in fuel cells to generate electricity.
- As a fuel for internal combustion engines (ICE), or in a fuel cell, hydrogen has the advantage of not generating direct combustion-related particulates nor releasing greenhouse gases.
- Hydrogen can be deployed for refueling as a high-pressure gas using infrastructure similar to that currently deployed at petroleum/diesel gas stations, allowing rapid refueling using familiar, widely distributed outlets with moderate infrastructural changes.

FCEVs [fuel cell electric vehicles], actually, produce no emissions at all besides water vapor. This is a very attractive feature for vehicles operating in closed spaces or spaces with limited ventilation.

Hydrogen engines release near zero, trace amounts of CO₂ (from ambient air and lubrication oil), but can produce nitrogen oxides, or NO_x. As a result, they are not ideal for indoor use and require exhaust aftertreatments to reduce NO_x emissions.

Jim Nebergall, General Manager Hydrogen Engine Business, Cummins.

⁶⁵ BCC Publishing. “*The Internet of Things*.” August 2021. Report Code: IFT118B

⁶⁶ It is notable that there have recently been significant investments in electric vehicles and battery systems in surrounding states (Michigan, Ohio, Kentucky) that help secure Indiana’s region of the Midwest as a multi-state electric vehicle industry growth hub.

The technologies for running a vehicle engine or a generator on hydrogen do not present substantial technical challenges, and already there are hydrogen engines in limited production. The primary challenge for hydrogen as a fuel source relates more to the sourcing of hydrogen itself.

Hydrogen is abundant on Earth, but it is almost always found as part of another compound, for example, in water (H₂O) or methane (CH₄). To derive pure hydrogen for use in fuel cells, or as a direct ICE fuel, it must be separated from the other elements in the compound. The abundance of water on our planet, and in Indiana, makes it clear that there are large-scale, renewable resources available for sourcing hydrogen—however, the key challenge is the process energy required to perform the separation (and whether that process energy is from a renewable, carbon-neutral source).

Today most of the hydrogen produced at industrial scale is produced using natural gas reforming/gasification. The process uses natural gas as the feedstock, and by reacting natural gas with high-temperature steam, a synthesis gas is produced (comprising hydrogen, carbon monoxide, and carbon dioxide). As noted by the US Department of Energy (DoE), “a synthesis gas can also be created by reacting coal or biomass with high-temperature steam and oxygen in a pressurized gasifier. This converts the coal or biomass into gaseous components—a process called gasification. The resulting synthesis gas contains hydrogen and carbon monoxide, which is reacted with steam to separate the hydrogen.”⁶⁷ The key challenge of producing hydrogen under this steam reforming technique is the required process energy (often coming from non-carbon-neutral sources) and the release of greenhouse gases in the process. An alternative, but currently significantly more expensive, process is the use of electrolysis, whereby the DoE notes “an electric current splits water into hydrogen and oxygen. If the electricity is produced

by renewable sources, such as solar or wind, the resulting hydrogen will be considered renewable as well, and has numerous emissions benefits.”⁶⁸

What is the Indiana Opportunity in Hydrogen?

Indiana has an opportunity to be an early pioneer in the production of affordable hydrogen and to integrate this hydrogen into the development of innovative business ventures in hydrogen power, propulsion, storage, and distribution. The opportunity is initially anchored in Indiana by favorable in-state geology for carbon sequestration that can enable the economically cost-effective and well-proven reforming/gasification process to be used with a “clean” production profile. **An as-yet confidential venture in Indiana is being planned by a major global multinational that will produce hydrogen on a large industrial scale with localized pipeline construction linking the manufacturing site to a CO₂ geologic sequestration site.**

Having access to affordable hydrogen at scale opens the path for Indiana to pursue related projects that can innovate the use of hydrogen in power and propulsion use cases. Cummins, for example—a global leader in commercial internal combustion engines—is investing in hydrogen technology because the fuel has a compelling use as a green fuel for commercial fleets and heavy equipment. Internal combustion engines still hold significant application advantages over electric motor-based power and are particularly suited to heavy continuous load applications. As noted by Cummins:

Hydrogen engines and hydrogen fuel cells offer complementary use cases. Internal combustion engines tend to be most efficient under high load—which is to say, when they work harder. FCEVs, in contrast, are most efficient at lower loads... So, for heavy trucks that tend to spend most of their time hauling the biggest load they can pull, internal combustion engines are usually the ideal and efficient

67 https://afdc.energy.gov/fuels/hydrogen_production.html

68 https://afdc.energy.gov/fuels/hydrogen_production.html

choice. On the other hand, vehicles that frequently operate without any load—tow trucks or concrete mixer trucks, for example, may be more efficient with a fuel cell. Fuel cell electric vehicles can also capture energy through regenerative braking in very transient duty cycles, improving their overall efficiency.⁶⁹

Hydrogen has an advantage of fitting into the existing ICE technology and application ecosystem, helping to sustain the advantages of internal combustion engines in a new renewable fuel paradigm. It is also fit to an emerging electric vehicle sector via fuel cell technology. **With Cummins, and other firms potentially engaged, Indiana may become the hub for early innovation and use cases around a hydrogen economy.** With Indiana's high profile as a hub for the logistics industry, there is a robust base of companies around which infrastructure and applications for hydrogen fueling and refueling can be built.

It should be noted that the type of investments required for positioning or repositioning major companies in new technology spaces that have large-scale infrastructure and business retooling components associated with them can be daunting—even for large multinational companies with access to public capital markets. Having the IEDC actively engaged with major players beginning to pursue this opportunity in Indiana will be important—serving to open channels for early discussion of incentives and other state support, but also, and perhaps more importantly, discussion of regulatory or legislative actions that may need to be put in place to optimize Indiana's environment for the growth of hydrogen power and propulsion as a major industry.

Beyond the energy applications of hydrogen, the element also has uses in other manufacturing industries within Indiana. Hydrogen is used in many industrial processes including in plastics production, fertilizer manufacturing, electronics manufacturing, and industrial welding.

It is recommended that IEDC immediately convene a Hydrogen Economy Task Force to facilitate provision of advice to the state by industry representatives regarding opportunities and needs for advancing the sector.

As IEDC moves to advance the hydrogen economy in Indiana, it should consider targeting the many existing companies currently engaged in hydrogen technology to discuss inward investment. TEconomy has accessed its market research subscriptions to develop a preliminary list of hydrogen-focused companies and their technology spaces which is included in Appendix B herein.

Indiana is a leading center for power and propulsion systems used in heavy-duty applications. Cummins, Allison Transmissions, Rolls Royce, and the Indiana operations of Caterpillar, for example, combine to form a potentially powerful in-state ecosystem of multinational leaders that can advance hydrogen technologies and applications—leveraging a new fuel that fits within their traditional core competencies.

69 Jim Nebergall. "Hydrogen Internal Combustion Engines and Hydrogen Fuel Cells." January 2022. Cummins Newsroom: Engines. <https://www.cummins.com/news/2022/01/27/hydrogen-internal-combustion-engines-and-hydrogen-fuel-cells>

Action 3.3: Onshoring and strategic recruitment to reinforce cross-cutting technology competencies

Recent supply chain shocks have raised interest in shortening the geographic length of critical supply chains. COVID-19 exposed a critical weakness in the prevailing “lowest cost supply” paradigm where, for a long time, industries have sourced raw materials, components, and critical sub-systems from a worldwide, least-cost-emphasized, supplier base. Lockdowns in efforts to control the spread of the virus significantly curtailed manufacturing output in China and other Southeast Asian nations that are central to the supply of critical inputs and components for U.S. manufacturers. In addition, severe supply chain constraints occurred due to shut down of ports and slowdown of port operations related to staffing challenges, major cutbacks in the ability to transport products in the cargo holds of commercial passenger flights due to reduction in flights, and closures of land borders and increased delays and inspections at borders.

In a 2020 report for Pfizer Inc. on lessons learned globally during the pandemic, TEconomy notes that:⁷⁰

Between February 22 and March 5, the Institute for Supply Management received 628 responses to a survey of U.S. manufacturing (52 percent) and nonmanufacturing (48 percent) organizations.⁷¹ Seventy-five percent of respondents reported supply-chain disruption in some capacity due to coronavirus-related transportation restrictions; and by the end of March, when resurveyed, this increased to 95 percent. Reduced Chinese manufacturing capacity was felt first, with Chinese manufacturing operating at only 50 percent of capacity by

late February. Other Asian nations, and European and North American manufacturing disruptions quickly followed.

As a result of the ongoing supply chain disruptions caused by the lingering pandemic, it is not surprising that **significant attention is now being paid to ensuring that assets and supply chains are organized for risk mitigation and resiliency, not just lowest cost.** Achieving this goal does not, however, automatically mean geographic redistribution of the production of manufacturing inputs or OEM production plants. Elements of resiliency can be built by requiring more information transparency up and down the supply chain so that producers know in real time the situation of their suppliers, and those who supply their suppliers. Digital tracking tools for inventory management across the supply chain may be leveraged to accomplish this. Building relationships with multiple suppliers of the same inputs, particularly suppliers not located in the same region as each other, also may be pursued.

That said, the new attention on risk mitigation and resiliency is absolutely leading to onshoring and reshoring opportunities. Onshoring and reshoring in the U.S is logically most likely to occur in high-value, more complex products that are less labor-cost sensitive. Claudio Knizek, global leader for advanced manufacturing and mobility at the consulting firm EY-Parthenon, is cited as expecting “**industries with complex and more expensive products to lead the resurgence, including automobiles, semiconductors, defense, aviation, and pharmaceuticals.** Anything that requires large amounts of manual labor, or that is difficult to automate, is much less likely to return.”⁷² In other words, Indiana’s recommended strategic industry sectors are prime candidates to see action in this area. Onshoring is not just a function of companies seeking to mitigate long supply chain risks, it is

70 TEconomy Partners. “Response and Resilience: Lessons Learned from Global Life Sciences Ecosystems in the COVID-19 Pandemic.” November 2020. Produced for Pfizer, Inc.

71 Institute for Supply Management. “**Covid-19 Survey: Impacts on Global Supply Chains.**” <https://www.ismworld.org/supply-management-news-and-reports/news-publications/releases/2020/covid-19-impacts-on-global-supply-chains/>.

72 Nelson D. Schwartz. “Supply Chain Woes Prompt a New Push to Revive U.S. Factories. Companies are testing whether the United States can regain some of the manufacturing output it ceded in recent decades to China and other countries.” New York Times. Jan. 5, 2022.

also made more feasible by the parallel rise of Industry 4.0 advancements in automation and high-efficiency domestic manufacturing. **Manufacturing centers like Indiana can therefore benefit from two converging forces**—industry seeking to shorten the geography of their supply chains, ideally to a near-sourcing or local-sourcing model, to mitigate risk AND the enhanced economic feasibility of domestic production made possible by automation and the rise of Industry 4.0 capabilities.

As a well-recognized hub for U.S. manufacturing, Indiana is better positioned than most states to make the case for new onshoring or reshoring projects to select the state. Indiana's central location and expertise in distribution and logistics also build a compelling case for the state.

Multiple tactics may be deployed by IEDC in identifying opportunities:

- Canvassing large Indiana and adjacent-state manufacturers to discuss their strategic needs and preferences for components and sub-system onshoring, and specifically identify target operations to pursue.
- Participation in major industry trade shows to highlight Indiana's location factor advantages as a manufacturing location and highlight incentives.
- Examining Indiana's identified (herein) strategic manufacturing sectors for components of the industries that are not currently present in Indiana, or well-served by domestic suppliers. Then working to identify leading international players in these products for targeted recruitment.
- Beyond physical manufactured products, Indiana also needs to boost its base of technology service companies—companies able to supply software engineering, programming, IoT and networking services, advanced analytics services, and other crosscutting support services that enable advanced industry operations and facilitate the state's rise in Business 4.0 application.
- Developing an "Indiana Supply Network" to identify existing companies that can supply, or build capacity to supply, in-demand components, sub-systems, parts, or assemblies for other Indiana companies. It is common for companies in a state to be relatively unfamiliar with smaller or midsize in-state companies that could meet supply chain needs locally. In recent work for Pittsburgh's fast emerging autonomous mobile systems industry,⁷³ TEconomy found the CEOs of major companies transitioning from product development into manufacturing of products at scale automatically assumed they would source components overseas—then were surprised to find that there were local companies that could meet their needs. Building connectivity between local companies can be a powerful way to reinforce the economy and is more likely to be considered under the current paradigm of rethinking resiliency and risk mitigation.

73 TEconomy Partners. "FOREFRONT: Securing Pittsburgh's Break-out Position in Autonomous Mobile Systems." September 2021. Performed for: Regional Industrial Development Corporation and the Greater Pittsburgh Chamber of Commerce, with funding support provided by the Richard King Mellon Foundation

VI. STRATEGY 4: COMPLETING THE ECONOMIC DEVELOPMENT ECOSYSTEM

In conducting the research and review work necessary for building an advanced economic development strategy for IEDC several areas of additional need and opportunity have been identified that will serve to enhance Indiana’s competitiveness in economic development. These additional factors are each influential in assuring Indiana’s economic development ecosystem is as complete as possible. Each were also raised by multiple CEOs during project interviews as requiring attention to improve business operations in the state and improve the marketability of Indiana for major development projects. The resulting recommended actions are shown on Table 11:

Table 11: Recommended Actions Under Strategy 4

Strategy	Actions
4. Completing the Economic Development Ecosystem	Action 4.1: Focus the legislature and state agencies on economic development and competitive annual funding for IEDC.
	Action 4.2: Develop and communicate a renewable and affordable energy roadmap for the state.
	Action 4.3: Secure a portfolio of strategic sites in the state suited to major projects.
	Action 4.4: Increase entrepreneurial activity and supports.

Action 4.1: Focus the legislature and state agencies on economic development

If Indiana is to substantially improve its GDP growth, it needs an all-hands-on-deck approach to making economic development a statewide legislative and administrative agency priority. As noted previously, the government of the State of Indiana has primed the pump by building a business-friendly tax and regulatory environment and securing a fiscally sound foundation with a current state budget surplus. Now, however, is the time to put that surplus to work by investing in economic development projects, supports, and competitive incentives. The impact of the pandemic on businesses and their supply chains, on workers, and on markets has been profound, and it has generated a changed landscape of economic development opportunity—a landscape where other states and regions are aggressively pursuing growth opportunities for their economies.

As evidenced in Appendix A, summarizing the findings of TEconomy’s assessment of Indiana’s economic development programming and expenditures in comparison to competing states, Indiana has not been competitive in terms of its investments in economic development at a state level. The topline finding from the analysis is that:

Our analysis shows that benchmark states are generally engaged in a similar number of activities within their economic development toolkit. However, Indiana lags considerably in economic development expenditures. On an absolute basis and when normalized for gross

state product (GSP), Indiana spends less on economic development than almost all benchmark states.

There have been recent improvements, with the legislature approving additional funds to help IEDC better position the state for success, but there is still a significant way to go to reach parity with competitors. TEconomy anticipates that the recent success of the State with the Stellantis/Samsung, Eli Lilly, Rolls-Royce, Evonik, and other high-profile projects should very much help with case-making to the legislature for further investment in IEDC and its program and incentives toolkit.

The IEDC needs help from the legislature in terms of increased funding to scale up its programs, invest in the significant initiatives under multiple actions in this strategy, and have a competitive war chest for competing for projects. Beyond IEDC however, the state also needs to invest further to improve pre-K through Grade 12 education statewide and improve some fundamentally underperforming areas, most notably in terms of public health and workforce participation supports.

From a legislative standpoint, it is also advisable that any legislation put forward should be developed with input and commentary provided by IEDC as to any positive or negative economic development implications of the legislation. This will enable political considerations to be balanced with an eye toward economic development ramifications—something critically important statewide as economic development is in the interest of all citizens and future generations.

Action 4.2: Develop and communicate a renewable and affordable energy roadmap for the state

Energy costs used to be a competitive advantage for Indiana, but the changing landscape of energy production, the imperative of minimizing carbon emissions, and expanding preference of industries and consumers for renewable energy sources has eroded Indiana's comparative position. U.S. Energy Information Administration data for 2010 placed Indiana as having the 11th lowest electric energy cost among the 50 states, at 7.67 cents/kWh.⁷⁴ Over the subsequent decade, Indiana experienced comparatively higher rate increases, leading to a 2020 rank of 28th, with an average rate of 9.92 cents/kWh. In terms of residential natural gas prices, Indiana performs much more competitively, ranked as having the 6th lowest natural gas prices in February 2022 (at \$9.75 per thousand cubic feet).

The key issue expressed by CEOs interviewed for the project was less a concern about utility rates (although comparative electricity rate increases were noted), but more about comparatively low levels of renewable energy generation and comparatively high carbon dioxide emissions (Indiana has the 8th highest level of emissions among the states). Companies are increasingly seeking renewable energy from a standpoint of meeting corporate environmental responsibility goals and for use in promoting corporate goodwill with customers concerned about the carbon footprint of industries. It will be important for the ongoing marketability of Indiana for major mobile industry projects, and to meet the desires of incumbent Indiana industry, that Indiana have a **strategic roadmap to increasing renewable energy generation and access across the state**. This needs to be a component of the ongoing work performed by the Indiana Office of Energy Development and informed by the Indiana 21st Century Energy Task Force, which is seeking to assess options for increased renewable deployment. These parties must balance the parallel need to assure energy affordability and reliability while consider-

⁷⁴ <https://www.eia.gov/electricity/state/>

ing the impacts of potential stranded assets of Indiana utilities transitioning from coal-fired generation.

Indiana needs a strategic energy plan because the state will be at a competitive disadvantage if its utility rates (especially electricity rates) continue to increase, and it has a sub-par renewable energy portfolio. Companies may have been prepared to overlook a low level of renewable energy availability if rates were low, but that will not likely be the case moving forward.

Action 4.3: Secure a portfolio of strategic sites in the state suited to major projects

When large-scale industry projects are considered, one basic requirement is that there be an available selection of serviced sites (either greenfield or appropriately mitigated brownfield sites) in locations that are well-served by transportation infrastructure and workforce. As shown on Figure 5, in TEconomy's interviews with major Indiana employers, "project-ready sites" only received a "fair" rating, ranked 10th among 15 business location factor variables assessed (ranked just below utility rates). **Each region of the state should be charged with identifying one or two strategic sites that meet a set of parameters set by IEDC based on experience with major projects.**

Action 4.4: Increase entrepreneurial activity and supports

Indiana has an innovative economy, with significant industry R&D and extensive academic R&D operations at major Indiana research universities. R&D and associated innovation are important, but ideally are accompanied by vibrant entrepreneurial activity, with entrepreneurs leveraging innovations to

produce new fast-growth business enterprises that substantially expand the economic base. Small businesses are frequently touted for their significant impact on job growth, but a longitudinal analysis of high-growth firms finds that a small cohort of mostly younger high-growth firms (Gazelles) stand out for their economic impact—with Gazelles accounting for roughly 50 percent of new jobs created each year between 1980 and 2010 in the United States. Because new high-performance companies can have such an outsized impact on the economy, it is important for IEDC to help ensure that Indiana has a complete and well-structured entrepreneurship ecosystem in place and operating effectively.

While all entrepreneurship is of value to an economy, studies show that young firms in innovation-based industries are particularly important. Research from the Information Technology and Innovation Foundation (ITIF) finds that innovation-based startups (firms younger than 10 years old in these innovative traded sectors) have an outsized impact on economic growth. This is because they provide better-paying, longer-lasting jobs than

The Center for American entrepreneurship, a nationally focused nonpartisan research, policy, and advocacy organization focused on entrepreneurship, notes as follows:

New ideas are the basic craft and contribution of entrepreneurs. Whether a new product or service, 'building a better mousetrap,' or new methods of producing, distributing, or delivering products and services, new ideas are the essence of innovation, which drives productivity gains and economic growth, and creates jobs, wealth, and opportunity. New ideas can come from the mind and imagination of entrepreneurs or as the result of scientific inquiry and discovery.

other startups and also contribute more to innovation, productivity, and competitiveness.⁷⁵ Because of these benefits, the authors argue that entrepreneurship policy should focus on spurring more innovation-based startups.

This prompts the question: “How well does Indiana fare versus other states in terms of innovation and entrepreneurship?” As noted in the Phase I report, Indiana ranked 18th in the nation in the size of its GDP in 2019. However, on the Milken Institute’s highly cited State Technology and Science Index,⁷⁶ which ranks states on various measures related to innovation, entrepreneurship, and technology-based economic development, Indiana ranked 27th in the latest 2020 index. The constituent components of this ranking are shown in Table 12. Evident in the table is that Indiana ranks below its GDP ranking on each of the five sub-measures used.

Table 12: Indiana Ranking and Sub-Rankings in the 2020 Milken Institute State Technology and Science Index.

Rank Overall	Risk Capital and Entrepreneurial Infrastructure ⁷⁷	Research and Development Inputs ⁷⁸	Technology Concentration and Dynamism ⁷⁹	Human Capital Investment ⁸⁰	Technology and Science Workforce ⁸¹
27	26	27	29	21	36

75 Information Technology and Innovation Foundation, “How Technology-Based Start-Ups Support U.S. Economic Growth.” November 2017.

76 <http://statetechandscience.org/statetech.taf?page=rankings-by-sub-index>

77 Includes measures of venture capital as well as entrepreneurial activity such as patents, business formation, and initial public offerings.

78 Uses state rankings for academic, industry, and federal government R&D funding; National Science Foundation activity; and Small Business Innovation Research awards.

79 Measures of concentration and dynamism include the proportion of establishments, employment, and payrolls in high-tech categories, as well as the employment location quotient, which quantifies each state’s industry concentration relative to the entire country.

80 Includes numbers of bachelor’s, master’s, and PhD degrees and measures specific to science, engineering, and health education.

81 Examines the intensity of the technology and science workforce as an indicator of whether states have sufficient depth of high-caliber technical talent, represented by the share of workers in a particular field relative to total state employment. The index uses 49 occupations spread across three categories: computer and information sciences, engineering, and life and physical sciences.

The Ewing Marion Kaufmann Foundation also produces a series of comparative measures of entrepreneurial activity for U.S. states, and its measures also indicate that Indiana is punching below its weight in terms of entrepreneurial start-up activity.⁸² Kaufmann's analysis finds that since 2002 the rate of production of new entrepreneurs in Indiana has been below the national rate. Indiana's rate in 2020 was 0.25%, meaning that 2.5 out of every 1,000 adults became new entrepreneurs, on average, in a given month—whereas the national rate was 0.34%. Indiana also lags in the number of jobs created by start-up businesses, where Indiana has been below the national level since 1996. Kaufmann shows 3.5 jobs created in startups per 1,000 people in Indiana in 2020, versus 5.0 for the nation.

The challenges of entrepreneurship in Indiana are also highlighted in a recent perspective document released by CICP⁸³, which notes:

Research completed for the Indiana GPS Project found that the state's entrepreneurial ecosystem is underperforming. The Economic Innovation Group (EIG), found that Indiana ranks last in the nation in the share of jobs at new firms and third for share of jobs in very old firms.⁸⁴ Brookings Institution scholars built on this finding with updated data noting that "Indiana has more employer firms that are 16 years old or older than it has firms younger than five years old—a trend that runs opposite to the country as a whole, indicating a relative lack of dynamism in the state."⁸⁵

A recent report for AgriNovus Indiana⁸⁶ examined Indiana's entrepreneurship ecosystem. While it did so with an eye toward specifically enhancing agbioscience entrepreneurship in the state, its review provides an overview of the Indiana entrepreneurship ecosystem and its strengths and weaknesses. The report's conclusions should form a starting point for IEDC and stakeholder deliberations regarding the role of IEDC in enhancing the ecosystem and the mechanisms that may be considered. Another report that contains in-depth actions pertaining to improving innovation and entrepreneurship is a recent strategy for the State of Oregon produced by TEconomy, and it would similarly be useful as review material in IEDC deliberations.⁸⁷

TEconomy is aware that both IEDC and CICP are in the process of preparing a pair of complementary in-depth studies of entrepreneurship for the state, so for the most part this action defers to the recommendations of that forthcoming work.

82 https://indicators.kauffman.org/wp-content/uploads/sites/2/2021/12/2020_Early-Stage-Entrepreneurship-IN_Snapshot.pdf

83 "Hoosier Perspectives on Entrepreneurship: Research Approach and Next Steps." Central Indiana Corporate Partnership.

84 Kenan Fikri, Rachel Reilly, and Daniel Newman. 2020. "Delivering Opportunity: A Diagnostic and Strategy Playbook to Maximize Indiana's Opportunity Zones." Economic Innovation Group. November. 2020. <https://indianagpsproject.com/delivering-opportunity-a-diagnostic-and-strategy-playbook-to-maximize-indianas-opportunity-zones/>

85 Mark Muro, Robert Maxim, and Jacob Whiton with Yang You, Eli Byerly-Duke, and Monica Essig Aberg. 2021. "State of Renewal: Charting a New Course for Indiana's Economic Growth and Inclusion" February 2021. Brookings Institution, Metropolitan Policy Program.

86 EntreWorks Consulting and Innovation Policyworks LLC. "The Entrepreneurial Ecosystem for Agbiosciences in Indiana. Ecosystem Assessment." Prepared for AgriNovus Indiana.

87 TEconomy Partners, LLC. "Oregon's 10-Year Innovation Plan." February 2021. Produced for the Oregon Business Development Department (Business Oregon).

VII. CONCLUSIONS

Indiana has been highly successful, in recent months, in attracting and securing major industry investment projects. Particular success has come in the development of major projects by life sciences companies and companies in the automotive power and population industry. Economic development momentum is building in Indiana, encouraged by a baseline business-friendly tax and regulatory environment. The state has accumulated financial resources and a bond rating that may be leveraged to further advance Indiana's economy to the next level.

While there have been recent major project wins, major government investment support and strategic actions are very much needed. Indiana has a long way to go to reach the upper echelon of states in terms of GDP growth rate by 2031. This was highlighted, in-depth, in the Phase I report. The state faces some significant headwinds in terms of demographics, educational performance and attainment levels, workforce availability, and other factors (highlighted herein), that will significantly constrain economic growth unless addressed.

This strategic plan is specifically designed to provide the IEDC and other state stakeholders with a near-term, action-oriented roadmap to address

headwinds and leverage evident opportunities. It is designed to build on Indiana's strengths, address weaknesses, and pursue the capture of significant economic development opportunities. The roadmap is divided into four key strategies, with a total of 17 specific recommended actions. It is, by design, a bold strategic plan because a robust near-term commitment to investing in and advancing Indiana's economic development is very much called for if ambitious GDP growth goals are to be achieved. Indiana has been significantly underinvesting, at a state government level, in economic development, but the current administration (as evidenced by the commissioning of this report) is ready to move to the next level of economic development commitment. This will require significant new funding for the strategic initiatives outlined in this plan, together with support for key strategic partners, such as the Central Indiana Corporate Partnership and regional economic development agencies, that share the ambitious vision for Indiana as advanced by the administration of Governor Holcomb.

APPENDIX A: MEMORANDUM FROM TECONOMY SUMMARIZING COMPETITIVE ANALYSIS

MEMORANDUM

To: Brad Chambers, Indiana Secretary of Commerce and CEO of IEDC
From: TEconomy Partners, LLC (TEconomy)
Subject: Comparing Indiana's Economic Development Expenditures and Incentives Programs to Benchmark States

Key Findings

The purpose of this document is to assess how Indiana's economic development toolkit and expenditures stack up against 10 benchmark states (see sidebar) as the state embarks on its ambitious goals to accelerate state GDP growth. This high-level assessment of Indiana's economic development activities utilizes two proprietary databases on economic development expenditures and incentives maintained by the Council for Community and Economic Research (C2ER). Because each state administers and funds economic development programs and incentives in a different way, comparisons across states can be challenging. However, the C2ER databases represent the best attempts at a clearinghouse that gathers information from all 50 state budgets in a standardized manner. C2ER categorizes economic development activities across 15 functional areas, as discussed in this memo.

Our analysis shows that benchmark states are generally engaged in a similar number of activities within their economic development toolkit. However, Indiana lags considerably in economic development expenditures. On an absolute basis and when normalized for gross state product (GSP), Indiana spends less on economic development than almost all benchmark states. Indiana ranked 10th among 11 states in total expenditures, and 8th among 11 states in expenditures when standardized by GSP. Across the various functional areas, economic development expenditures in Indiana are generally smaller than the average expenditures in benchmark states.

Indiana's lower levels of investment in economic development are not a short-term blip, but rather a consistent trend. Economic development expenditures in Indiana have

consistently ranked at or near the bottom among benchmark states since FY2008. While average economic development expenditures in Indiana were substantially higher for the most recent five-year period (2016-2020) than in the five years previously (2011-2015), expenditures peaked in FY 2019 (\$152M). A cursory analysis also suggests that

Indiana invests less in economic development than its benchmark states, and has a lower GSP. Although Indiana ranked 6th among states analyzed in growth in economic development expenditures from 2010-2020, the state ranked just 9th in growth in GSP and 10th in GSP per capita. It should be noted that this data is insufficient to measure correlation or causation:

10-Benchmark States Identified by IEDC:

- Arizona
- Colorado
- Georgia
- Illinois
- Ohio
- Michigan
- North Carolina
- Tennessee
- Texas
- Utah

Indiana is comparatively low on both economic development expenditures and GSP, but we cannot conclude that one is the result of the other.

Indiana ranked third among all benchmark states in the number of total programs included in the C2ER State Incentive Database, trailing only Ohio and Georgia. That said, on a percentage basis, Indiana demonstrates a relatively balanced portfolio of programs across the incentive types: Indiana is the only state where no incentive type comprises more than 40% of the total number of programs.

Overview

In the following memo, TEconomy explores the various elements of “The Economic Development Toolkit” and conducts three analyses: 1) comparing Indiana’s economic development expenditure activity to benchmark states; 2) comparing Indiana’s competitive positioning relative to other economic development metrics; and 3) comparing Indiana’s economic development incentive activity to benchmark states. Last, TEconomy draws several conclusions from the analysis.

This analysis utilizes two proprietary databases on economic development expenditures and incentives by the Council for Community and Economic Research (C2ER). C2ER is a nationally recognized, trusted leader in the community, economic and workforce research field. Data on economic development expenditures by state are sourced from C2ER’s State Economic Development Expenditures Database, a compilation of data on state investments in economic development that uses a consistent categorization of expenses across states. Information on incentives comes from C2ER’s State Business Incentives Database, a one-stop resource for information about incentive programs in all 50 states.

Five Key Takeaways on Indiana’s Economic Development Expenditures and Incentive Programs

TEconomy’s analysis of Indiana’s economic development toolkit relative to 10 benchmark states resulted in 10 findings, each of which is fully described in this memo. A review of these 10 findings yields the following five key takeaways that, taken together, suggest Indiana’s economic development leaders should continue efforts to augment and strengthen the state’s expenditures and incentives programs.

1. **Indiana lags considerably behind benchmark states in economic development expenditures: In FY2020, Indiana ranked 10th among 11 states in total expenditures, and 8th among 11 states in expenditures when standardized by GSP.**
2. **Indiana’s lower levels of investment in economic development are not a short-term blip, but rather, a consistent trend: Despite growth in the most recent five-year period, Indiana still ranked last or near last in expenditures in each year across the entire decade.**
3. **Cumulative economic development spending in Indiana was nearly \$900 million over the past decade—ranking 10th out of 11 states, and nearly \$600 million less than the 9th place state.**
4. **Across the range of economic development program areas, expenditures in Indiana are generally smaller than those in benchmark states.**
5. **Unlike many of the benchmark states make significant, Indiana does not make a sustained investment in signature initiatives—an average of \$40M from FY2016-2020 in a particular economic development areas.**

Although these databases are the leading source of data on state economic development expenditures, they are not without limitations. Key limitations of the C2ER Expenditure database mainly relate to inconsistencies across each state's budget process in a given year,⁸⁸ the uniqueness of some programs,⁸⁹ and the categorization process used by C2ER to analyze programs with multiple components.⁹⁰ A key limitation of the State Business Incentives Database is its qualitative nature: while information is available on program type (e.g., tax credits, grants, loans) and the number of programs available, there are no data on the magnitude or value of these credits or awards.

Importantly, the databases are somewhat limited in their abilities to capture the entirety of a state's approach to economic development. While focused economic development programs are included, a state's full economic development toolkit may also look at areas such as educational attainment, quality of life, tax incidence, and additional factors that may fall under different state agencies other than economic development. These types of activities are outside of the confines of this analysis.

Given this analysis's use of 2020 as the most recent year of analysis, it should also be noted that Indiana has committed significant funding in more recent budgets to economic development, namely through the Regional Economic Acceleration and Development Initiative (READI). Although Indiana should be commended for these recent commitments, neighboring states also are committing unprecedented levels of expenditures toward economic development, building on spending levels already well-above Indiana's. From FY2010-FY2020, total economic development expenditures in Indiana were \$892 million—ranking 10th out of 11 states, and roughly \$576 million less than the 9th place state (Figure A1). Adding an additional \$500M of READI funds to Indiana's 10-year total would not change Indiana's overall ranking in comparison to benchmark states.

88 Many states may experience changes in their budget expenditures in a given year, and there are many dissimilarities in the budget process across states. To overcome this limitation, it is recommended that a multi-year trend and series of averages be used instead of a single year snapshot.

89 Many economic development programs contain multiple elements, but the database labels each state's initiatives with just a single functional area and a single programmatic area. This complicates comparisons for states with unique programs (such as Indiana's Manufacturing Readiness Grants, which are labeled as technology development but could also be considered business or special industry assistance).

90 For example, a state like North Carolina encourages workforce development through many of its business assistance programs, even though the C2ER database does not list any workforce-specific expenditures. It is recommended that the totality of a state's economic toolkit be analyzed based on expenditures, instead of looking at each individual tool.

Figure A1: Total Economic Development Expenditures in Indiana and Benchmark States (FY2010-2020)



Source: TEconomy analysis of C2ER State Economic Development Expenditures Database

Analyzing the Economic Development Toolkit

Based on C2ER's categorization of economic development expenditures, the "Economic Development Toolkit" can be categorized across 15 functional areas (Figure A2). TEconomy's analysis of state usage across these 15 areas finds that nine functions stand out as commonly used (in color), while six secondary functions (in white) are used less frequently. As is noted in Appendix A1, each of these functions consists of various programs.

Figure A2: Functional Areas of Economic Development Expenditures Based on C2ER Categorization



Source: TEconomy analysis of C2ER State Economic Development Expenditures Database

Comparing Indiana's Economic Development Expenditure Activity to Benchmark States

Finding 1: Benchmark States generally utilize a similar number of functional areas within their economic development toolkit. From 2016-2020, Indiana has programs receiving state funding for 11 of the 15 areas identified in the database (Table A1). This total is ranked as tied for fourth among the 10 benchmark states analyzed.

Table A1: Functional Areas of Economic Development Expenditures by State (FY2016-2020)⁹¹

Functional Area	Indiana	Arizona	Colorado	Georgia	Illinois	Michigan	North Carolina	Ohio	Tennessee	Texas	Utah	Total States (11)
Administration	•	•	•	•	•	•	•	•	•		•	10
Business Assistance	•	•	•	•	•	•	•	•	•	•	•	11
Business Finance	•	•	•	•	•		•	•	•	•	•	10
Community assistance	•	•	•	•	•	•	•	•	•	•	•	11
Domestic Recruitment/Out-of-State	•		•		•	•		•	•	•		7
Entrepreneurial Development	•		•		•	•		•		•		6
International Trade and Investment	•		•	•	•			•		•	•	7
Minority Business Dev.				•	•		•	•				4
Other Program Areas					•							1
Program Support		•	•	•	•		•			•	•	7
Special Industry Assistance	•	•	•	•	•	•	•	•	•	•	•	11
Strategic Business Attraction Fund							•			•		2
Technology Development	•			•		•	•	•	•	•	•	8
Tourism/Film	•	•	•	•	•	•	•	•	•	•	•	11
Workforce Preparation & Dev.	•	•	•	•	•	•		•	•	•	•	10
Total, All Areas (15)	11	8	11	11	13	9	10	12	9	12	10	

Source: TEconomy analysis of C2ER State Economic Development Expenditures Database

Based on Table 1, all 11 states had programs related to business assistance, community assistance, special industry assistance, and tourism and film. Meanwhile, 10 out of 11 states had programs related to administration, business finance, and workforce development and preparation. A small share of states had programs related to minority-business development, strategic business attraction funds, and other program areas.

91 State expenditure data stems from each Governor’s proposed budget. While the C2ER database contains data up until FY2022, using FY2020 as a cut-off year allows for a comparison of actual/appropriated funds. As a result, a decision was made to use 2020 as the most recent years for most components of this analysis.

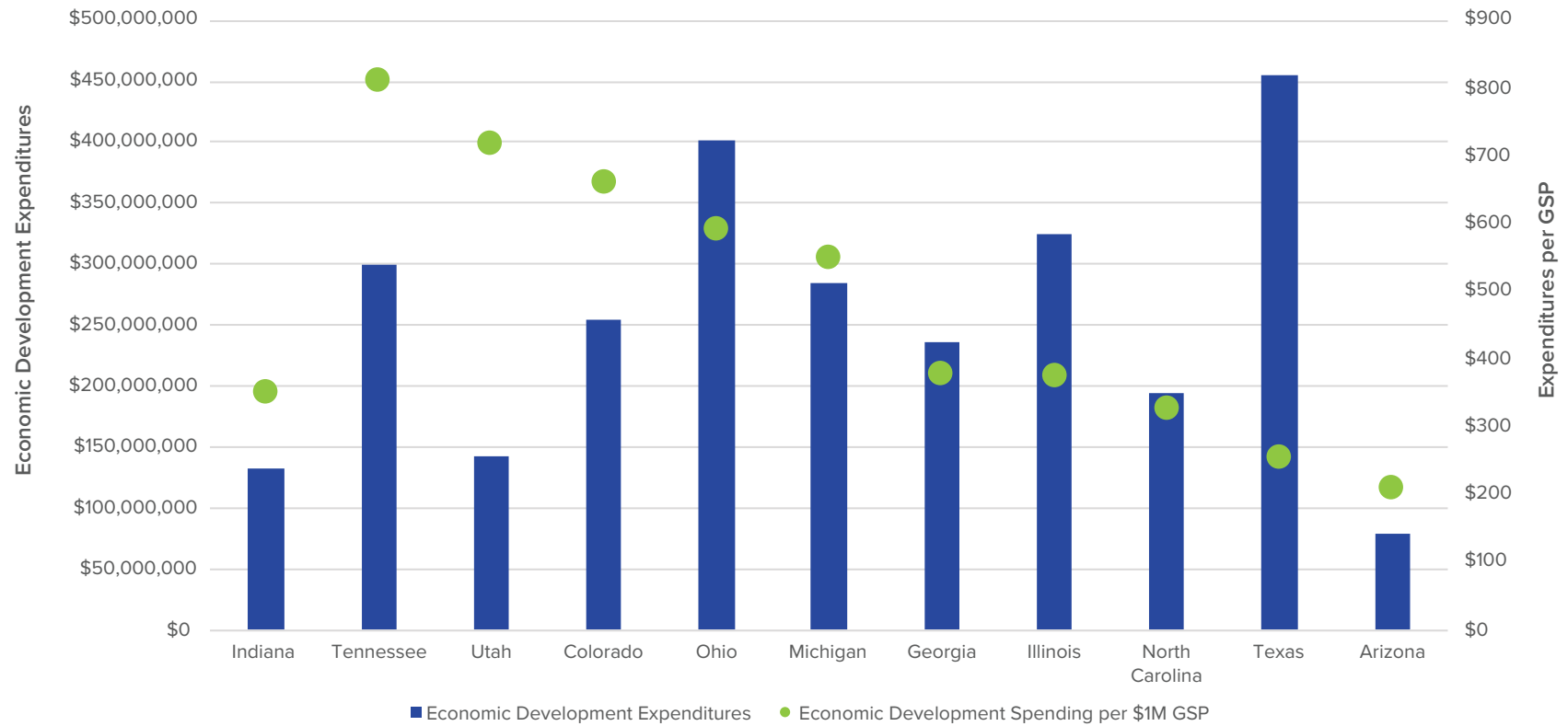
Finding 2: Indiana lags considerably behind benchmark states in economic development expenditures —though performance has improved over the past decade. On an absolute basis and when normalized by gross state product (GSP), Indiana spends less on economic development than benchmark states (Table A2 and Figure A3). In 2020, Indiana ranks in the bottom third of each metric analyzed. Indiana ranked 10th among 11 states in total expenditures, and 8th among 11 states in expenditures when standardized by gross state product (GSP). As noted in Appendix A2, Indiana ranks 31st among all states in total economic development expenditures, but just 39th in expenditures when standardized by GSP.

Table A2: Economic Development Expenditures and Gross State Product (2020)

State	Economic Development Expenditures	Rank	Economic Development Spending per \$1M GSP	Rank	GSP (Millions Current Dollars)	Rank	GSP Per Capita	Rank	Population	Rank
Indiana	\$132,151,804	10	\$352	8	\$375,337	8	\$55,313	8	6,785,644	9
Tennessee	\$299,964,400	4	\$812	1	\$369,574	10	\$53,406	9	6,920,119	8
Utah	\$142,137,197	9	\$719	2	\$197,562	11	\$60,201	4	3,281,684	11
Colorado	\$254,060,573	6	\$664	3	\$382,585	7	\$66,142	2	5,784,308	10
Ohio	\$402,359,433	2	\$594	4	\$677,561	3	\$57,466	6	11,790,587	3
Michigan	\$284,176,097	5	\$552	5	\$515,120	6	\$51,166	11	10,067,664	6
Georgia	\$236,052,883	7	\$379	6	\$622,628	4	\$58,050	5	10,725,800	4
Illinois	\$324,622,700	3	\$378	7	\$858,367	2	\$67,137	1	12,785,245	2
North Carolina	\$194,651,465	8	\$330	9	\$589,829	5	\$56,404	7	10,457,177	5
Texas	\$455,252,468	1	\$256	10	\$1,775,588	1	\$60,771	3	29,217,653	1
Arizona	\$78,334,200	11	\$210	11	\$373,719	9	\$52,065	10	7,177,986	7

Source: TEconomy analysis of C2ER State Economic Development Expenditures Database

Figure A3: Economic Development Expenditures and Gross State Product (2020)

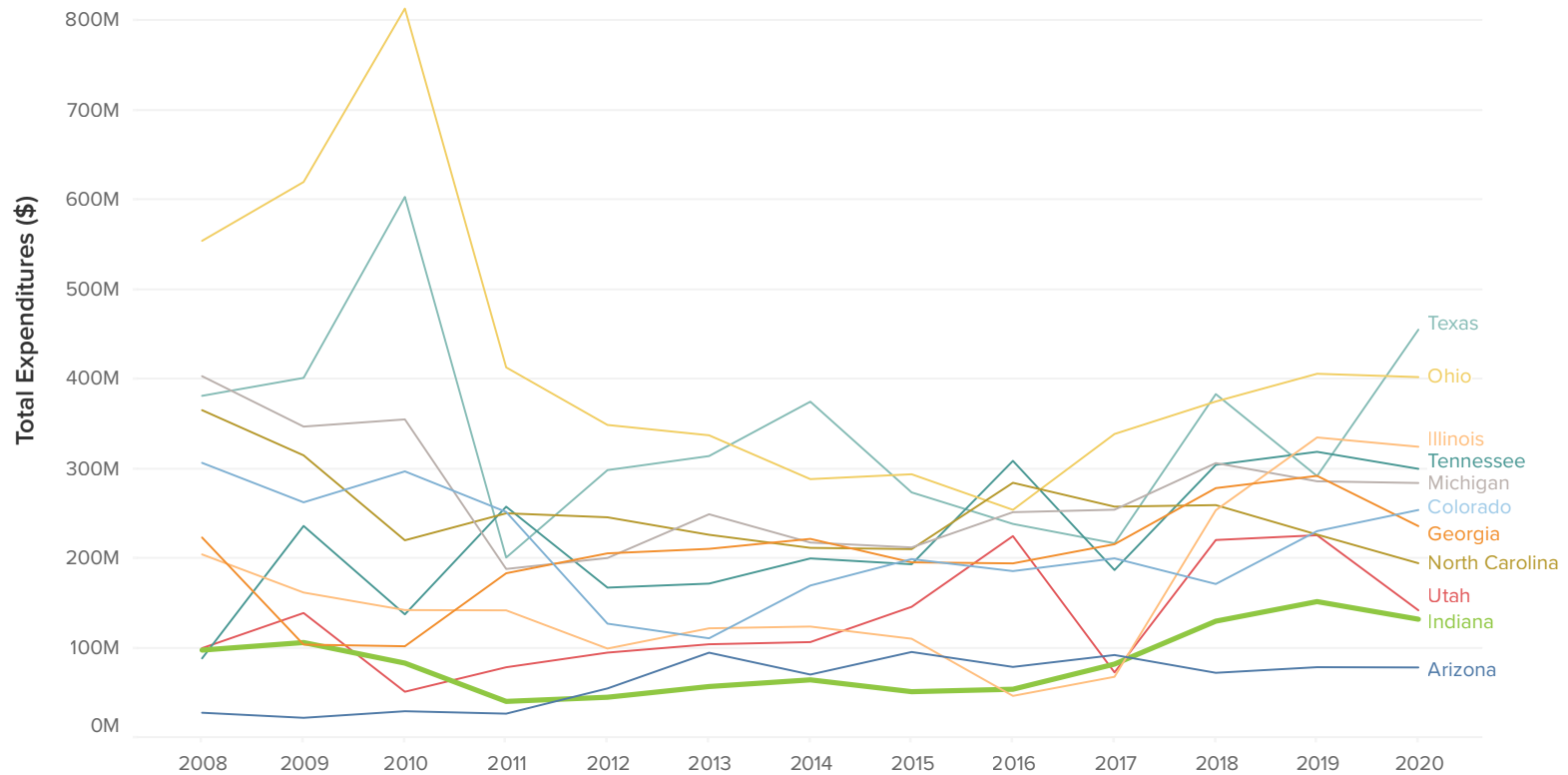


Source: TEconomy analysis of C2ER State Economic Development Expenditures Database

Finding 3: Indiana's lower levels of investment in economic development are not a short-term blip, but rather, a consistent and long-term trend.

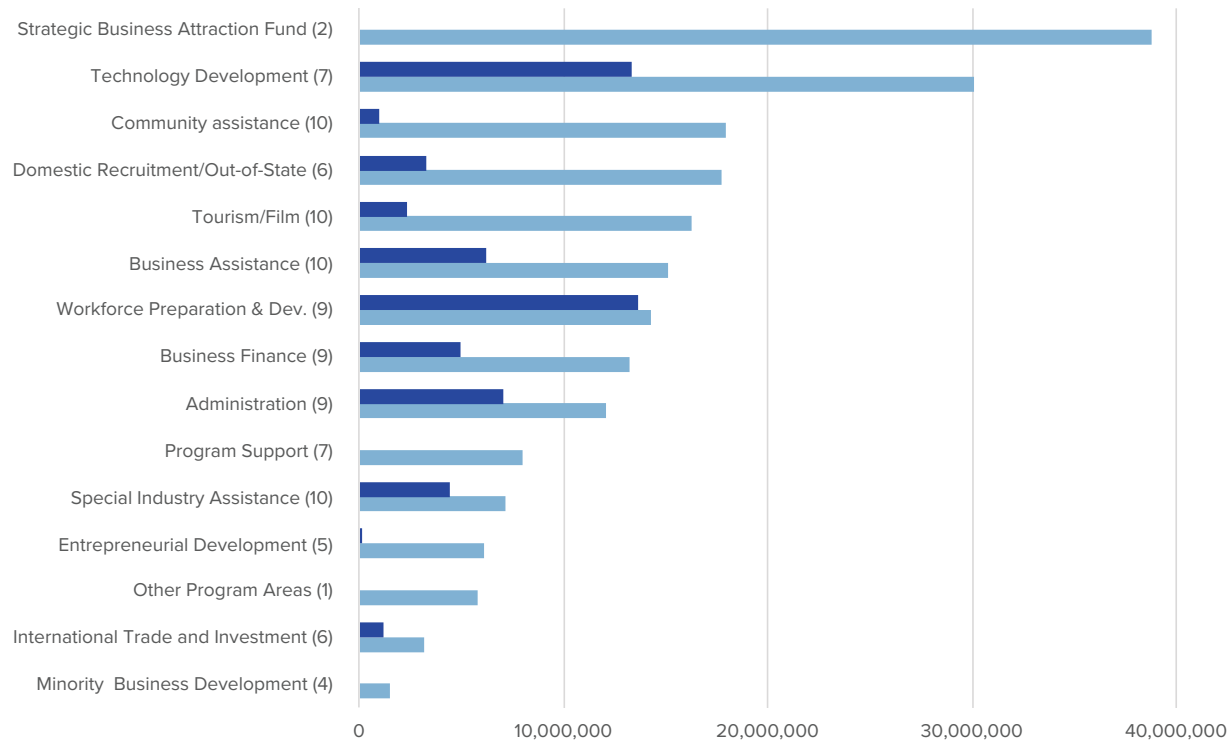
Economic development expenditures in Indiana have consistently ranked at or near the bottom among benchmark states since FY2008 (Figure A4). Among benchmark states, three of the five highest estimated economic development expenditures in FY2020 are in Indiana's three neighbors—Illinois (\$325M), Ohio (\$402M), and Michigan (\$284M).

Figure A4: Total Economic Development Expenditures (FY 2008-FY2020) Source: TEconomy analysis of C2ER State Economic Development Expenditures Database



Finding 4: Across the various functional areas, economic development expenditures in Indiana are generally smaller than the average expenditures in benchmark states (Figure A5). Areas with the highest average expenditure include strategic business attraction funds, technology development, and domestic business recruitment. The sole area of the toolkit where Indiana's average expenditures exceed the 10-State Benchmark Average are in workforce development. In this area, the majority of Indiana's expenditures are related to the Skills Enhancement Fund. It is also important to note that spending in one area does not necessarily suggest that this is a competitive strength, and that there are limitations within this database and how each expenditure is recorded. For example, North Carolina's well-regarded customized training programs (which are operated through their community college system) are not captured in this database.

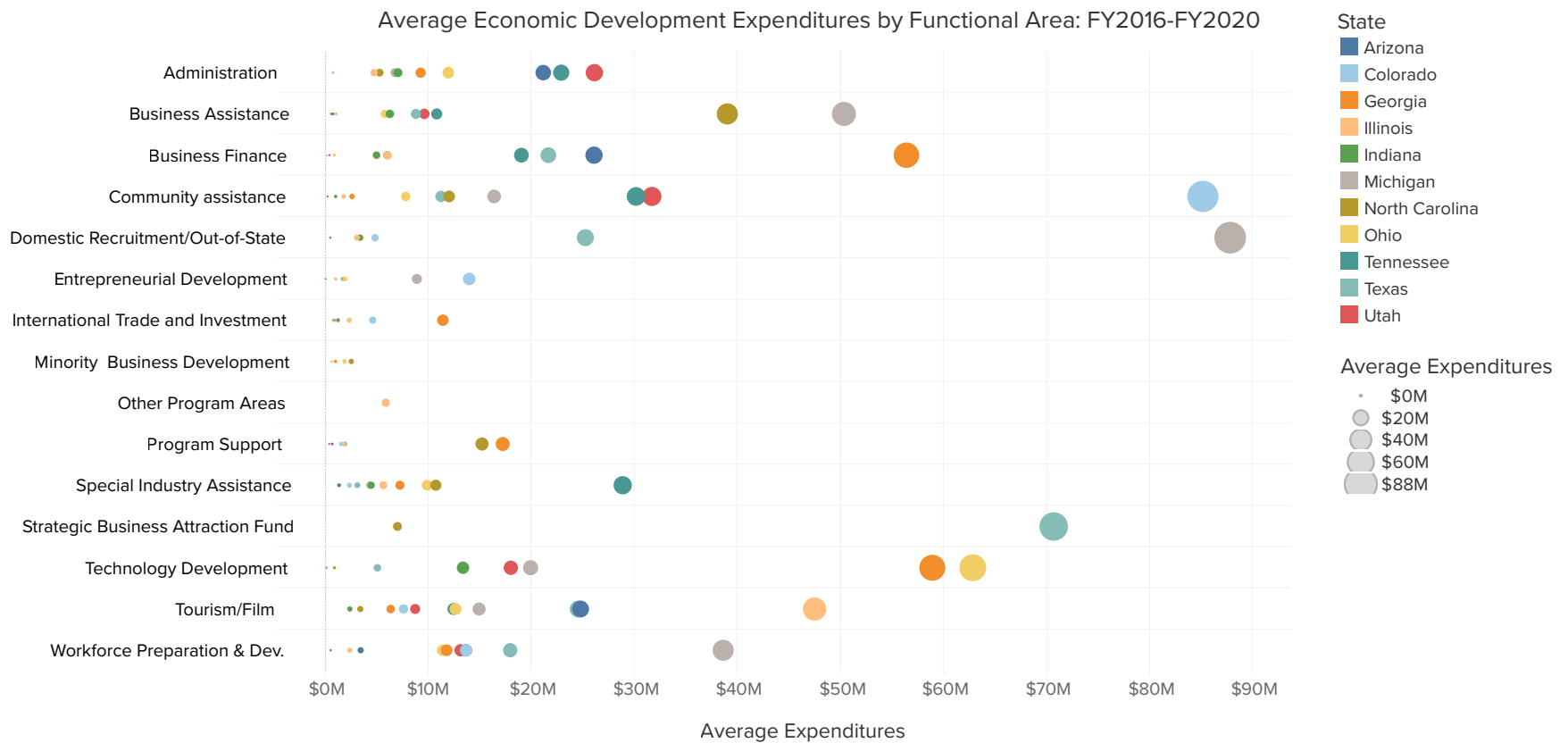
Figure A5: Average Economic Development Expenditures Across Functional Areas (FY2016-2020) and Number of Benchmark States with Programs (Parenthesis)



Source: TEconomy analysis of C2ER State Economic Development Expenditures Database

Finding 5: There are lessons learned from Signature Initiatives—defined as those functional areas where states averaged \$40M or more from FY2016-2020. As more than just an influx of cash or a one-time experiment in an area, these programs illustrate a state’s sustained commitment to particular economic development strategies. Signature Initiatives can be found in eight of the functional areas (Figure A6). Seven states have what could be considered a signature initiative, with Georgia and Michigan having multiple signature initiatives. Three benchmark states and Indiana do not feature a signature initiative.

Figure A6: Identifying “Signature Initiatives” Across State Economic Development Expenditures



Source: TEconomy analysis of C2ER State Economic Development Expenditures Database

While conducting a deep dive on each signature initiative is outside the scope of this analysis, there are numerous opportunities to use these investments by benchmark states to help inform the strategic planning portions in later stages of this work.

Examples of Signature Initiatives (\$40M Average from FY2016-2020)

- Business Assistance—North Carolina* (Job Development Investment Act (JDIG) Special Revenue Fund) and Michigan (Job Creation Services)
- Business Finance—Georgia (One Georgia Authority)
- Community Assistance—Colorado (Local Government Mineral and Energy Impact Grants)
- Domestic Recruitment—Michigan (Business attraction and community revitalization)
- Strategic Business Attraction Funds—Texas (Texas Enterprise Fund)
- Technology Development—Ohio (Ohio Third Frontier) and Georgia (Agricultural Research)
- Tourism/Film—Illinois (Tourism, Exposition, Convention Promotion)
- Workforce Development—Michigan* (Workforce Development Programs)

One area of interest to Indiana is in special industry assistance. The C2ER database identifies expenditures in eight areas, with the most activity occurring in agriculture and agribusiness (Figure A7). Indiana ranks first in average expenditures to support biotechnology and life sciences, largely due to a one-time appropriation to support Indiana Bioscience Research Institute. Few other states record spending to support economic development in biotechnology and life sciences, which may present an opportunity for Indiana to build upon. Indiana also ranks fifth in average expenditures to support agriculture and agribusiness.

Figure A7: Average Expenditures in Special Industry Assistance (FY2016-2020)



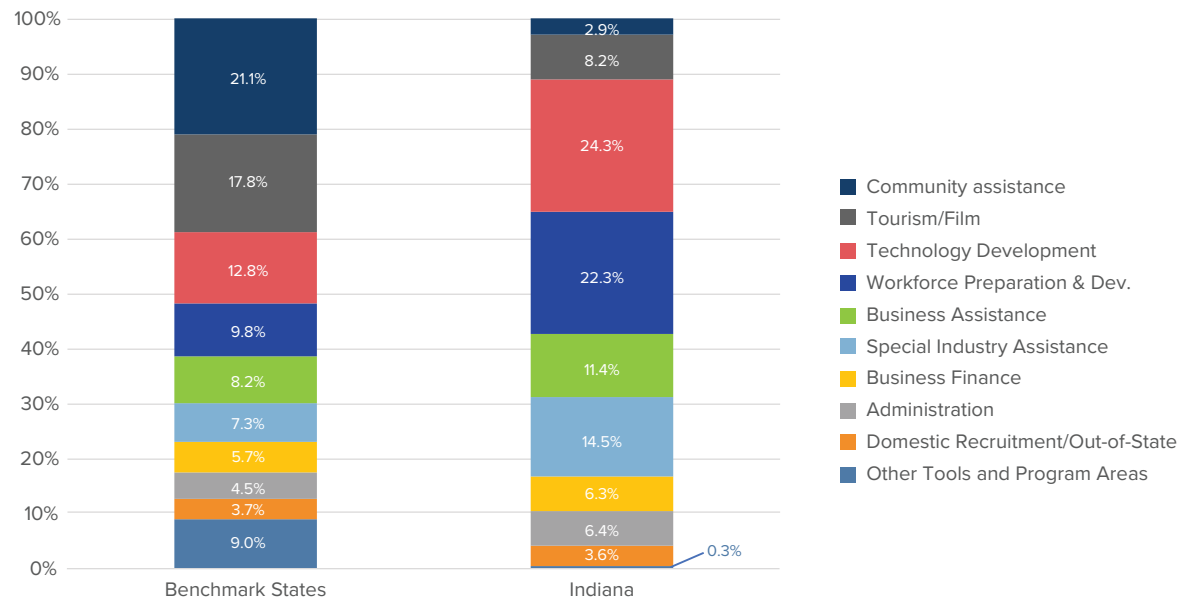
Source: TEconomy analysis of C2ER State Economic Development Expenditures Database

Finding 6: The composition of Indiana’s economic development toolkit, as defined by expenditures, differs from benchmark states (Figure A8).

Compared to Benchmark States, a higher share of Indiana’s economic development expenditures goes toward workforce preparation and development, technology development, and special industry assistance and business assistance. While Figure A3 looks at average spending for each functional area based

on participating states, Figure A5 looks at the totality of economic development activity in benchmark states, including all expenditures for all states for all years from FY2016 to FY2020. This helps paint a more complete picture of economic development expenditures in benchmark states. Although a state like Texas may invest heavily in economic development and may choose to leverage strategic business attraction funds as a signature approach, this represents a relatively small share of overall economic development expenditures across all benchmark states throughout the five-year period.

Figure A8: Composition of Economic Development Expenditures by Functional Area (FY2016-2020)

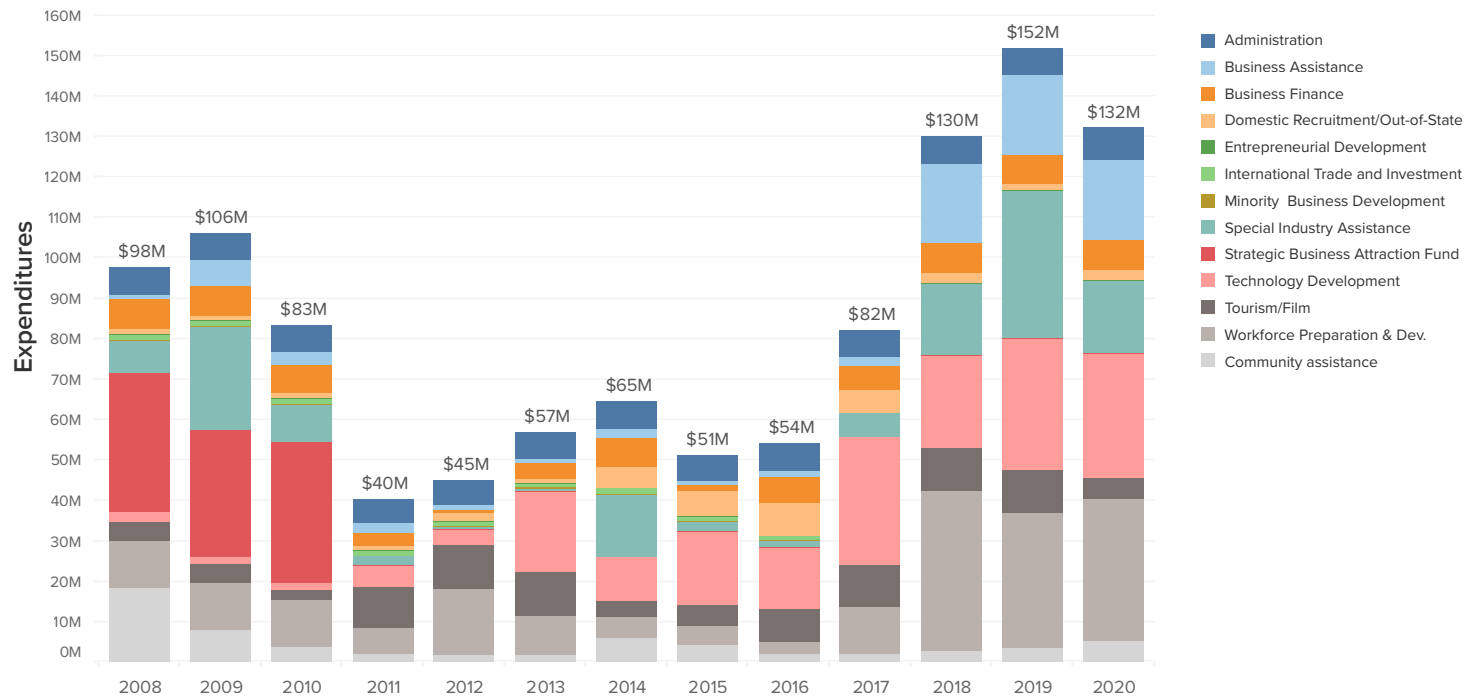


Source: TEconomy analysis of C2ER State Economic Development Expenditures Database

Other tools include strategic business attraction funds (3.2 percent of total economic development spending in benchmark states), program support (3.4 percent), entrepreneurial development (1.1 percent), international trade and investment (1.0 percent), minority business development (0.2 percent), and other program areas (0.0 percent).

Finding 7: While average economic development expenditures in Indiana were substantially higher from the most recent five-year period (2016-2020) than in the five years previously (2011-2015), expenditures peaked in FY 2019 (\$152M) (Figure A9). Indiana's strategic business attraction fund comprised the bulk of spending from 2008-2010, though expenditures today consist largely of workforce preparation, technology development, and industry/business assistance.

Figure A9: Economic Development Expenditures in Indiana by Function (FY2008-FY2020)



Source: TEconomy analysis of C2ER State Economic Development Expenditures Database

Exploring Indiana's Competitive Positioning Relative to Economic Development Metrics

Beyond exploring Indiana's overall economic development expenditures relative to peer states, this analysis also offers a cursory look at the relationship between the scale of these expenditures and the recent economic performance of Indiana and the benchmarks. In particular, this analysis looks at overall economic performance as defined by GSP growth trends and GSP per capita.

As noted previously in Table A2, in 2020 Indiana ranked in the bottom third of states studied in total and adjusted economic development expenditures (both overall and per GSP). While current economic development expenditures remain comparably low, Indiana's growth over the past decade in expenditures (overall and per GSP) ranks sixth among states (Table A3).

Although Indiana has experienced greater growth in economic development expenditures compared to other states, Indiana has not seen similar growth in its GSP or its population. As seen in Table A3, Indiana grew in both GSP and population, but the state ranked just 9th in gross state product and 8th in population growth.

Table A3: Percent Change in Economic Development Expenditures and Performance (2010-2020)

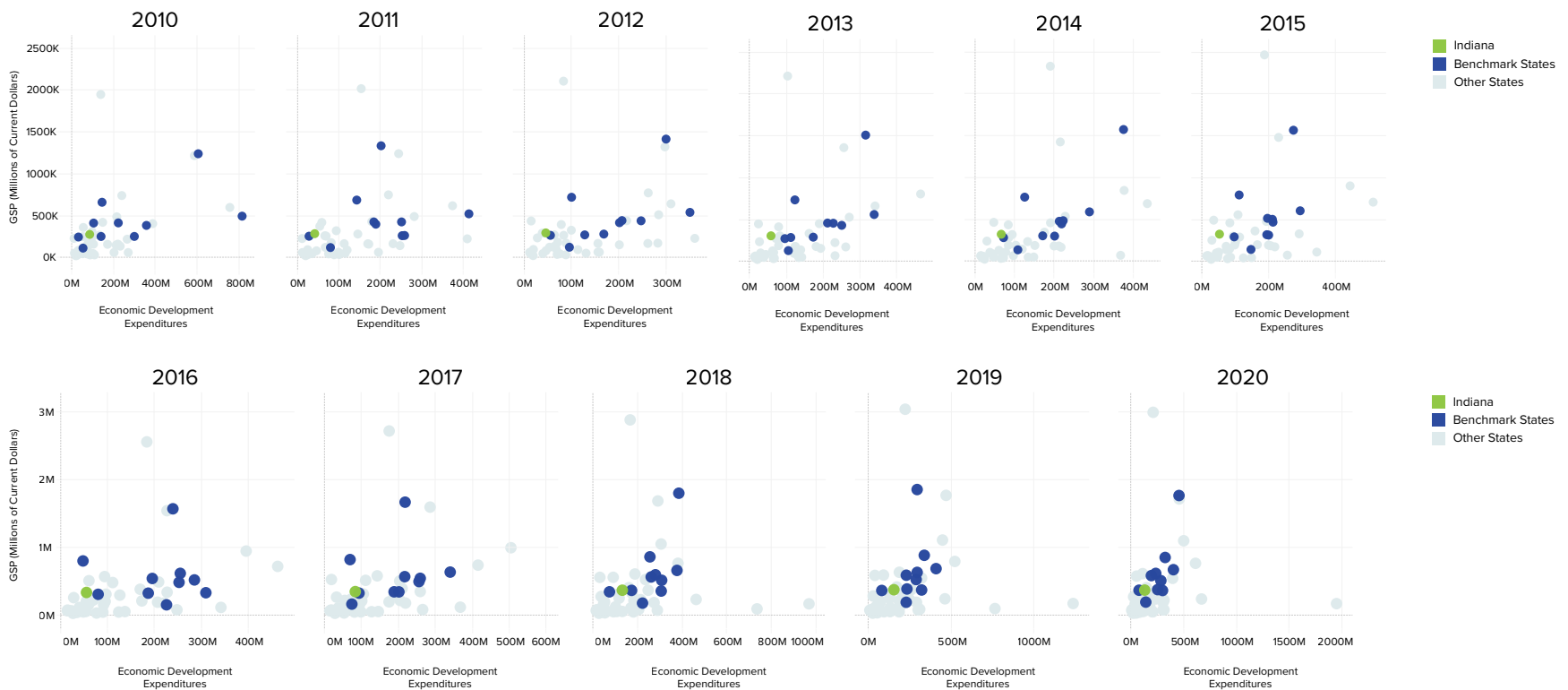
State	Economic Development Expenditures	Rank	Economic Development Spending per \$1M GSP	Rank	GSP (Millions Current Dollars)	Rank	GSP Per Capita	Rank	Population	Rank
Indiana	58.9%	6	19.6%	6	32.8%	9	27.1%	10	4.5%	8
Arizona	165.6%	2	78.5%	1	48.8%	3	32.8%	3	12.0%	4
Illinois	128.0%	4	77.0%	2	28.8%	11	29.4%	7	-0.4%	11
Utah	177.4%	1	66.6%	3	66.5%	1	40.8%	1	18.2%	1
Georgia	131.4%	3	55.4%	4	48.9%	2	34.8%	2	10.4%	5
Tennessee	118.0%	5	52.0%	5	43.4%	5	31.7%	5	8.9%	7
North Carolina	-11.6%	7	-37.1%	7	40.4%	7	28.6%	9	9.2%	6
Michigan	-20.0%	9	-39.4%	8	32.1%	10	29.6%	6	1.9%	10
Colorado	-14.5%	8	-42.3%	9	48.1%	4	29.2%	8	14.6%	3
Texas	-24.6%	10	-47.1%	10	42.5%	6	23.1%	11	15.8%	2
Ohio	-50.5%	11	-63.5%	11	35.4%	8	32.5%	4	2.2%	9

Source: TEconomy analysis of C2ER State Economic Development Expenditures Database

Figure A10 provides a high-level summary of the relationship between a state's economic development expenditures and its GSP. Although a linear-regression analysis is well-beyond the scope of this analysis, these bubble charts shows that Indiana's positioning among peer states remains consistent throughout the decade.

Finding 8: While it is difficult to ascertain the competitive position of Indiana based on this chart alone, it is evident that Indiana invests less in economic development than its benchmark states, and it has a lower GSP.

Figure A10: Relationship Between Economic Development Expenditures and Gross State Product in Indiana and Benchmark States (2010-2020)



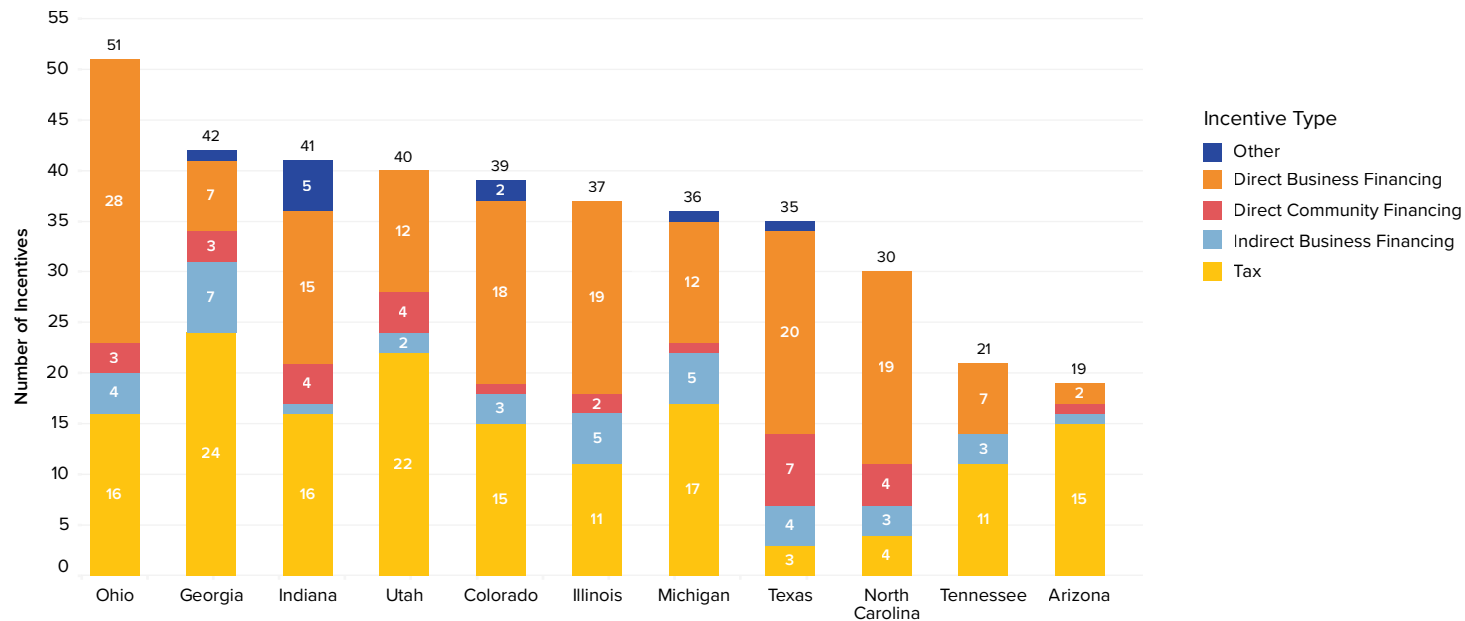
Source: TEconomy analysis of C2ER State Economic Development Expenditures Database and Bureau of Economic Analysis data

Comparing Indiana's Economic Development Incentive Activity to Benchmark States

Beyond a look at economic development expenditures, TEconomy also used the C2ER State Business Incentives Database to explore the number of economic development incentive programs across states, the types of incentives (e.g., direct business financing, direct community financing, tax) and the types of programs within each domain (e.g., tax credits, abatements, refunds, etc.). As noted previously, one limitation of the State Business Incentives Database is its qualitative nature: while information is available on program type (e.g., tax credits, grants, loans) and the number of programs available, there is no data on the magnitude or value of these credits or awards. In some instances, incentives included multiple types of program category. The first listed program category was used in these cases.

Finding 9: Indiana ranked third among all benchmark programs in the number of total programs included in the C2ER State Incentive Database, trailing only Ohio and Georgia (Figure A11). Unlike other states, Indiana is home to numerous unique incentive programs that C2ER classifies as other.⁹² Indiana offers seven incentives primarily related to direct business financing, tied for second fewest of states analyzed.

Figure A11: Number of Incentive Programs in Benchmark States by Incentive Type

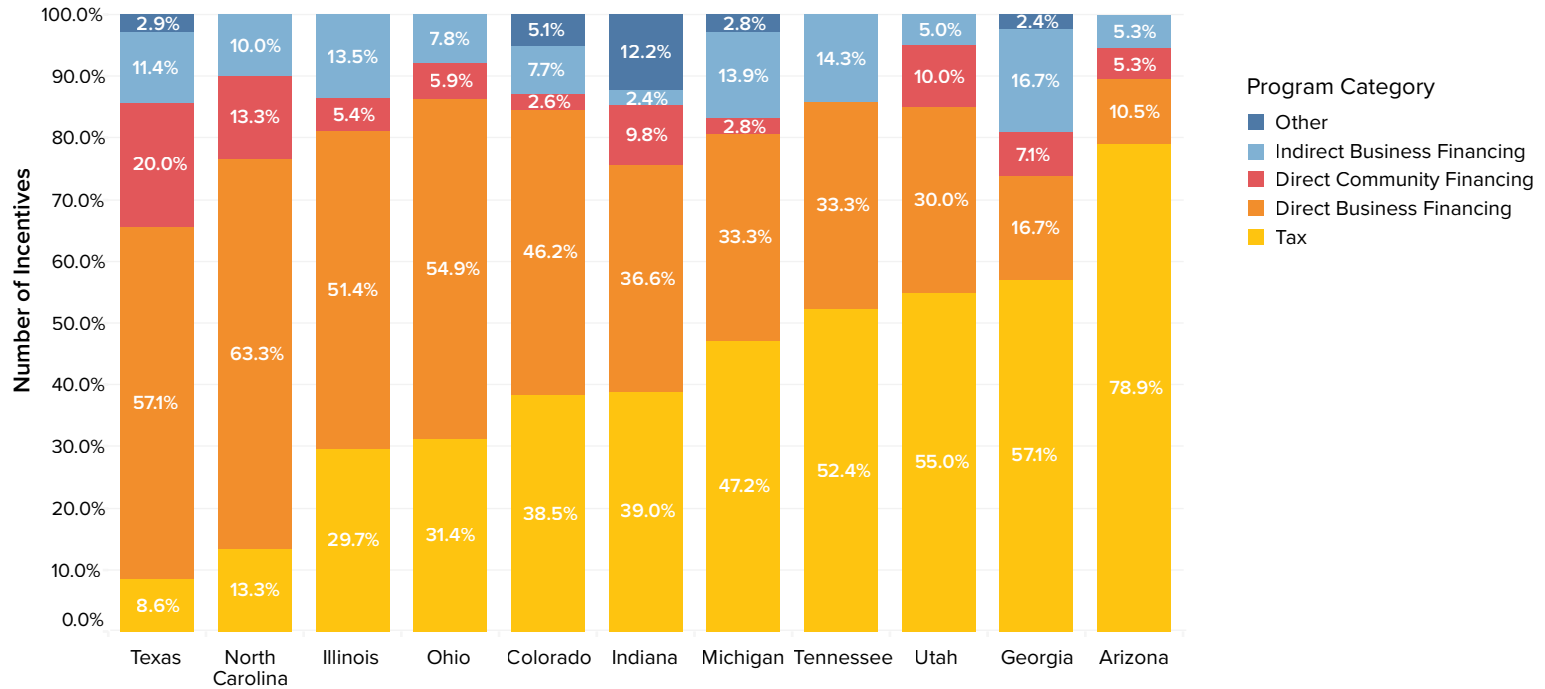


Source: TEconomy analysis of C2ER State Business Incentives Database

⁹² Indiana incentives classified as "Other" include: Regulatory Assistance Program, Compliance and Technical Assistance Program, JOBS Program, Petroleum Orphan Sties Program, Phase I Environmental Sites Program

Finding 10: On a percentage basis, Indiana has a relatively balanced portfolio of programs across the incentive types. Indiana is the only state where no incentive type comprises more than 40% of the total number of programs (Figure A12). In addition to ranking first in the highest share of unique or other incentive programs, Indiana ranks fourth in support for direct community financing.

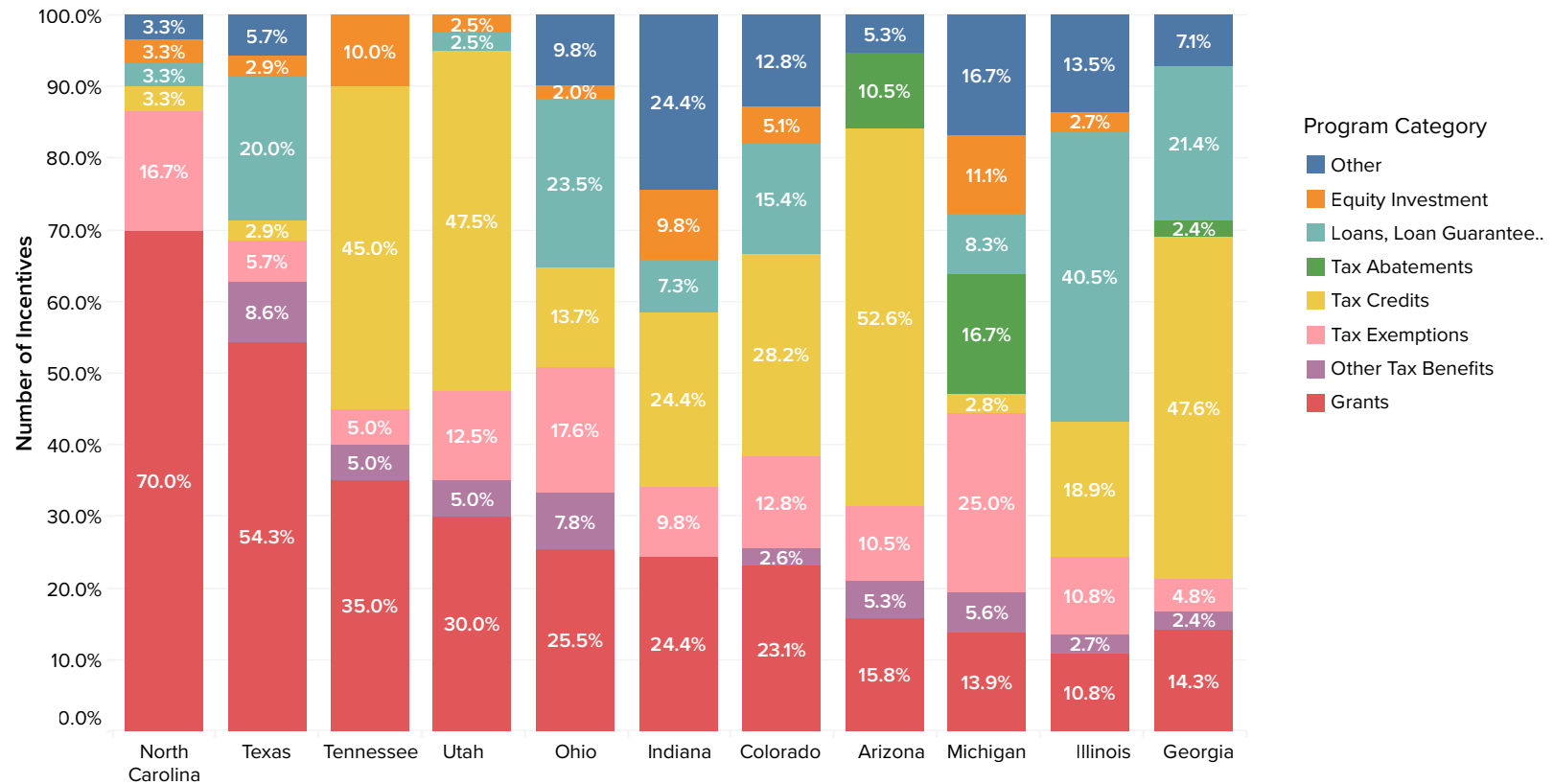
Figure A12: Percentage of Total Incentive Programs in Benchmark States, by Incentive Type



Source: TEconomy analysis of C2ER State Business Incentives Database

A closer look at economic development incentive programs suggests that the benchmark states support a wide array of incentives, and they do so in a variety of ways (Figure A13). For example, more than half of all incentives in North Carolina and Texas are grants, while these states engage in a relatively small number of tax-related programs. Illinois, Ohio, and Georgia are more likely to utilize loans and loan guarantee programs. In addition to offering the most other or unique programs, Indiana also ranks third in the share of programs dedicated to equity investments.

Figure A13: Percentage of Total Incentive Programs in Benchmark States, by Incentive Type



Source: TEconomy analysis of C2ER State Business Incentives Database

Conclusions

Based on an analysis of two proprietary databases on economic development expenditures and incentives, this high-level assessment helps build a greater understanding of Indiana's competitive positioning in economic development expenditures and incentives compared to other selected states.

This analysis finds that Indiana lags considerably behind benchmark states in economic development expenditures: In FY2020, Indiana ranked 10th among 11 states in total expenditures, and 8th among 11 states in expenditures when standardized by GSP. Over the past decade (FY2010-FY2020), cumulative economic development expenditures in Indiana were nearly \$900 million—ranking 10th out of 11 states, and nearly \$600 million less than the 9th place state. Indiana's lower levels of investment in economic development are not a short-term blip, but rather, a consistent trend: Despite growth in the most recent five-year period, Indiana still ranked last or near last in expenditures in each year across the entire decade. Across the range of economic development program areas, expenditures in Indiana are generally smaller than those in benchmark states. Furthermore, unlike many of the benchmark states, Indiana does not make a sustained investment in signature initiatives (defined as an average of \$40M from FY2016-2020 in a particular economic development area).

To build on this analysis, future research could include an evaluation of the effectiveness of Indiana's economic development spending and programs, as well as a deeper look at best practices employed by benchmark states. As Indiana continues to build on its strengths and enhance its own programs to achieve its ambitious goals of accelerating GSP, there are opportunities to learn from Indiana's own experiences, as well as from those in other states.

Appendix A1: Development Functions and Programs

Administration

- Info systems, accounting, human resources, etc.

Business Assistance

- Business retention/expansion
- Other Business Assistance
- Small business dev. (e.g., SBDCs)
- Procurement (gov't or business to business)
- Industry association support

Business Finance

- Other Business Finance
- Grants to businesses
- Loans available to Business
- Fund Management

Community assistance

- Grants to local/regional dev. orgs.
- Community center revitalization
- Other Community assistance
- Infrastructure (e.g., road/sewer/telecommunications)
- Funding for targeted geographic zones
- Project-specific infrastructure
- Technical assistance/capacity building to communities (including rural)
- Site preparation and development

Domestic Recruitment/Out-of-State

- Marketing/Prospect Dev. (Domestic)

- Prospect Site Location Assistance
- Other Domestic Recruitment/Out-of-State

Entrepreneurial Development

- Seed/venture capital
- Other Entrepreneurial Development
- Incubator dev./operations support
- Assistance to startups

International Trade and Investment

- Other International Trade and Investment
- Export promotion (excl. overseas representation)

Strategic Business Attraction Fund

Minority Business Development

- Bonding and contracting, lending, and grant assistance
- Business development assistance
- Other Minority business development

Other Program Areas

Program Support

- Other Program Support
- Economic research
- In-state regional offices
- Policy and planning
- Data dissemination/web site
- Public relations/intergovernmental

Special Industry Assistance

- Information and technology
- Agriculture/agribusiness
- Biotechnology/life sciences
- Racing and gaming
- Energy and environment
- Advanced manufacturing
- Other Special Industry Assistance
- Aerospace and defense

Technology Development

- Research & development
- Other Technology Transfer
- Technology commercialization
- Modernization/mfg. extension

Tourism/Film

- Tourism development
- Tourism advertising
- Tourism promotion (exc. Advertising)
- Film Promotion
- Major events/festivals
- Other Tourism/Film

Workforce Preparation & Development

- Other Workforce Development
- Customized training
- Incumbent worker training
- Sector-specific training (all nonmanufacturing industries)
- Apprenticeships
- o Sector-specific training (manufacturing)

Appendix A2: Summary of State Economic Development Expenditures and Other Indicators (2020)

State	Economic Development Expenditures	Rank	Economic Development Spending per \$1M GSP	Rank	GSP (Millions of Current Dollars)	Rank	GSP Per Capita	Rank	Population	Rank
Alabama	\$313,903,908	10	\$1,383	12	\$226,897	27	\$45,155	47	5,024,803	24
Alaska	\$85,498,500	37	\$1,716	8	\$49,820	48	\$68,019	9	732,441	48
Arizona	\$78,334,200	38	\$210	44	\$373,719	19	\$52,065	35	7,177,986	14
Arkansas	\$179,970,514	27	\$1,376	13	\$130,751	35	\$43,407	48	3,012,232	33
California	\$211,516,000	22	\$70	50	\$3,007,188	1	\$76,132	6	39,499,738	1
Colorado	\$254,060,573	16	\$664	23	\$382,585	16	\$66,142	13	5,784,308	21
Connecticut	\$27,316,115	47	\$99	48	\$276,423	23	\$76,779	4	3,600,260	29
Delaware	\$9,872,600	50	\$130	47	\$75,787	42	\$76,406	5	991,886	45
Florida	\$499,358,074	4	\$451	31	\$1,106,036	4	\$51,277	37	21,569,932	3
Georgia	\$236,052,883	18	\$379	34	\$622,628	8	\$58,050	24	10,725,800	8
Hawaii	\$303,752,879	13	\$3,665	5	\$82,885	40	\$57,087	28	1,451,911	40
Idaho	\$313,735,600	11	\$3,743	3	\$83,822	39	\$45,364	46	1,847,772	38
Illinois	\$324,622,700	9	\$378	35	\$858,367	5	\$67,137	10	12,785,245	6
Indiana	\$132,151,804	31	\$352	39	\$375,337	17	\$55,313	30	6,785,644	17
Iowa	\$305,025,525	12	\$1,570	10	\$194,268	30	\$60,924	19	3,188,669	31
Kansas	\$1,940,051,818	1	\$11,077	1	\$175,142	32	\$59,656	22	2,935,880	35
Kentucky	\$186,805,000	26	\$879	16	\$212,540	28	\$47,190	44	4,503,958	26
Louisiana	\$128,973,745	32	\$548	30	\$235,437	26	\$50,619	40	4,651,203	25
Maine	\$64,834,830	40	\$936	15	\$69,272	43	\$50,850	39	1,362,280	42
Maryland	\$147,987,590	29	\$360	37	\$410,675	15	\$66,531	12	6,172,679	18
Massachusetts	\$55,231,071	42	\$95	49	\$582,477	12	\$82,948	2	7,022,220	15
Michigan	\$284,176,097	15	\$552	29	\$515,120	14	\$51,166	38	10,067,664	10
Minnesota	\$246,055,695	17	\$658	24	\$373,739	18	\$65,486	14	5,707,165	22
Mississippi	\$97,162,066	36	\$853	17	\$113,846	36	\$38,502	50	2,956,870	34
Missouri	\$119,762,908	34	\$364	36	\$329,367	22	\$53,517	33	6,154,481	19
Montana	\$31,016,605	46	\$602	27	\$51,509	47	\$47,421	43	1,086,193	44

State	Economic Development Expenditures	Rank	Economic Development Spending per \$1M GSP	Rank	GSP (Millions of Current Dollars)	Rank	GSP Per Capita	Rank	Population	Rank
Nebraska	\$58,903,174	41	\$441	32	\$133,439	34	\$68,031	8	1,961,455	37
Nevada	\$41,409,407	45	\$242	43	\$170,944	33	\$54,894	32	3,114,071	32
New Hampshire	\$13,557,316	49	\$155	46	\$87,621	38	\$63,593	16	1,377,848	41
New Jersey	\$112,397,000	35	\$182	45	\$618,579	9	\$66,659	11	9,279,743	11
New Mexico	\$155,161,000	28	\$1,576	9	\$98,472	37	\$46,502	45	2,117,566	36
New York	\$456,887,000	5	\$265	41	\$1,724,759	3	\$85,575	1	20,154,933	4
North Carolina	\$194,651,465	25	\$330	40	\$589,829	11	\$56,404	29	10,457,177	9
North Dakota	\$203,670,969	24	\$3,713	4	\$54,854	45	\$70,420	7	778,962	47
Ohio	\$402,359,433	7	\$594	28	\$677,561	7	\$57,466	26	11,790,587	7
Oklahoma	\$73,610,120	39	\$391	33	\$188,057	31	\$47,465	42	3,962,031	28
Oregon	\$667,685,811	2	\$2,739	6	\$243,777	25	\$57,474	25	4,241,544	27
Pennsylvania	\$610,941,000	3	\$791	19	\$771,898	6	\$59,424	23	12,989,625	5
Rhode Island	\$120,244,704	33	\$1,986	7	\$60,556	44	\$55,241	31	1,096,229	43
South Carolina	\$235,821,532	19	\$963	14	\$244,882	24	\$47,728	41	5,130,729	23
South Dakota	\$208,024,931	23	\$3,797	2	\$54,789	46	\$61,762	18	887,099	46
Tennessee	\$299,964,400	14	\$812	18	\$369,574	20	\$53,406	34	6,920,119	16
Texas	\$455,252,468	6	\$256	42	\$1,775,588	2	\$60,771	20	29,217,653	2
Utah	\$142,137,197	30	\$719	20	\$197,562	29	\$60,201	21	3,281,684	30
Vermont	\$23,018,973	48	\$688	22	\$33,435	50	\$52,039	36	642,495	49
Virginia	\$395,348,316	8	\$719	21	\$549,536	13	\$63,662	15	8,632,044	12
Washington	\$216,563,000	21	\$358	38	\$604,254	10	\$78,284	3	7,718,785	13
West Virginia	\$49,480,434	44	\$652	26	\$75,855	41	\$42,382	49	1,789,798	39
Wisconsin	\$220,348,626	20	\$652	25	\$337,714	21	\$57,314	27	5,892,323	20
Wyoming	\$52,074,232	43	\$1,434	11	\$36,324	49	\$62,923	17	577,267	50

Source: TEconomy analysis of C2ER State Economic Development Expenditures Database and US Bureau of Economic Analysis and US Census Figures

Appendix A3: Average, Maximum, and Minimum Economic Development Expenditures Across Functional Areas (FY2016-2020)

Functional Area	10-State Average				Indiana		
	Average Expenditures	Maximum Expenditures	Minimum Expenditures	Number of States	Average Expenditures	Maximum Expenditures	Minimum Expenditures
Administration	12,071,109	112,298,720	647,990	9	7,031,527	7,975,684	6,752,302
Business Assistance	15,145,440	99,280,003	55,700	10	6,247,311	16,930,215	190,000
Business Finance	13,290,082	104,441,938	8,340	9	4,951,416	7,478,829	243,734
Community assistance	17,928,509	131,859,000	5,500	10	984,515	2,500,000	77,577
Domestic Recruitment/Out-of-State	17,782,116	92,120,887	7,837	6	3,328,544	6,155,302	1,375,000
Entrepreneurial Development	6,118,603	15,614,396	335,708	5	11,537	11,537	11,537
International Trade and Investment	3,203,059	13,046,146	18,000	6	1,223,565	1,223,565	1,223,565
Minority Business Development	1,457,779	4,000,000	485,400	4			
Other Program Areas	5,848,300	5,848,300	5,848,300	1			
Program Support	7,988,576	88,619,616	11,323	7			
Special Industry Assistance	7,168,127	59,481,700	100	10	4,444,194	19,400,000	43,688
Strategic Business Attraction Fund	38,819,070	105,088,000	4,005,974	2			
Technology Development	30,121,616	107,238,146	30	7	13,341,293	30,788,039	50,000
Tourism/Film	16,223,562	207,970,300	433,772	10	2,363,317	4,733,680	633,175
Workforce Preparation & Dev.	14,331,233	62,406,820	156,300	9	13,613,085	23,506,472	294

Source: TEconomy analysis of C2ER State Economic Development Expenditures Database

APPENDIX B: SELECTED COMPANIES ACTIVE IN HYDROGEN TECHNOLOGIES

Company Name	Location	Technology Space
ABB	Sweden	Hydrogen production and storage tech
Advanced Materials Corporation	Pittsburgh, PA	Hydrogen storage materials
AFC Energy PLC	United Kingdom	Fuel cells
AGCO/Fendt	Germany	Hydrogen powered agricultural tractors
Air Products and Chemicals Inc.	Allentown, PA	Hydrogen production
Alchemix Corporation	Carefree, AZ	Hydrogen syngas processing
Alstom	Germany	Hydrogen fuel cell passenger rail systems
Alumifuel Power Corporation	Englewood, CO	Hydrogen production
AMEX Foster Wheeler Corporation	Hampton, NJ	Hydrogen production
Asia Pacific Fuel Cell Technology Ltd.	Taiwan	Fuel cells
Avalence LLC.	Milford CT	Electrolysis tech
Ballard Power Systems	BC, Canada	Fuel cells
BMW	Germany	Hydrogen ICE powertrains and fuel cells
Bloom Energy Corp.	San Jose, CA	Fuel cells
Blue Fuel Solutions/New Holland	Netherlands	ICE hydrogen/diesel blend ICE agricultural tractors
Caterpillar, Inc.	Deerfield, IL	Hydrogen fueled generators/ICE tech
Ceramatec	Golden, CO	Hydrogen production tech
Ceres	United Kingdom	Fuel cells
Chemical Design Inc.	Lockport, NY	Hydrogen production tech
Cummins Corporation	Columbus, IN	Hydrogen ICE tech and fuel cells
Deutz AG	Germany	Hydrogen ICE tech
Diversified Energy Corporation	Las Vegas, NV	Gasification tech
Du Pont	Wilmington, DE	Hydrogen storage materials

Company Name	Location	Technology Space
Element One	Boulder, CO	Hydrogen sensors
Eprida Technologies	Marietta, GA	Biomass to hydrogen tech
Ergenics	Ringwood, NJ	Hydrogen storage tech
Etudes Chimiques et Physiques Sarl	France	Biofuels to hydrogen tech
FEV Europe GmbH	Germany	Hydrogen ICE tech
Fuel Cell Energy Inc.	Danbury, CT	Fuel cells
General Motors/GM Defense	Detroit, MI	Military Fuel Cell Vehicles (FCVs)
H2Scan	Valencia, CA	Hydrogen sensors
Haldor Topsoe A/S	Denmark	Hydrogen production tech
HCE LLC	Oakton, VA	Integral plasma fuel cells
Hyundai Motors	South Korea	Fuel Cell Vehicles (FCVs)
HTC Pure Energy	Saskatchewan, Canada	Hydrogen production tech
HY9 Corporation	Foxboro, MA	Hydrogen purification tech
Hydrogenics Corporation	Ontario, Canada	Hydrogen production tech, fuel cells, and storage systems
Innovatek, Inc.	Kennewick, WA	Hydrogen production tech
Intelligent Energy	United Kingdom	Fuel cells
ITM Power PLC	United Kingdom	Hydrogen production tech and fueling tech
JCB	United Kingdom	Hydrogen ICE agricultural and construction equipment
Jetstream Energy Technologies, Inc.	Santa Fe, NM	Solar thermo electrolysis tech
Kenworth	Kirkland, Washington	Toyota supplied fuel cell Class 8 trucks
Linde AG	Germany	Hydrogen production tech
Luxfer Holdings PLC	United Kingdom	Hydrogen storage systems
Magna Steyr AG & Co.	Austria	Hydrogen storage systems
MakeI Engineering, Inc.	Chico, CA	Hydrogen sensors
MAN Energy Solutions	Germany	Hydrogen maritime engines
Membrane Technology & Research, Inc.	Newark, CA	Hydrogen production tech
Meritor Inc.	Troy, MI	Hydrogen ICE tech
Mitsubishi Hitachi Power Systems Ltd.	Japan	Fuel cells

Company Name	Location	Technology Space
MO-SCI Corporation	North Rolla, MO	Hydrogen storage materials
Nanomix, Inc.	Emeryville, CA	Hydrogen sensors
NEL ASA/NEL Hydrogen AS	Norway	Hydrogen production tech, electrolysis and fueling systems
Nuvera Fuel Cells LLC.	Billerica, MA	Fuel cells
Plastic Omnium Group	France	Hydrogen storage materials
Plug Power LLC	Latham NY	Fuel Cell Systems
Proton Onsite	Wallingford, CT	Hydrogen production and storage tech
PowerCell Sweden AB	Sweden	Fuel cells
Powertech Labs	BC, Canada	Hydrogen fueling tech
Quantum Fuel Systems & Technologies Worldwide	Like Forest, CA	Hydrogen storage and fueling tech
SECAT, Inc.	Lexington, KY	Hydrogen pipeline materials and tech
Siemens Energy	Germany	Hydrogen production tech
Solaris Bus and Coach	Poland	Hydrogen electric buses
SotaCarbo SPA	Italy	Hydrogen production tech
TechnipFMC	France	Hydrogen production tech
Terberg Special Vehicles	Netherlands	Hydrogen powered freight terminal tractors
Toshiba Corporation	Japan	Hydrogen production tech, storage, and fuel cells
Toyota Motors	Japan	Fuel cells and Fuel Cell Vehicles (FCVs)
US Fuel Cell	South Windsor, CT	Fuel cells
Weldship Corporation	Bethlehem, PA	Hydrogen storage systems
Xebec, Inc.	Quebec, Canada	Hydrogen production and storage tech
Yamaha Motor	Japan	Hydrogen ICE tech in collaboration with Toyota
Yangtze Energy Technologies, Inc.	Taiwan	Fuel cell materials
ZTEK Corporation	Woburn, MA	Fuel cells

APPENDIX C: LARGEST COMPANIES ACTIVE IN IOT DEVELOPMENT AND SYSTEMS

Hardware

Company Name	Location	2020 Revenues (U.S. \$ billions)
Intel Corporation	Santa Clara, CA	77.9
Broadcom, Inc.	San Jose, CA	23.9
Qualcomm, Inc.	San Diego, CA	23.5
Texas Instruments	Dallas, TX	14.5
TE Connectivity, Ltd.	Switzerland	12.2
Mediatek, Inc.	Taiwan	10.7
STMicroelectronics	Switzerland	10.2
Infineon Technologies AG	Germany	9.6
NXP Semiconductors NV	Netherlands	8.6
ON Semiconductor Corporation	Phoenix, AZ	5.2

Platform, Software, and Service Providers

Company Name	Location	2020 Revenues (U.S. \$ billions)
Amazon.com, Inc.	Seattle, WA	386.0
Alphabet, Inc.	Mountain View, CA	182.5
Microsoft Corporation	Redmond, WA	143.0
Huawei Technologies Co. Ltd.	China	136.2
Bosch Software Innovations GMBH	Germany	86.6
IBM Corporation	Armonk, NY	73.6
Cisco Systems, Inc.	San Jose, CA	49.3
Oracle Corporation	Austin, TX	39.1
SAP SE	Germany	33.1
PTC, Inc.	Boston, MA	1.4

Other U.S.-Based IoT Engaged Companies. See following pages.

2lemetry (Amazon Web Services)	Bestmile	Cree
3D Systems	Biz4Intellia	Crestron Electronics
3M Company	Bourns	CTS Corp.
Abracon	Bright Wolf	Cypress Semiconductor
Adafruit Industries	B-SCADA	DAQRI
Adesto Technologies	Bsquare	Dataram
Aeris	Bug Labs	Decisyon
Allegro MicroSystems	C3 IoT	Dell Technologies
Altair SmartWorks	CalAmp	Deloitte LLP
Altera Corp.	California Eastern Laboratories (CEL)	Devicify
Altizon Systems	Capsule Tech	Digi
AMD	Caterpillar Inc.	Diodes
Analog Devices	Cirro	Diodes Incorporated
Anaren	Clear Object	DXC Technology
Arduino	ClearBlade	Eclipse IoT
Arxan Technologies	Cognizant	ei3 Corp.
AT&T	Compasses	eInfochips
Atheer	Compology	elastic
Augury	CompuCom	Electric Imp
Augury	Control4	Emerson
Autodesk	Corlina	EON Reality
Ayla Networks	Couchbase	EVERYTHNG
Bastille Networks	Covisint	Exar (Maxlinear)
Bayshore Networks Inc.	Cradlepoint	Exosite

Feeney Wireless
Filament
Flextronic
FogHorn
FreeWave Technologies
Fusion Connect
General Dynamics
General Electric
GlobalLogic
Goeee
GreenRoad Technologies
Greenwave Systems
Gumstix, Inc
Helium
Helium Systems
Heroku
Hewlett Packard Enterprise (HPE)
Hologram
Honeywell
Human Condition Safety
Impinj
infinimesh
Infor
Informatica
Ingenu

IoTium
IQMS
Itron
IXYS Corp.
John Deere
Johnson Controls
Juniper Networks
KaaIoT Technologies
Kaazing
Kingston Technology
Kopin Corp.
KORE Wireless
Lantronix
Lattice Semiconductor
Leverge
Linear Technology
Litmus Automation
Littelfuse
LogMeIn
Losant
MAANA
MachineMetrics
MACOM
Marvell Technology Group
Mesh Systems

Meshify
Microchip Technology
Micron Technology
Micropac Industries
Microsemi Corp.
Mitsubishi Electric Automation
Mocana
Mojix
Molex
Monnit
MOXA
Nebbiolo Technologies
NetApp
NI
NLP Logix
Novatel Wireless Solutions
Nozomi Networks
Numerex
Nutanix
NVIDIA
Objectivity
ON Semiconductor
OpenStack
Opti
Opto 22

OSisoft	Sensus	Ubidots
OutSmart Power Systems	Sight Machine	Utilidata
Panduit	Silicon Labs	VANTIQ
Particle	Silver Spring Networks	Verdigris Technologies
People Power	Simbe Robotics	Verizon
Petasense	Sine-Wave Technologies	Veros Systems
Phunware	Sirqul, Inc	Vishay
PLAT.ONE	SmartCap Tech	VUZIX
PNY Technologies	SmartCloud	WAVIoT
Predixion (Greenwave Systems)	Sopheon	WIN-911
Prodea	SparkCognition	Wind River
PubNub	Splunk	Wi-NEXT
Pulse Electronics Corp.	Sprint	Wyless (KORE)
Radisys	Synapse Wireless	WyzeBee (Redpine Signals)
RapidValue	Synaptics	Xage Security
Raytheon Technologies	Tachyus	Zebra Technologies
Reality AI	Temboo	Zones
Redpine Signals	Teradata	Zonoff
Rockwell Automation	Terbine	Zscaler
Rovisys	Tesla	
RTI	ThingLogix	
Salesforce	ThingsBoard	
Samsara	Thingspeak	
Schlumberger	Thingswise	
Semtech	ThoughtWorks	
SenseGrow	Tridium (Honeywell)	
Sensity Systems	Trilliant	

APPENDIX D: SUMMARY FROM CEO INTERVIEWS— IDENTIFIED STRENGTHS, WEAKNESSES, OPPORTUNITIES, THREATS, AND NEEDS.

It should be noted when referring to this summary that only issues raised by two or more interviews are included in the summary. Outlier comments by only one individual are not included.

Strengths

- Public Utility Commission willingness to use TED
- Quality of universities
- Fiscally responsible state
- Low business taxes
- Favorable regulatory environment
- Good water availability
- Geology suited to carbon sequestration
- Power reliability and quality
- Labor costs (but advantage weakening)
- Distribution and logistics
- Improving in diversity, equity and inclusion (although considerable way still to go)
- Elevate Ventures
- Purdue as a highly innovative educational institution
- Ivy Tech
- Ability to get attention from highest levels of state government
- In-state engineering programs in higher education (PU, RH, ND)
- Robust life science ecosystem with major players (Lilly, Roche, Elanco, etc.) Halo effect on smaller companies in the sector
- Big company/private sector leadership during COVID
- CICP and the communications between companies and sectors it engenders

- Responsiveness of state and local authorities when approached

Weaknesses

- Skilled, semi-skilled, unskilled labor all in short supply
- Poor K-12 education system and attainment/outcomes
- College graduates leaving state
- Lack of project-ready major sites
- Less competitive customized training (vs. best practice states, e.g. NC)
- Conservative attitudes, low risk-taking (stay in comfort zone)
- High cost of healthcare (partly offsets labor cost advantages)
- Too few college students in STEM disciplines
- Lack of diversity across the workforce and state population (especially outside Indianapolis)
- Slipping reputation as a “welcoming and friendly state,” especially for non-white populations
- Poor public health and state commitment to it
- No large-scale strategic investment fund
- Lack of affordable housing. Many tight housing markets
- Education system not concentrating on subject matter/capabilities needed for future jobs and success
- Access to analytics and associated talent
- No carbon tax to incent investments in alternative/renewable energy
- Difficulty encouraging younger skilled workers to move to Indiana

- Difficult to find software engineering expertise in the state (that includes getting the universities to engage)
- Significant portion of manufacturing is technologically unsophisticated
- Government needs to be “more at the table” with CICIP and corporate community

Opportunities

- Hydrogen economy (using sequestration)
- Building capacity in green energy
- Recognition of need to improve in customized training
- Early participation in electric vehicle projects
- Pursue more packaged approaches to targeted economic development
- Simplify economic development offerings and messages
- Reshoring of supply chains (electronics should be a key priority)
- Defense technology (needs to be domestic)
- Build a strategy around insurance and finance strengths and growth
- Projects needing water—Many of the newer drugs/biologics, for example, have very large-scale water needs
- Leverage less desire for 4-year college enrollment in Indiana into an advantage for expanding vocational programs and customized job training
- Attract automation equipment companies
- ESOP or other programs for succession strategies
- Major companies pivoting into alternative power and propulsion (e.g. Cummins, Allison)
- Fuel cells as an expanding sector together with electrolyzer investment for hydrogen production
- Leverage base of big multinational HQ's to fully meet their needs in state
- Large site “River Ridge” across from Louisville
- Good conversations happening around diversity, equity, and inclusion
- Nuclear power

- Analytics education programs delivered on-site at companies to train internal personnel.
- Headroom to potentially strategically raise business taxes for dedicated investment for economic development and improving overall long-term business ecosystem in Indiana.

Threats

- Local opposition to green power projects (especially solar farms and windmills)
- Resistance to change
- Lack of educational attainment
- Continued loss of graduates
- Business regulatory uncertainties due to legislature
- Utility rates climbing
- Labor costs climbing
- “Lights out” manufacturing and logistics coming
- Automotive/power/propulsion sectors vulnerable to disruptives and lack of carbon cost
- Lack of succession strategies for many small/midsize manufacturers
- Limited number of IP generating jobs and companies. Lots of “making” but lesser amount of “inventing.”
- Loss of corporate HQ's to out-of-state in some sectors (e.g., medical devices)
- Lack of competitive, large, serviced, ready-to-go sites in strategic locations for responding to mega-projects
- Inability to source expertise and talent in the state to implement Manufacturing 4.0, automation and robotics, IT, software engineering, analytics, and cybersecurity.
- Extreme competition for analytics talent
- Retirement of an aging skilled workforce
- Long lead-times to acquire and install automation equipment
- Kelley school steers graduates out-of-state

- Indiana not well positioned for energy move from fossil carbon (not ideal wind and solar environment)
- Slippage in quality/productivity with companies abandoning drug testing to get workers
- Companies coming into state with comparatively low-wage projects that then compete for scarce labor (e.g., Amazon warehouses)
- Other states being aggressive and winning projects
- Legislature pursuing “culture war” issues instead of concentrating on economy. Takes eye off the ball. Identity politics is a huge distraction and absolutely hurts recruitment
- Protecting the old instead of embracing and investing in the new
- Increasingly companies and their projects are seeking renewable energy guarantees (often 100% renewable power wanted). Also a need for corporate responsibility purposes at public corporations
- Transitioning to renewables and then mothballing fossil-fuel assets is a big cost for utilities
- Very different platforms for life science manufacturing (drugs and biologics) now demanded. Need expertise in these new areas
- Changing manufacturing environment in pharma. Seeing a redefining in what constitutes “drugs” and how they are manufactured. Some involve solvent chemistries and other flammable inputs that suggest out-of-city locations needed
- Some recent locations of Indiana-based companies to some out-of-state locations are seen as “a signal”.
- Increased engagement between universities and key strategic industry sectors
- Clear, branded positioning of Indiana for economic development and a recognizable strategy
- Supports to help expand workforce participation (e.g. daycare, drug rehab, work readiness training, etc.)
- Encourage and celebrate immigration. Increase population more widely.
- Concentrate on core competencies and focus
- Reliable electricity base load generation required (natural gas) as transition from coal
- Enhanced strategic collaboration and shared new tech investments across the diverse “automotive” sector in Indiana. Multiple companies in same need areas but not competing in markets.
- Brownfield remediation supports for NW Indiana sites
- Clear training pathways for jobs, communicated to the population
- A clear strategy for energy transition that assures reliable and cost-effective power and renewable energy options.
- Invest in advanced manufacturing, including development of talent who can design, install, and operate advanced manufacturing. Help to plan it.
- Financing for plant modernization.
- Cybersecurity is an increasingly crosscutting need.
- Must see state image and reputation as a key input to industry, not a byproduct. It is increasingly central in talent wars.
- Increased housing construction, especially affordable housing.
- Build a long-term strategy and stick to it. Give industry reassurance that working on the right things and not getting distracted.

Needs

- Serviced sites ready-to-go
- A workforce training program competitive with NC’s (and, increasingly, China’s). A guarantee that the workforce will be prepared as new company locations are developed.
- Substantial improvement to K-12 education statewide, especially STEM emphasis

APPENDIX E: COMPANIES ENGAGED IN INDUSTRY 4.0 IMPLEMENTATION AND INTEGRATION SERVICES

In terms of major systems integration services, the leading Industry 4.0 solutions providers tend to be large producers of digital, IoT, and robotics/automation solutions. There will be significant overlap with the companies noted as engaged in IoT (Appendix C).

Prominent Companies Offering Industry 4.0 Solutions; Top 10 by Revenue⁹³

1. Intel Corporation
2. General Electric Company
3. IBM Corporation
4. Siemens AG
5. Cisco Systems Inc.
6. Mitsubishi Electric Corporation
7. Honeywell International Inc.
8. Toshiba Corporation
9. ABB Ltd.
10. Emerson Electric Co.

An alternative (albeit similar) list of leading companies in Manufacturing 4.0 is provided by Emergen Research, as follows:⁹⁴

- General Electric Company
- Mitsubishi Electric Corporation
- Cisco Systems, Inc.
- ABB Ltd.
- KUKA
- Stratasys, Ltd.
- IBM Corporation
- FANUC
- Yaskawa Electric Corporation
- Siemens AG.

The graphic logo map of companies (below) engaged in Industry 4.0, with special reference to the Systems Integrator's category, would also be a good starting place for further research into potential company targets.

⁹³ <https://www.emergenresearch.com/blog/top-10-leading-companies-offering-industry-4-0-solutions>

⁹⁴ "Industry 4.0 Market." January 2021. <https://www.emergenresearch.com/industry-report/industry-4-market>

Leading Industry 4.0 Vendors 2019

Connected Industry Building Blocks

Hosting 	Industrial IoT Platforms 	Analytics 
Microchips 	Sensors 	Connectivity Hardware 
Cybersecurity 		
Systems Integrators 		

Other Industry 4.0 Supporting Technologies

Additive Manufacturing 
Augmented and Virtual Reality 
Collaborative Robots 
Connected Machine Vision 
Drone / UAVs 
Self-Driving (Material Transport) Vehicles 

Source: IoT Analytics, January 2019. Vendor map does not include suppliers of vertical or use case specific solutions (i.e. end-to-end vibration monitoring solutions, etc.). Leading companies were selected based on a number of factors including sophistication of relevant product offerings, number of compelling case studies, and size of Industry 4.0 business. It is possible that some vendors have been missed. To submit a company for consideration in the 2020 vendor map, please contact research@iotalytics.com with the company information.

Copyright © 2019 by www.iotalytics.com. All rights reserved.



TECONOMY
PARTNERS LLC