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Smart Mobility Blueprint for Illinois

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16. Abstract

Connected, automated, shared, and electric (CASE) technologies have invoked Mobility 4.0—a connected, digitized, multimodal, and autonomous system of systems. This project established a flexible and adaptable blueprint that would streamline multidisciplinary and multistakeholder efforts as well as leverage available resources to prepare the Illinois Department of Transportation and other transportation agencies. Illinois has several strengths that make it an attractive location for CASE technology companies, including a talent pool from top-ranked universities, well-developed transportation infrastructure, government support, and a robust ecosystem of collaboration and innovation. Illinois also faces potential challenges (e.g., competition from other states and countries, limited access to funding, regulatory hurdles, and infrastructure readiness for new mobility technologies). Seven smart mobility pillars were identified in this study for Illinois—namely, connected and automated (CA) freight, scaling intelligent transportation systems, farm automation, insurance, urban mobility, CA logistics, and alternative fuels. The balanced scorecard ranked the pillars as follows (from highest): alternative fuels, scaling intelligent transportation systems, CA freight, farm automation, CA logistics, insurance, and urban mobility. Tactical focus areas were also identified per pillar and were prioritized with suggested leads and stakeholders to champion the CASE directives and opportunities. Near-term actions for Illinois were also suggested that included establishing a central structure for Illinois' CASE program, enriching the knowledge base and experience, preparing transportation infrastructure, partnerships with external stakeholders, and expansion of laws, regulations, and policies that will help administer and grow CASE technology deployment and integration.

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EXECUTIVE SUMMARY

The automotive industry has recently integrated new mobility services that have altered the competitive technology landscape—building the future of mobility through connected, automated, shared, and electric (CASE) technologies. Although CASE was initially introduced by the vehicle industry, its premise of technologies is applicable to smart mobility. This project established a flexible and adaptable blueprint that would streamline multidisciplinary and multistakeholder efforts as well as leverage available resources to prepare the Illinois Department of Transportation, and other transportation agencies, for Mobility 4.0—a connected, digitized, multimodal, and autonomous system of systems.

Private, public, and academic sectors have physical assets and an active presence in Illinois—most are notably located in the northeast region of the state, reflective of the region's stronghold as the multimodal freight and logistics hub for the US and international domain. In addition, CASE activities, education programs, and workforce are present throughout the state—at levels comparable to that at other states, which are more established in CASE. In anticipation of increasing CASE technologies' market penetration, Illinois has established legal and regulatory guidelines as well as incentives.

Illinois has several strengths that make it an attractive location for CASE technology companies, including a talent pool from top-ranked universities, well-developed transportation infrastructure, government support, and a robust ecosystem of collaboration and innovation. Illinois also faces potential challenges (e.g., competition from other states and countries, limited access to funding, regulatory hurdles, and infrastructure readiness for new mobility technologies).

Seven smart mobility pillars were identified in this study for Illinois—namely, connected and automated (CA) freight, scaling intelligent transportation systems, farm automation, insurance, urban mobility, CA logistics, and alternative fuels. A balanced scorecard analysis was completed to rank the CASE pillars and to prioritize the identified needs from stakeholder consensus, while strategically aligning them with Illinois' strengths and resources. The scorecard balanced multiple criteria—namely, industry presence, workforce talent, education, investments, legal and regulatory framework, CASE-related activities and engagement, competitiveness, and collective opinions. The balanced scorecard ranked the pillars as follows (from highest): alternative fuels, scaling intelligent transportation systems, CA freight, farm automation, CA logistics, insurance, and urban mobility.

Tactical focus areas were also identified per pillar and were prioritized with suggested leads and stakeholders to champion the CASE directives and opportunities. Near-term actions for Illinois were also suggested that included establishing a central structure for Illinois' CASE program, enriching the knowledge base and experience, preparing transportation infrastructure, partnerships with external stakeholders, and expansion of laws, regulations, and policies that will help administer and grow CASE technology deployment and integration.

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CHAPTER 1: INTRODUCTION

BACKGROUND

Mobility is the backbone of the US economy. It connects various transportation modes and infrastructure. Quality of life and productivity depend directly on the quality of the transportation infrastructure system. The most recent release of the American Society of Civil Engineers' Report Card for Illinois Infrastructure in 2022 revealed that the state has an overall grade of "C-," which signifies a mediocre rating and requires immediate attention. Considering the present demands on the state's transportation infrastructure, transportation agencies face complex and interconnected challenges, which are bound to become more complex with the emergence of connected, autonomous, and 3D mobility technologies.

Earlier coined in Germany, the "Fourth Industrial Revolution" of the twenty-first century invokes the core innovations of connectivity and digitization into current and emerging mobility options, including multimodal, partly autonomous systems (Saur, 2020). One of the main challenges is the combination of mobility options with the new technological disruption, also referred to as "Mobility 4.0." This requires flexible solutions under real-time orchestration and integration of many systems. Mobility 4.0 prompts effective and efficient mobility of goods and people, streamlined via data and energy use, along with multimodal transport and logistics. A modernized, human-centered transportation system in Illinois will promote the state's economic competitiveness (Lavey & Zegas, 2020).

In the continued preparation for connected and autonomous vehicle (CAV) technologies, the US Department of Transportation (USDOT) released the updated AV 4.0—*Ensuring American Leadership in Automated Vehicle Technologies*—in collaboration with the National Science and Technology Council (USDOT, 2020). In that report, USDOT expressed proactive support of CAVs and suggested providing guidance, best practices, and opportunities for research and pilot programs to aid many ongoing and collaborative efforts of stakeholders across the country. As of 2022, 171 active and planned projects for connected vehicle deployment have been reported, and research collaborations continue to form between government agencies, industry partners, and academic institutions, as reported in the USDOT Interactive Connected Vehicle Deployment Map presented in Figure 1.

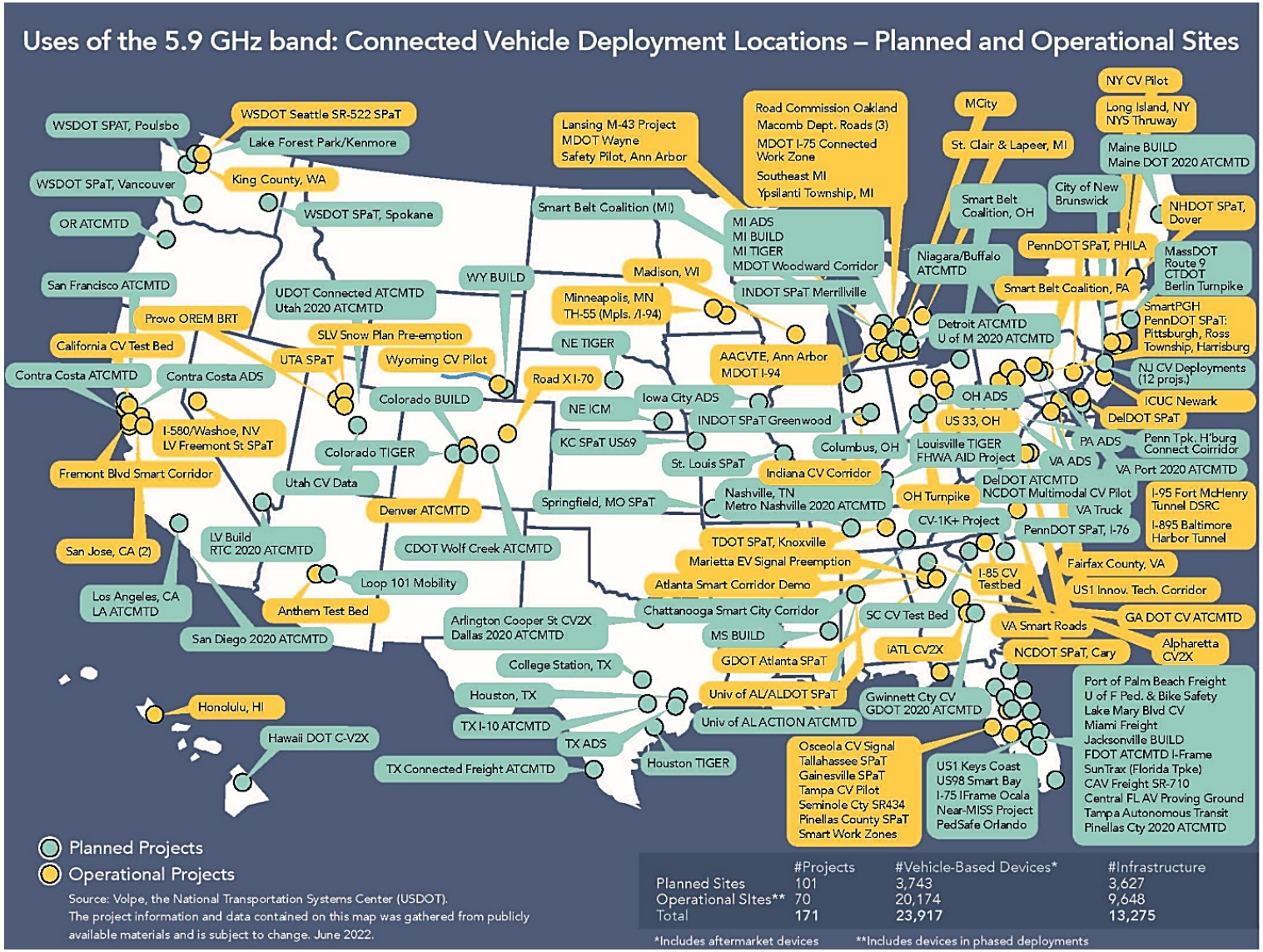


Figure 1. Map. Locations of active and planned projects of connected vehicle deployment.

Source: USDOT (2022)

Parallel to the national CAV effort, the Mid-America Association of State Transportation Officials (MAASTO) released the 2020 CAV Summit Summary Report involving all 10 states in the Midwest region—namely, Illinois, Indiana, Iowa, Kansas, Kentucky, Michigan, Minnesota, Missouri, Ohio, and Wisconsin. The goals of the summit included understanding how the region should plan and prepare for CAVs and establishing a 10-year CAV Regional Strategy through stakeholder interactions. The short-term strategies, based on stakeholder feedback, included the following items:

- researching CAVs' impact on transportation budgets, projects, operations, and business needs
- leveraging industry partners and academia
- identifying opportunities to share data across states and address data governance
- working with local communities to address accessibility and equity
- hosting an annual CAV conference
- encouraging DOTs to understand CAV legislation concerns and associated impact on regulation

As MAASTO defines the regional directives, the Illinois Long-Range Transportation Plan, spanning years 2019–2040, aims to provide strategic direction for developing and advancing the Illinois transportation system, along with creating sustainable and multimodal solutions that will support local goals and grow the statewide economy. Although Illinois is currently not identified in the USDOT Connected Vehicle Deployment map as having active or planned deployment activities, ongoing efforts in preparing the state for advanced mobility include the Illinois Statewide Intelligent Transportation System (ITS) Strategic Plan (last updated in July 2019). The ITS plan utilizes the statewide ITS concept of operations, statewide ITS architecture, and regional ITS architectures to establish a roadmap for deployment and operation of enhanced transportation services across the state (IDOT, 2019).

The strategic plan presented solutions related to CAVs, including, but not limited to, smart cities, enhanced communication links to field devices, connected vehicle-to-vehicle and vehicle-to-infrastructure applications, and automated vehicle deployment. In November 2020, the Federal Communications Commission expressed plans to phase out dedicated short-range communication services. Instead, the new rules include reserving the upper 30 MHz for ITS and designating cellular vehicle-to-everything communication as the technology standard for safety-related transportation and vehicular communications.

Two projects related to connected vehicle deployment are listed in the ITS Strategic Plan. The first project, Develop Connected Vehicle Pilot, is led by the Illinois Tollway to procure and deploy 11 dedicated short-range communication units to estimate travel time and to identify traffic congestion locations. The second project, Multimodal Traffic Signal System Integration Including Connected Vehicles, deals with the integration of transit (i.e., with traffic signals) to enable vehicle-to-

infrastructure communication. A planned project, Smart Lighting, will focus on determining lighting adjustment considering environmental conditions and presence of connected vehicles. Other projects supported by the Illinois Department of Transportation (IDOT) include the development of 5G communications, advanced air mobility, electrification, and energy harvesting for the state of Illinois.

IDOT will deliver the next Statewide Transportation Improvement Program (STIP) document detailing all federal- and state-funded highway and public transportation projects proposed in Illinois over a four-year period, including highway, transit, and intercity railroad elements. The STIP document is typically developed in cooperation with local officials, including programs for all 16 metropolitan planning organizations in Illinois. In anticipation of short-, medium- and long-term efforts that will be appended and considered in STIP, it is critical to strategically organize and align smart mobility goals and resources, including stakeholders, within Illinois to account for future demands of connected, automated, shared, and electric (CASE) technologies.

In the last decade, the automotive industry has integrated new mobility services that have altered the competitive technology landscape—leading to the adoption of the acronym "CASE," which describes the future of vehicles as connected, automated, shared, and electric. Although initially adopted by the vehicle industry, the premise of CASE technologies is applicable to Mobility 4.0 or advanced mobility.

C—Connected: A connected system can communicate bidirectionally with other external systems, along with sharing data with surrounding vehicles or infrastructure. Connectivity may include infotainment, safety, roadside assistance, diagnostics, navigation, and payments.

A—Automated: An automated or autonomous system can sense its environment and operate without human involvement. Technologies that enable automation include a wider variety of sensors, such as cameras, radar, lidar, sonar, GPS, and inertial measurement units. Collected data is used to detect and recognize objects, paired with advanced control systems that interpret and make decisions to identify safe navigation paths and execute the movement of the vehicle. According to the Society of Automotive Engineers, there are six levels of automation, ranging from Level 0 of no automation to Level 6 of full automation (i.e., highest level of autonomy without human interaction required).

S—Shared: Transportation services and resources are shared among users, which may include public transit, micromobility (bike or scooter sharing), car-based modes (car sharing, on-demand rides, and microtransit), and commute-based modes (carpooling).

E—Electric: An electric vehicle or charging infrastructure is completely or partially powered by an electric or alternative energy source.

PROJECT OBJECTIVE AND SCOPE

The main objective of this project is to establish a flexible and adaptable blueprint that will not only streamline multidisciplinary and multistakeholder efforts, but also leverage available resources to prepare IDOT, and other transportation agencies, for Mobility 4.0—a connected, digitized,

multimodal, and autonomous system of systems. To achieve this objective, the following steps were conducted:

1. Review major efforts in connected autonomous vehicle/truck (CAV/T) integration into the mobility network of the US, relevant to the needs of Illinois.

2. Identify current and future/planned resources within the state of Illinois that can be leveraged to prepare for Mobility 4.0.

3. Establish a stakeholder list from state, regional, and local transportation agencies, emergency services, law enforcement, key private industries, nonprofit organizations, civic groups, academic institutions, and research facilities.

4. Invite stakeholders to attend a "stakeholder workshop" to enumerate and prioritize program areas related to CAV/T integration and connectivity.

5. Conduct interviews and a survey to scope key program areas from the stakeholder workshops as well as statewide and local transportation system needs.

6. Conduct a balanced scorecard analysis to prioritize needs and solutions that maximize the effective use of available resources and partnership/collaboration opportunities, while minimizing costs, environmental impact, and future risks.

7. Build a flexible and adaptable blueprint that leverages current and planned initiatives in Illinois and creates an integrated system for Illinois and neighboring states to develop protocols and a testbed arena.

8. Define a model for implementation and activation of the blueprint, which will also incorporate best practices.

CHAPTER 2: SYNTHESIS OF ILLINOIS RESOURCES

CASE ACTIVITIES

As an initial step in matching the future demands of CASE technologies in Illinois' transportation system, publicly documented key activities, efforts, and resources were reviewed. Organizing such a database provides a means to describe the CASE ecosystem in Illinois. A total of 272 entries were identified across the academic, public, and private sectors, including information on the entity name, location, activity, program area, timeline, and description. The database breakdown per sector is 43%, 42%, and 14% for public agencies, academic institutions, and private industry, respectively. Currently, the database is tabulated with a recommended objective of establishing a platform that can be dynamically updated as more activities occur. The database has been aggregated to categorically identify tactical areas of focus, key resources, and key regions of activities. Key topics that became evident from aggregating the data include artificial intelligence, broadband, CAV development and deployment, CA freight, connected rail, connected transit, data security policy, design standards, electrification, electric vehicle (EV) charging technology, EV routing, intermodal automation, ITS for curb management and freight, last-mile delivery, mapping, micromobility, mobility plans, multimodal planning, policy, ride-hailing and ride-sharing, warehouse automation, and workforce development.

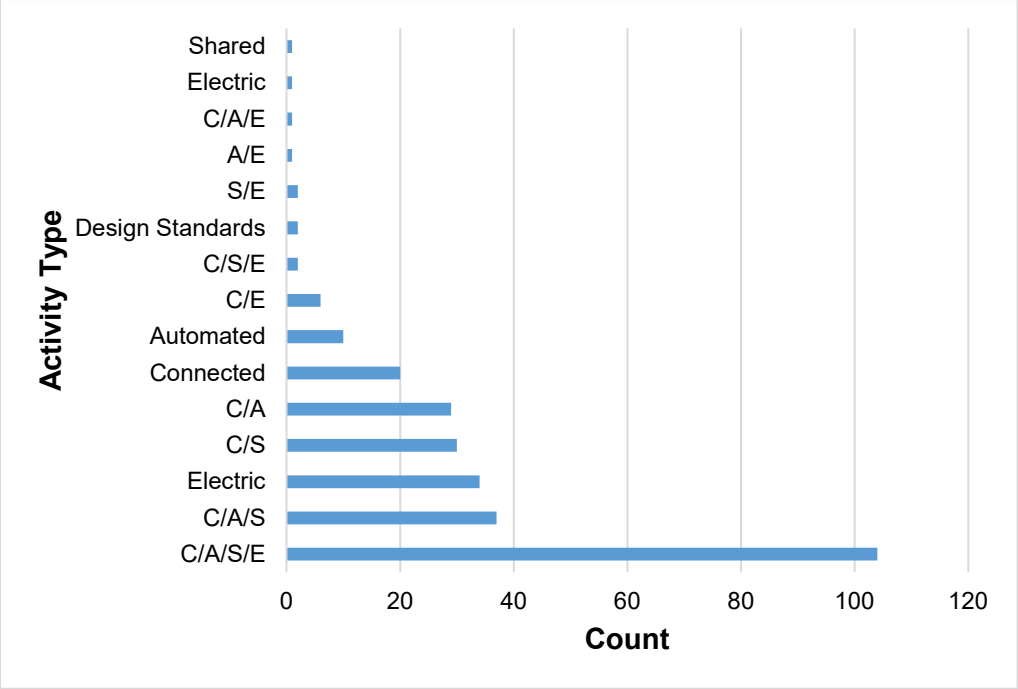


Figure 2. Chart. Cross-cutting involvement of activities in CASE (connected, automated, shared, and electric).

Note that 206 of the 272 total database entries (76%) are activities within Cook County, Illinois, while the remaining entries include notable activities within the state. The activities were also categorized

as connected, automated, shared, and/or electric, including cross-cutting involvement in CASE (Figure 2). Over 75% of the activities have cross-cutting involvement in at least two types (two combinations of C/A/S/E) and over 37% were involved in all four (i.e., C/A/S/E). In this limited database, active and planned activities are already occurring to advance Illinois' mobility ecosystem. Figure 3 highlights some examples of major CASE activities within the state. Hence, an opportunity exists to strategically align the current and future mobility demands of Illinois with organized and comprehensive in-state resources.

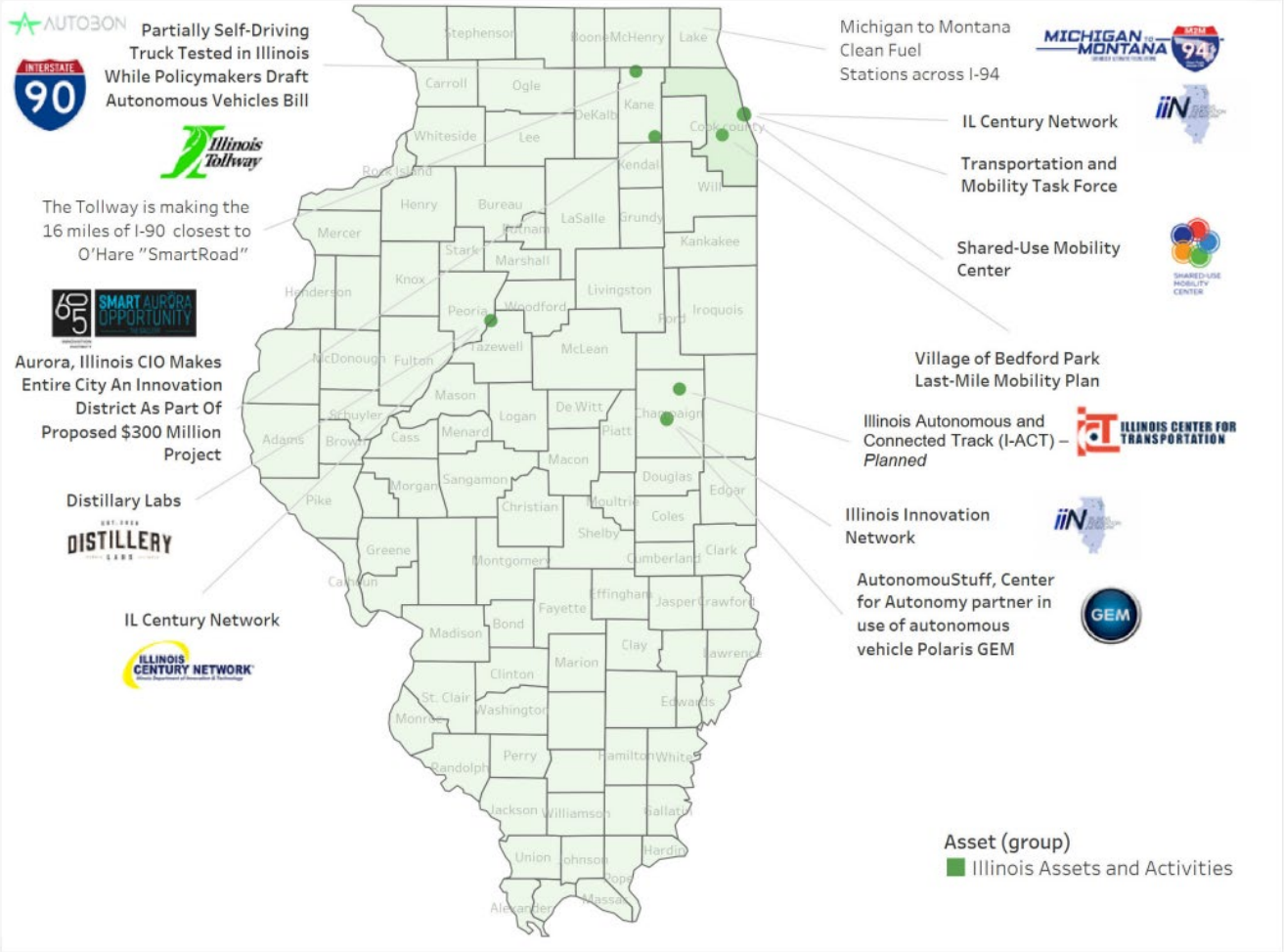


Figure 3. Map. Major CASE activities in Illinois.

Illinois plays an integral role in the nation's transportation system as a multimodal freight hub, linking many cross-cutting economic sectors. The state's agriculture domain has also significantly impacted the region and leverages Illinois' supply-chain and logistics resources. Parallel to key sectors in moving goods and agriculture, personal mobility resources for moving people span ITS and related technology, electric mobility, and insurance, to name a few. A brief aggregation of key stakeholders from the public, private, academic, and nongovernmental sectors is presented in Figures 4–9.

Figure 4. Image. Public sector stakeholders.

Across the public sector, varying levels of smart mobility technologies have been deployed. Moreover, long-range transportation plans are drafted in anticipation of servicing higher and more complex future demands. As part of preparing the communication infrastructure, the state's existing 2,100-mile fiber optic network will be further extended via the recent allocation of $253 million from the American Rescue Plan Act to promote digital equity by expanding broadband internet reach to low-income and rural communities. Although Illinois is poised to be the next logistics technology hub, there is limited use of in-state resources by leading private CASE sector stakeholders. A baseline scan of the private sector is showcased in Figures 5 through 9, which includes entities that are headquartered in Illinois.

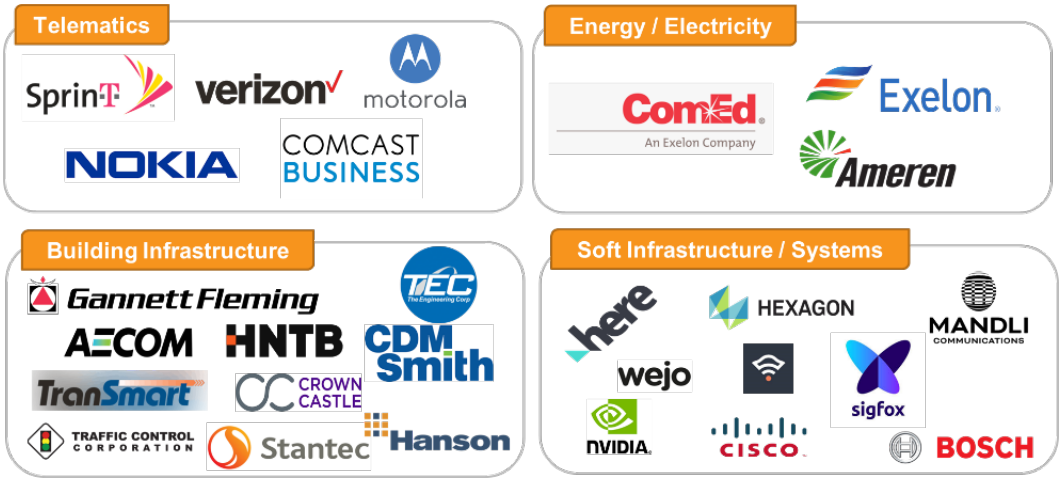


Figure 5. Image. Infrastructure private sector stakeholders.

The presented partitioning compartmentalizes Illinois' private industry players in mobility by goods, people, and agriculture. The freight and logistics category includes original equipment manufacturer (OEM), large-scale goods distribution, air freight, and rail. The mobility of people category further extends the private industry category to include parking, bus transit, insurance, CAV technology, mobility-as-a-service (MAAS), charging management, and mobile wallet technology.

Figure 6. Image. Freight and logistics private sector stakeholders.

Figure 7. Image. Industrial and agricultural private sector stakeholders.

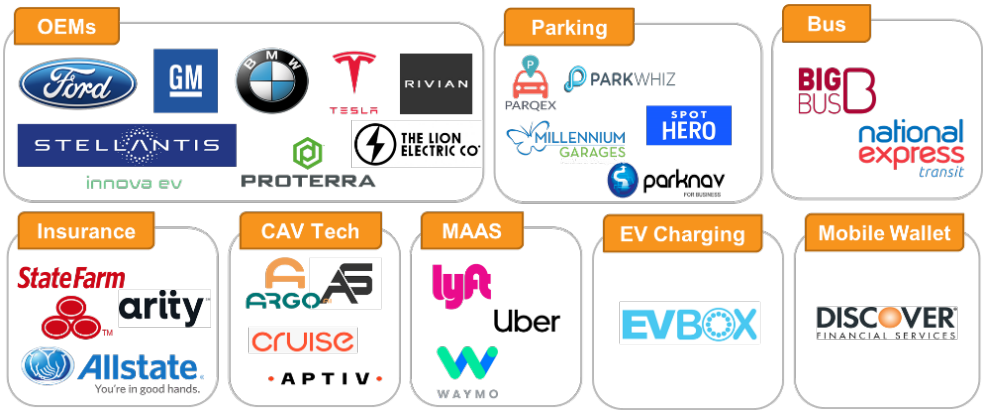
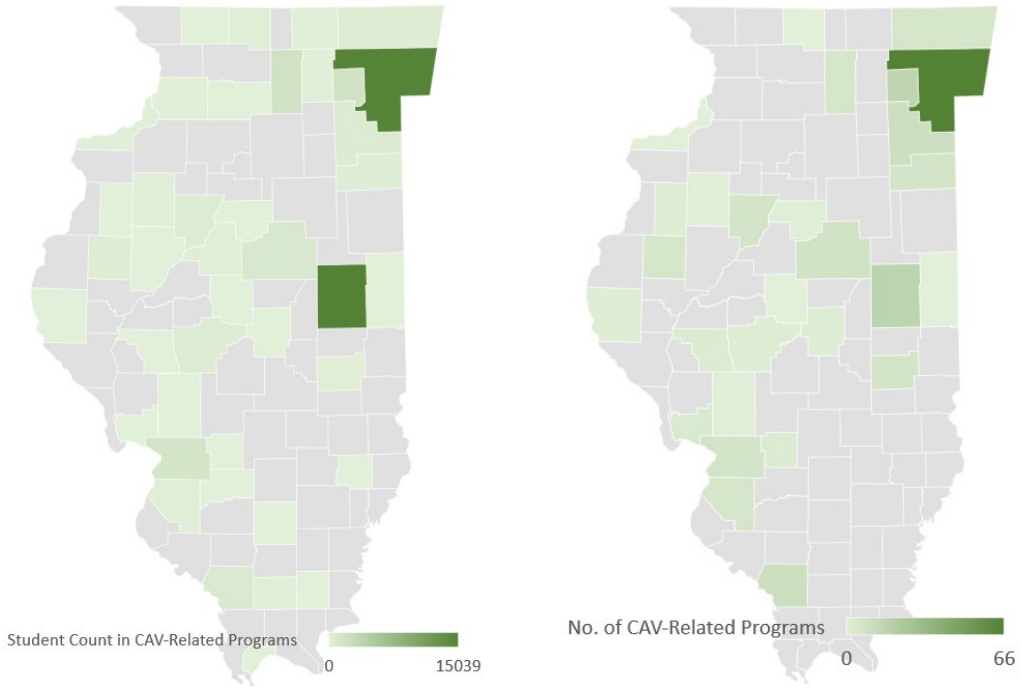


Figure 8. Image. Stakeholders in mobility of people.

Figure 9. Image. Mobility consulting stakeholders.

EDUCATION

To date, there are 116 universities, 77 community colleges, and 115 trade schools in Illinois. A subset of post-graduate students, up to 15,040 students, are in CAV-related programs. There are higher concentrations of students in CAV-related programs in Cook and Champaign Counties given the presence of major universities, with the highest concentration in Cook County (Figure 10a). In line with public entity activities in mobility, CAV-training programs in community colleges and universities exist throughout the state, as illustrated in Figure 10b. This entails that the state can build upon existing training and workforce development programs that not only support Illinois' CASE goals and objectives, but also the state's economy.



a) Number of students b) Number of programs

Figure 10. Map. CAV-related programs and associated enrolled students in Illinois.

WORKFORCE

Throughout the US, the CASE-related workforce exists predominantly in California, Texas, Washington, and New York. As illustrated in Figure 11, Illinois' CASE workforce level is comparable to other states with ongoing advanced mobility efforts and deployments, including Arizona, Colorado, Florida, Michigan, Ohio, Wisconsin, and Virginia. The distribution of the CAV-related workforce (Figure 12) across Illinois counties relatively follows the CAV-related student enrollment (Figure 10b), with the highest count level in Cook County. Moreover, there is a lower number of clusters for the workforce, i.e., the count is more concentrated within a reduced number of counties. However, as the state embarks on advanced mobility directives and efforts, the CAV-related workforce is expected to increase along with the corresponding geographic coverage.

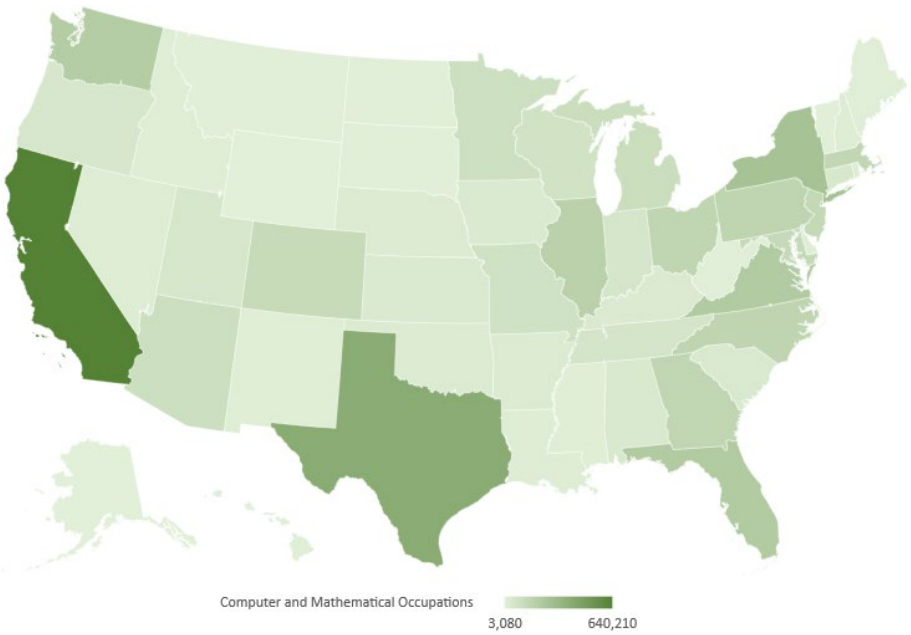
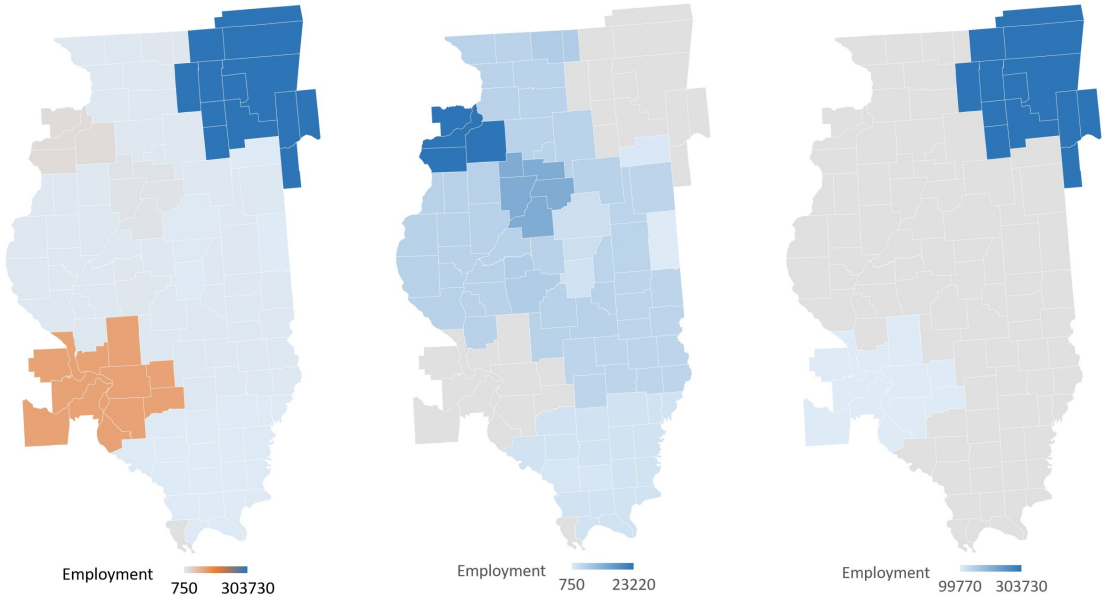


Figure 11. Map. Existing CAV-related workforce in the United States.



a) Statewide b) Inner Illinois regions c) Outer Illinois regions

Figure 12. Map. CAV-related workforce in Illinois.

LEGAL AND REGULATORY FRAMEWORK

Given the increasing importance of CASE technology, which is bound to dramatically change daily lives, government policies are imperative to safeguard all users and promote cross-cutting technology integration into the mobility ecosystem. According to the National Conference of State Legislatures, 15 states enacted 18 bills related to autonomous vehicles (AVs) as of 2018. The 29 states that have

enacted legislation related to AVs include Alabama, Arkansas, California, Colorado, Connecticut, Florida, Georgia, Illinois, Indiana, Kentucky, Louisiana, Maine, Michigan, Mississippi, Nebraska, New York, Nevada, North Carolina, North Dakota, Oregon, Pennsylvania, South Carolina, Tennessee, Texas, Utah, Virginia, Vermont, Washington, and Wisconsin—and Washington DC. Moreover, governors in Arizona, Delaware, Hawaii, Idaho, Illinois, Maine, Massachusetts, Minnesota, Ohio, Washington, and Wisconsin have issued executive orders related to AVs. Nevada was the first state to authorize the operation of AVs in 2011. Since then, other states have passed legislation or enacted executive orders, or both (Figure 13).

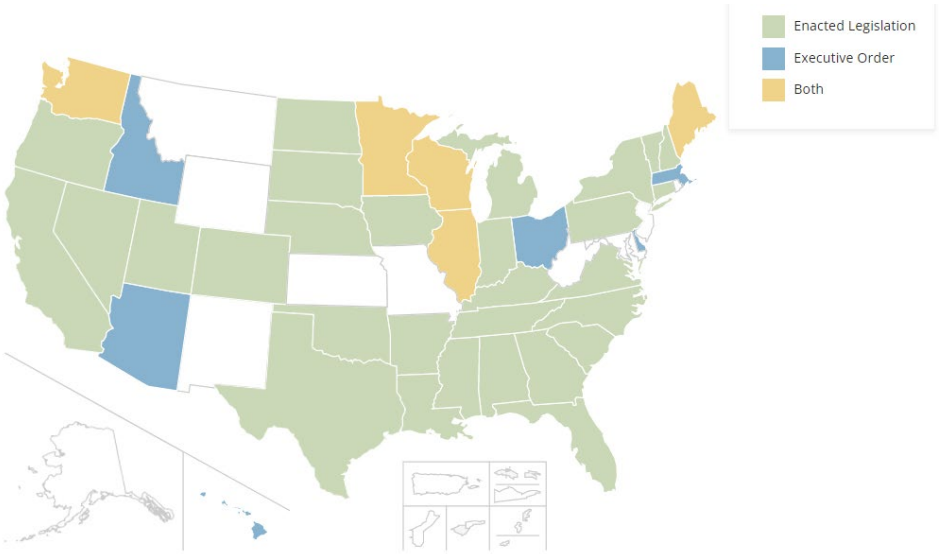


Figure 13. Map. States with AV enacted legislation and executive orders.

Source: National Conference of State Legislatures

In 2017, the House of Representatives passed the SELF Drive Act to support the testing and deployment of highly automated cars, described as a "motor vehicle that is equipped with an automated driving system capable of executing the complete dynamic driving duty on a sustained basis, other than a commercial motor vehicle." In addition, the Senate introduced S. 1885, the American Vision for Safer Transportation through the Advancement of Revolutionary Technologies (AV START) Act to create a framework for the federal government's role in guaranteeing safety of highly automated cars. The AV START Act also aimed to establish requirements for introducing highly automated cars into interstate commerce for testing, assessment, and demonstrations.

For Illinois, Governor Bruce Rauner signed Executive Order 2018-13 to direct IDOT to lead the "Autonomous Illinois" initiative to promote the development, testing, and deployment of CAV technologies and related infrastructure and data needs within Illinois. This executive order established the Autonomous Illinois Testing Program, with IDOT as the administering entity to collect and maintain information on the CAV landscape in Illinois. Moreover, IDOT was required to collaborate with state agencies and other stakeholders to develop, test, and implement CAV technology, along with overlooking permit legal testing and programs on state public roads or highways, where a licensed driver remains behind the wheel and in control of the vehicle at all times.

To date, more laws and incentives have been established in Illinois to promote EVs and use of alternative fuel (Figure 14).

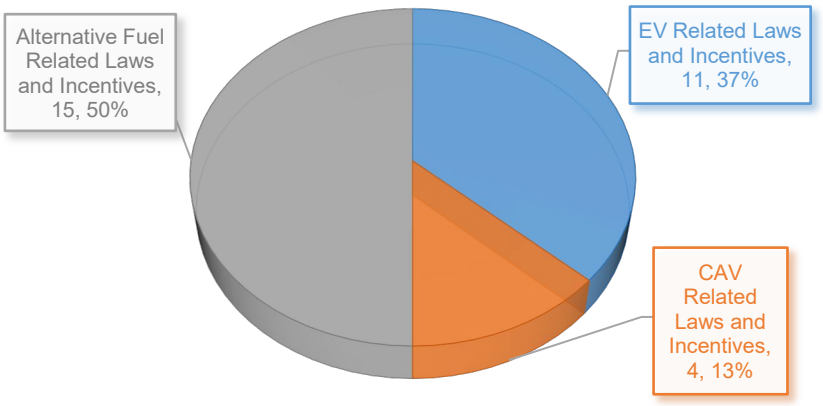


Figure 14. Chart. Breakdown of Illinois laws and incentives related to electric vehicles, connected and autonomous vehicles, and alternative fuel as of March 2023.

CASE STAKEHOLDERS

The state of Illinois' venture into CASE will require cooperation from stakeholders that will maximize mutual benefits and use of cross-cutting resources.

- IDOT—A successful CASE program will require the internal coalition of the Offices of the Secretary of Transportation, Planning and Programming, Highway Project Implementation, and Intermodal Project Implementation.
- Other State Government Agencies—CASE technologies will impact other "non-transportation" entities, including the Department of Agriculture, Department of Innovation and Technology, Emergency Management Agency, Environmental Protection Agency, Illinois Tollway, and the Office of the Secretary of State.
- Business Development—The Department of Commerce and Economic Opportunity, county-level economic development corporations, local chambers of commerce, and other groups within the Illinois Commerce Commission will be able to help identify funding streams and opportunities to bring economic opportunities to the state.
- County and Municipal Government—Established networks between the state, county, and municipal levels will be leveraged as CASE's impact on the Illinois transportation network will eventually become statewide. The state will play a significant role in assisting local governments in adapting and supporting the integration and scaling of CASE technologies.
- Metropolitan Planning Organizations—IDOT coordinates with 16 metropolitan planning organizations across the state, along with developing the STIP document and long-range transportation plans. This long-standing coordination will be critical in statewide rollout and administration of CASE technologies.

- Law Enforcement—Engagement with law enforcement will influence safe navigation and impact in responsibility and authority between human drivers and CASE vehicles to ensure that safety is the highest priority at any stage of integration.
- Academia—Illinois has top universities and community colleges that attract and train the next generation of the workforce. Leaders in global transportation research are from the Illinois Center for Transportation at the University of Illinois Urbana-Champaign, Northwestern University Transportation Center, and Urban Transportation Center at the University of Illinois Chicago, among others in the state.
- Private Industry—Key sectors across the mobility ecosystem, along with private consulting, are spearheading applying and integrating CASE technologies into the transportation system. Their engagement in research, development, community partnership, manufacturing, and distribution will be required to the future success of Illinois' CASE program.
- Nongovernmental organizations—Environmental, social, advocacy, and human-centric nongovernmental organizations' activities play a critical role in developing society, improving communities, and promoting community participation.

CASE PILLARS FOR ILLINOIS

Based on the collected information on CASE-related activities, assets, education, and workforce in Illinois, seven tactical areas of focus became evident, as illustrated in Figure 15. The focus areas are connected/automated freight, scaling ITS, farm automation, insurance, urban mobility, connected/automated logistics, and alternative fuel. Figure 16 provides the topic of each pillar.

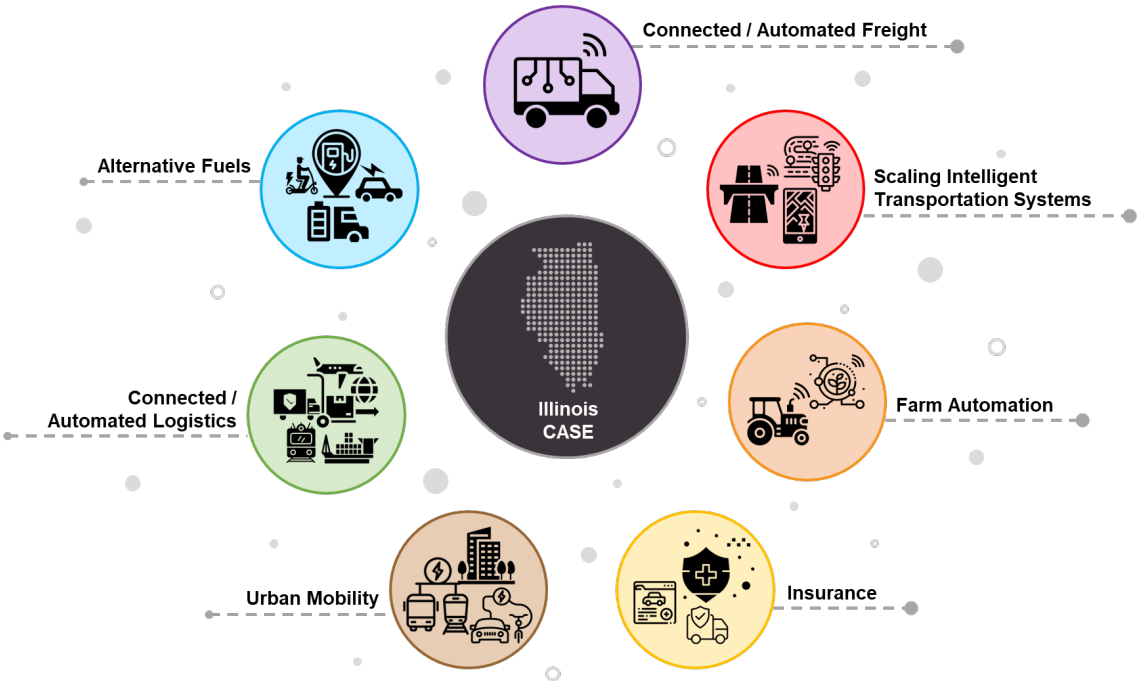


Figure 15. Diagram. CASE pillars for Illinois.

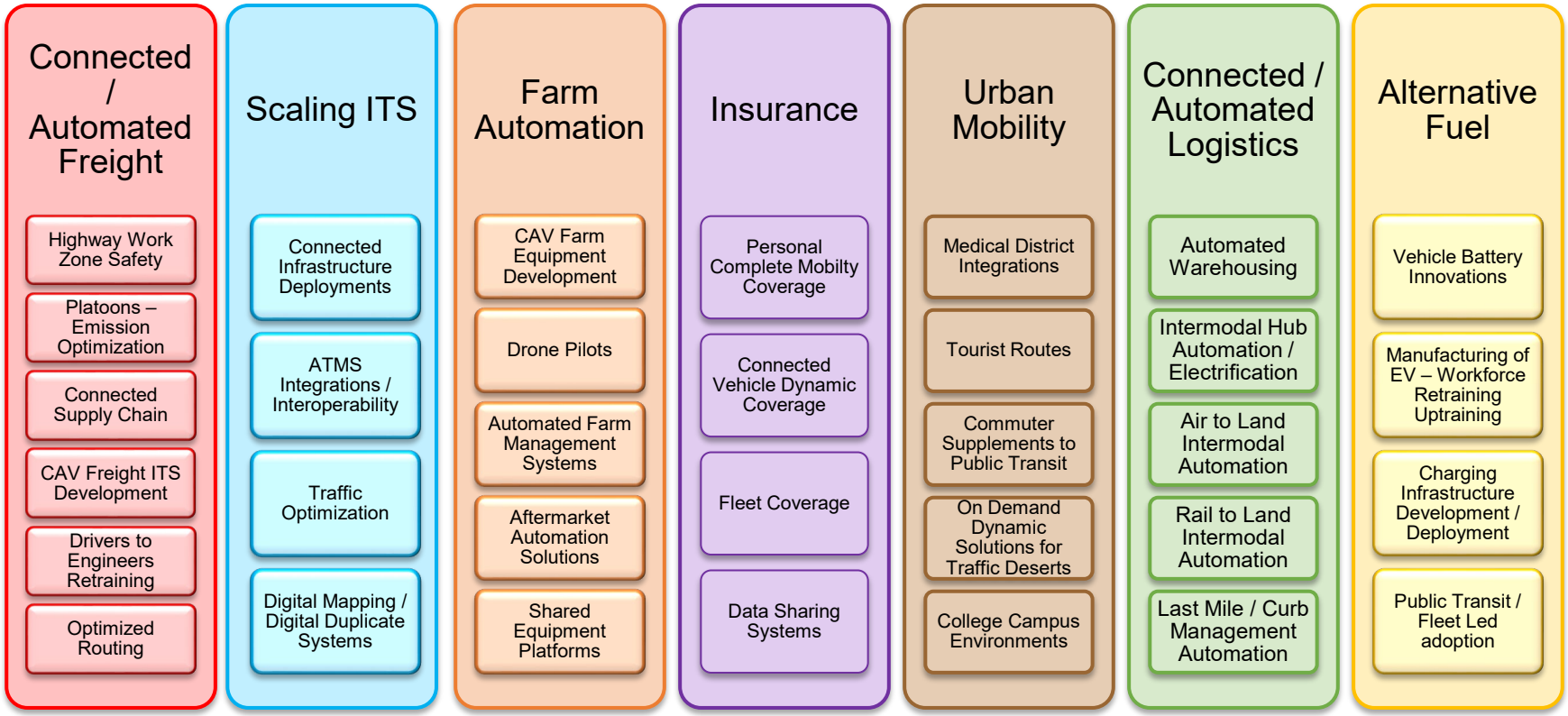


Figure 16. Diagram. Tactical focus areas for each CASE pillar.

PRIVATE INDUSTRY ASSETS

Given limited publicly available information on private industry activities, compared to ones from public agencies and academic institutions, the database included a lower count of private sector efforts. In lieu of activities, a database of facilities was organized that included locations of headquarters, manufacturing facilities, research and development (R&D), distribution centers, and satellite offices for notable companies for all seven key pillars. A total of 232 facilities were noted, spanning insurance, farm automation, urban mobility, alternative fuel, connected and automated (CA) logistics, CA freight, and scaling ITS. As enumerated in Table 1, there are 71 companies headquartered in Illinois, serving the mobility ecosystem at varying economic impacts to the state. There are 12 manufacturing facilities, most of which are focused on alternative fuels and farm automation, along with 11 R&D centers and 16 distribution centers.

Table 1. Facilities across the State of Illinois

Pillars	Headquarters	Manufacturing Facility	Research & Development	Distribution Center	Satellite Offices
Alternative Fuel	13	6	4	1	12
CA Freight	12	–	2	9	29
CA Logistics	9	–	–	6	19
Farm Automation	12	5	–	–	4
Insurance	7	–	–	–	2
Scaling ITS	6	1	5	–	44
Urban Mobility	12	–	–	–	12
Total	***71***	***12***	***11***	***16***	***122***

Figures 17 through 23 illustrate the private industry presence in Illinois for each pillar. The star marker in the figure denotes a company headquarter. Moreover, the entities are clustered in each pillar. For example, in Figure 23, the asset categories include battery manufacturing, charging station manufacturing, energy provider, installation, and OEM. In line with the workforce distribution, the majority of the private industry sector facilities are located in Cook, DuPage, and Lake Counties.

Connected/Automated Freight

The CA freight asset map demonstrates that Cook and DuPage Counties have the largest number of firms and activities tied to CA freight across the CASE ecosystem compared to other counties. Will County also has a high number of CA freight assets, given the presence of logistic and distribution companies in the Joliet area. Cook County is home to a number of original equipment manufacturers (OEMs), third-party logistics businesses (3PLs), and rail companies, the majority of which are situated in Chicago. In a similar vein, the concentration of 3PLs and CAV OEMs is higher in DuPage County.

Alternative Fuels

The asset map revealed that Cook, DuPage, and Lake Counties have the highest concentrations of businesses and activities linked to alternative fuels across the ecosystem, while other counties in the

ecosystem have a lower concentration. Specifically, the counties' shares of the alternative fuel asset map correspond to the counties' proportional contributions of academic and industrial assets. A few alternative fuel assets are present in McLean and Will Counties compared to other counties, which either have one or none. Cook County is home to a number of OEMs, battery manufacturers, charging station manufacturers, and installation companies, the majority of which are situated in Chicago. The concentration of OEMs is larger in Lake County, but the concentration of battery manufacturers is higher in DuPage County.

Scaling Intelligent Transportation Systems

Illinois is home to several companies that specialize in ITS. These are some examples, among many other companies in Illinois, that are involved in ITS and have the capability to scale their services:

- Cubic Transportation Systems (headquartered in San Diego, California, with a regional office in Chicago) designs, develops, and delivers advanced transportation systems, including fare collection systems, real-time passenger information systems, and traffic management systems.

- Siemens Mobility (headquartered in Munich, Germany, with a regional office in Chicago) designs, develops, and delivers advanced transportation systems, including fare collection systems, real-time passenger information systems, and traffic management systems.

- AECOM (headquartered in Houston, Texas, with a regional office in Chicago) provides consulting, design, construction, and management services for transportation infrastructure, including intelligent transportation systems and EVs.

- Iteris (headquartered in Santa Ana, California, with a regional office in Chicago) designs, develops, and delivers advanced transportation systems, including traffic management systems, weather information systems, and transportation analytics.

- WSP USA (headquartered in New York City, New York, with a regional office in Chicago) provides consulting, design, construction, and management services for transportation infrastructure, including intelligent transportation systems.

The scaling ITS asset map revealed that Cook and DuPage Counties again have the highest concentration of businesses and activities linked to scaling ITS. Moreover, assets are present in McLean and Will Counties at a lower concentration. Cook County is home to a number of broadband, vehicle-to-everything, advanced traffic management system (ATMS), and installation assets, most of which are located in Chicago. Additionally, ATMS companies are situated in DuPage County.

Connected/Automated Logistics

As a multimodal, global hub of freight logistics, Illinois is home to several companies that specialize in connected and automated logistics. Some examples include the following companies:

- Navistar International (headquartered in Lisle, Illinois) designs, manufactures, and sells commercial trucks, buses, and defense vehicles.

- C.H. Robinson Worldwide (headquartered in Eden Prairie, Minnesota, with a regional office in Chicago) is a 3PL provider that uses technology to connect businesses with transportation and logistics solutions.

- UPS Supply Chain Solutions (headquartered in Atlanta, Georgia, with regional locations in Illinois) provides logistics and supply chain management services, including automated warehouse solutions.

- XPO Logistics (headquartered in Greenwich, Connecticut, with regional locations in Illinois) offers transportation, logistics, and supply chain management services, including automation and digitalization.

- Echo Global Logistics (headquartered in Chicago, Illinois) provides technology-enabled transportation and supply chain management services, including automation and real-time tracking.

Although not an exhaustive list, many of the identified logistics companies are utilizing internet-of-things (IoT), artificial intelligence (AI), and machine learning (ML) to optimize and streamline their logistics operations. The CA logistics asset map reveals that Cook, DuPage, and Will Counties have the highest concentration of private industry facilities linked to CA logistics. The counties' shares of the CA logistics asset map also align with academic and industrial assets. Additional CA logistics assets are in McLean and Will Counties. A number of consulting, warehouse, and intermodal yard companies are in Cook County, mainly in Chicago. In addition, drone companies are mostly situated in DuPage County.

Farm Automation

Illinois is home to several companies that specialize in farm automation. Some examples include the following companies:

- AGCO Corporation (headquartered in Duluth, Georgia, with a regional office in Assumption, Illinois) designs, manufactures, and distributes agricultural equipment and solutions, including automated systems for planting, harvesting, and spraying.

- Deere & Company (headquartered in Moline, Illinois) manufactures and sells agricultural equipment and solutions, including precision farming technologies, such as automated guidance and data management systems.

- AG Leader Technology (headquartered in Ames, Iowa, with a regional office in Illinois) designs and manufactures precision farming equipment, such as guidance and control systems, GPS receivers, and data management software.

- Raven Industries (headquartered in Sioux Falls, South Dakota, with a regional office in Illinois) designs and manufactures precision farming equipment, such as guidance and control systems, sensors, and data management software.

- AgJunction (headquartered in Scottsdale, Arizona, with a regional office in Illinois) designs and manufactures precision farming equipment, such as guidance and control systems, sensors, and data management software.

Among the limited list, agricultural companies are making use of technology such as IoT, AI, and ML to optimize and streamline farming operations as well as to help farmers increase efficiency, reduce costs, and improve yields. The farm automation asset map revealed that Cook and DuPage Counties have the highest concentration of businesses and activities linked to farm automation, followed by McLean and Will Counties. Manufacturing and CAV OEMs facilities are mainly in Cook County, and some manufacturing companies are concentrated in DuPage County.

Urban Mobility

For urban mobility, Cook and DuPage Counties have the higher concentrations of assets with involvements in parking, payments, OEM, MAAS, routing/tracking, and curb management.

Insurance

Illinois is home to State Farm, Allstate, Country Financial, Farmers Insurance, American Family Insurance, and Nationwide Insurance. These companies are all headquartered in Illinois and employ numerous people in the state. Additionally, Illinois has a well-established regulatory environment for insurance companies. For the insurance asset map, Cook and DuPage Counties encompass the higher concentrations of assets with involvements in coverage/products, software, and research.

SUMMARY

Chapter 2 identified seven Smart Mobility pillars for Illinois—namely, CA freight, scaling ITS, farm automation, insurance, urban mobility, CA logistics, and alternative fuels. Activities and physical assets across the private, public, and academic sectors have a significant presence in Illinois—most are notably located in the northeast region of the state, reflective of the region's stronghold as the multimodal freight and logistics hub nationally and internationally. Tactical focus areas per pillar were identified, which must be cross-checked with key stakeholders in the state across an array of expertise and entities.

Furthermore, the presence of CASE activities, education programs, and workforce are evident throughout the state—in levels comparable to other states that are much more established in the field of CASE. Illinois also has established legal and regulatory guidelines as well as incentives in anticipation of increasing market penetration of CASE technologies. Illinois has clear attributes and established resources that will be significantly useful in the state's transition toward a smart mobility ecosystem but with the overarching issue of lack of strategic orchestration.

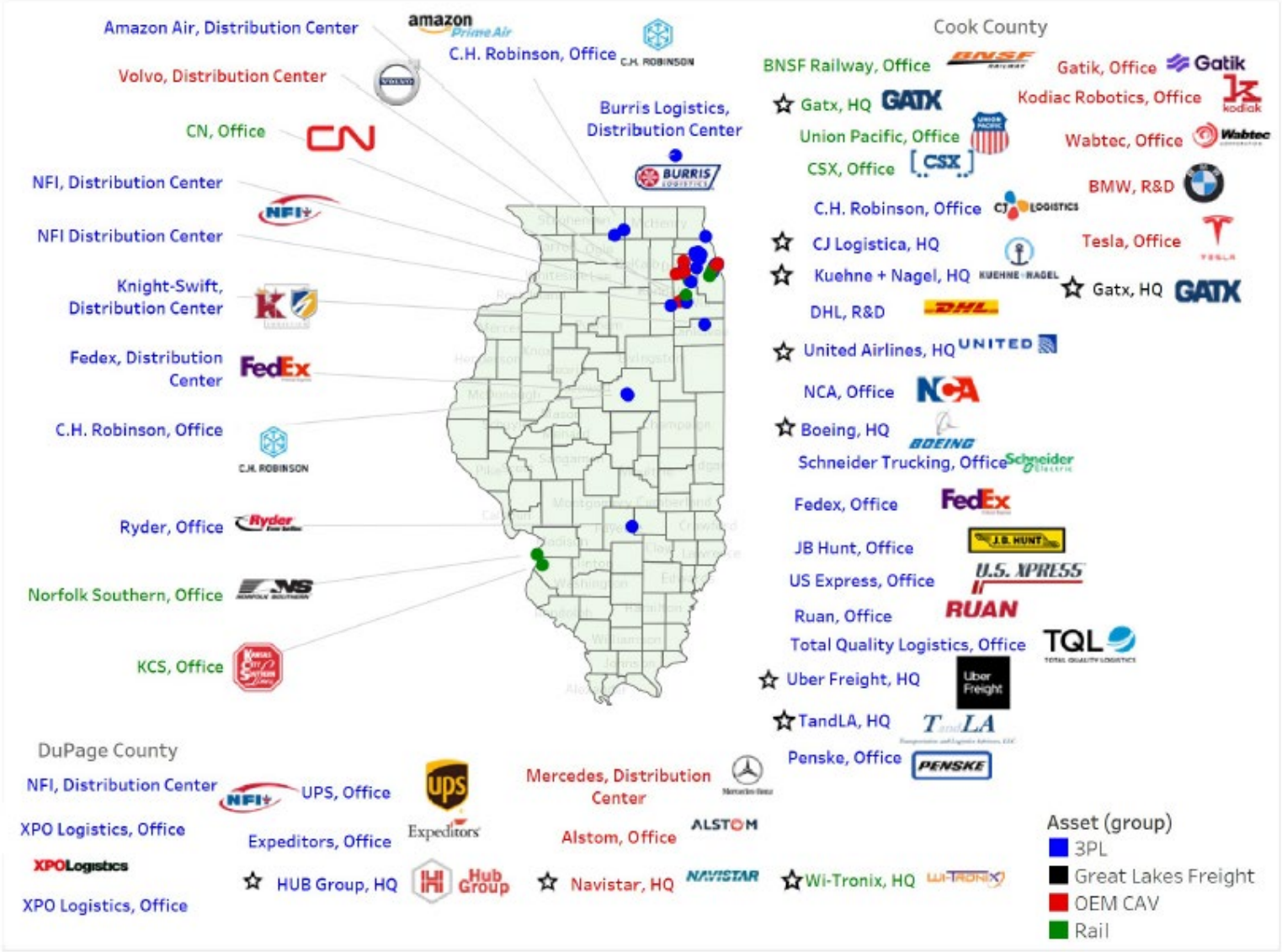


Figure 17. Map. Connected and Automated Freight asset map.

Figure 18. Map. Scaling ITS asset map.

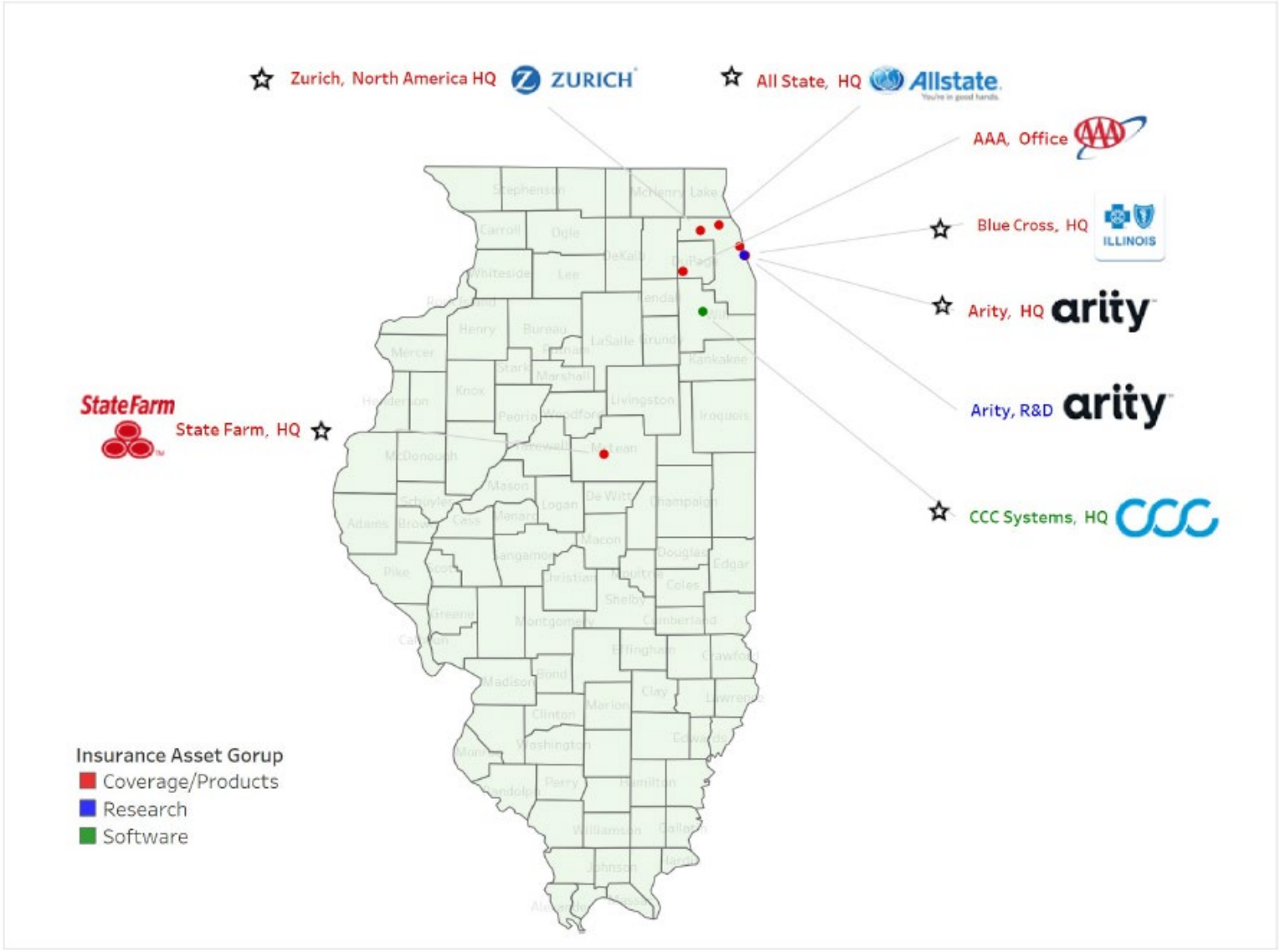


Figure 19. Map. Insurance asset map.

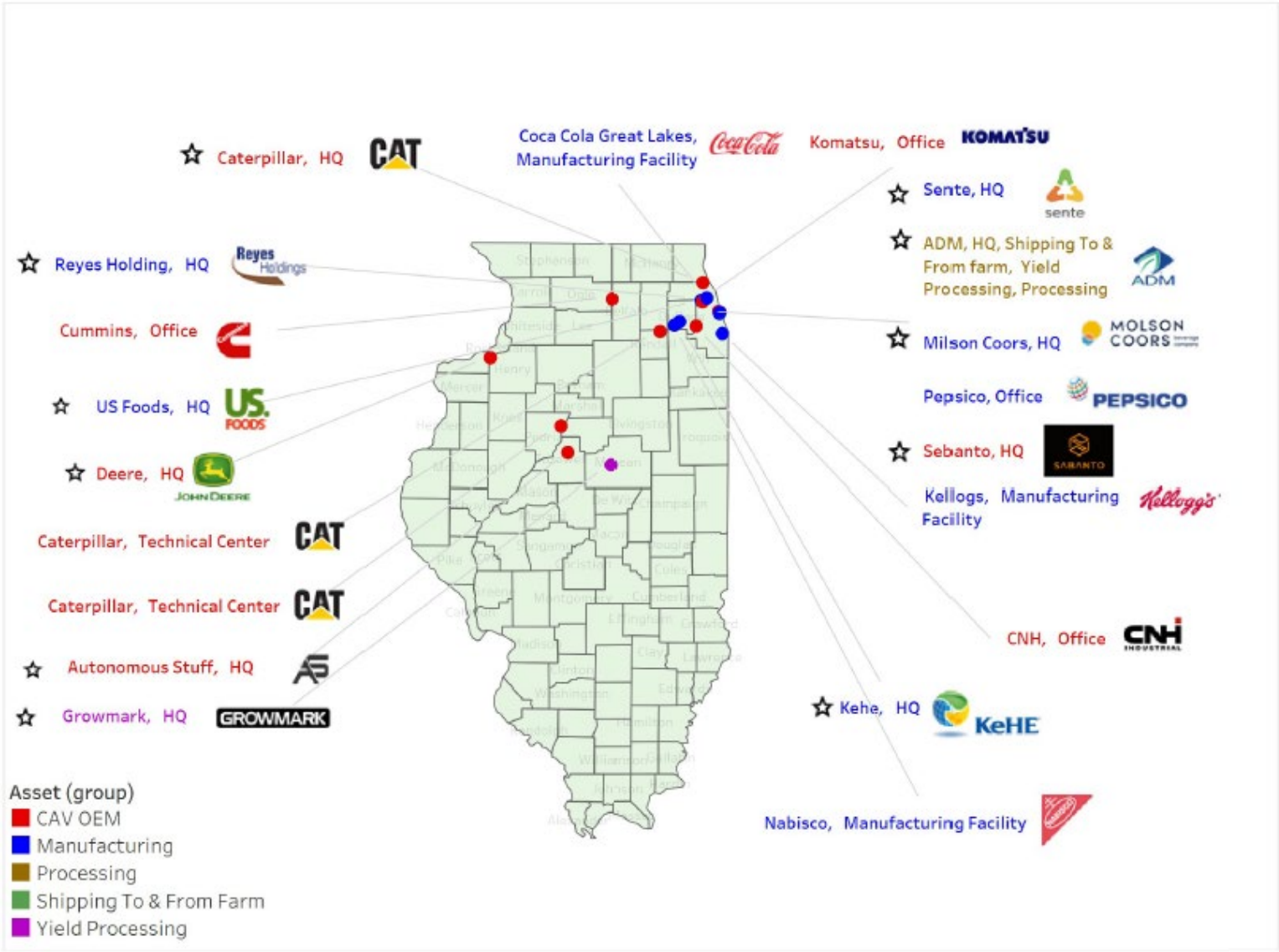


Figure 20. Map. Farm Automation asset map.

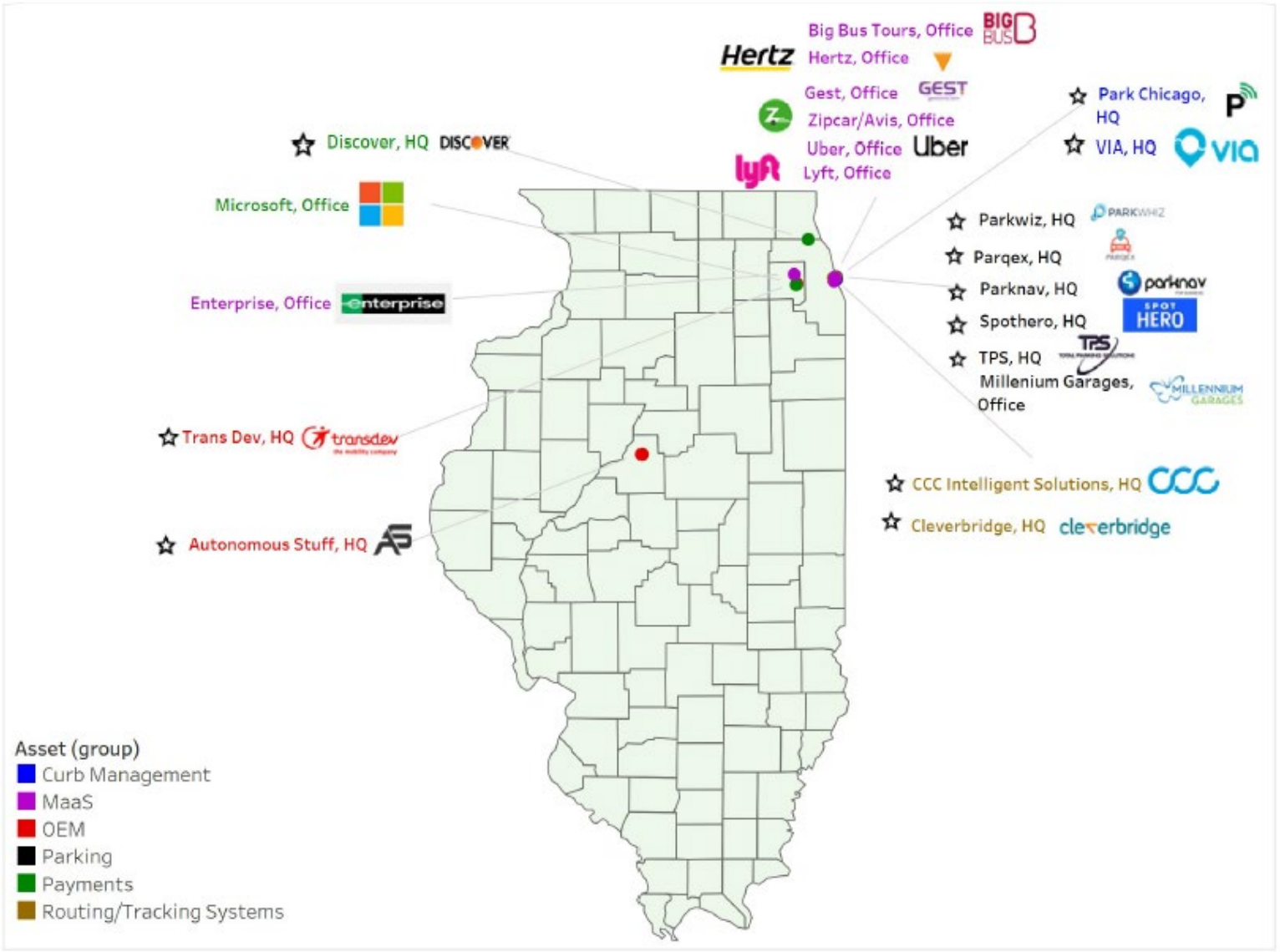


Figure 21. Map. Urban Mobility asset map.

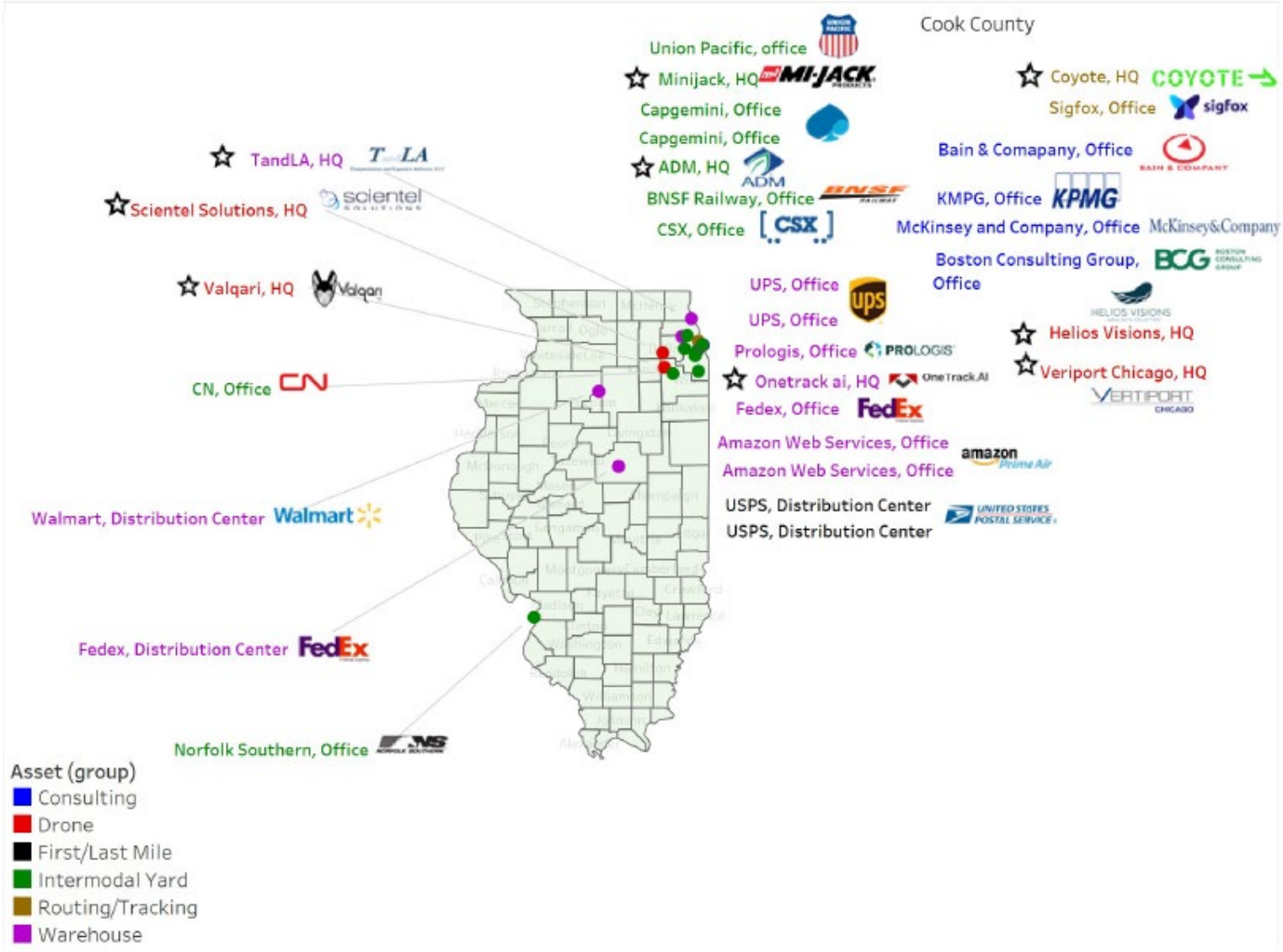


Figure 22. Map. Connected and Automated Logistics asset map.

Figure 23. Map. Alternative Fuels asset map.

CHAPTER 3: STAKEHOLDER ENGAGEMENT

A wide and diverse group of stakeholders, including representatives from state, regional, and local transportation agencies, emergency services, law enforcement, key private industries in both person and freight mobility sectors, nonprofit organizations, civic groups, academic institutions, and research facilities, were invited to participate in workshops, interviews, and surveys. The collected data served to establish key program areas and stakeholder consensus on Illinois' need prioritization and resource appropriation.

SURVEY

A detailed survey was designed, tested, and administered to the stakeholders to gather input on key statewide CAV/T needs, enumerate existing and planned efforts by both public and private sectors, and identify priorities of CAV/T integration and connectivity requirements throughout the state. Over 500 stakeholders across the private, public, and academic sectors were identified to complete the survey as the baseline database for stakeholder consensus. The questions included the following categories:

- activity location and scope
- revenue level
- employee count in organization
- CASE-related investment level (current and projected)
- engagement in CASE pillars and focus areas
- interest in business opportunities in Illinois
- competitiveness
- count in movement of goods, people, and agriculture

Questions on outlook and perspectives were appended, focusing on the impact of social and technology trends on the future of mobility and the estimated time frame of increased market penetration for self-driving, electric vehicle, and rideshare technologies.

A total of 256, 99, and 177 potential respondents received the survey corresponding to private, public, and academic sectors, respectively. Out of each sector, 55%, 35%, and 34% of the invited survey-takers responded. (The response percentages include both partial and completed surveys.) Note that most of the invited stakeholders are in Illinois; however, other pertinent stakeholders outside the state were also invited to share feedback and complete the survey.

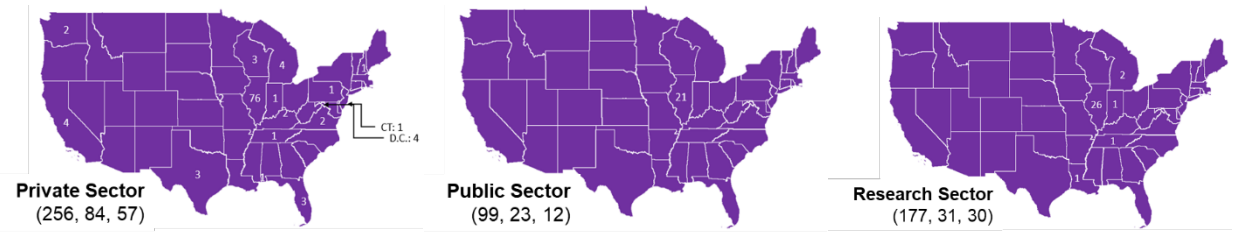


Figure 24. Map. Tally and location of responses for the private, public, and academic sectors. The total number of responders that opened the survey, fully completed the survey, and partially completed the survey are displayed in parenthesis below the maps.

Most stakeholders from any of the three sectors indicated highest engagement in alternative fuel, connected and autonomous freight, connected and autonomous logistics, and scaling ITS (Figure 25). Note that the relatively low response count from the farm automation and insurance pillars is due to a lower number of stakeholders who accepted and completed the survey invitation.

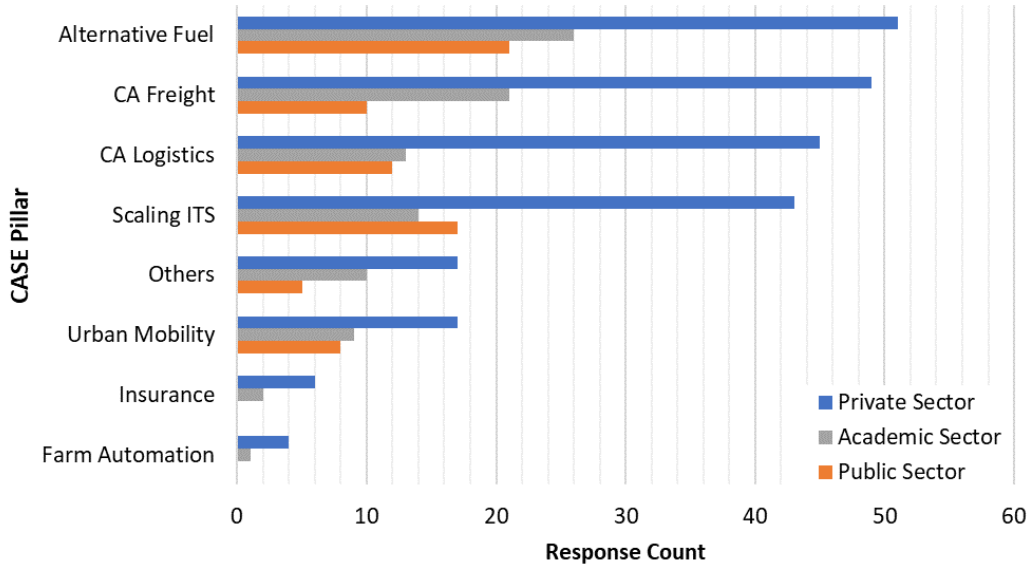


Figure 25. Graph. Tally of responses for CASE-pillar engagement.

Most private sector respondents were involved in operations, manufacturing, testing, and insurance (in decreasing response count). In contrast, the public sector consists of expertise in planning, policy, infrastructure, operations, design, compliance/equity, renewal/maintenance, legal/institutional, economics, and prototyping/testing. The academic sector respondents focused on fundamental research, education, infrastructure, vehicles, policy, planning, design, systems engineering, prototyping/testing, operations, economics, and legal/institutional.

The private sector survey included identifying locations of business activities and companies' annual revenue (Figure 26). The Illinois, other Midwest, and West categories received the highest number of responses for business locations, wherein the manufacturing column was highest for Illinois and Other Midwest. Despite the neutral consensus on competitive positioning and business

opportunities, the private sector stakeholders indicated ongoing business activities in Illinois—demonstrating that the state is in the periphery of their business strategy. The survey also indicated that projected CASE investments may positively impact the state's economy.

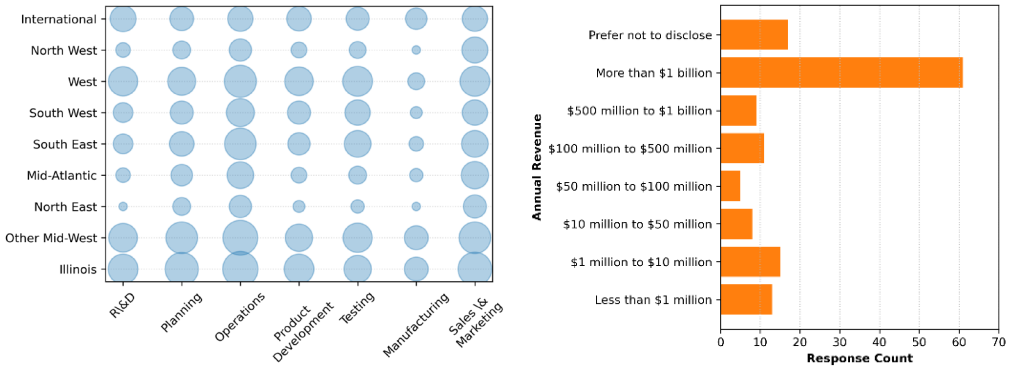


Figure 26. Graph. Activity locations and annual revenue for the private sector.

Investment levels in CASE, in percentage, were reported for all sectors, wherein most selected current and projected investments range between 0% and 10% (Figure 27). The private sector has a more notable increase in projected investments across ranges of 11% to 90% than current investments. The public sector noted the lowest response count in projected and current investments above 10% among all sectors; however, an increase in 11% to 40% budget allocation was indicated for projected investments. The academic sector indicated the least difference between the shift from current to projected investments.

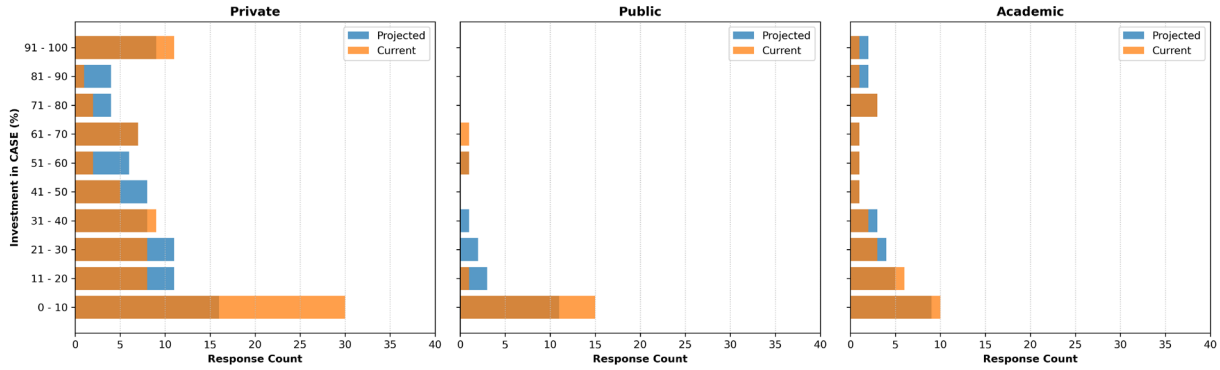


Figure 27. Graph. Tally of responses for CASE-pillar investment.

The survey included rating Illinois' competitive position in CASE-related activities (Figure 28). All three sectors mostly indicated neutral responses (i.e., score of zero between −5 and 5 for least and most competitive positioning) across all seven CASE pillars. The private sector had slightly positive positioning for insurance, CA logistics, and CA freight. The public and academic sectors had a cumulatively neutral response to Illinois' competitive positioning across most pillars, while positively rated insurance and alternative fuels. Despite the lowest number of survey responses, farm automation was rated with a positive competitive positioning for Illinois across all three sectors (Figure 25).

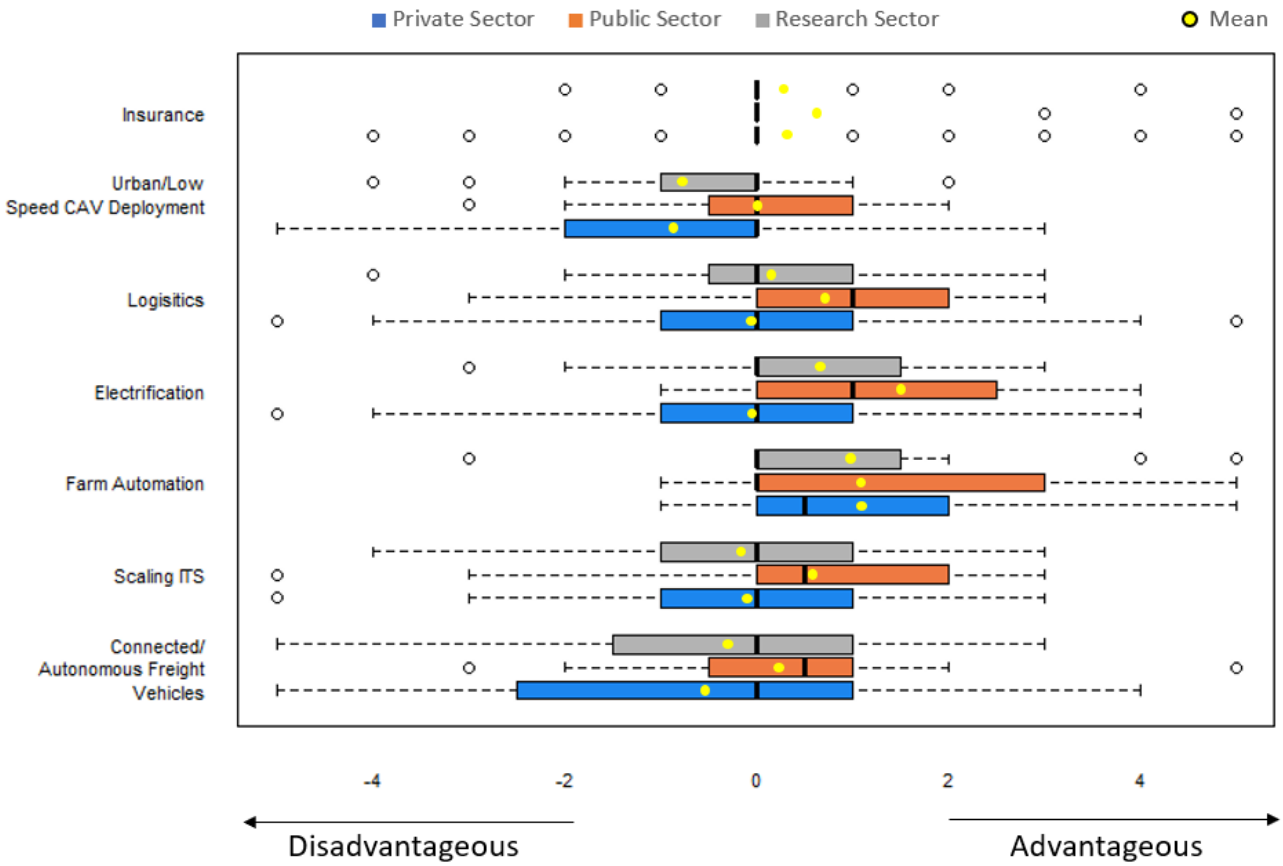


Figure 28. Graph. Tally of Illinois' competitive position in CASE.

The survey responders also provided their perspective on business opportunities in Illinois pertaining to university resources, knowledge base (or know-how), corporate partnerships, unskilled labor, skilled labor, governmental resources, testing facilities, real estate, manufacturing facilities, technology and research, and capital (Figure 29). In line with the responses to competitive positioning, the public and academic sectors provided relatively neutral responses (i.e., neither agree nor disagree). In contrast, the private sector provided relatively positive responses to Illinois business opportunities.

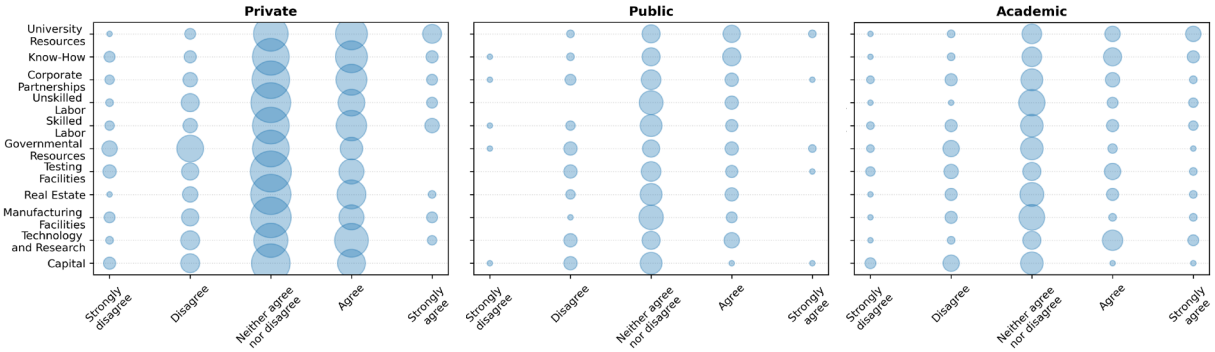


Figure 29. Graph. Tally of CASE business opportunities in Illinois (note: bigger bubble indicates higher response count).

Respondents selected the CASE pillar that relates to their organization's expertise and scope, which prompts the associated tactical focus areas (Figure 16) that were established from the synthesis. For brevity, a sampling from the CA freight pillar is presented in Figure 30, while Appendix F presents the ones for the remaining six pillars. One can identify the key focus areas that have active participation (horizontal axis) and the scope of engagement (vertical axis). For the private sector, the highest tally of responses belonged to connected supply chain and CAV freight ITS development, followed by highway work zone safety, platooning, and optimized routing. Driver retraining had the least number of responses. The public and academic sectors had similar responses, wherein CAV freight ITS development became the top focus area followed by the remaining tactical areas with relatively similar gravity, except for driver retraining. Despite the difference in CASE-pillar engagement (recall Figure 25), all sectors have similar prioritization of the tactical focus areas (Figure 30).

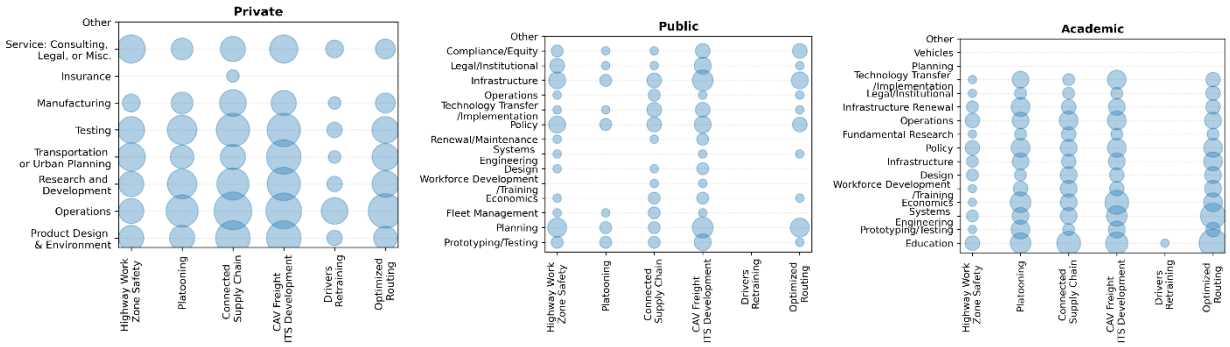


Figure 30. Graph. Tally of the entity engagement in key focus areas of the CA freight pillar.

The pillars of perceived opportunity in Illinois include alternative fuels (spanning electrification), scaling ITS, CA logistics, and farm automation, whereas CA freight was revealed to be the main area of competitive disadvantage in the state. Stakeholder outlook on the key social trends that will drive CASE technology implementation include the future of work, e-commerce, sustainability, and information security. Like social trends, the technology drivers of CASE include electrification, big data, 5G communication, application monitoring interface, cloud computing, and IoT. Supplementary survey questions on EV and CAV market penetration revealed respondents' consensus that in 5 to 10 years, 50% of passenger and last-mile delivery vehicles will be electric while Class 8 trucks will lag. Additionally, 10% CAV market penetration is anticipated to occur in at least 10 years for personal, medium-delivery, and heavy-duty vehicles.

STAKEHOLDER WORKSHOP

Two workshops were held to invite key stakeholders in Illinois across private, public, and academic sectors: (1) an in-person workshop on February 16, 2022, and (2) a virtual workshop on March 3, 2022. The attendee count was 20 and 72 for the first and second workshops, respectively. There were two breakout groups in the in-person workshop: movement of goods and people. There were five breakout categories for the virtual workshop: electrification, freight and logistics, infrastructure, scaling ITS, and urban/suburban mobility. Vehicle manufacturers, Tier 1 suppliers, software vendors, military, and public and academic sector organizations attended to represent various elements of the CASE ecosystem. Appendix E contains a full list of attendees for both workshops.

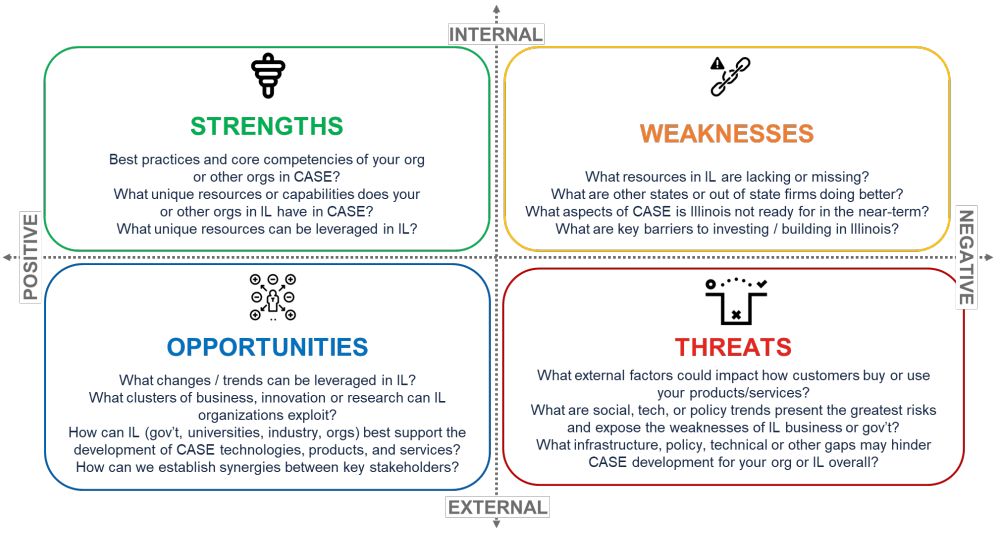


Figure 31. Diagram. SWOT analysis questions for the workshops.

SWOT Analysis

The SWOT analysis is a methodological tool designed to help an entity optimize performance, maximize potential, manage competition, and minimize risk. It identifies strengths, weaknesses, opportunities, and threats, which provides organizational awareness and aids with strategic planning and decision-making. Often presented in a two-by-two grid, the SWOT analysis is aggregated into internal and external categories. Strengths and weaknesses internally assess the organization, while opportunities and threats provide external insights. Figure 31 details the guiding questions for the SWOT analysis workshops. Summaries of Illinois' strengths, weaknesses, opportunities, and threats are enumerated in the next section.

Summary of Illinois' Strengths

- ✓ multimodal freight and logistics technology
- ✓ innovative industry players who have in-state investments
- ✓ robust multimodal public transit and road tollway network
- ✓ strong and diverse workforce talent and training network
- ✓ mix of urban, suburban, and rural environments
- ✓ all-season weather conditions

Summary of Illinois' Weaknesses

- ✗ lack of coordinated state leadership or policy
- ✗ no or lack of dedicated CAV testing facilities
- ✗ public and private investment in CASE technologies

Summary of Illinois' Opportunities

- ✓ leverage freight and logistics industry
- ✓ prepare future CASE workforce

- ✓ leadership in equitable electric charging
- ✓ better public and private funding mechanisms
- ✓ test beds—leverage Tollway investments and invest in ex-military facilities

Summary of Illinois' Threats

- × lack of cybersecurity measures
- × state bureaucracy and regulation
- × lack of CASE testbeds
- × electrification erodes fuel tax revenues
- × failure to leverage existing assets and infrastructure

INTERVIEWS

Additional one-on-one interviews were conducted for targeted conversation to fill in the gaps from the survey and the workshops. The interviewee list included:

- Private industry: AECOM, Google, Growmark, Intel, and Navistar
- Public agency: Lake County, Chicago Department of Transportation, Illinois Tollway, and Region 1 Planning Council
- Academic organization: Argonne National Lab
- Nonprofit organization: Chicago Southland Economic Development Corporation and Distillery Labs

The interviews reinforced the consensus from the survey and workshops as well as provided additional stakeholder perspective that will be incorporated in the balanced scorecard analysis.

SUMMARY

Engagements with key stakeholders from private, public, and academic sectors in Illinois through a survey, two workshops, and several interviews revealed similar findings. The seven pillars—CA freight, alternative fuels, scaling ITS, CA logistics, farm automation, urban mobility, and insurance—have active efforts and investments in Illinois. Moreover, prioritization of the tactical focus areas per pillar (identified from the synthesis) became evident.

A neutral perspective on the competitiveness and business opportunities in Illinois was similar across all responses; however, the projected investment in CASE should encourage the state to maximize in-state strengths and opportunities. Despite the lack of statewide coordination and CASE technology testing facilities, Illinois may use the revealed weaknesses and threats to develop new opportunities as the state plans for the future of mobility.

CHAPTER 4: PRIORITIZATION VIA BALANCED SCORECARD ANALYSIS

BALANCED SCORECARD OVERVIEW

The balanced scorecard is a tool that allows users to create a strategic agenda, while considering a set of measurements along with financial and non-financial data. Each information category triggers a column in the scorecard that contributes to defining strategic objectives and their corresponding prioritization. The collected information from the synthesis and stakeholder engagement are incorporated as contributing factors in the scorecard, which contribute to a final balanced score for prioritization. The final scoring of the pillars is derived from six areas: assets, investments, activities, stakeholder perspective, engagement, and competitiveness (Figure 32).

Figure 32. Diagram. Scoring framework of the balanced scorecard analysis.

The synthesis and the stakeholder engagement revealed the collective consensus of the seven pillars as critical targets of focus for Illinois. Their ranking or prioritization was unclear, so the number of assets per pillar, associated investments and engagement from the survey, compiled list of CASE activities, overall perspective on competitiveness, and stakeholder perspectives from the survey, workshop, and interview were all incorporated into a balanced score to objectively rank the pillars. The analysis of each balanced scorecard factor is described in the subsequent section.

FACTORS AFFECTING THE BALANCED SCORECARD ANALYSIS

Assets

Recall in the synthesis that information on notable private industry facilities were recorded and organized to identify physical investments of companies in Illinois—summarized in the asset maps presented earlier. Internal databases and publicly available information online were examined to filter CASE-related entities across the private industry ecosystem. Different weights were applied to the facility type, with the higher facility investment or overall operation scale having a higher weight. The assumed weighting is as follows, from most importance: headquarters (HQ), manufacturing facilities, distribution facilities, research and development (R&D) facilities, and satellite business offices. The asset score incorporates the total number of each facility type multiplied by the assumed weights. Each facility type score was then normalized to the sum of the total facilities. For example, the HQ score for alternative fuels is 18.3%, because that partition belongs to the alternative fuel pillar out of the total HQ in all pillars. The same process was applied to the rest of the facility, followed by the weighted sum per pillar.

The asset score revealed the following ranking, in descending order: alternative fuels, CA freight, farm automation, scaling ITS, CA logistics, urban mobility, and insurance (Figure 33). This ranking is due to a significant number of headquartered businesses, manufacturing facilities, and distribution facilities (top three facility weights) in Illinois belonging to the alternative fuels, CA freight, and farm automation pillars (top pillars per asset score). Recall that from the survey, farm automation ranked last in CASE engagement due to the limited number of responses but was viewed to have a positive competitiveness due to the presence of private industry. This competitiveness aligns with the shifted position of farm automation within the top three pillars per the asset score.

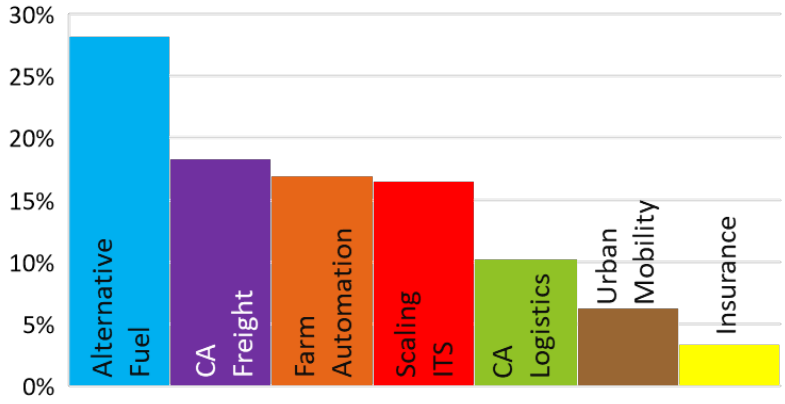


Figure 33. Chart. Ranking of pillars according to the number of assets.

Based on the distribution of assets across the pillars, most of the CASE-related assets are concentrated in Cook and DuPage Counties, followed by Lake and Will Counties. A closer inspection of the map revealed that the CASE industry has established roots and has been developing in the northeastern part of the state. This area has the potential to serve as a development catalyst for the state and to support IDOT's next steps toward CASE technologies. Moreover, the extensive presence of key stakeholders in each pillar offers partnership opportunities between the private, public, and

academic sectors. Nonprofit organizations, accelerators, academic institutions, and training colleges were appended to the asset database. Cook County is home to nearly a third of the state's 184 colleges and universities with CAV-related programs. Colleges and universities across the state have already established or have initiated CASE programs and courses to train the workforce as well as develop innovative research directives.

Activities

There are several ongoing CASE initiatives and projects in Illinois. For example, IDOT has launched the Autonomous Illinois vision and working group, which is tasked to develop a framework for the deployment and regulation of autonomous vehicles in the state. In addition, IDOT has funded several pilot projects to test the use of autonomous vehicles for various transportation applications, including public transit, freight delivery, and last-mile connectivity.

Additionally, IDOT has established the "Drive Illinois Electric" plan in support of the Climate and Equitable Jobs Act. The plan will transition the state to 100% clean energy, support a responsible transition away from carbon-intensive power generation, encourage further diversity and inclusion within the renewable energy industry, accelerate EV adoption, and expand charging station infrastructure. It will also create statewide clean energy workforce training programs and support communities facing energy transition barriers. The state has implemented various incentives and programs to encourage the adoption of EVs, such as tax credits and rebates, as well as the installation of charging infrastructure. There are also several shared mobility services operating in Illinois, including ride-hailing companies and car-sharing programs.

Overall, Illinois is actively pursuing CASE initiatives to improve the efficiency, safety, and sustainability of the mobility ecosystem. These efforts are expected to contribute to the state's economic growth and competitiveness as well as improve the quality of life of all Illinoisans. A number of CASE activities are taking place in Illinois. A few examples are listed as follows:

- Research and development: Illinois is home to a number of universities and research institutions that are actively working on developing and advancing CASE technologies. For example, Northwestern University, University of Illinois Urbana-Champaign, and University of Illinois Chicago have a strong focus on transportation research, freight logistics, electrification, and infrastructure, to name a few.

- Testing and deployment: As part of the Autonomous Illinois initiative, IDOT was tasked to create a registration system for pilot demonstrations and testing as well as to identify communities to host testing, while connecting them with companies and other groups. State law allows for Level 3 autonomous driving (i.e., conditional automation), which requires a licensed driver behind the vehicle as fallback for emergency situations. Autobon AI has tested autonomous trucks on the Illinois Tollway, and AutonomouStuff is actively testing autonomous driving software in downtown Peoria.

- Manufacturing: Illinois is home to a number of companies that manufacture components and systems for CASE technologies, such as electric vehicle batteries and charging infrastructure.

For example, Rivian has an EV manufacturing facility in Normal from stamping and body to paint, propulsion, general assembly, and end of line. Moreover, Lion Electric has the largest dedicated production site for zero-emission medium- and heavy-duty vehicle manufacturing in Joliet. It is expected to produce 20,000 vehicles per year, which is associated with 1,400 clean energy jobs for four years.

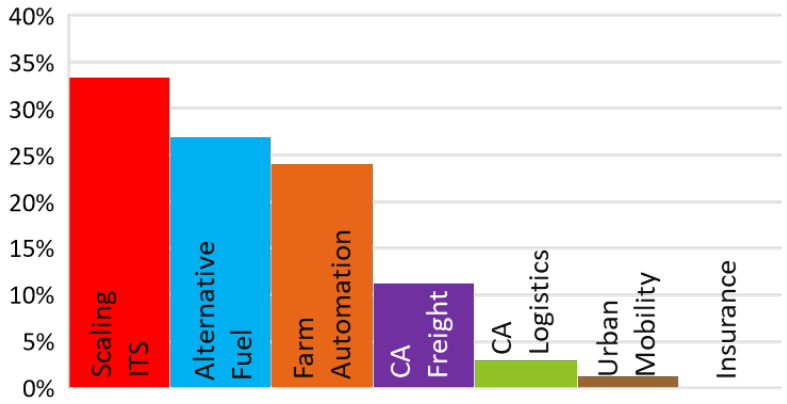


Figure 34. Chart. Ranking of pillars according to the number of activities.

These are just a few examples of the activities that are currently taking place in the CASE technology ecosystem within the state of Illinois. Companies, research institutions, and government agencies that are working to advance and deploy these technologies can be found in Illinois in significant numbers. Through in-depth research, major activities in Illinois were identified along with the associated funding (when publicly available). Each pillar had a cumulative value for all pertinent activities that were normalized to the total value. The largest share of activities and associated funding belonged to the scaling ITS pillar, followed by alternative fuels, farm automation, CA freight, CA logistics, urban mobility, and insurance (Figure 34).

Investments

Illinois has seen a number of investments related to the CASE technology ecosystem in recent years. Here are a few examples:

- Rivian, a Michigan-based electric vehicle manufacturer, invested $700 million to build an electric vehicle factory in Normal, Illinois. Since opening the manufacturing facility in McClean County in 2020, over 6,000 workers were reported in mid-2022.

- ChargePoint, a California-based provider of EV charging infrastructure, has installed charging stations across the state of Illinois, from Rockford to Mattoon.

- Electrify America, a Virginia-based company of EV charging infrastructure with an office in Chicago, has installed DC fast charging stations in Illinois that span from Rockford to Mount Vernon, along with upcoming future installations.

- Lion Electric, a medium- and heavy-duty EV manufacturer, has committed an initial investment of $70 million with the government of Illinois over a three-year period.

- Gatik, a California-based logistics company with an office in Chicago, may receive an investment of over $10 million from Microsoft Corporation to use their cloud and edge computing platform Azure in developing autonomous delivery technology for trucks.

Overall, companies have significant interest in tapping into the state of Illinois talent pool, infrastructure, and supportive business environment. In the survey, public, private, and academic stakeholders were asked to provide their organization's approximate product, project, and/or research investment currently targeted for CASE products, services, and projects in Illinois, which were integrated into the final ranking, as shown in Figure 35. According to the overall findings, investments in alternative fuels were leading in Illinois, followed by investments in CA freight, scaling ITS, urban mobility, CA logistics, insurance, and farm automation.

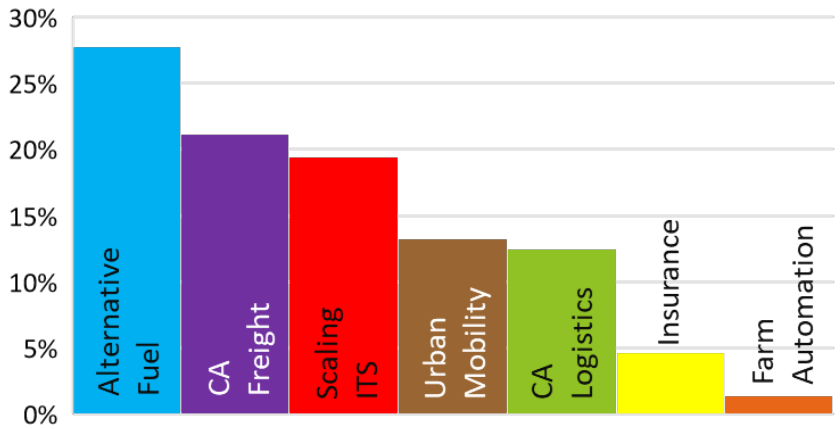


Figure 35. Chart. Ranking of pillars according to investment level.

Competitiveness

Illinois has several strengths that make it an attractive location for companies working in the CASE technology ecosystem. Overall, Illinois' combination of talent, infrastructure, government support, and a strong ecosystem make it an attractive location for companies working in the CASE technology ecosystem. A partial list of the key factors that contribute to Illinois' competitiveness follows:

- Talent: Illinois has a strong talent pool, with several top-ranked universities. These institutions produce a steady stream of highly skilled professionals who could support the development, deployment, and scaling of CASE technologies.

- Infrastructure: Illinois has a well-developed transportation infrastructure, including a network of roads, highways, and airports that support its essential role in multimodal freight logistics. A variety of safety-critical across different settings and communities exist throughout the state.

- Government support: The state of Illinois has shown a commitment to support the development of CASE technologies, with initiatives such as Autonomous Illinois and Drive Electric Illinois, and the Illinois Electric Vehicle Deployment Plan. The latter was approved by the Federal Highway Administration in September 2022.

- Strong ecosystem: Illinois is home to a wide array of companies and organizations working in CASE, including major automakers, tech startups, and research institutions—a clear opportunity for a strategic and synergistic collaboration and innovation.

There are a few potential challenges that Illinois may face related to CASE technologies, including the following, per the survey outcome:

- Competition from other states and countries: Illinois is not the only location that is attractive for companies working in CASE. Other states and countries may offer favorable business environment and/or financial incentives.

- Limited access to funding: Starting and growing a technology company is expensive, and access to funding could be a major factor in a company's success. While Illinois has several resources available to support technology startups, it may not be as well-funded as other areas, such as Silicon Valley. However, Chicago has been recently coined as the new logistics tech hub, which may enhance Illinois' competitive position.

- Regulatory hurdles: The development and deployment of CASE technologies often requires navigating a complex regulatory environment. In Illinois, this could involve obtaining permits, complying with safety regulations, and working with various government agencies. Currently, overall guidance could benefit from improvements (e.g., the state law only allows Level 3 automation).

- Infrastructure challenges: While Illinois has a well-developed transportation infrastructure, there may still be challenges to deploying CASE technologies, such as limited access to long-range charging infrastructure for EVs or limited connectivity in certain areas.

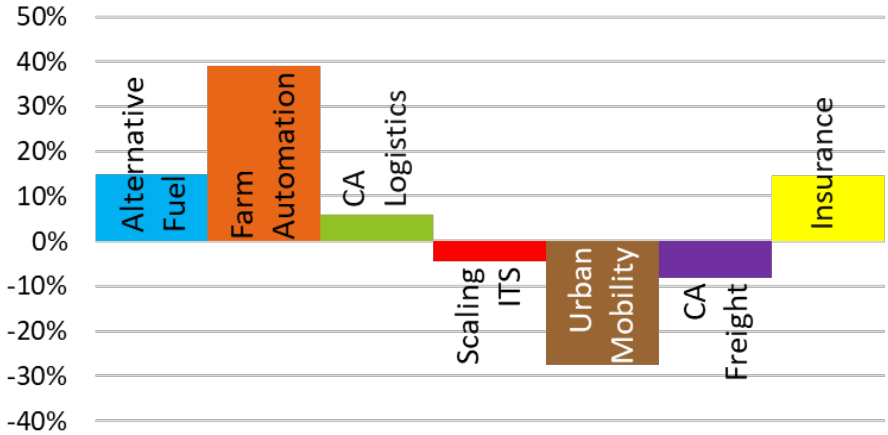


Figure 36. Chart. Ranking of pillars according to competitiveness.

In the survey, public, private, and academic stakeholders were asked to rate Illinois' relative competitiveness in relation to the seven pillars: Alternative fuels, CA freight, scaling ITS, urban mobility, CA logistics, insurance, and farm automation. Illinois exhibited the greatest competitiveness over other states in farm automation (highest rated), insurance, alternative fuels, and CA logistics, while urban mobility was collectively rated as the lowest, followed by CA freight and scaling ITS (Figure 36).

Engagement

Stakeholder engagement in CASE varies by level and scope. As part of the survey, the stakeholders provided information on their engagement in each pillar, along with key focus area per pillar. The obtained data were aggregated and an associated cumulative score for all private, public, and academic sectors was calculated to help rank the pillars according to stakeholder engagement and to prioritize the key focus areas for each pillar (recall Figure 16).

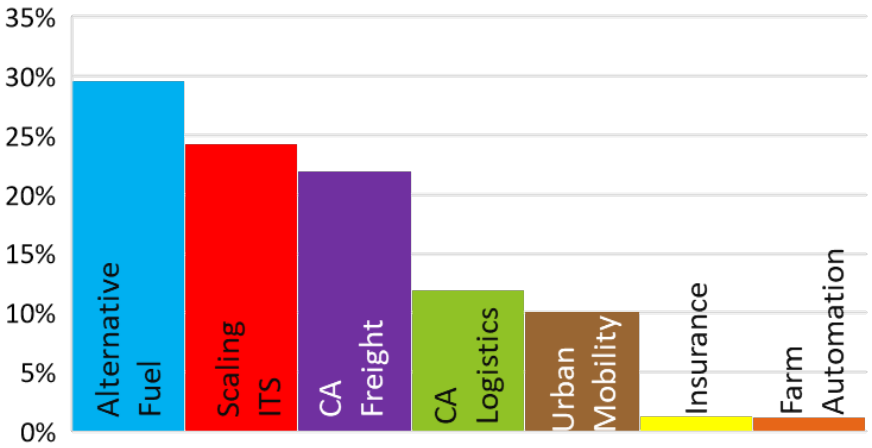


Figure 37. Chart. Ranking of pillars according to stakeholder engagement.

Figure 37 illustrates the pillar ranking based on stakeholder engagement, wherein alternative fuels was ranked first, followed by CA freight, scaling ITS, urban mobility, CA logistics, insurance, and farm automation. A sample ranking of the key focus areas is presented in Figure 38, wherein the top five focus areas (per stakeholder engagement) were charging infrastructure development/deployment from the alternative fuels pillar, connected infrastructure deployments from the scaling ITS pillar, vehicle battery innovations from the alternative fuels pillar, public transit/fleet-led adoption from the alternative fuels pillar, and traffic optimization from the scaling ITS pillar. Across all pillars, the top focus areas stemmed from the alternative fuels and scaling ITS pillars. Note that the same process was applied to the rest of the seven CASE pillars.

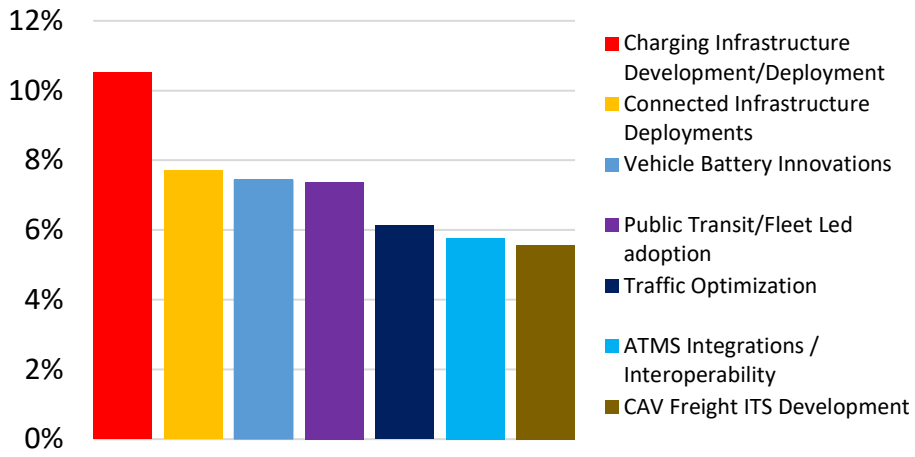


Figure 38. Chart. Ranking of key focus areas for the alternative fuels pillar according to stakeholder engagement.

Stakeholder Perspective

The survey was designed to gather a broad range of stakeholders' views on CASE technology, including the perceived benefits and challenges, the potential impacts on various industries and organizations, and concerns on future deployment and integration. Apart from numeric-based responses (e.g., employee count, investment, percentage of expenditures in CASE, rating with respect to competitiveness, and selection of pillar and focus area), the survey and workshops gathered important information on the stakeholders' experience and perspective for the future of the CASE ecosystem in Illinois.

A workshop was held that brought together a diverse group of stakeholders, including representatives from private industries, nongovernment organizations, academia, and public agencies. The workshop's goal was to identify the internal and external factors that may impact the adoption and implementation of CASE technology in Illinois. During the workshop and through facilitated discussions and brainstorming, the attendees completed a strengths, weaknesses, opportunities, and threats (SWOT) analysis associated with CASE technology in Illinois. Given that the information is in the form of text, natural language processing (NLP), which is a subfield of artificial intelligence that deals with interactions between computers and humans using natural language, was used to quantify and score the stakeholders' input from the survey and SWOT analyses as they pertain to the seven CASE pillars.

NLP could analyze text inputs, akin to social media companies using posted text responses online. In this case, the stakeholder survey output and workshops were processed via NLP to draw insights and sentiments, which were translated into a metric for the scorecard. Sentiment analysis (one of the NLP techniques) was used to determine the overall sentiment (i.e., view or attitude) of the text responses. The analysis identified trends in the stakeholders' opinions and aided to understand if the sentiment is positive or negative toward the seven pillars and key focus areas. The sentiment of the response could be quantified on a scale (e.g., negative, neutral, positive) or as a numeric score (e.g., −1 to +1).

Additionally, topic modeling was implemented to identify main themes and issues that stakeholders are significantly invested in for their organization's current and future priorities.

The state could benefit from the collective insight to strategically prepare and maximize resources for CASE technology integration. As illustrated in Figure 39, the ranking with the highest positive sentiment was the alternative fuels pillar, followed by CA logistics, CA freight, urban mobility, scaling ITS, farm automation, and insurance. Note that insurance was ranked the lowest, given the scarcity of data from the low number of attendees compared to the other pillars.

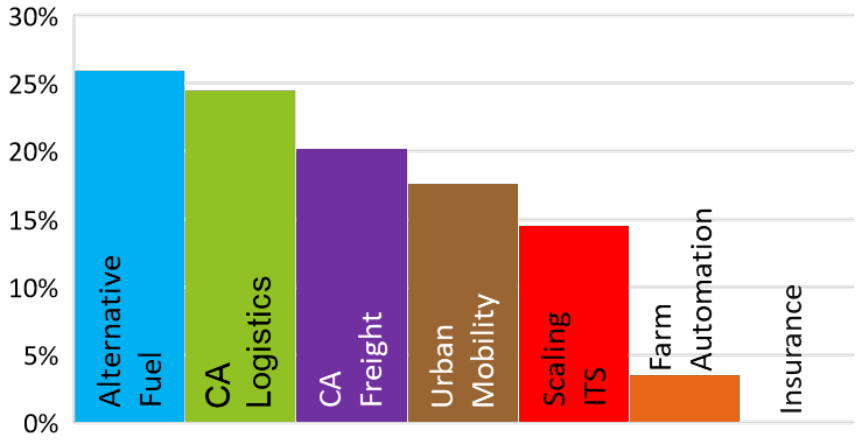


Figure 39. Chart. Ranking of pillars according to stakeholder perspectives.

SCORECARD SUMMARY

An evaluation of Illinois' readiness for CASE integration was completed through synthesis and stakeholder engagement via survey, workshops, and interviews. To combine all numeric and text data, a balanced scorecard analysis was completed to objectively rank the CASE pillars and to prioritize the identified needs from stakeholder consensus while strategically aligning them with Illinois' strengths and resources. The scorecard balanced multiple criteria—namely, industry presence, workforce talent, education, investments, legal and regulatory framework, CASE-related activities and engagement, competitiveness, and collective opinions.

The balanced scorecard analysis ranked the pillars as follows (from highest): alternative fuels, scaling ITS, CA freight, farm automation, CA logistics, insurance, and urban mobility (Figure 40). This final ranking incorporates all collected data from the synthesis (assets, CAV-related training programs, universities and colleges, and activities) and stakeholder engagement. As each scorecard factor was appended to the score, shifting in the pillar importance was observed, but the top three remained near each other and were always ranked highly across all criteria: alternative fuels, scaling ITS, and CA freight.

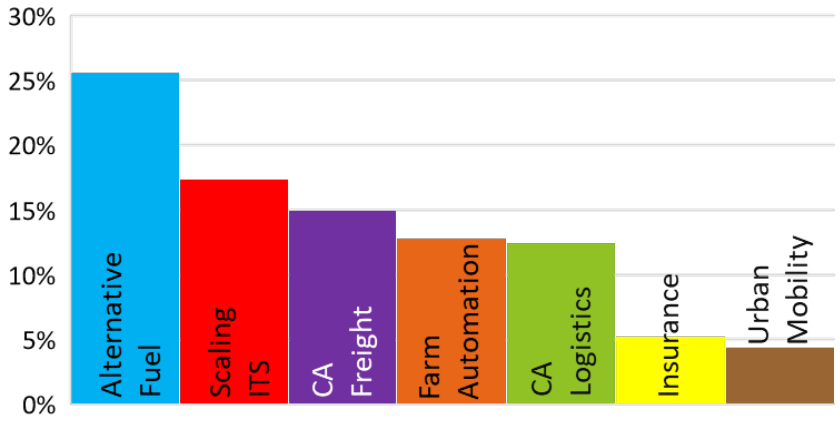


Figure 40. Chart. Final ranking of pillars per the balanced scorecard.

The alternative fuels pillar was leading for Illinois, with an emphasis on EV manufacturing and charging infrastructure development and deployment. Recall that the alternative fuels pillar included the key focus areas of vehicle battery innovations, alternative energy, and manufacturing EVs (workforce retraining/uptraining), charging infrastructure development/deployment, public transit/fleet-led adoption, and clean energy production in the mobility ecosystem. In addition, the alternative fuels pillar was the highest scored pillar for assets (i.e., industry presence), investments, and stakeholder perspective. It was the second highest pillar with respect to competitiveness. Based on collective stakeholder perspective, engagement, and activities, the top two key focus areas were manufacturing of EVs (workforce retraining/uptraining) and charging infrastructure development/deployment, followed by public transit/fleet-led adoption and vehicle battery innovations.

Scaling ITS was the second highest ranked pillar in Illinois. Based on the scorecard factors, scaling ITS received the fourth highest asset score (industry presence), third highest score under investments, highest score with number of activities pursued in Illinois, second highest score with engagement, fifth highest score with competitiveness, and second highest score based on stakeholder perspective. Moreover, traffic optimization and connected infrastructure deployments were the top two key focus areas, followed by ATMS integrations/interoperability and digital mapping/digital duplicate systems. Centralized traffic management and road safety through connectivity were major emerging technologies in traffic optimization, whereas 5G network improvements, pedestrian ITS connectivity, and smart road were major emerging technologies under the connected infrastructure deployments focus area.

Connected and automated freight was the third pillar in the balanced scorecard. CA freight received the second highest asset score (industry presence), second highest score in investments, fourth highest rank in terms of activities, third highest rank in terms of engagement in the public and private sector, sixth highest competitiveness score among seven pillars, and third highest score in terms of stakeholder perspective of CA freight in Illinois. Additionally, CA freight was centered around key focus areas of highway work zone safety, platoons (emissions optimization), connected supply chain, CAV freight ITS development, drivers-to-engineers retraining, and optimized routing.

Based on stakeholders' collective perspective, engagement, and activities, CAV freight ITS development and platoons (emission optimization) were the top two key focus areas, followed by highway work zone safety and optimized routing. Major emerging technologies were the autonomous freight corridor and freight technology under the CAV freight ITS development focus area, while connected long-haul trucks and autonomous trucks were the major emerging technologies under platoons. Lastly, advanced driver notification was the major emerging technology for highway work zone safety.

Farm automation was the fourth highest ranked pillar, which received the third highest asset score based on industry presence, the lowest score with investments, third highest score with activities, lowest score with engagement, highest score with competitiveness, and sixth ranking based on stakeholder perspective. Based on stakeholder perspective, engagement, and activities, the top key focus areas were CAV farm equipment development and automated farm management systems, followed by drone pilots. Major emerging technologies were advanced agriculture and goods delivery.

Connected and automated logistics, ranked fifth, was slightly below farm automation. CA logistics had the fifth highest asset, investment, and activities score, fourth highest engagement and competitiveness score, and second highest score based on collective stakeholder perspective. Major key focus areas under CA logistics are intermodal hub automation/electrification and last-mile/curb management automation, followed by automated warehousing. Major emerging technologies were drone delivery technology and smart logistics.

Insurance was ranked as the sixth pillar. In contrast to other pillars, the number of assets and participation relatively curtailed the ranking of the insurance pillar. However, it is important to incorporate insurance organizations into Illinois' blueprint for Smart Mobility, given the role they play in the CASE ecosystem. Insurance was the third highest in the competitiveness score by the stakeholders; Illinois is the home for major insurance company headquarters.

Urban mobility ranked last in the balanced scorecard. The combination of low industry presence and stakeholder perception contributed to its low ranking, including the perceived lowest competitiveness in the CASE ecosystem for Illinois. The key focus areas for the urban mobility pillar were related to personal mobility and public transportation. Additionally, the emerging technologies for this pillar were ridesharing, micro-transit mobility, and shared on-demand autonomous vehicles.

CHAPTER 5: ACTIONS AND RECOMMENDATIONS

In assessing Illinois' preparedness and trajectory toward a smart mobility and clean energy ecosystem, a data-gathering approach (via synthesis and stakeholder engagement) was completed. The following key questions drive Illinois' CASE blueprint:

- What available and future resources are needed?
- Which entities and organizations have established and invested in the state of Illinois?
- Where are the activities and efforts occurring, and which type of communities are such efforts serving?
- What immediate steps and orchestrated milestones in the future must be completed by key stakeholders to improve Illinois' readiness for CASE?

At a glance, Illinois has propelling strengths and curtailing weaknesses that make the path to a synergistic CASE ecosystem unclear. According to the general comments by the stakeholders, Illinois is powered by the following:

- ✓ a diverse workforce and start-up environment
- ✓ agency incentives for private industry
- ✓ workforce development programs
- ✓ universities and colleges with CASE-related programs
- ✓ availability of labor
- ✓ willingness to pursue innovative directives
- ✓ strong community group
- ✓ need for CASE technology and program
- ✓ opportunity for digital equity

However, the state's transition to CASE must abate some key issues in the following areas:

- × workforce preparedness
- × funding opportunities (e.g., via venture capitalists) and disorganized funding structure
- × low investments in advanced transportation hardware
- × risk-averse mentality in the public sector
- × missing CASE agenda for the state
- × restrictive policies
- × labor union
- × legacy agencies and associated status quo
- × insufficient knowledge in CASE

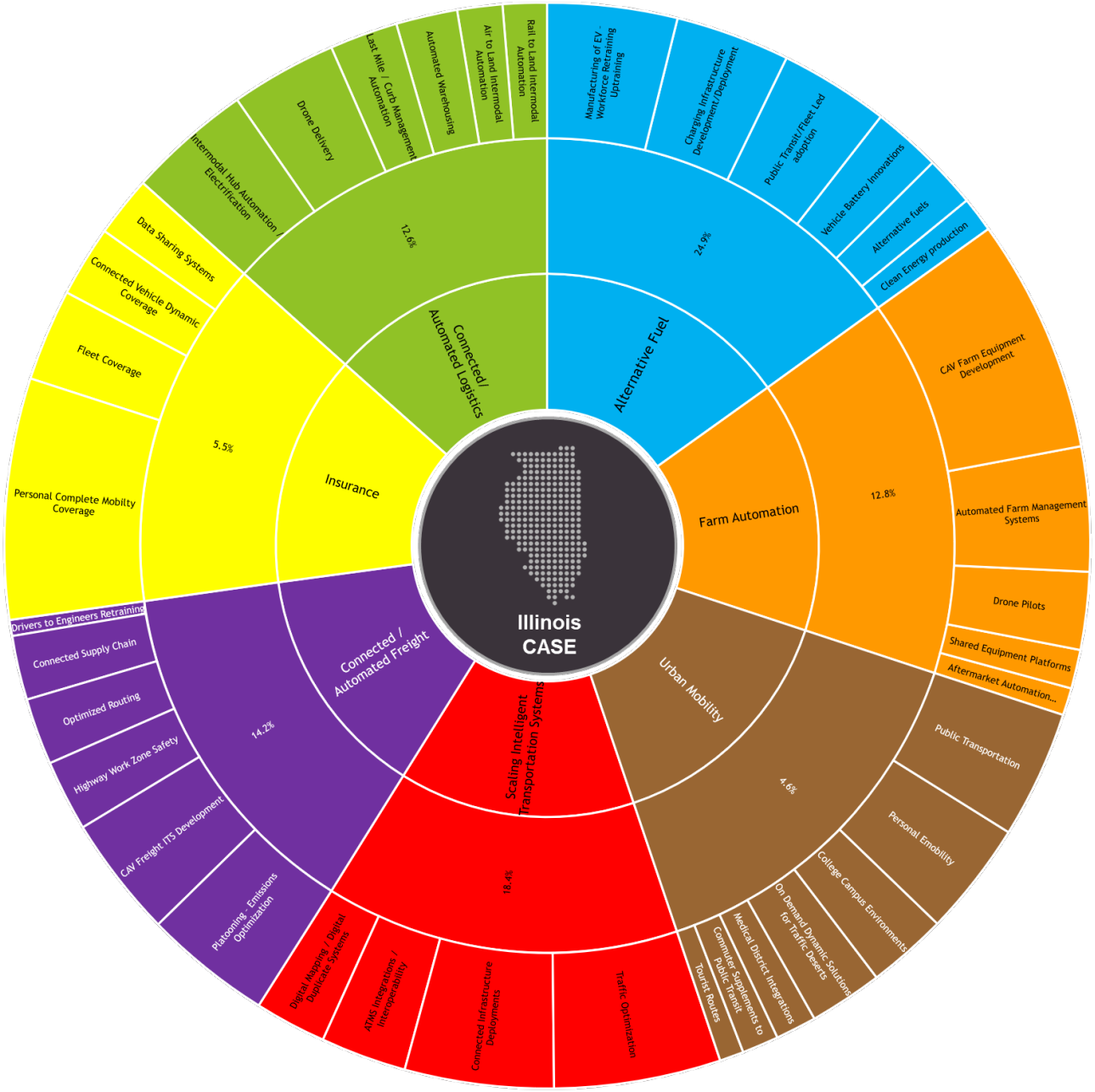


Figure 41. Chart. Tactical focus area prioritization per CASE pillar.

Despite the lag in establishing Illinois' stronghold in CASE, the most compelling finding from the balanced scorecard analysis is the extent and scope of readily available assets, unlinked CASE activities, and poor orchestration between key sectors—meaning Illinois' lag in CASE is not necessarily attributed to lack of resources. Instead, it is due to unidentified synergies and strategies across the mobility ecosystem. IDOT may lead as the champion for smart mobility, but CASE stakeholders across other state government agencies, business developments, county and municipal governments, metropolitan planning organizations, law enforcement, academia, private industries, and nongovernmental organizations must also participate and collectively contribute to build and

dynamically adapt Illinois' smart mobility blueprint. In the previous chapter, an objective means of ranking Illinois' CASE pillars revealed the following ranking: alternative fuels, scaling ITS, CA freight, farm automation, CA logistics, insurance, and urban mobility (Figure 40). The scorecard and NLP techniques were implemented to rank the key focus areas objectively, serving as Illinois' action items and recommended prioritized next steps. The following section details the prioritization of the key focus areas for Illinois. Figure 41 illustrates three rings, starting from the outer one: ranking of key focus areas (with the larger area pertaining to a higher ranking), final balanced score per pillar (with a larger score for the higher pillar ranking), and the pillar name (innermost ring).

KEY FOCUS AREAS FOR ILLINOIS

Confirmation of the tactical focus areas (established from the synthesis) became evident following the balanced scorecard analysis. Through maximizing all available data from the synthesis and stakeholder engagement, the key focus areas were also ranked using the balanced scorecard framework—aimed to prioritize the focus areas. Moreover, the associated investment per focus area was aggregated based on the survey responses.

For the alternative fuels pillar, the charging infrastructure development and deployment ranked as the first tactical focus area. Some of the emerging technologies associated with this focus area include charging infrastructure technology (perceived to be most critical) and urban curbside management. Synergistic collaborations between researchers in technology development and efficiency optimization; private industry in commercialization, scaling, and maintenance; and public agency ownership with respect to infrastructure and energy resource management are required to ensure the effective delivery of this action item. Ranking of the remaining core areas include (from highest) vehicle battery innovations, public transit/fleet-led adoption, and manufacturing of EVs (workforce retraining/uptraining).

For scaling ITS, connected infrastructure deployments rose to the top-ranking key focus areas per the overall score and allocated funding. This focus area's associated emerging topics are ITS connectivity, Illinois Tollway SmartRoad, 5G network connectivity, and connected road infrastructure (ranked from highest). On the other hand, the third-ranked pillar, CA freight, has tactical focus areas of CAV freight ITS development and connected supply chain according to stakeholder consensus and total allocation funding categories, respectively. The emerging technologies of interest include freight technology, autonomous freight corridor/lane, vehicle-to-vehicle communication, broadband connection, and shared technology.

Moreover, for CA logistics, air-to-land intermodal automation and last-mile/curb management automation were the top-ranked focus areas according to the overall core and allocated investment, respectively. The farm automation pillar revealed that the top key focus area is automated farm management, with an emerging topic on goods delivery regarding advanced agriculture applications. Lastly, the insurance pillar ranked personal mobility coverage as the leading focus area according to the collective stakeholder input. Ranking of the key focus area per CASE pillar for the state of Illinois is detailed in Table 2. As the state formulates the strategy for CASE, the listing not only provides the overall ranking of CASE directives with respect to the pillar, but also the lower-barrier-to-entry

tactical focus areas that Illinois can readily explore and invest, given the assets, resources, workforce, and positive perspective by the key stakeholders that will support such an endeavor. The state must champion the effort and coalesce the resources and stakeholders to strategically orchestrate and inclusively benefit private and public industries, academia, and nongovernmental organizations.

Table 2. Prioritized Key Focus Areas Per CASE Pillar

Ranked Pillars	Ranked Key Focus Areas
Alternative Fuel	1. Charging Infrastructure Development/Deployment 2. Vehicle Battery Innovations 3. Public Transit/Fleet-led Adoption 4. Manufacturing of EVs—Workforce Retraining/Uptraining 5. Clean Energy Production 6. Alternative Fuels
Scaling Intelligent Transportation Systems	1. Connected Infrastructure Deployments 2. ATMS Integrations/Interoperability 3. Traffic Optimization 1. Digital Mapping/Digital Duplicate Systems
Connected / Automated Freight	1. CAV Freight ITS Development 2. Connected Supply Chain 3. Optimized Routing 4. Platoons—Emission Optimization 5. Highway Work Zone Safety 6. Drivers to Engineers Retraining
Farm Automation	1. Automated Farm Management Systems 2. CAV Farm Equipment Development 3. Drone Pilots 4. Shared Equipment Platforms 5. Aftermarket Automation Solutions
Connected/ Automated Logistics	1. Rail to Land Intermodal Automation 2. Air to Land Intermodal Automation 3. Last-mile/Curb Management Automation 4. Intermodal Hub Automation/Electrification 5. Automated Warehousing 6. Drone Delivery
Insurance	1. Personal Complete Mobility Coverage 2. Fleet Coverage 3. Connected Vehicle Dynamic Coverage 4. Data Sharing Systems
Urban Mobility	1. Public Transportation 2. On-Demand Dynamic Solutions for Traffic Deserts 3. College Campus Environments 4. Commuter Supplements to Public Transit 5. Tourist Routes 6. Medical District Integrations 7. Personal E-mobility

NEAR-TERM ACTIONS FOR ILLINOIS

This section presents suggested actions that IDOT may consider supporting the goals and strategies of the Illinois CASE program. These actions could be directly leveraged as the baseline list to create IDOT's CASE Strategic Plan.

Objective 1—Establish an Organizational Structure to Set the Direction of CASE and to Coordinate Related Planning, Actions, and Needs across IDOT

The first objective deals with establishing a group of IDOT individuals who will champion CASE as the key directive for IDOT to pursue and sustain, akin to the Bureau of Materials and Physical Research which is dedicated to quality assurance in materials testing and physical research. The Illinois CASE organizational structure would comprise of high-level guidance and low-level (or detailed/specific) expertise, as a direct resource for IDOT in CASE technologies.

Action Item 1.1—Establish CASE/Smart Mobility Standing Committee

As IDOT pursues more CASE activities that directly enrich its knowledge base and experience, an internal structure should be established that would provide guidance and oversight on CASE initiatives. The standing committee would coordinate planning and strategize actions across the agency. A member from the Offices of Planning and Programming, Highways Project Implementation, Intermodal Project Implementation, Communications, Legislative Affairs, Finance and Administration, and Business and Workforce Diversity could be part of the committee. The committee would work closely with the Secretary of Transportation and the Smart Mobility Lead.

Action Item 1.2—Establish CASE/Smart Mobility Lead

Under the Office of Planning and Programming, a Smart Mobility Lead may be designated as the main coordinator of CASE activities and integration, while closely working with the standing committee to ensure that CASE efforts and activities align with the standing committee's overall goals. This person would act as the main liaison to external groups from private, public, and academic sectors, communicating new findings and opportunities to the standing committee.

Action Item 1.3—Establish a CASE Technical Advisory Group

The CASE technical advisory group (TAG) would be responsible for pursuing multidisciplinary efforts across cross-cutting CASE topics, including giving guidance to research needs statements administered via the Illinois Center for Transportation (ICT). IDOT has already established eight TAGs, and this would be the ninth. The team would ensure that IDOT will sustain CASE activities and efforts, while actively pursuing external partnerships and collaborations to further enrich the knowledge base and experience of IDOT. Optimally, a technical lead for each identified pillar should be included in the team to adequately represent cross-cutting interests in CASE.

Objective 2—Enrich Knowledge Base in CASE Technologies and Participate in Collaborative Training Opportunities and Research

Action Item 2.1—Create CASE Training Programs for IDOT Personnel

In line with continuing education for professionals, the Smart Mobility Standing Committee will identify training programs and educational materials for IDOT leadership and personnel. Such training opportunities will allow personnel to stay up-to-date and to create effective tools for CASE planning and integration. The committee may also coordinate with private and academic sectors to enrich the training materials, including tours or site visits to facilities with CASE programs and activities.

Action Item 2.2—Participate in Pooled Fund Studies Related to CASE

Through the guidance of the standing committee, IDOT may pursue participation in pooled fund studies related to CASE technology deployment (currently State of Illinois may not lead a pool fund per legislation). Presently, Illinois is participating in the Connected Vehicle Pooled Fund Study, led by the Virginia Department of Transportation and alongside 23 partners throughout the country. The objectives of this pooled fund study include technology transfer to transportation agencies; creation of a multi-phase program to facilitate research, field demonstration, and evaluation of connected vehicle infrastructure, vehicles, and application; and aid agencies to scale the use of connected vehicles. Additionally, the automated vehicle pooled fund study is active and is led by the Ohio Department of Transportation in partnership with 10 state DOTs. (Illinois is not a participant.) The main objective is to establish projects in vehicle-roadway interactions, spanning data failures and mitigation methods, standards development, and interoperability across state borders.

Objective 3—Pursue CASE Demonstration and Pilot Studies to Tailor Solutions to Illinois Needs

Action Item 3.1—Test and Deploy in a Controlled Setting

Given the safety-critical scenarios of CASE technologies, IDOT may leverage the planned Illinois Autonomous and Connected Track (I-ACT), spearheaded by ICT and in partnership with Governors State University, IDOT, Illinois Tollway, Northwestern University, University of Illinois Chicago, Smart Mobility Illinois, and the Village of Rantoul, among others. (Discussions with private industry are ongoing). The I-ACT facility aims to offer a closed-loop facility for freight testing, alternative fuel/electrification development, smart infrastructure monitoring, 5G connectivity, connectivity (infrastructure-to-vehicle, vehicle-to-vehicle, infrastructure-to-network), and energy harvesting as baseline capabilities. The testing features and evolving databases will continue to expand, which IDOT may access.

Action Item 3.2—Explore Validation Opportunities for Pilot Tests and Deployments in Illinois

Among ongoing efforts from Illinois Tollway and the Peoria region, IDOT should pursue pilot testing and deployment in a variety of settings and communities in Illinois. Despite the availability of CASE technologies, guidance in allowing such technologies to safely traverse Illinois roadways is limited. To establish community-specific solutions, IDOT may explore a variety of initial implementation settings

and environments for CASE pilot efforts. This continued growth in experience will provide valuable insights and data to establish future standards and protocols to scale CASE technologies statewide.

Objective 4—Prepare Illinois' Transportation Infrastructure for CASE Technology Integration

Action Item 4.1—Participate in Efforts Evaluating Infrastructure Improvements for CASE Technology Integration

Highway and transit infrastructure requirements for CASE technology integration will rely on best practices from pilot and demonstration projects, CASE research, CASE technology capabilities, and collaborative implementation of national standards. IDOT may consider exploring multimodal CASE pilot projects to improve Illinois' CASE infrastructure readiness.

Action Item 4.2—Incorporate CASE Technology in Planning Activities

CASE technologies are bound to disrupt the entire mobility ecosystem, so incorporating their impact at the early stages of planning is crucial. IDOT may utilize scenario-based transportation modeling to identify critical changes to planning with respect to capital investment, asset management, safety, and project-specific planning, along with their statewide implications.

Action Item 4.3—Develop and Update Standards to Allow CASE Technology Adoption

IDOT standards serve state project guidance and at local and municipal levels. Hence, IDOT may continue to actively participate in standard development at the national level. Once CASE technologies are at a higher maturity level and more widespread, CASE-related standards could become part of the statewide ITS architecture and project design protocols.

Objective 5—Strategize with External Stakeholders for Partnerships, Continued Engagement, and Collaboration on Competing for Funding Opportunities

Action Item 5.1—Collaborate with Key Stakeholders to Establish a CASE Forum

Lack of strategic orchestrations and partnerships across sectors became evident from the aggregated dataset and balanced scorecard analysis (presented earlier). IDOT should work with key stakeholders to establish CASE forums that would lead to strategic partnerships and collaborations, which would improve the state's readiness for advanced mobility technologies.

Action Item 5.2—Pursue Partnerships to Compete for Funding Opportunities

Given the database of private industries, public agencies, academic institutions, and nongovernmental organizations, along with the priority list of CASE pillars and key focus areas, IDOT may leverage the database to form partnerships to seek new funding sources that would support CASE activities. Moreover, partnerships may also be maximized to improve CASE education and workforce training, research, and large-scale deployment plans in Illinois.

Objective 6—Expand Laws, Regulations, and Policies That Will Promote Success of CASE Technologies in Illinois

Action Item 6.1—Establish CASE Legislative Task Force

Among the current CAV and electrification legislation, IDOT should consider establishing a CASE legislative task force, including representation from the Offices of Policy, Secretary of State, Insurance, and Emergency Management Agency to recommend specific amendments to Illinois laws and regulations. The established legislative framework will dynamically update as CASE technologies continue to mature for safe and efficient deployment on Illinois roadways.

Action Item 6.2—Participate in Regional Policy Efforts

Recently, MAASTO released the 2030 CAV Regional Strategy to set short-, medium-, and long-term priorities for the region, involving DOT organizational readiness, data sharing, AV legislation, AV freight and platoons, research, planning and forecasting, and local and tribe coordination. Illinois may consider continuing to participate in the forefront of defining the CASE agenda for the state and the region in alignment with national planning efforts and transportation action plan.

DIRECTIVES AND OPPORTUNITIES FOR ILLINOIS

1. ***Safety****: CASE technology will be leveraged to improve the safety of the Illinois mobility ecosystem* in alignment with Illinois' Long-Range Transportation Plan of significantly reducing traffic fatalities and serious injuries on all public roads

   1.1 Scaling ITS Focus Area: Deploy ITS technologies to establish a connected infrastructure and to adapt to current industry standards.

   Priority Level
   - Time frame: Immediately
   - Cost: Medium
   - IDOT staff effort: Medium
   - Impact: Internal and external

   Identified Lead: Office of Planning and Programming (Bureaus of Planning, Programming, and Innovative Project Delivery)

   Other Internal Stakeholders
   - Office of Highways and Project Implementation
   - Office of Intermodal Project Implementation

   1.2 Scaling ITS Focus Area: Optimize traffic with increasing CASE technology market penetration.

   Priority Level
   - Time frame: 1–5 years
   - Cost: Low/Medium
   - IDOT staff effort: Medium
   - Impact: Internal and external

Identified Lead: Office of Highways and Project Implementation (Bureaus of Operations, and Safety Programs and Engineering)

Other Internal Stakeholders

- Office of Planning and Programming
- Office of Intermodal Project Implementation

1.3 CA Freight Focus Area: Improve highway work zone safety with CASE technologies.

Priority Level

- Time frame: Immediately
- Cost: Low/Medium
- IDOT staff effort: Medium
- Impact: Internal and external

Identified Lead: Office of Highways and Project Implementation (Bureaus of Operations, and Safety Programs and Engineering)

Other Internal Stakeholders

- Office of Planning and Programming
- Office of Intermodal Project Implementation

2. Robust Freight Logistics

2.1 CA Freight Focus Area: Deploy and integrate CAV Freight ITS technologies.

Priority Level

- Time frame: 5–10 years
- Cost: Medium
- IDOT staff effort: Medium
- Impact: Internal and External

Identified Lead: Office of Planning and Programming (Bureaus of Planning, Programming, and Innovative Project Delivery)

Other Internal/External Stakeholders

- Office of Highways and Project Implementation
- Office of Intermodal Project Implementation
- Private industry

2.2 CA Freight Focus Area: Integrate connected supply chain CASE technologies.

Priority Level

- Time frame: 5–10 years
- Cost: Low
- IDOT staff effort: Low
- Impact: Internal and External

Identified Lead: Private industry

Other Internal/External Stakeholders

- Office of Highways and Project Implementation

- Office of Intermodal Project Implementation

2.3 CA Freight Focus Area: Optimize CA Freight routing.

Priority Level

- Time frame: 1–5 years
- Cost: Medium
- IDOT staff effort: Medium
- Impact: Internal and External

Identified Lead: Office of Intermodal Project Implementation

Other Internal/External Stakeholders

- Office of Planning and Programming
- Office of Highways and Project Implementation

2.4 CA Logistics Focus Area: Implement rail-to-land and air-to-land automation technologies.

Priority Level

- Time frame: 5–10 years
- Cost: Medium
- IDOT staff effort: Medium
- Impact: Internal and External

Identified Lead: Office of Intermodal Project Implementation

Other Internal/External Stakeholders

- Office of Planning and Programming
- Office of Highways and Project Implementation

2.5 CA Logistics Focus Area: Implement automated and electrified intermodal hub technologies.

Priority Level

- Time frame: 5–10 years
- Cost: Medium
- IDOT staff effort: Medium
- Impact: Internal and External

Identified Lead: Office of Intermodal Project Implementation

Other Internal/External Stakeholders

- Office of Planning and Programming
- Office of Highways and Project Implementation

3. Optimized Urban Mobility and Reduced Congestion

3.1 Alternative Fuels Focus Area: Adopt electrified fleets and work closely with local and municipal entities to provide infrastructure support for electrified public transit.

Priority Level

- Time frame: 1–5 years
- Cost: High

- IDOT staff effort: Medium
- Impact: Internal and external

Identified Lead: Office of Planning and Programming (Bureau of Innovative Project Delivery)
Other Internal Stakeholders

- Office of Highways and Project Implementation
- Office of Intermodal Project Implementation

3.2 Farm Automation Focus Area: Pilot drone deliveries.
Priority Level

- Time frame: 5–10 years
- Cost: Low
- IDOT staff effort: Low
- Impact: External

Identified Lead: Private industry
Other Internal/External Stakeholders

- Department of Commerce and Economic Opportunity
- Academic universities

3.3 CA Logistics Focus Area: Implement last-mile and curb management automation.
Priority Level

- Time frame: 5–10 years
- Cost: Low
- IDOT staff effort: Low
- Impact: Internal and External

Identified Lead: Local and municipal transportation agencies
Other Internal/External Stakeholders

- Office of Planning and Programming
- Office of Highways and Project Implementation

3.4 CA Logistics Focus Area: Integrate drone delivery.
Priority Level

- Time frame: 5–10 years
- Cost: Low
- IDOT staff effort: Low
- Impact: External

Identified Lead: Private industry
Other Internal/External Stakeholders

- Department of Commerce and Economic Opportunity
- Academic universities
- Office of Intermodal Project Implementation

3.5 Urban Focus Area: Implement CASE technologies in public transportation, traffic deserts, college campus, tourist routes, and medical district.

Priority Level

- Time frame: 5–10 years
- Cost: Low
- IDOT staff effort: Low
- Impact: External

Identified Lead: Private industry

Other Internal/External Stakeholders

- Office of Intermodal Project Implementation
- Local and municipal transportation agencies
- Department of Commerce and Economic Opportunity
- Academic universities

4. Alternative Energy Resources and Environmental Impact

4.1 Alternative Fuels Focus Area: Develop, deploy, and manage EV charging infrastructure.

Priority Level

- Time frame: Immediately
- Cost: High
- IDOT staff effort: Medium
- Impact: Internal and external

Identified Lead: Office of Planning and Programming (Bureau of Innovative Project Delivery)

Other Internal Stakeholders

- Office of Highways and Project Implementation
- Office of Intermodal Project Implementation

4.2 Alternative Fuels Focus Area: Innovate vehicle battery technology.

Priority Level

- Time frame: 1–5 years
- Cost: None
- IDOT staff effort: None
- Impact: External

Identified Lead: Private industry

Other External Stakeholders

- Department of Commerce and Economic Opportunity
- Academic universities

4.3 Alternative Fuels Focus Area: Integrate clean and alternative energy sources.

Priority Level

- Time frame: 1–5 years
- Cost: Medium
- IDOT staff effort: Medium

- Impact: Internal and External

Identified Lead: Office of Planning and Programming (Bureaus of Planning, Programming, and Innovative Project Delivery)

Other Internal/External Stakeholders

- Office of Highways and Project Implementation
- Office of Intermodal Project Implementation
- Department of Commerce and Economic Opportunity
- Private industry

4.4 CA Freight Focus Area: Reduce emissions via optimized truck platooning.

Priority Level

- Time frame: 1–5 years
- Cost: None
- IDOT staff effort: None
- Impact: External

Identified Lead: Private industry

Other Internal Stakeholders

- Office of Intermodal Project Implementation
- Environmental Protection Agency
- Academic institutions

5. Standards and Interoperable Platforms

5.1 Scaling ITS Focus Area: Integrate ATMS and ensure interoperability features to support CASE technologies.

Priority Level

- Time frame: 1–5 years
- Cost: Medium
- IDOT staff effort: Medium
- Impact: Internal and external

Identified Lead: Office of Planning and Programming

Other Internal Stakeholders

- Office of Highways and Project Implementation
- Office of Intermodal Project Implementation

6. Information Sharing

6.1 Scaling ITS Focus Area: Integrate digital mapping, including digital duplicate systems, for service planning and monitoring.

Priority Level

- Time frame: 1–5 years
- Cost: High
- IDOT staff effort: Medium

- Impact: Internal and external

Identified Lead: Office of Planning and Programming
Other Internal Stakeholders
- Office of Highways and Project Implementation
- Office of Intermodal Project Implementation

6.2 Farm Automation Focus Area: Integrate shared, autonomous farm equipment platforms.
Priority Level
- Time frame: 5–10 years
- Cost: Low
- IDOT staff effort: Low
- Impact: External

Identified Lead: Private industry
Other Internal/External Stakeholders
- Department of Agriculture
- Department of Commerce and Economic Opportunity
- Academic universities

6.3 Insurance Focus Area: Integrate data-sharing systems.
Priority Level
- Time frame: 1–5 years
- Cost: Low
- IDOT staff effort: Low
- Impact: External

Identified Lead: Private industry
Other Internal/External Stakeholders
- Department of Commerce and Economic Opportunity
- Emergency Management Agency
- Central Management Services

7. Cross-Cutting Economic Opportunities

7.1 Farm Automation Focus Area: Integrate automated farm management systems.
Priority Level
- Time frame: 1–5 years
- Cost: None
- IDOT staff effort: None
- Impact: External

Identified Lead: Private industry
Other External Stakeholders
- Department of Agriculture

- Department of Commerce and Economic Opportunity
- Academic universities

7.2 Farm Automation Focus Area: Develop CAV farm equipment.

Priority Level

- Time frame: 1–5 years
- Cost: None
- IDOT staff effort: None
- Impact: External

Identified Lead: Private industry

Other External Stakeholders

- Department of Agriculture
- Department of Commerce and Economic Opportunity
- Academic universities

7.3 Farm Automation Focus Area: Implement aftermarket automation solutions.

Priority Level

- Time frame: 1–5 years
- Cost: None
- IDOT staff effort: None
- Impact: External

Identified Lead: Private industry

Other External Stakeholders

- Department of Agriculture
- Department of Commerce and Economic Opportunity
- Academic universities

7.4 CA Logistics Focus Area: Implement automated warehousing technologies.

Priority Level

- Time frame: 1–5 years
- Cost: None
- IDOT staff effort: None
- Impact: External

Identified Lead: Private industry

Other External Stakeholders

- Department of Commerce and Economic Opportunity
- Academic universities

7.5 Insurance Focus Area: Provide coverage for personal mobility, fleet, and connected vehicles.

Priority Level

- Time frame: 5–10 years
- Cost: None

- IDOT staff effort: None
- Impact: External

Identified Lead: Private industry
Other External Stakeholders
- Department of Commerce and Economic Opportunity
- Emergency Management Agency
- Central Management Services

8. Next-Gen Workforce Training and Development

8.1 Alternative Fuels Focus Area: Establish retraining/uptraining programs for EV manufacturing.
Priority Level
- Time frame: Immediately
- Cost: None
- IDOT staff effort: None
- Impact: External

Identified Lead: Department of Commerce and Economic Opportunity
Other External Stakeholders
- Office of Business and Workforce Diversity
- Academic universities
- Community and technical colleges
- Private industry

8.2 CA Freight Focus Area: Establish CAV driver retraining programs.
Priority Level
- Time frame: Immediately
- Cost: None
- IDOT staff effort: None
- Impact: External

Identified Lead: Department of Commerce and Economic Opportunity
Other External Stakeholders
- Office of Business and Workforce Diversity
- Academic universities
- Community and technical colleges
- Private industry

RISK ASSESSMENT

Computing power and miniaturization, communications, and networking as well as an increase in the volume of data and access to it have accelerated the innovation in transportation technologies. This has the potential to transform Illinois' transportation system and people's mobility throughout the

state. In spite of the tremendous benefits to the state of Illinois' transportation system, social impact should be considered.

CASE technology advancements may make the transportation system safer, more reliable, and more accessible, all while reducing its negative effects on the environment. However, the same technologies may have the potential to negatively influence travel demand and mobility as well as patterns of land use and the environment. Even while the magnitude of the potential repercussions to the transportation system in the next decades is not yet known, state and municipal agencies have been brainstorming possible impacts.

A well-thought-out list of objectives and ideal results for the state of Illinois' transportation system would serve as the focal point of the risk assessment process. Eight fundamental aims were identified and presented in Figure 42. The presented risk assessment focuses on mitigating negative impacts of emerging CASE technologies. The risk assessment illustrates possible effects that these improvements might have on Illinois' transportation system. Moreover, the risk assessment describes significant trends in developing transportation technologies, evaluates the possible implications to Illinois' transportation system, and recommends a suite of options Illinois may consider exploring to shape future transportation outcomes.

Figure 42. Diagram. Fundamental aims of the risk assessment.

Table 3. Impacts of CASE Technologies on IDOT Goals

Goal Area	Possible Overall Impact
Safety	• Safety is expected to improve significantly even with the limited adoption of CVs and Avs. • Truck platoons, automated freight vehicles, and advanced logistics are likely to improve the safety and reliability of freight movement.
Efficient freight movement	• Shared automated trips, including public transit vehicles and transportation network company trips, are likely to cost less per mile than trips taken by private auto or public transit today. • Automated technology is likely to allow some people to commute farther and access new career and educational opportunities.
Equity	• More transportation choices are likely to be available to many people who are unable to drive today. However, the benefits may not extend to all transportation-disadvantaged populations.
Mobility	• Travel time reliability is likely to improve even with moderate adoption of CV and AV technologies. • Impacts to congestion are uncertain and depend on the uses of Avs. Non-recurrent congestion should decrease under any scenario. • It is difficult to predict impacts to vehicle miles traveled; the degree of impact will depend on whether Avs will be used predominantly as private or shared vehicles.
Transportation options	• Residents of urban communities are likely to experience increased access to more transportation options, potentially resulting in improved access to jobs, education, and services. • Access to transportation options could moderately improve in rural areas with limited public transit services, but this outcome is dependent on market support for expansion in rural areas. • Increased access to shared mobility options could enable greater use of active transportation options for short trips, addressing first- and last-mile issues. However, if motorized trips become more affordable, active transportation trips could decrease.
Reducing carbon missions	• Some fleet electrification is likely and could generate environmental benefits. The prevailing usage of Evs could minimize vehicle miles traveled as a factor in emissions.
Transportation funding sufficiency	• Integrated vehicle technology enables some degree of expansion for a “user-pays” funding system, and some mechanisms are identified to ensure that all vehicles are paying some share for their use of the roadway. However, funding continues to be constrained, and increases in revenue are not fully sufficient to cover existing and future infrastructure needs.
Land use management	• It is difficult to predict impacts on land use patterns. However, any impact will be somewhat tempered by IDOT’s statewide planning goals.

CASE technology deployment is accompanied by a number of risks, including the following:

- Cybersecurity risks: The deployment of connected vehicles and autonomous systems creates new cybersecurity risks, such as hacking, data breaches, and the threat of cyberattacks.

- Technical challenges: Complex technical challenges may be involved, such as ensuring the reliability and safety of autonomous systems, and the integration of new technologies into existing transportation networks.

- Infrastructure needs: Significant investment in infrastructure will be required, such as charging and maintenance facilities for EVs, and road upgrades to support autonomous vehicles.

- Privacy concerns: Connected and autonomous vehicle deployment raises privacy concerns, such as the collection, storage, and use of data generated by these technologies.

- Legal and regulatory challenges: Several legal and regulatory challenges may arise, such as liability issues in the event of accidents involving autonomous vehicles, and the need to develop new regulations to govern the operation of these technologies.

- Societal and behavioral changes: Societal and behavioral changes must be considered, such as changes in transportation habits, the impact on employment in the transportation sector, and the adjustment of the public to new transportation technologies.

- Economic impacts: Significant economic impacts are anticipated, such as the cost of investment in infrastructure, the cost of deploying these technologies, and the potential impact on existing businesses in the transportation sector.

The enumerated risks are not exhaustive and new risks may emerge as these technologies are deployed on a larger scale. It is important for organizations to consider these risks as they plan for CASE technology deployment.

To assess the overall impact of each risk, different criteria were considered. Each risk was analyzed through various levels of automation, assigning a high or low rating based on the literature for each specific level of automation period. Furthermore, the likelihood of occurrence for each impact as a risk to the independent owner/operator's assets and operations at varying levels of automation is calculated, with level 1 assigned to have a high probability of occurrence in the short term, while levels 4 and 5 were assigned a low probability of occurrence in the short term.

The operational impact of each risk was calculated based on its effect and severity at various levels of automation within four distinct categories: cyber risk, connectivity risk, human machine interaction (HMI) risk, and operation dependency. After the role of each impact was determined with the associated technology readiness level, category scores were summed to calculate the overall operational impact, within the 0 to 9 scale. Moreover, behavioral risk involved both the driver risk

and technology risk, with the former primarily resulting from human error and the latter being difficult to assess due to challenges with the technology implementation. In addition, the internal risk referred to potential technology failures, while connectivity risk accounted for networked driving.

Cyber risk accounted for potential cyber-attacks that could affect all three of the above risks. Lastly, risk-related operation dependency is another criterion to assess the overall impact of the risk, which defines the ability of different CASE technology readiness levels to handle the risk. Table 4 lists the rubric for the risk assessment. The risk assessment summary may be found in Appendix H.

Table 4. Risk Assessment Rubric

Level 0	Level 1	Level 2	Level 3	Level 4	Level 5
Behavioral Risk					
Only Human Risk	Human Risk but Mitigated by CASE Tech	Human Risk but Mitigated by CASE Tech	Driver and CASE Tech Risk	Driver and CASE Tech Risk	CASE Tech risk Only
Internal Risk					
Only Standard Components	Standard + CASE Enablers	Standard + CASE Enablers	Standard + CASE Enablers	Standard + CASE Enablers	Standard + CASE Enablers
Cyber Risk					
None	Low	Low	Medium	High	High
Connectivity Risk					
None	Low	Low	High	High	High
HMI Risk					
None	Low	Medium	High	Low/Medium	None
Risk-Related Operation Dependency at Different Levels of Automation					
High-Low	Low	Medium	Medium/High	High	High

In accordance with the goals enumerated in Table 3, IDOT may consider the following to address such risks in implementing CASE technologies in Illinois.

Safety: Technology deployment and scaled commercialization are driven by the development of safety standards and protocols. IDOT may consider working closely with private industry in developing communication standards and strategies, aligned with federal regulatory directives. In addition, IDOT's relationship with local, municipal, and regional agencies may be leveraged to aid in statewide adoption and address interoperability requirements. Policies and planning may be revised to account for real-time data collection of roadway and weather conditions, traffic closures, and emergency routes. IDOT may establish operational strategies tailored to support the implementation of vehicle-to-infrastructure (V2I) and infrastructure-to-network (I2N) CASE technologies on IDOT facilities and corridors, along with cybersecurity measures to protect from cyberattacks. The anticipated large datasets of V2I and I2N communications may also encourage more public-private partnerships in promoting the safe integration of CASE technologies (e.g., providing precise information about work zones, closures, and other system disturbances). Moreover, as the market penetration level of CASE technologies increases, IDOT may consider identifying potential

amendments to highway design requirements. Such policy and protocol changes may also include close collaboration with the Office of the Illinois Secretary of State for driver licensing for higher levels of automation, and with the Illinois State Police for emergency routing management, as examples.

Efficient Freight Movement: In bolstering efficient and safe freight movements in Illinois, a global hub of freight mobility, IDOT may adopt operational procedures to promote V2I technology deployment on state-owned roadways, along with multimodal plans for regional facility deployments. IDOT may also consider pursuing pilot projects of CA freight movement, in partnership with private industry and academic institutions, to guide considerations and changes on infrastructure design and traffic management to address safety concerns with CA freight operations in Illinois. In addition, IDOT may work closely with private industry to facilitate CA freight route planning using real-time and digitized databases.

Equity: IDOT may incorporate policy directives that would promote equitable implementation of CASE technologies for all Illinois residents, particularly for transportation-disadvantaged groups. For instance, equity criteria may be integrated in planning, in line with investment decisions that will promote access and benefit to underserved populations from future transportation technologies.

Mobility: The future integration of CASE technology needs and requirements in IDOT's operational strategies may include pricing techniques to account for the potential increase in vehicle miles traveled on state-owned roadways, V2X infrastructure to facilitate real-time traveler information and integration of diverse sources of data, highway design standard modifications, and incident response protocols for real-time route planning. IDOT may also consider establishing development review policies, particularly as they relate to curb space management in urban areas for passenger pick-up/drop off and product deliveries to mitigate potential congestion issues.

Transportation options: Policies that would facilitate and support universal payment systems and mobility-as-a-service applications may be needed to support trip planning and first-/last-mile transportation. IDOT may consider collaborating with transportation providers and local governments to coordinate mobility options and promote the growth of mobility hubs around the state.

Reducing carbon emissions: Aligned with the state's goals and IDOT's electrification plan, IDOT may build on the growing list of stakeholders to identify infrastructure requirements and coverage gaps and develop investment strategies to promote alternative fuel infrastructure in Illinois. This may also entail participation in multistate and regional initiatives to assist growth in EV adoption, charging infrastructure network, and alternative fuel use.

Transportation funding sufficiency: In anticipation of declining gas tax revenues, implementation of road usage charge may be considered to augment the state's transportation funding, including use of pricing mechanisms associated with vehicle miles traveled. As other states have implemented, IDOT may consider working with the Office of the Secretary of State as higher vehicle automation levels become allowed on Illinois roadways through issuing of a different driver's license category and the associated fee.

Land use management: Future mobility policies and targets are bound to change to cater to more CASE technology deployments. IDOT may revise standards, guidance policies, and processes that would account for capacity issues in anticipation of mixed fleets of connected, CA, and legacy vehicles, which will have implications on area or right-of-way management.

CHAPTER 6: SUMMARY AND CONCLUSIONS

Illinois has several strengths that makes it an attractive location for CASE technology companies, including a talent pool from top-ranked universities, well-developed transportation infrastructure, government support, and a robust ecosystem of collaboration and innovation. Illinois also faces potential challenges, including competition from other states and countries, limited access to funding, regulatory hurdles, and infrastructure challenges for new mobility technologies.

An evaluation of Illinois' readiness for CASE integration was accomplished through a synthesis and stakeholder engagement via survey, workshops, and interviews. To incorporate the collected data, a balanced scorecard analysis was completed to objectively rank the CASE pillars and prioritize the identified needs from stakeholder consensus while strategically aligning them with Illinois' strengths and resources. The criteria included industry presence, workforce talent, education, investments, legal and regulatory framework, CASE-related activities and engagement, competitiveness, and collective opinions. The balanced scorecard analysis ranked the pillars as follows (from highest): alternative fuels, scaling ITS, CA freight, farm automation, CA logistics, insurance, and urban mobility.

Moreover, key focus areas were defined per pillar and were prioritized with recommended leads and stakeholders to champion the CASE directives and opportunities. Near-term actions for Illinois were suggested, which include establishing a central structure for Illinois' CASE program, enriching the knowledge base and experience, considerations for preparing the transportation infrastructure, partnerships with external stakeholders, and expansion of laws, regulations, and policies that to better administer and grow CASE technology deployment and integration.

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APPENDIX A: CASE ACTIVITIES IN ILLINOIS

Table 5. CASE Activities in Illinois: Alternative Fuels Pillar

Key Focus Areas	University/Facility	Program	Projects
Vehicle Battery Innovations	IIT	Wanger Institute for Sustainable Energy Research (WISER)	Novel Polymer Electrolytes to Prevent Dendrites in Lithium Metal Batteries
	IIT	Wanger Institute for Sustainable Energy Research (WISER)	Theoretically Pre-Designed Supercapacitors with the Energy Density of Li-Ion Batteries
	IIT	Wanger Institute for Sustainable Energy Research (WISER)	Developing Bi-Functional Heteroatom Catalysts for High Efficiency and Long Cycle Life Lithium-Air Batteries
	IIT	Wanger Institute for Sustainable Energy Research (WISER)	Monolithic Electrodes Made of Nanostructured Materials to Advance Li-S Battery Technology
Alternative Fuels	IIN		Midwest Hydrogen and Fuel Cell Partnership
Manufacturing of EV – Workforce Retraining/Uptraining	IIT	Autonomous Control Systems Lab	Hybrid Electric Vehicle Control in Presence of Uncertainty
	IIT	EDEC Lab	automotive powertrains (HEV, PHEV and EV)
Charging Infrastructure Development/Deployment	IIT	Transportation WISER	Facilitating Vehicle-to-Grid (V2G) Integration Through Multidisciplinary Research and Partnership on V2G Topologies and Building the Case for Development of a Market Simulation Tool
	IIT	CSMART	Energy Efficiency Research for Large-Scale Data Centers
	NU	Data Science initiative	The vulnerability of the US power grid
	UIUC	ICT	Electric Vehicle Infrastructure Plan in Illinois
Public Transit/Fleet-led Adoption	IL State	Business Support/Environmental Support	Department of Central Management Services (CMS) to jump-start conversion of the state government vehicle fleet to zero emission vehicles and to deploy electrical charging infrastructure throughout Illinois
Clean Energy Production	IIT	Jin Lab	
	IIT	Qing-Chang Zhong, Max McGraw Endowed Chair of Energy and Power Engineering and Management	Moving Toward a More Sustainable Power Grid
	IIT	CSMART	Energy Sustainable Wireless Acoustic Emission Sensors for Structural Health Monitoring
	IIN		IIN awards seed grants to eight research teams focused on projects that include using renewable technologies

Table 6. CASE Activities in Illinois: Farm Automation Pillar

Key Focus Areas	University/Facility	Program	Projects
CAV Farm Equipment Development	UIUC	Illinois Autonomous Farm	Increasing the Level of Autonomy for Agricultural Robots through Effective Interaction and Programming Paradigms
	UIUC	Illinois Autonomous Farm	Center for Research on Autonomous Farming (CRAFT)
	UIUC	Center for Autonomy	Terra-MEPP: High-throughput Phenotyping for Breeding Better Biofuel Plants
	UIUC	ISEE	I-Farm
	UIUC	Illinois Robotics Group	Ag robot speeds data collection, analyses of crops as they grow
Drone Pilots	UIUC Center for Digital Agriculture	AIRFARMS	Farmers Using Drones and Artificial Intelligence to Determine the Perfect Time to Harvest Crops
Automated Farm Management Systems	UIUC	Illinois Autonomous Farm	I-FARM: Illinois Farming and Regenerative Management Testbed
	UIUC	ISEE	Smart farm
	UIUC	Illinois Autonomous Farm	Using Data-Drive Approaches to Develop Effective Social Media Marketing Strategies for Small and Medium-Sized Farms
	UIUC	Illinois Autonomous Farm	National AI Institute: Artificial Intelligence for Future Agricultural Resilience, Management, and Sustainability (AIFARMS)
	UIUC	Illinois Autonomous Farm	CPS: FRONTIER: Collaborative Research: Coalesce: Context Aware Learning for Sustainable Cyber- agricultural System
	UIUC Center for Digital Agriculture	AIRFARMS	Autonomous Farming
Shared Equipment Platforms	IIT/urban agriculture program	Wanger Institute for Sustainable Energy Research	Interprofessional Project (IPRO) Program projects
	UIUC Center for Digital Agriculture	AIRFARMS	Autonomous Farming

Table 7. CASE Activities in Illinois: Connected/Automated Logistics Pillar

Key Focus Areas	University/Facility	Program	Projects
Air to Land Intermodal Automation		Distributed Autonomous Systems Lab	Robust Adaptive Autonomy in Contested Environments (RAACE)
	UIUC		Solar-Powered Long-Endurance UAV for Real-Time Onboard Data Processing
	UIUC	Advanced Controls Research Laboratory	Synergetic Drone Delivery Network in Metropolis
	IIT	The Robotics Lab	Sub-Canopy Autonomous Flight
	AUVSL		UAV Based Terrain Identification
	UIUC	Advanced Controls Research Laboratory	Cooperative Trajectory Generation
	UIUC	Advanced Controls Research Laboratory	L1 Adaptive Control
Rail to Land Intermodal Automation	NU	NU Transportation Center	Analytical Models of Rail Service Operations; Trends in Grain and Soybean Economics; Econometric Analysis of Rail Transport Rates
Last Mile / Curb Management Automation	NU	Civil and ENV Engr department	Smart Crowdsourced Urban Delivery (CROUD) System
	NU		Application for Tier 1 UTC addressing Communications Technology and E-Commerce Effects on Travel Demand
	IIT	The Robotics Lab	The Urban Design and Policy Implications of Ubiquitous Robots and Navigation Safety

Table 8. CASE Activities in Illinois: Scaling Intelligent Transportation Systems Pillar

Key Focus Areas	University/Facility	Program	Projects
Connected Infrastructure Deployments			CAREER: A Combined Experimental and Theoretical Study of Human-Connected Automated Vehicle Interactions
	IIT	Jin Lab	An Automated Synthesis Framework for Network Security and Resilience Analysis
	IL State	Capital Funding	$30.2 million to address cybersecurity risks and threats
	UIUC	Advanced Digital Sciences Center (ADSC)	CREATE Programme Projects
	UIUC	Advanced Digital Sciences Center (ADSC)	Enhancing Power System Resilience through Distributed Intelligence and Adaptive Infrastructure
	UIUC	ICT	Policy and Design Guidelines to Plan for Connected and Autonomous Vehicles (CAVs)
ATMS Integrations / Interoperability	IIT	Sustainable Transportation and Infrastructure Research Center (STAIR)	Optimal Investment Decision-Making for Highway Transportation Asset Management under Risk and Uncertainty, funded by Midwest Regional University Transportation Center.
	NU	NU Transportation Center	Mobility 2050: A Vision for Transportation Infrastructure
	NU	NICO	Transportation Networks
	IIT	Autonomous Control Systems Lab	Suggestion-Based Advanced Driver Assistance System
	UIC	Robotics Laboratory	CPS: Monitoring Techniques for Safety Critical Cyber-Physical Systems
	Tollway		Tollway to add 'smart highway' features to I-90
	UIUC	ICT	Illinois, a Leader in Mobility 4.0 and Beyond
Traffic Optimization	IIT	Sustainable Transportation and Infrastructure Research Center (STAIR)	A Methodology to Prioritize Projects for Intersection Safety Enhancements in Urban Areas. Supported by Chicago Department of Transportation (CDOT)
	IIT	Autonomous Control Systems Lab	Learning-Based Scalable Predictive Control Strategies for Heterogeneous Traffic Networks
	UIC	Robotics Laboratory	Application of Hybrid Optimal Control to Multi-vehicle Path Planning
	IIT	Autonomous Control Systems Lab	Learning-Based Scalable Predictive Control Strategies for Heterogeneous Traffic Networks
	UIUC	ICT	Safety and Efficiency Benefits of Implementing Adaptive Signal Control Technology in Illinois
	UIUC	ICT	Opportunistic Traffic Sensing Using Existing Video Sources (Phase II)

Table 9. CASE Activities in Illinois: Urban Mobility Pillar

Key Focus Areas	University/Facility	Program	Projects
Medical District Integrations	NU		Improving healthcare access in marginalized communities through smart connected technologies
Public Transportation	UIUC	Coordinated Science Lab	Socially Aware Control of Autonomy: Reshaping Urban Mobility in Traffic Networks with Mixed Vehicle Autonomy
	NU	NICO	Urban Traffic Signal Timing
	UIUC	ADSC	SecUTS: A Cyber-Physical Approach to Securing Urban Transportation Systems
Personal E-mobility	UIUC	Center for Autonomy	Collaborative Research: ASPIRE: Automation Supporting Prolonged Independent Residence for the Elderly
	UIUC	Center for Autonomy	AutonomouStuff, Center for Autonomy partner in use of autonomous vehicle Polaris GEM
	UIUC	ISEE	The Effect of Mobility-on-Demand Services on the 'Last Mile Problem'
	AUVSL		Automated Parking
	NU	IDEAS	End-to-end Analysis, Design, and Verification of Autonomous Driving Systems

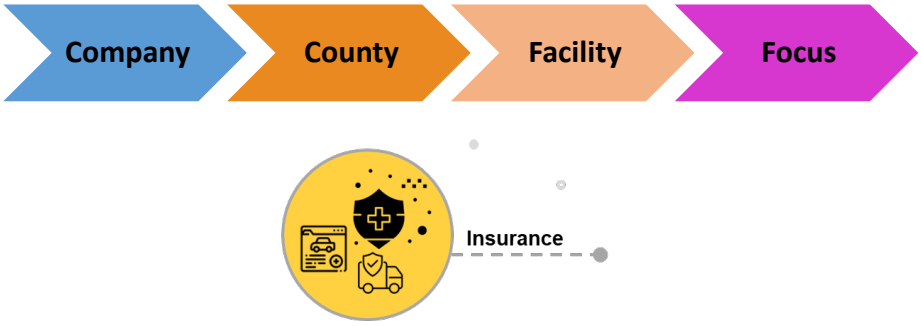
Table 10. CASE Activities in Illinois: Connected/Automated Freight Pillar

Key Focus Areas	University/Facility	Program	Projects
Highway Work Zone Safety	IIT	Sustainable Transportation and Infrastructure Research Center (STAIR)	Crash Data Analysis and Engineering Solutions for Local Agencies. Joint with UIUC, funded by the Illinois Department of Transportation (IDOT).
	UIUC	ICT	Improving the Effectiveness of Smart Work Zone Technologies
Platooning – Emissions Optimization	UIUC	ICT	Truck Platooning on Illinois Flexible Pavements
Connected Supply Chain		Caterpillar East Peoria Factory	Caterpillar Showcases Cat MineStar at CES at East Peoria Factory
	UIC	Robotics Laboratory	Distributed Switching Algorithms for Robotic Networks
	NU		An Autonomous Modular Vehicle Technology-based Multifaceted Mobility Service Paradigm – A Proof-of-Concept Study
	NU	NU Transportation Center	Smart Crowdsourced Urban Delivery (CROUD) System
		Caterpillar East Peoria Factory	Caterpillar has over 1M connected assets in which they have data flowing from each day.
			Peoria Innovation Hub
CAV Freight ITS Development			Eastern Illinois University and Lake Land College Partnership
	IIT	Transportation WISER	2019: "Driver-Assistance and Human-Automation Interface Design for Energy Efficient Semi-Automated Hybrid Electric Vehicles." PI: Baisravan HomChaudhuri (MMAE), Co-PI: Tomoko Ichikawa (ID)
	IIT	Autonomous Control Systems Lab	Fuel and Energy Efficient Control of Connected and Autonomous Vehicles
	UIUC	Illinois Center for Transportation	I-ACT
	IIT		Novatel IIT partnership to help solve High Precision, High Integrity Positioning for Autonomous Vehicles
	IIT	Advanced Engine Control Laboratory	Evaluation of Energy Efficient Mobility Systems
	NU	IDEAS	Planner Design and Addressing Safety and Security Challenges in Connected and Autonomous Vehicles
Optimized Routing	IIT		Receding Horizon Integrity-A New Navigation Safety Methodology for Co-Robotic Passenger Vehicles
	IIT	The Robotics Lab	Navigation Integrity

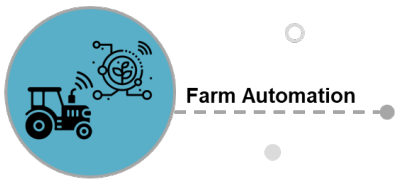
Table 11. CASE Activities in Illinois: Insurance Pillar

Key Focus Areas	University/Facility	Program	Projects
Personal Complete Mobility Coverage		State Farm	Autonomous Vehicle Policymaking

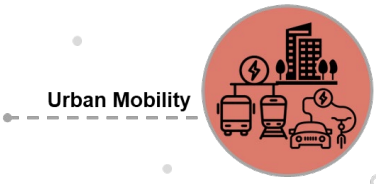
Illinois CASE Industry Assets



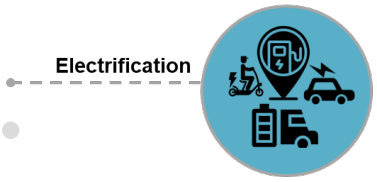
Insurance			
COMPANY	**COUNTY**	**FACILITY**	**FOCUS**
AAA	Kane County	Office	Coverage/Products
All State	Cook County	Headquarters	Coverage/Products
American Family Insurance	Cook County	Office	Coverage/Products
Arity	Cook County	Headquarters	Coverage/Products
Blue Cross	Cook County	Headquarters	Coverage/Products
State Farm	McLean County	Headquarters	Coverage/Products
Zurich	Cook County	North America Headquarters	Coverage/Products
Arity	Cook County	Headquarters	Research
CCC Systems	Will County	Headquarters	Software



Farm Automation			
COMPANY	**COUNTY**	**FACILITY**	**FOCUS**
Autonomous Stuff	Tazewell County	Headquarters	CAV OEM
Caterpillar	Lake County	Headquarters	CAV OEM
Caterpillar	Kendall County	Technical Center	CAV OEM
Caterpillar	Peoria County	Technical Center	CAV OEM
CNH	DuPage County	Office	CAV OEM
Cummins	DeKalb County	Office	CAV OEM
Deere	Rock Island County	Headquarters	CAV OEM
Komatsu	Cook County	Office	CAV OEM
Sabanto	Cook County	Headquarters	CAV OEM
Coca Cola Great Lakes	Cook County	Manufacturing Facility	Manufacturing
Kehe	DuPage County	Headquarters	Manufacturing
Kellogg's	Cook County	Manufacturing Facility	Manufacturing
Milson Coors	Cook County	Headquarters	Manufacturing
Nabisco	DuPage County	Manufacturing Facility	Manufacturing
Pepsi Co	Cook County	Office	Manufacturing
Reyes Holding	Cook County	Headquarters	Manufacturing
Sente	Cook County	Headquarters	Manufacturing
US Foods	Cook County	Headquarters	Manufacturing
ADM	Cook County	Headquarters	Shipping To & From Farm
ADM	Cook County	Headquarters	Yield Processing
Deere	Rock Island County	Headquarters	Yield Processing
Growmark	McLean County	Headquarters	Yield Processing
ADM	Cook County	Headquarters	Processing



Urban Mobility			
COMPANY	**COUNTY**	**FACILITY**	**FOCUS**
Park Chicago	Cook County	Headquarters	Curb Management
VIA	Cook County	Headquarters	Curb Management
Big Bus Tours	Cook County	Office	Mobility as a Service (MaaS)
Enterprise	DuPage County	Office	MaaS
Gest	Cook County	Office	MaaS
Hertz	Cook County	Office	MaaS
Lyft	Cook County	Office	MaaS
Uber	Cook County	Office	MaaS
Zipcar/Avis	Cook County	Office	MaaS
Lyft	Cook County	Office	Multimodal
Uber	Cook County	Office	Multimodal
Autonomous Stuff	Tazewell County	Headquarters	OEM
Trans Dev	DuPage County	Headquarters	OEM
Discover	Lake County	Headquarters	Payments
Microsoft	DuPage County	Office	Payments
Millennium Garages	Cook County	Office	Parking
Millennium Garages	Cook County	Office	Parking
Parknav	Cook County	Headquarters	Parking
Parkwiz	Cook County	Headquarters	Parking
Parqex	Cook County	Headquarters	Parking
Spothero	Cook County	Headquarters	Parking
TPS	Cook County	Headquarters	Parking
CCC Intelligent Solutions	Cook County	Headquarters	Routing/Tracking Systems
Cleverbridge	Cook County	Headquarters	Routing/Tracking Systems

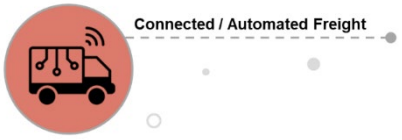


Alternative Fuels			
AllCelll	Cook County	Headquarters	Battery Manufacturing
Exponential Power	DuPage County	Manufacturing Facility	Battery Manufacturing
Gamma Technologies	DuPage County	Headquarters	Battery Manufacturing
Littlefuse	Cook County	Headquarters	Battery Manufacturing
Nanograf	Cook County	Headquarters	Battery Manufacturing
Wanxiang	Kane County	Office	Battery Manufacturing
Zeus Batteries	DuPage County	Headquarters	Battery Manufacturing
EVBox	Lake County	North American Headquarters	Charging Station Manufacturing
Rivian	McLean County	Manufacturing Facility	Charging Station Manufacturing
Schneider Electric	DuPage County	Executive Center	Charging Station Manufacturing
Siemens	Cook County	Research & Development Hub	Charging Station Manufacturing
Siemens	Lake County	Manufacturing Facility	Charging Station Manufacturing
Tesla	Cook County	Office	Charging Station Manufacturing
Ameren	Madison County	Office	Energy Provider
ComEd	DuPage County	Headquarters	Energy Provider
Constellation	Cook County	Office	Energy Provider
Exelon	Cook County	Headquarters	Energy Provider
Charge point	Cook County	Office	Installation
EV Connect	Cook County	Office	Installation
EV Go	Cook County	Office	Installation
Greenlots	Cook County	Office	Installation
Rivian	McLean County	Manufacturing Facility	Installation
Tesla	Cook County	Office	Installation
Volta	DuPage County	Office	Installation
BMW	Cook County	Research & Development	OEM
Bosch	Cook County	Research & Development	OEM
Cisco	McLean County	Office	OEM
Cisco	Cook County	Office	OEM
Cisco	Cook County	Office	OEM
Continental	Jefferson County	Tire	OEM
Continental	Lake County	Research & Development	OEM
Ford	Cook County	Office	OEM

Alternative Fuels			
GM	Will County	Office	OEM
Harman	Lake County	Office	OEM
Hyzon	Will County	Headquarters	OEM
Innova EV	DuPage County	Headquarters	OEM
Mercedes	DuPage County	Parts Distribution Center (PDC)	OEM
Rivian	McLean County	Manufacturing Facility	OEM
Stellantis	Boone County	FCA Belvidere Assembly Plant	OEM
Tenneco	Lake County	Headquarters	OEM
The Lion Electric Co	Cook County	Office	OEM
The Lion Electric Co	Will County	Manufacturing Facility	OEM
ZF	Lake County	Region North America Headquarters	OEM

Connected / Automated Logistics

Connected and Automated Logistics			
COMPANY	**COUNTY**	**FACILITY**	**FOCUS**
Bain & Company	Cook County	Office	Consulting
Boston Consulting Group	Cook County	Office	Consulting
KMPG	Cook County	Office	Consulting
McKinsey and Company	Cook County	Office	Consulting
Helios Visions	Cook County	Headquarters	Drone
Scientel Solutions	Kane County	Headquarters	Drone
Valqari	Will County	Headquarters	Drone
Veriport Chicago	Cook County	Headquarters	Drone
Amazon Web Services	Cook County	Office	First/Last Mile
FedEx	Cook County	Office	First/Last Mile
FedEx	McLean County	Distribution Center	First/Last Mile
UPS	DuPage County	Office	First/Last Mile
USPS	Cook County	Distribution Center	First/Last Mile
Walmart	Bureau County	Distribution Center	First/Last Mile
ADM	Cook County	Headquarters	Intermodal Yard
BNSF Railway	Cook County	Office	Intermodal Yard
Capgemini	Cook County	Office	Intermodal Yard
Capgemini	Cook County	Office	Intermodal Yard
CN	Will County	Office	Intermodal Yard
CSX	Cook County	Office	Intermodal Yard
Minijack	Cook County	Headquarters	Intermodal Yard
Norfolk Southern	Saint Louis	Office	Intermodal Yard
Union Pacific	Cook County	Office	Intermodal Yard
Coyote	Cook County	Headquarters	Routing/Tracking
Sigfox	Cook County	Office	Routing/Tracking
Amazon Web Services	Cook County	Office	Warehouse
FedEx	Cook County	Office	Warehouse
FedEx	McLean County	Distribution Center	Warehouse
Onetrack AI	Cook County	Headquarters	Warehouse
Prologis	Cook County	Office	Warehouse
TandLA	Lake County	Headquarters	Warehouse
UPS	DuPage County	Office	Warehouse
USPS	Cook County	Distribution Center	Warehouse
Walmart	Bureau County	Distribution Center	Warehouse



Connected/Automated Freight			
COMPANY	**COUNTY**	**FACILITY**	**FOCUS**
GATX	Cook County	Headquarters	Great Lakes Freight
Alstom	DuPage County	Office	OEM CAV
BMW	Cook County	Research & Development	OEM CAV
Gatik	Cook County	Office	OEM CAV
Kodiac Robotics	Cook County	Office	OEM CAV
Mercedes	DuPage County	Parts Distribution Center (PDC)	OEM CAV
Navistar	DuPage County	Headquarters	OEM CAV
Tesla	Cook County	Office	OEM CAV
Volvo	Will County	Parts Distribution Center	OEM CAV
Wabtec	Cook County	Office	OEM CAV
BNSF Railway	Cook County	Office	Rail
CN	Will County	Office	Rail
CSX	Cook County	Office	Rail
Gatx	Cook County	Headquarters	Rail
KCS	St. Clair County	Office	Rail
Norfolk Southern		Office	Rail
Union Pacific	Cook County	Office	Rail
Wi-Tronix	Will County	Headquarters	Rail
Amazon Air	Winnebago County	Distribution Center	3PL
Boeing	Cook County	Headquarters	3PL
Burris Logistics	Waukesha County	Distribution Center	3PL
C.H. Robinson	McLean County	Office	3PL
C.H. Robinson	Winnebago County	Office	3PL
C.H. Robinson	Cook County	Office	3PL
CJ Logistica	Cook County	Headquarters	3PL
DHL	Cook County	Innovation Center	3PL
Expeditors	DuPage County	Office	3PL
Fedex	Cook County	Office	3PL
Fedex	McLean County	Distribution Center	3PL
HUB Group	DuPage County	Headquarters	3PL
JB Hunt	Cook County	Office	3PL
Knight-Swift	Kankakee County	Terminal	3PL
Kuehne + Nagel	Cook County	Headquarters regional	3PL
NCA	Cook County	Office	3PL
NFI	Will County	Warehouse	3PL

Connected/Automated Freight			
COMPANY	**COUNTY**	**FACILITY**	**FOCUS**
NFI	DuPage County	Warehouse	3PL
NFI	Grundy County	Distribution Center	3PL
Penske	Cook County	Office	3PL
Ruan	Cook County	Office	3PL
Ryder	Fayette County	Office	3PL
Schneider Trucking	Cook County	Office	3PL
TandLA	Lake County	Headquarters	3PL
Total Quality Logistics	Cook County	Office	3PL
Uber Freight	Cook County	Global Headquarters	3PL
United Airlines	Cook County	Headquarters	3PL
UPS	DuPage County	Office	3PL
US Express	Cook County	Office	3PL
XPO Logistics	DuPage County	Office	3PL
XPO Logistics	DuPage County	Office	3PL

Scaling ITS			
COMPANY	**COUNTY**	**FACILITY**	**FOCUS**
AECOM	Cook County	Office	ATMS
Antreo Group	Cook County	Headquarters	ATMS
Cambridge Systematics	Cook County	Office	ATMS
CDM Smith	Jackson County	Office	ATMS
CDM Smith	Cook County	Office	ATMS
CommScope	DuPage County	Office	ATMS
Crown Castle	DuPage County	Office	ATMS
Cubic	Cook County	Office	ATMS
EY	Cook County	Office	ATMS
Gannett Fleming	Cook County	Office	ATMS
Hanson	Sangamon County	Office	ATMS
Hanson	Sangamon County	Office	ATMS
HNTB	Cook County	Office	ATMS
MoboTrex	Lake County	Office	ATMS
Parsons	Cook County	Office	ATMS
Stantec	DuPage County	Office	ATMS
Stantec	Cook County	Office	ATMS
Terra Engineering	Cook County	Headquarters	ATMS
TransSmart	Cook County	Office	ATMS
Tranzact	DuPage County	Headquarters	ATMS
UL	Cook County	Office	ATMS
WSP	Cook County	Office	ATMS
AT&T	Cook County	Office	Broadband
AWS	Cook County	Office	Broadband
Comcast	Cook County	Office	Broadband
Motorola	Cook County	Headquarters	Broadband
Sprint	Cook County	Office	Broadband
T Mobile	Cook County	Office	Broadband
Verizon	Cook County	Office	Broadband
Verizon	Cook County	Office	Broadband
Verizon	Cook County	Office	Broadband
Esri	Cook County	Research & Development HUB	Digital Mapping
Google	Cook County	Office	Digital Mapping
HERE	Cook County	Office	Digital Mapping

Scaling ITS			
COMPANY	**COUNTY**	**FACILITY**	**FOCUS**
Hexagon Manufacturing Intelligence	Kane County	Office	Digital Mapping
Bosch	Cook County	Research & Development	Hardware
Costar Group	Cook County	Office	Hardware
Econolite	DuPage County	Office	Hardware
Intel	Champaign County	Office	Hardware
Intel	Lake County	Office	Hardware
Intel	DuPage County	Office	Hardware
Intel	Cook County	Office	Hardware
Miovision/ Ctgroup	DuPage County	Office/ TrafficLink ITS Product Platform	Hardware
Siemens	Cook County	Research & Development Hub	Hardware
Siemens	Lake County	Manufacturing Facility	Hardware
TAPCO	Cook County	Office	Hardware
Gannett Fleming	Cook County	Office	Installation
Traffic Control Corporation	DuPage County	Headquarters	Installation
Walsh	Cook County	Office	Installation
Bosch	Cook County	Research & Development	V2X
Continental	Jefferson County	Tire	V2X
Continental	Lake County	Research & Development	V2X
Haas Alert	Cook County	Headquarters	V2X
Nvidia	Champaign County	Office	V2X
Qualcomm	Cook County	Office	V2X
Qualcomm	Cook County	Office	V2X
RTB	Cook County	Office	V2X

APPENDIX B: COUNTY LIST FOR ILLINOIS METROPOLITAN AND NON-METROPOLITAN REGIONS

Davenport-Moline-Rock Island, IA-IL

- Illinois counties: Henry, Mercer, Rock Island
- Iowa county: Scott

Bloomington, IL

- Illinois counties: De Witt, McLean

Carbondale-Marion, IL

- Illinois counties: Jackson, Williamson

Champaign-Urbana, IL

- Illinois counties: Champaign, Ford, Piatt

Chicago-Naperville-Elgin, IL-IN-WI

- Indiana counties: Lake, Newton, Porter
- Wisconsin county: Kenosha
- Illinois counties: Cook, DeKalb, DuPage, Grundy, Kane, Kendall, Lake, McHenry, Will

Northwest Illinois metropolitan area

- Counties: Bureau, Carroll, Jo Daviess, La Salle, Lee, Ogle, Putnam, Stephenson, Whiteside

West Central Illinois nonmetropolitan area

- Counties: Adams, Brown, Cass, Christian, Fulton, Greene, Hancock, Henderson, Knox, Livingston, Logan, Mason, McDonough, Montgomery, Morgan, Moultrie, Pike, Schuyler, Scott, Shelby, Warren

East Central Illinois nonmetropolitan area

- Counties: Clark, Clay, Coles, Crawford, Cumberland, Douglas, Edgar, Effingham, Fayette, Iroquois, Jasper, Lawrence, Marion

South Illinois nonmetropolitan area

- Counties: Edwards, Franklin, Gallatin, Hamilton, Hardin, Jefferson, Johnson, Massac, Perry, Pope, Pulaski, Randolph, Saline, Union, Wabash, Washington, Wayne, White

Danville, IL

- County: Vermillion

Decatur, IL

- County: Macon

Kankakee, IL

- County: Kankakee

Peoria, IL

- Counties: Marshall, Peoria, Stark, Tazewell, Woodford

Rockford, IL

- Counties: Boone, Winnebago

Springfield, IL

- Counties: Menard, Sangamon

Cape Girardeau, MO

- County: Alexander

St. Louis, MO-IL

- Illinois counties: Bond, Calhoun, Clinton, Jersey, Macoupin, Madison, Monroe, St. Clair
- Missouri counties: Franklin, Lincoln, St. Charles, St. Louis, Warren

APPENDIX C: ILLINOIS LAWS AND INCENTIVES AROUND CASE

Table 12. Abbreviation Legend for Technology Categories

Abbreviation	Technology Categories
AFTMKTCONV	Aftermarket Conversions
AUTONOMOUS	Connected and Autonomous Vehicles
BIOD	Biodiesel
EFFEC	Fuel Economy or Efficiency
ELEC	All-Electric Vehicles (EVs)
ETH	Ethanol / Flexible Fuel Vehicles
HEV	Hybrid Electric Vehicles (HEVs)
HY	Hydrogen Fuel Cells
IR	Idle Reduction
LPG	Propane (LPG) / Propane Vehicles
NEVS	Neighborhood Electric Vehicles (NEVs)
NG	Natural Gas
PHEV	Plug-in Hybrid Electric Vehicles (PHEVs)

Table 13. Summary of Illinois State Laws and Incentives

Title	Type	Technology Categories
Fleet User Fee Exemption	State Incentives	ELEC
Alternative Fuel Vehicle Labeling Requirement	Laws and Regulations	NG|LPG
Biofuels Tax Exemption	State Incentives	BIOD|ETH
Biofuels Preference for State Vehicle Procurement	Laws and Regulations	BIOD|ETH
Biodiesel Blend Use Requirement	Laws and Regulations	BIOD
Idle Reduction Requirement	Laws and Regulations	IR
State Vehicle Fuel Economy Requirements	Laws and Regulations	EFFEC
Biodiesel Production Tax	Laws and Regulations	BIOD
Alternative Fuel Labeling Requirement	Laws and Regulations	BIOD|ETH
Advanced Vehicle Acquisition and Biodiesel Fuel Use Requirement	Laws and Regulations	BIOD|ETH|ELEC|PHEV
Biofuels Education and Promotion	Laws and Regulations	BIOD|ETH
Low-Speed Vehicle Access to Roadways	Laws and Regulations	NEVS
School Bus Retrofit Reimbursement	State Incentives	AFTMKTCONV|BIOD|ETH|ELEC|EFFEC|HY|IR|NG|PHEV|LPG
Biodiesel Definition and Specification	Laws and Regulations	BIOD
Ethanol and Hydrogen Production Facility Permits	Laws and Regulations	ETH|HY
Idle Reduction Weight Exemption	State Incentives	IR

Title	Type	Technology Categories
Fleet User Fee Exemption	State Incentives	ELEC
Alternative Fuel Vehicle Labeling Requirement	Laws and Regulations	NG|LPG
Biofuels Tax Exemption	State Incentives	BIOD|ETH
Biofuels Preference for State Vehicle Procurement	Laws and Regulations	BIOD|ETH
Electric Vehicle Supply Equipment (EVSE) Installation Requirements	Laws and Regulations	ELEC|PHEV
Smart Grid Infrastructure Development and Support	State Incentives	ELEC|PHEV
Public Utility Definition	Laws and Regulations	ELEC|NG|PHEV
Highway Electric Vehicle Supply Equipment (EVSE) Installation Authorization	Laws and Regulations	ELEC|PHEV
Natural Gas and Propane Vehicle Weight Exemption	State Incentives	NG|LPG
Battery Electric Vehicle (BEV) Emissions Inspection Exemption	State Incentives	ELEC
Alternative Fuels Tax and Reporting	Laws and Regulations	NG|LPG
Connected and Autonomous Vehicle (CAV) Initiative	Laws and Regulations	AUTONOMOUS
Autonomous Vehicle Testing Program	Laws and Regulations	AUTONOMOUS
Toll Highway Electric Vehicle Supply Equipment (EVSE) Installation Requirement	Laws and Regulations	ELEC|PHEV
Battery Electric Vehicle (BEV) Fee	Laws and Regulations	ELEC
Diesel Emission Reduction Grants	State Incentives	BIOD|ETH|ELEC|HEV|HY|NG|PHEV|LPG
Transportation Electrification Infrastructure Projects	State Incentives	ELEC|HEV|PHEV
Plug-In Electric Vehicle (PEV) Parking Space Regulation	Laws and Regulations	ELEC|PHEV
Plug-In Electric Vehicle (PEV) Time-Of-Use (TOU) Rate - Ameren Illinois	Utility/Private Incentives	ELEC|HEV|PHEV
Regional Electric Vehicle (REV) Midwest Plan	Laws and Regulations	ELEC|PHEV
Zero-Emission Vehicles (ZEV) Deployment Support	Laws and Regulations	ELEC

APPENDIX D: CAV-RELATED PROGRAMS IN ILLINOIS

Table 14. Count Summary CAV-Related Programs and Students in Universities

Region	District	County	City	Universities	Total University Programs	Number of Students	CAV Related Programs	Percentage to Total Students	Number of Students-CAV Related
3	5	Champaign	Champaign	UIUC	100	52331	17	28.3	14810
1	1	Dupage, Kane, Kendall and will	Aurora	Aurora University	40	4003	2	3.1	124
1	1	Lake	Bannockburn	Trinity International University	27	565	2	6.3	36
3	5	McLean	Bloomington	Illinois Wesleyan University	45	1619	3	8.6	139
2	3	Kankakee	Bourbonnais	Olivet Nazarene University	70	3079	7	11.5	354
5	9	Jackson, Williamson	Carbondale	Southern Illinois University	88	8375	10	11	921
4	6	Macoupin	Carlinville	Blackburn College	26	480	1	4.2	20
4	7	Coles	Charleston	Eastern Illinois University	58	4577	7	3.5	160
1	1	Cook	Chicago	UIC	77	21311	7	16.5	3516
1	1	Cook	Chicago	Uchicago	49	6801	3	18.6	1265
1	1	Cook	Chicago	DePaul University	93	14009	6	9.1	1275
1	1	Cook	Chicago	Loyola University	76	12014	5	3.1	372
1	1	Cook	Chicago	IIT	32	3032	8	47.3	1434
1	1	Cook	Chicago	Northeastern Illinois University	41	5626	2	10	563
1	1	Cook	Chicago	Chicago State University	29	2045	2	3	61
1	1	Cook	Chicago	North Park University	42	1906	2	1.3	25
1	1	Cook	Chicago	East-West University Chicago	6	447	2	29.3	131
1	1	Cook	Chicago	Columbia College Chicago	50	6596	1	0.4	26
1	1	Cook	Chicago	Roosevelt University	10	2293	3	4.1	94
1	1	Cook	Chicago	Saint Xavier University	45	2943	3	4.7	138

Region	District	County	City	Universities	Total University Programs	Number of Students	CAV Related Programs	Percentage to Total Students	Number of Students-CAV Related
1	1	Cook	Chicago	Moody Bible Institute	10	2225	0	0	0
1	1	Cook	Chicago	American Academy of Art College	9	205	0	0	0
1	1	Cook	Chicago	School of the Art Institute of Chicago	4	2983	0	0	0
1	1	Cook	Chicago	VanderCook College of Music	1	74	0	0	0
1	1	Cook	Chicago	DeVry University	14	13965	4	10.7	1494
3	5	Vermilion	Danville	Lakeview College of Nursing	1	148	0	0	0
4	7	Macon	Decatur	Millikin University	43	1929	2	1.8	35
2	3	DeKalb	DeKalb	Nothern Illinois University	58	12017	6	15.8	1899
5	8	Madison	Edwardsville	Southern Illinois University Edwardsville	47	10339	7	13.8	1427
1	1	Cook, Kane	Elgin	Judson University	36	1026	1	0.8	8
1	1	Dupage	Elmhurst	Elmhurst University	56	2807	3	3.3	93
5	8	Jersey	Elsah	Principia College	29	402	4	6.2	25
3	4	Woodford	Eureka	Eureka College	28	497	1	2.5	12
1	1	Cook	Evanston	NWU	82	21946	10	12.7	2787
3	4	Knox	Galesburg	Knox College	41	1229	1	5.9	73
5	8	Bond	Greenville	Greenville University	41	876	3	4	35
4	6	Morgan	Jacksonville	Illinois College	36	1044	3	4	42
2	3	Will, Kendall	Joliet	University of St. Francis	37	1646	4	3.2	53
1	1	Lake	Lake Forest	Lake Forest College	32	1527	4	7.7	118
5	8	St. Clair	Lebanon	McKendree University	40	1764	6	7.2	127
4	6	Logan	Lincoln	Lincoln College	13	1034	0	0	0
4	6	Logan	Lincoln	Lincoln Christian University	12	357	0	0	0
1	1	DuPage	Lisle	Benedictine University	43	2461	3	3	74

Region	District	County	City	Universities	Total University Programs	Number of Students	CAV Related Programs	Percentage to Total Students	Number of Students-CAV Related
3	4	McDonough	Macomb	Western Illinois University	65	5958	6	6.6	393
3	4	Warren	Monmouth	Monmouth College	29	900	2	4.3	39
1	1	DuPage, Will	Naperville	North Central College	64	2578	4	5.7	147
3	5	McLean	Normal	Illinois State University	74	18199	5	4.9	892
1	1	Cook	Oak Park	West Suburban College-Nursing	2	754	0	0	0
1	1	Cook	Palos Heights	Trinity Christian College	44	926	3	3.8	35
3	4	Peoria	Peoria	Bradley University	85	4625	7	12.4	574
3	4	Peoria	Peoria	Saint Francis Medical Center College of Nursing	1	320	0	0	0
3	4	Peoria	Peoria	Methodist College	3	675	0	0	0
4	6	Adams	Quincy	Blessing-Rieman College of Nursing & Health Sciences	1	165	0	0	0
4	6	Adams	Quincy	Quincy University	32	957	2	3.1	30
1	1	Cook	River Forest	Dominican University	51	2137	2	5.3	113
1	1	Cook	River Forest	Concordia University Chicago	50	1501	1	1.1	17
2	2	Rock Island	Rock Island	Agustana College	57	2532	3	4.6	116
2	2	Rock Island	Rock Island	Trinity College of Nursing	2	157	0	0	0
2	2	Winnebago	Rockford	Rockford University	25	943	1	6.2	58
2	2	Winnebago	Rockford	Saint Anthony College of Nursing	1	202	0	0	0
1	1	Will	Romeoville	Lewis University	63	4125	4	12.5	516

Region	District	County	City	Universities	Total University Programs	Number of Students	CAV Related Programs	Percentage to Total Students	Number of Students-CAV Related
4	6	Sangamon	Springfield	University of Illinois Springfield	29	2613	2	16.5	431
4	6	Sangamon	Springfield	St. John's College of Nursing	1	119	0	0	0
1	1	Will	University Park	Governors State University	27	3172	2	6.4	203
1	1	DuPage	Wheaton	Wheaton College, Illinois	38	2358	4	5.7	134

Table 15. Count Summary CAV-Related Programs and Students in Community Colleges

Region	District	City	Community Colleges in Illinois	Community College Programs	Number of Students	CAV Related Programs	Percentage to Total Students	Number of Students-CAV Related
5	8	Belleville	SWIC Southwestern Illinois College	49	6614	5	2.3	152
3	4	Canton	Spoon River College	13	962	1	2.5	24
5	9	Carterville	John A. Logan College	26	2660	2	6	160
5	9	Centralia	Kaskaskia College	30	1867	3	2.4	45
3	5	Champaign	Parkland College	44	4889	4	4.7	230
1	1	Chicago	Harry S Truman College	8	2591	2	0.3	8
1	1	Chicago	Kennedy-King College	10	1511	0	0	0
1	1	Chicago	Olive-Harvey College	6	1254	0	0	0
1	1	Chicago	Richard J. Daley College	10	2877	1	0.5	14
1	1	Chicago	St. Augustine College	10	907	1	7.5	68
1	1	Chicago	Taylor Business Institute	4	106	1	41.2	44
1	1	Chicago	MacCormac College	6	276	0	0	0
1	1	Chicago	Pacific College of Health and Science - Massage Therapy & Acupuncture School	1	46	0	0	0
1	1	Chicago	Coyne College	5	530	0	0	0
1	1	Chicago	Midwestern Career College	5	547	0	0	0
1	1	Chicago	Wilbur Wright College	10	5455	2	2.4	131
1	1	Chicago	Harold Washington College, City College of Chicago	14	5880	0	0	0
1	1	Chicago	Malcolm X College	13	5483	0	0	0
1	1	Chicago Heights	Prairie State College	22	3047	1	0.8	24
1	1	Cicero	Morton College	17	3410	2	1.8	61

Region	District	City	Community Colleges in Illinois	Community College Programs	Number of Students	CAV Related Programs	Percentage to Total Students	Number of Students- CAV Related
1	1	Crystal Lake	McHenry County College	32	4521	7	2.3	104
3	5	Danville	Danville Area Community College	18	1583	2	3.5	55
4	7	Decatur	Richland Community College	25	1821	1	1.6	29
1	1	Des Plaines	Oakton Community College	25	7619	4	1.9	145
2	2	Dixon	Sauk Valley Community College	16	1260	3	5.2	66
3	4	East Peoria	Illinois Central College - East Peoria Campus	38	6077	5	4.3	261
1	1	Elgin	Elgin Community College	30	7813	3	2.3	180
2	2	Freeport	Highland Community College	19	1115	1	0.2	2
3	4	Galesburg	Carl Sandburg College	31	1328	0	0	0
1	1	Glen Ellyn	Campus Maintenance Center	10	16082	7	7.7	1238
5	8	Godfrey	Lewis and Clark Community College Benjamin Godfrey Campus	21	3137	1	1	31
1	1	Grayslake	College of Lake County	25	9908	4	3	297
5	9	Harrisburg	Southeastern Illinois College	13	840	1	2.9	24
5	9	Ina	Rend Lake College	28	1431	4	2.8	40
2	3	Joliet	Joliet junior college	46	10966	2	3.3	362
2	3	Kankakee	Kankakee Community College	24	2168	1	0.6	13
1	1	Lombard	National University of Health Sciences	1	30	0	0	0
2	3	Malta	Kishwaukee College	18	2069	1	1	21
1	1	Melrose Park	Lincoln College of Technology	3	830	0	0	0
2	2	Moline	Black Hawk College	22	2816	1	0.2	6
2	2	Morrison	Morrison Institute of Technology	2	88	1	83	73
2	2	Mount Pleasant, WI	Midwest College of Oriental Medicine	1	17	0	0	0
3	5	Normal	Heartland Community College	13	3405	1	1	34
2	3	Oglesby	Illinois Valley Community College	22	2178	2	2	44
4	7	Olney	Olney Central College	14	663	0	0	0
1	1	Palatine	Harper College	35	10721	2	2	214
1	1	Palos Hills	Moraine Valley Community College	35	9310	3	2.7	251
1	1	River Grove	Triton College	29	7229	2	3.4	246

Region	District	City	Community Colleges in Illinois	Community College Programs	Number of Students	CAV Related Programs	Percentage to Total Students	Number of Students-CAV Related
2	2	Rockford	Rock Valley College	23	5387	5	4	215
2	2	Rockford	Rasmussen University - Rockford	10	2101	0	0	0
1	1	Skokie	Hebrew Theological College	5	107	0	0	0
4	6	Springfield	Lincoln Land Community College	30	4372	3	2	87
4	6	Sugar Grove	Waubonsee Community College	10	6411	2	2	128
5	9	Ullin	Shawnee Community College	28	684	0	0	0
1	1	Wheeling	Worsham College of Mortuary Science	1	118	0	0	0
4	7	Mattoon	Lake Land College	35	3050	7	2.6	79
1	1	South Holland	South Suburban College	23	2772	0	0	0

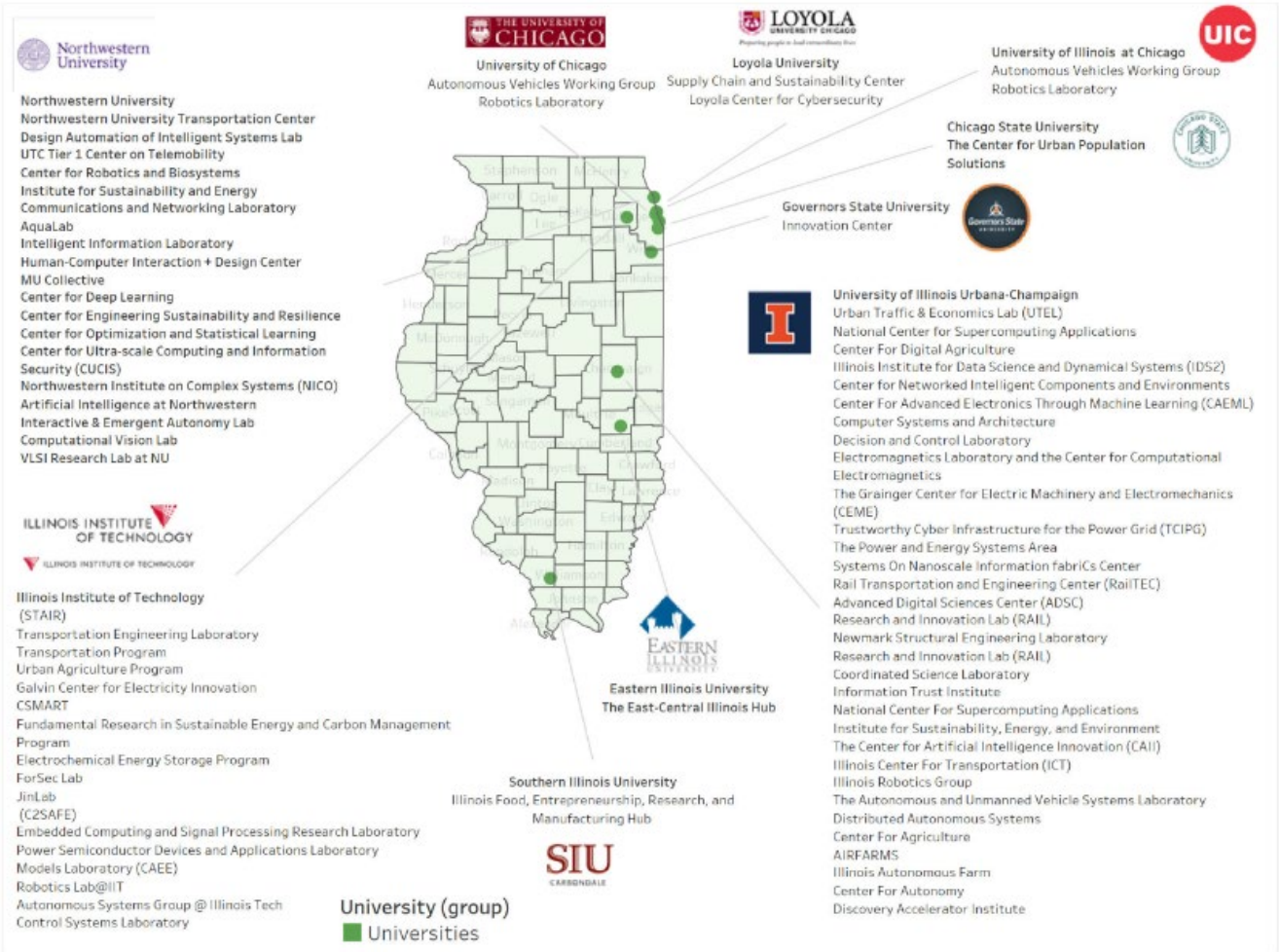


Figure 43. Map. CAV-related academic research centers in Illinois.

APPENDIX E: STAKEHOLDER LIST FOR WORKSHOPS

Table 16. Stakeholder Workshop 1 Attendee List

Attendee	Breakout Group	Company / Organization
Bret Johnson	Movement of Goods	NU
Imad Al-Qadi	Movement of Goods	UIUC
Krystian Gebis	Movement of Goods	Autobon
Angeli Jayme	Movement of Goods	UIUC
Hani Mahmassani	Movement of Goods	NU
Bill Seliger	Movement of Goods	Amazon
Jeannette Tamayo	Movement of Goods	UIC
Ryan Walsh	Movement of Goods	Valqari
Shawn Wilcockson	Movement of Goods	IDOT
Berkan Usta	Movement of Goods	UIUC
Jerry Quandt	Movement of People	Illinois Autonomous Vehicles Association
Jessie Carroll	Movement of People	CDM Smith
Neal Hemenover	Movement of People	Stantec
Chris Kopp	Movement of People	HNTB
Mike Myers	Movement of People	Safety National
Marco Nie	Movement of People	NU
Chloe Spano	Movement of People	Transdev
Amanda Stathopoulos	Movement of People	NU
Andrew Watkins	Movement of People	Marketplace.city
Nadim Hamad	Movement of People	NU

Table 17. Stakeholder Workshop 2 Attendee List

Attendee	Breakout Group	Company / Organization
Elizabeth Kocs	Electrification	UIC
Holly Benz	Electrification	Northwestern
Jessica Suda	Electrification	Southern Illinois University Carbondale
Jibo Sanyal	Electrification	Oak Ridge National Lab
Kawonna Travis	Electrification	Illinois Tollway
Michael Wang	Electrification	Argonne National Laboratory
Nic Tat	Electrification	Capgemini Invent
Ria Kontou	Electrification	UIUC
Robert Rosner	Electrification	U Chicago
Ryan Westrom	Electrification	Ford
Sam Bingham	Electrification	CDOT
Stephen Marlin	Electrification	BrightDrop
Tim Krauskopf	Electrification	Motiv Power Systems
Wayne Aldrich	Electrification	Farnsworth Group
Amgad Elgowainy	Freight & Logistics	Argonne National Laboratory
Bo Zou	Freight & Logistics	UIC
Cynthia Watters	Freight & Logistics	IDOT
Dave Schaller	Freight & Logistics	NACFE
Kevin Siegel	Freight & Logistics	Kodiak Robotics
Kirby Wagner	Freight & Logistics	Growmark Inc - Bloomington, IL
Matt Hart	Freight & Logistics	Illinois Trucking Association
Mike Hewitt	Freight & Logistics	Loyola University Chicago
Reggie Greenwood	Freight & Logistics	CSEDC
Scott Lee	Freight & Logistics	TranSmart
Serhat Cicekoglu	Freight & Logistics	Sente Foundry, LLC
Shuake Wuzhati	Freight & Logistics	CCRPC
Tom Cahill	Freight & Logistics	Illinois Tollway
Tom Murtha	Freight & Logistics	Chicago Metropolitan Agency for Planning
Ana Mendoza	Infrastructure	McLean County Regional Planning Commission
Anthony Corso	Infrastructure	Hanson Professional Services, Inc.
Art Manaois	Infrastructure	Illinois Tollway
Charles Frangos	Infrastructure	Orion Engineers, LLC
Clark Kaericher	Infrastructure	Illinois Chamber of Commerce
Craig Smith	Infrastructure	Overair Inc.
Dean Mentjes	Infrastructure	FHWA Illinois Division
Ken Boyce	Infrastructure	UL
Mercy Davison	Infrastructure	Town of Normal

Attendee	Breakout Group	Company / Organization
Patrick Hoban	Infrastructure	Normal Economic Development Council
Paul Gurklys	Infrastructure	FHWA Illinois Division
Scott Sigman	Infrastructure	Equinanimous Advisory Service Ent. (EASE)
Shawn Wilcockson	Infrastructure	Illinois Department of Transportation
Stan Wang	Infrastructure	AECOM
Tom Budescu	Infrastructure	Ernst & Young Infrastructure Advisors, LLC
Abraham Emmanuel	Scaling ITS	Chicago Dept. of Transportation
Aymeric Rousseau	Scaling ITS	Argonne National Laboratory
Bini William	Scaling ITS	Parsons
Brian Plum	Scaling ITS	TCC
Charlie McCarthy	Scaling ITS	TranSmart
Cory Hohs	Scaling ITS	HAAS Alert
Darryl Dawson	Scaling ITS	Darryl Dawson, President
Jon Nelson	Scaling ITS	Lake County Division of Transportation
Jonathon Hart	Scaling ITS	CDM Smith
Josh Witkowski	Scaling ITS	ABATE
Megan Swanson	Scaling ITS	IDOT
Randy Berry	Scaling ITS	Northwestern
Roberto Alvarado	Scaling ITS	CDM Smith
Ryan Legare	Scaling ITS	Lake County Division of Transportation
Taqhi Mohammed	Scaling ITS	Pace Bus
Terrance Heffron	Scaling ITS	IDOT
Aimee Lee	Urban/Suburban Mobility	IL Tollway
Alex Rosander	Urban/Suburban Mobility	Shared-Use Mobility Center
Alvaro Villagran	Urban/Suburban Mobility	Shared-Use Mobility Center
Erin Aleman	Urban/Suburban Mobility	CMAP
Jessica Hector-Hsu	Urban/Suburban Mobility	RTA
John Criezis	Urban/Suburban Mobility	Overair Inc.
Josh Naven	Urban/Suburban Mobility	Peoria
Matt Spenko	Urban/Suburban Mobility	IIT
Molly Poppe	Urban/Suburban Mobility	Chicago Transit Authority
Ray Lees	Urban/Suburban Mobility	Tri-County Regional Planning Commission
Raymond Lai	Urban/Suburban Mobility	McLean County Regional Planning Commission
Ryan Walsh	Urban/Suburban Mobility	Valqari
Sean Weidel	Urban/Suburban Mobility	Chicago DOT
Vasu Gadhiraju	Urban/Suburban Mobility	Town of Normal

APPENDIX F: SURVEY RESPONSES ON CASE ENGAGEMENT

Figure 44. Graph. Survey responses on CASE engagement (alternative fuels).

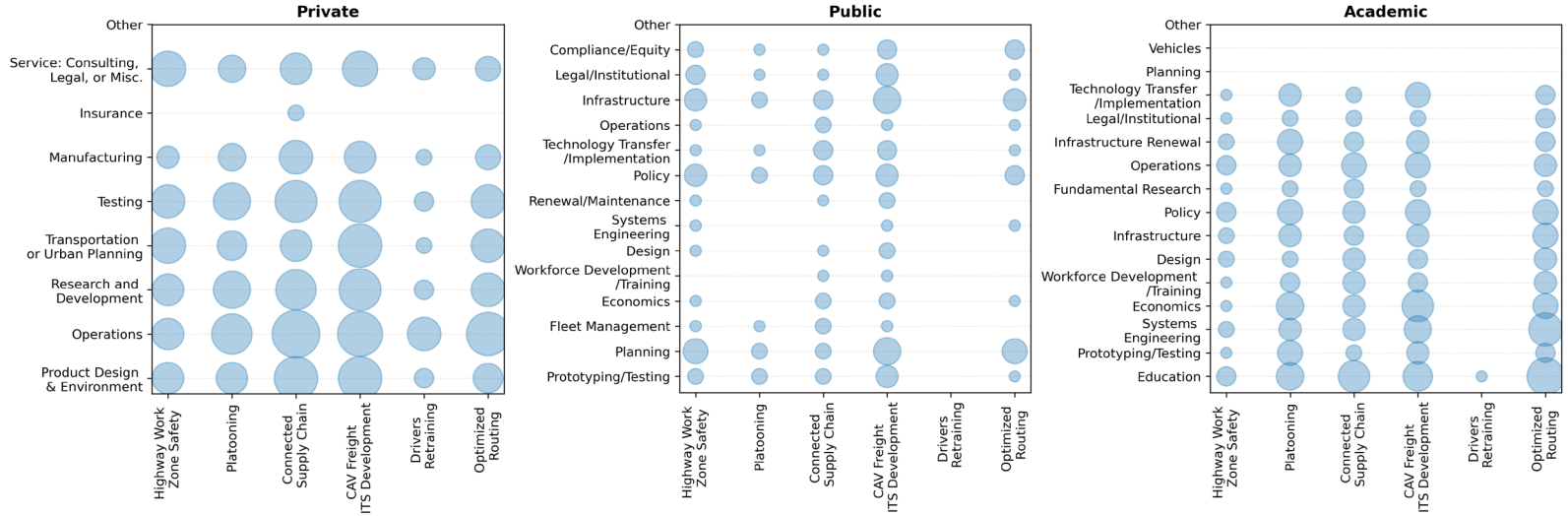


Figure 45. Graph. Survey responses on CASE engagement (CA freight).

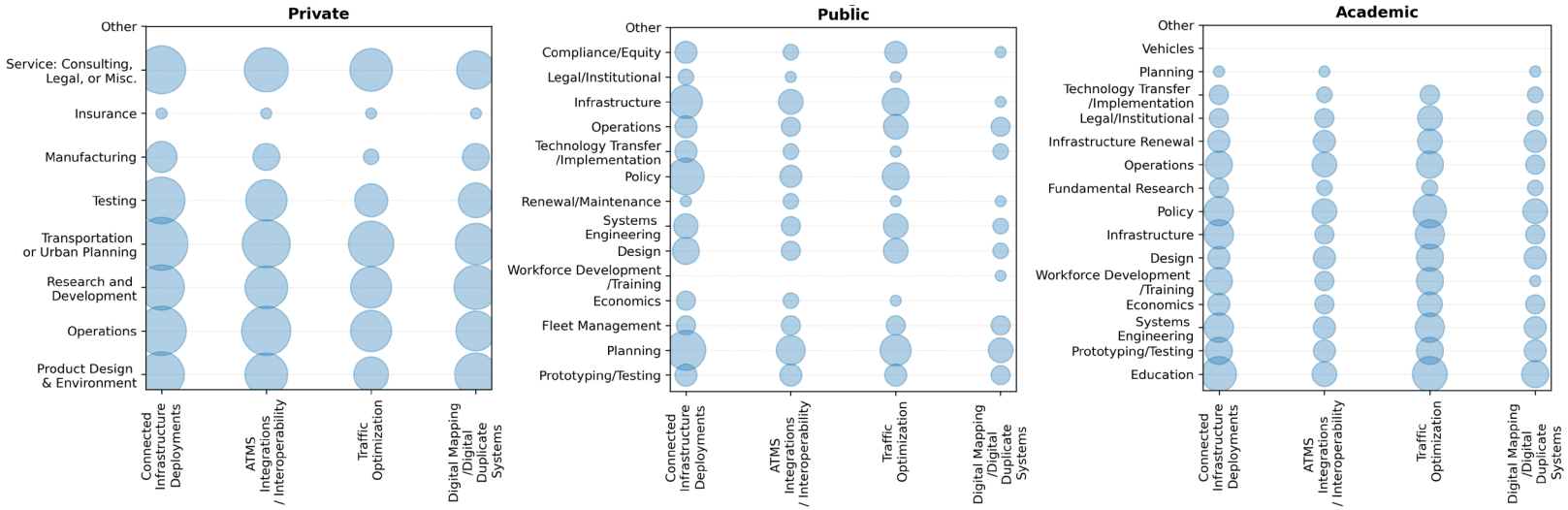


Figure 46. Graph. Survey responses on CASE engagement (scaling ITS).

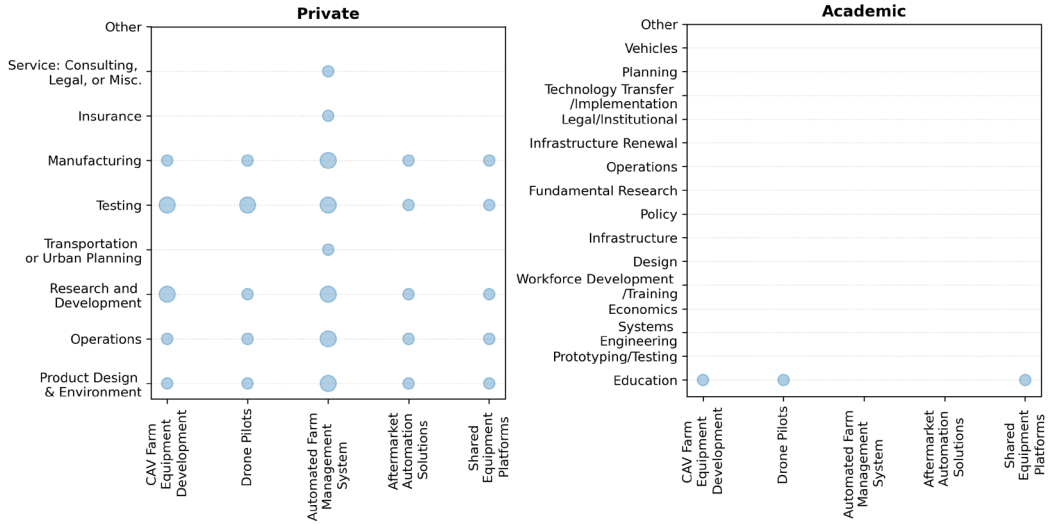


Figure 47. Graph. Survey responses on CASE engagement (farm automation). There were no solicited responses from the public sector.

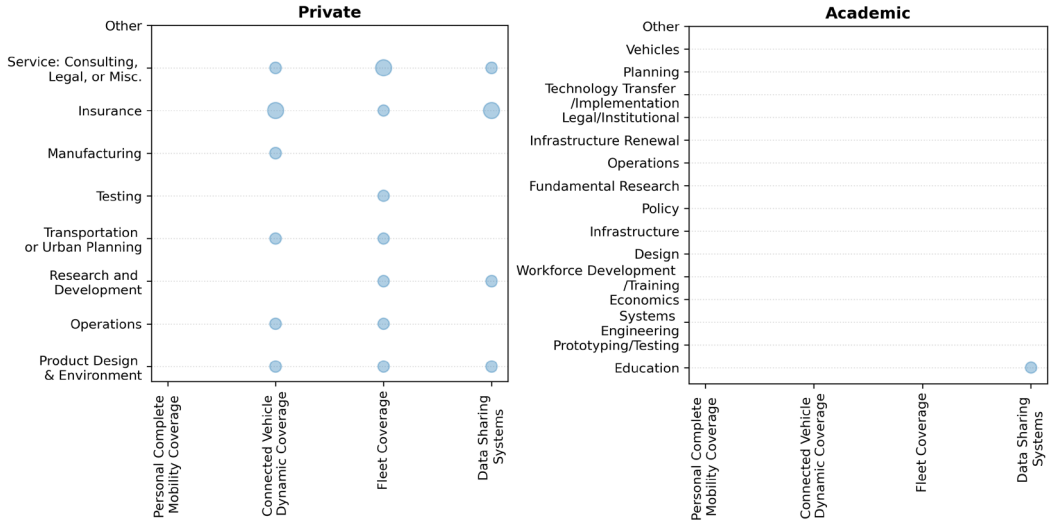


Figure 48. Graph. Survey responses on CASE engagement (insurance). There were no solicited responses from the public sector.

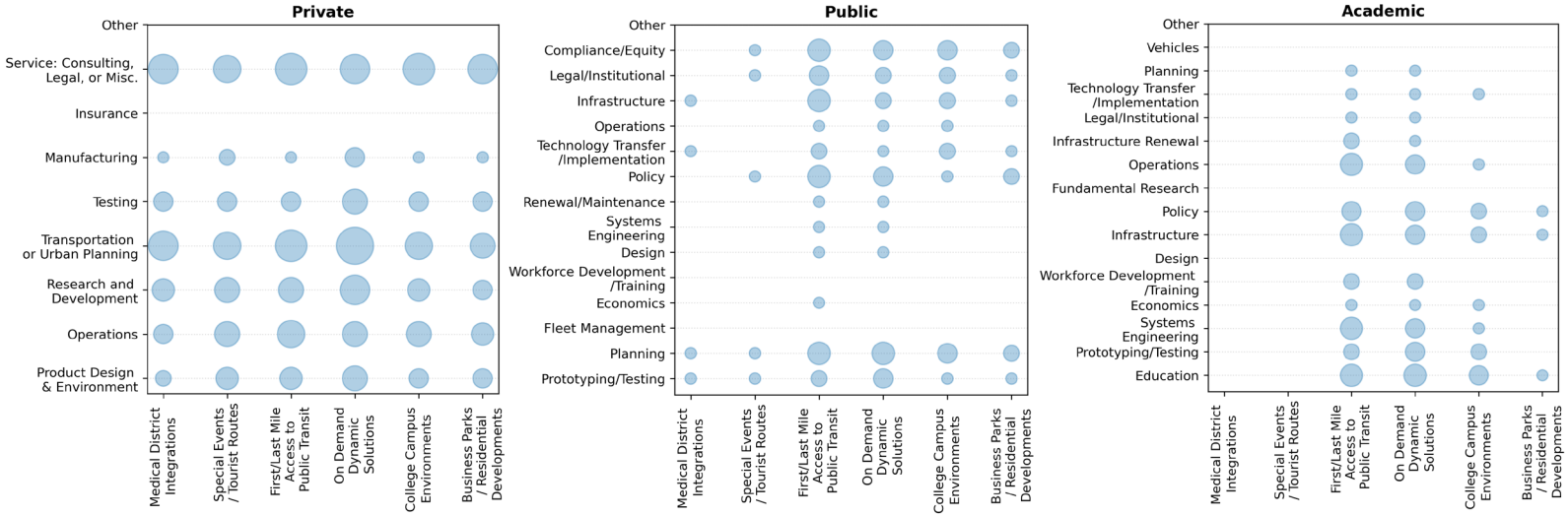


Figure 49. Graph. Survey responses on CASE engagement (urban mobility).

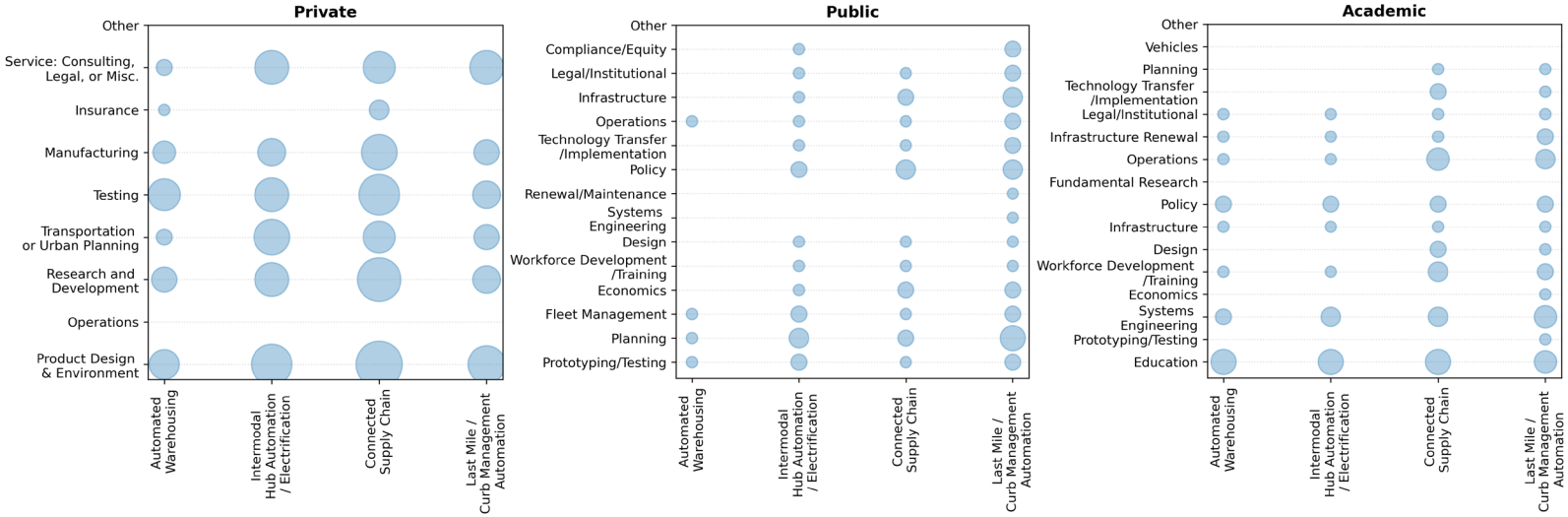


Figure 50. Graph. Survey responses on CASE engagement (CA logistics).

APPENDIX G: SCORECARD RESULT DETAILS

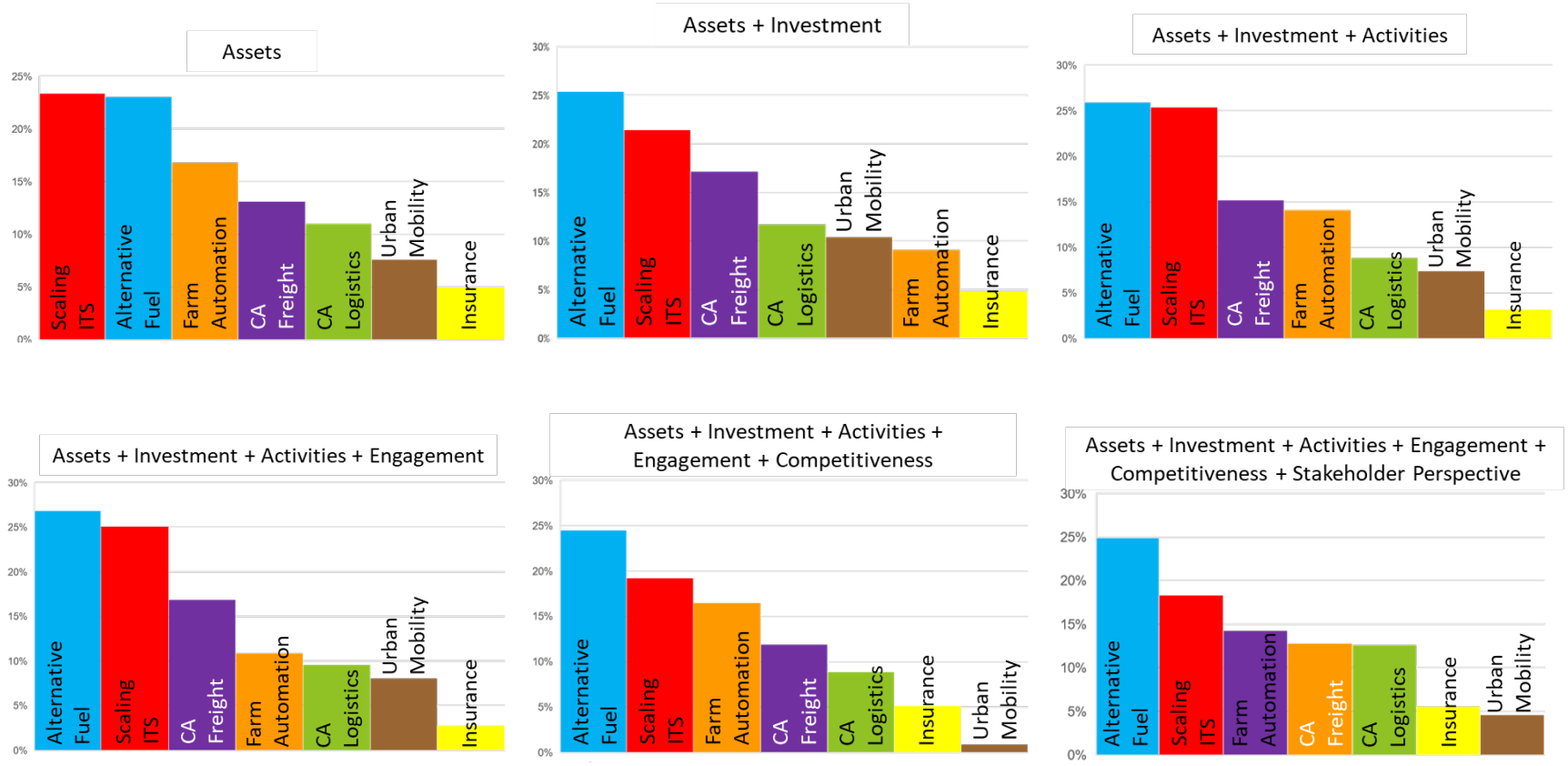


Figure 51. Chart. Step-by-step addition of each criterion to the final ranking of pillars per the balanced scorecard analysis.

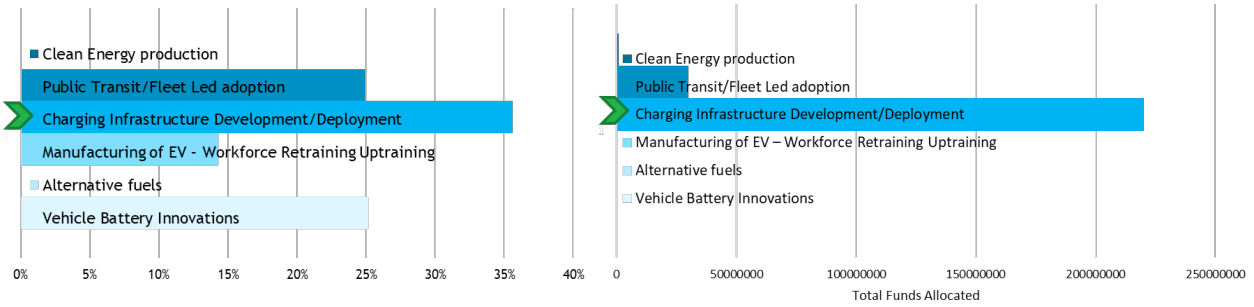


Figure 52. Chart. Key focus area ranking per the balanced score (left) and investment (right) for alternative fuels.

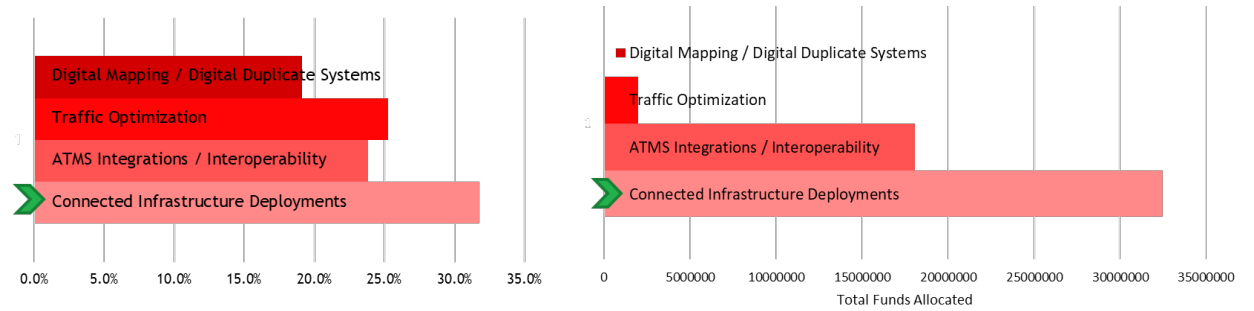


Figure 53. Chart. Key focus area ranking per the balanced score (left) and investment (right) for scaling ITS.

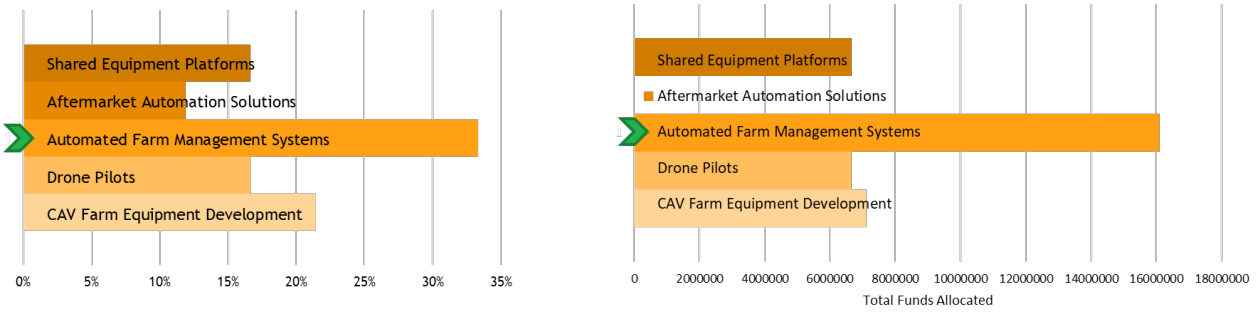


Figure 54. Chart. Key focus area ranking per the balanced score (left) and investment (right) for farm automation.

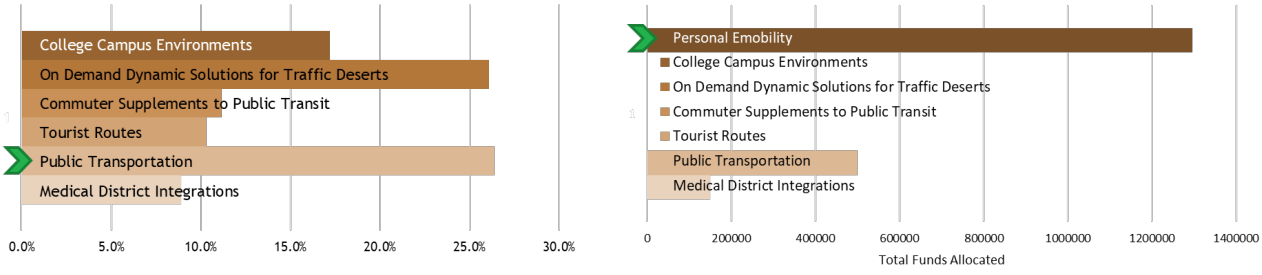


Figure 55. Chart. Key focus area ranking per the balanced score (left) and investment (right) for urban mobility.

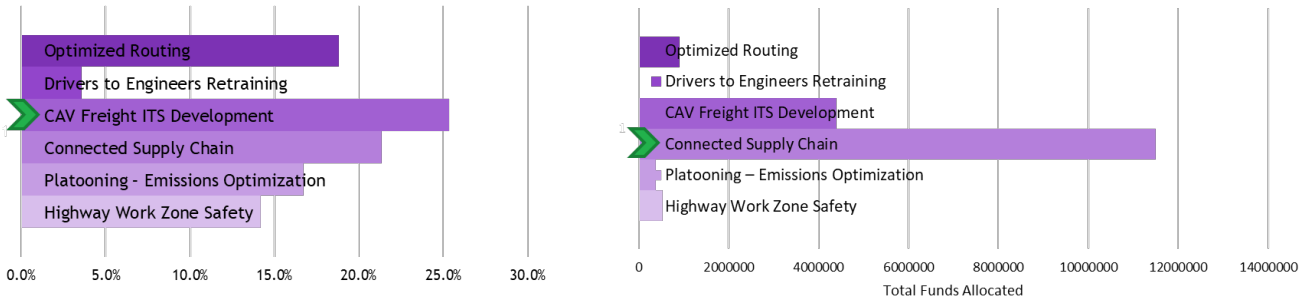


Figure 56. Chart. Key focus area ranking per the balanced score (left) and investment (right) for connected and automated freight.

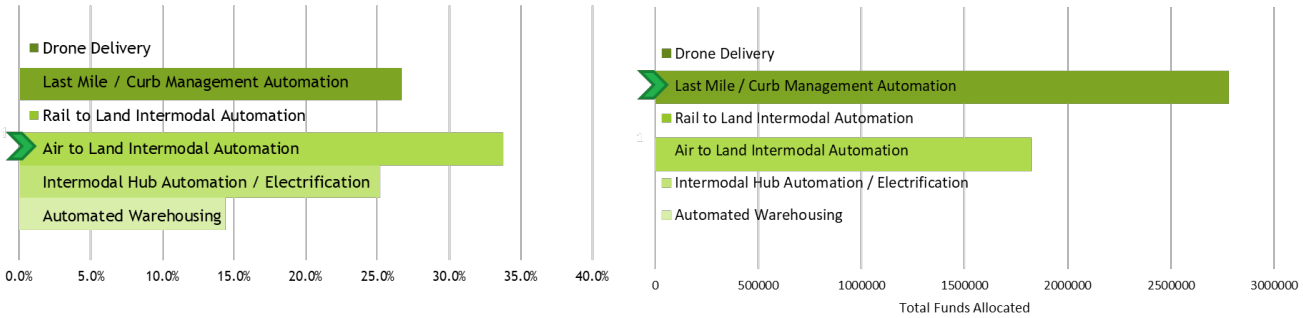


Figure 57. Chart. Key focus area ranking per the balanced score (left) and investment (right) for connected and automated logistics.

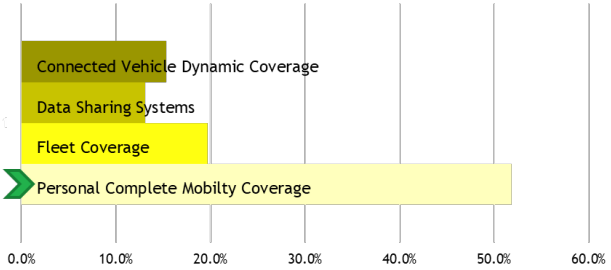


Figure 58. Chart. Key focus area ranking per the balanced score (left) and investment (right) for insurance. (Note: missing investment data due to limited survey responders.)

APPENDIX H: SUMMARY OF OPERATIONAL RISKS FOR CASE TECHNOLOGIES

Table 18. Risks Associated with Increased Mobility Options

Risk	Target	Way(s) of Impact	Consequence	Outcome	Recommendation	Goal Categories
Increase in roadway conflicts	Bicycle, pedestrian, and transit infrastructure 	Pedestrian Safety	Difficulty for CAV sensors in detecting and predicting travel paths of nonmotorized roadway users in a mixed human–vehicle operating environment	Multimodal odds can create safety risks for vulnerable road users	• Lane guidance for pedestrians and cyclists • Short vehicle platoons and mini-roundabouts • Prioritize high occupancy vehicle lanes to mitigate congestion	
Increase in roadway conflict to impact roadway and curb space	Design and allocation of curb space 	Ride-sharing and e-commerce	Pickup and drop off areas for ride-sharing vehicles requires dedicated street design and access management standards	Increased demand for curb space and imbalance between availability and demand	• Compatible design and allocation of curb space for AV integration	
Expansion of suburban areas / densification of urban areas	Land use 	Land use per AV operations	Denser urban cores and potential larger dispersion of low-density development in suburban areas	Low-density, dispersed land use patterns around metropolitan areas	• Analyze long-run CAV impact needs and associated action plans	

Table 19. Risks Associated with Increased Mobility Data Availability

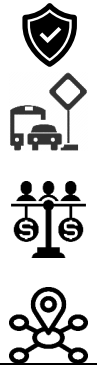
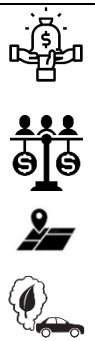
Risk	Target	Way(s) of Impact	Consequence	Outcome	Recommendation	Goal Categories
Lack of Transportation Systems Management and Operations (TSMO) strategies	Trip planning guidance 	Traffic flow, operations, and safety	Traffic delay with improper management of CAV traffic	Demand-management strategies becomes critical for reliability	• Data-management framework, including event and incident management • Signal preemption and smart pathways, especially for emergency responders	
Lack of TSMO systems	Traffic management center 	Mobility data management	Significant raw data produced by CAV cannot be easily processed by operators, requiring new or upgraded systems to ingest and manage large datasets	New data-management framework required; lack of guidance for deployment may bring cyberattacks	• Establish data-sharing agreements, privacy policies, and IT/ network security	
Lack of TSMO digital infrastructure	Data privacy 	Data transmission security between vehicles, infrastructure, and network	Requirement to enhance data-management and communication network capabilities	Informational privacy	• Prepare data-sharing agreements, privacy policies, and IT/ network security	
Lack of digital information standards for AVs	Cybersecurity 	CAV operation safety	Increased exposure to cybersecurity threats and system -wide vulnerability	Compromised protection of integrity, confidentiality, and accessibility of information, which may lead to CAV system failures and serious risks to safety and privacy	• Create standardized, secure digital information for CAVs • Commensurate infrastructure cybersecurity measures with ones from CAVs	

Table 20. Risks Associated with Electrification

Risk	Target	Way(s) of Impact	Consequence	Outcome	Recommendation	Goal Categories
Uncoordinated plug-in EV (PEV) charging	Power grid distribution systems 	Increased/ localized power demand	Uncoordinated charging systems may alter aggregate demand with associated electricity infrastructure impacts	Clustering effects in EV adoption; peak demand increase will require infrastructure upgrades; potential for higher home charging power requirement	• Assess impact of PEV charging on electric power system • Determine vehicle-to-grid opportunities for system stability	
Required expansion of statewide EV charging infrastructure	EV trip range 	Access to charging infrastructure	Imbalanced charging access across surburban and urban communities	Lack of coordinated EV charging stations could limit EV growth; operations will be impacted by charging station reliability	• Invest in charging infrastructure and support planning for statewide implementation	
Lack of charging time management	EV trip range 	Varying charging load	Inability to account for different operational requirements	Grid flexibility and sustainability, operating schedule, and fleet operations will be impacted	• Identify smart charging protocols	
Lack of charging infrastructure reliability for EVs in rural areas	Charging network 	EV adoption and operation	Inequity of public charging network in rural areas	Insufficient public charging network will dissuade EV adoption in rural areas	• Invest in rural area EV charging infrastructure	

Risk	Target	Way(s) of Impact	Consequence	Outcome	Recommendation	Goal Categories
Lack of charging infrastructure for electric trucks	Charging network 	Electric truck adoption and freight operation	Longer charging time and required energy-intensive supercharger network	Drive need for electric truck charging and associated depots; charging time will impact fleet operations and grid system changes	• Implement smart grid • Alter power grid to ensure stable energy supply	

Table 21. Risks Associated with CAV Technologies

Risk	Target	Way(s) of Impact	Consequence	Outcome	Recommendation	Goal Categories
Lack of vehicle-to-infrastructure (V2I) support from physical roadway infrastrucutre	V2I connectivity 	Infrastructure incompatibility with CAV needs	Inability to support safe operations of CAV, especially near real-time data transmission	Lag time in CAV communication, with detrimental implications to user safety	• Upgrade design standards, tools, and asset management programs • Invest in smart/ instrumented connected infrastructure	
Low reliability of V2I connectivity	V2I connectivity 	CAV operations	Inadequate installation of V2I technologies within roadway infrastructure	Impact deployment of automation levels 4 and 5; poor CAV communication support	• Create CAV-specific data and cloud data integration, e.g., for signal timing and work zones • Collaborate to safely deploy and integrate CAV	
Lack of traffic control device uniformity and quality	CAV operations safety and efficiency 	Pavement markings, traffic signs, traffic signals, work zone devices, vertical delineation devices	Safety rely on CAV evaluation of roadway elements to guide operations	Inconsistent levels of safe operations and robustness of CAV operations on roadways	• Develop high-contrast markings, compatible with CAV technologies, with reduced glare • Implement national uniformity, electronic signs, and use of pictograms over text • Traffic signal placement consistency, lane-direction uniformity • Sign standardization and use of retroreflective devices	

Risk	Target	Way(s) of Impact	Consequence	Outcome	Recommendation	Goal Categories
Lack of ITS roadway equipment for CAV	ITS architecture 	CAV operations and safety	CAV issues in reading signs and receiving information that are not conflicting	Limit automation levels 4 and 5 deployment, with critical safety issues	• Standardize equipment and associated ITS protocols for CAV integration	
Lack of ITS roadway-payment/ toll-collection system applicable for CAVs		CAV operations and safety	Barriers may present significant challenge for CAV operation when providing continuous eyes-off/ hands-off travel	Incompatible equipment that could hinder CAV adoption	• Enable virtual tolls that do not need physical barriers	
Inclement weather management for CAVs	Safety 	CAV operations and safety	CAV safety will be detrimentally affected	Bad weather is a hindrance in safe CAV integration	• Provide systematic and unified review of weather effect on CAV sensors	
CAV-induced congestion	Traffic flow 	CAV operations and safety	Congestion due to private and ridesharing CAVs	Increase in vehicle-miles traveled or congestion if more unregulated, zero-occupancy vehicles appear on roadways	• Prioritize high-occupancy vehicles to mitigate congestion related to CAV deployment	

Table 22. Risks Associated with CA Freight Technologies and Long-Haul Trucking

Risk	Target	Way(s) of Impact	Consequence	Outcome	Recommendation	Goal Categories
Increased expectation of on-demand delivery of goods and services	Infrastructure changes 	CAT integration	Speeding up of e-commerce fulfillment; warehouse locations may be moved to remote places (assuming decline in transport costs) while utilizing urban regions to accommodate increased demand	Required quick access to highways, which may induce limiting local surface traffic	• Plan highway access for CATs, including access to docks and parking lots	
AV impact on roadway infrastructure	Pavement and bridges 	Channelized platooning of CASE trucks	Increased roadway damage	Increased frequency of maintenance and rehabilitation triggers	• Leverage connectivity to offset wheel wander • Implement more suitable pavement and bridge materials and structural design • Implement dedicated CAT lanes	
Increased expectation of on-demand delivery of goods and services	Infrastructure changes 	CAT integration	Speeding up of e-commerce fulfillment; warehouse locations may be moved to remote places (assuming decline in transport costs) while utilizing urban regions to accommodate increased demand	Required quick access to highways, which may induce limiting local surface traffic	• Plan highway access for CATs, including access to docks and parking lots	
Supply chain impact	Intermodal rail carriers 	Autonomous truck integration	Manage cost parity	CAT may strain highway system capacity and maintenance	• Effectively interface railway with CAT	
Inconsistent state regulations of freight movement	Freight operations 	Inconsistent protocols	Prevent free movement of CA freight	CA freight operations and adoption rates will be negatively impacted	• Establish state regulations and coordinate with other states	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