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Electrification of Illinois Transit: Bridging the Gap with Heavy-Duty Technician Training Initiatives

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16. Abstract

This report examines the evolving landscape of technician training in Illinois' transit industry, with a particular focus on electric vehicle (EV) technology. The report aims to identify the current challenges, explore collaborative training initiatives between community colleges and transit agencies, and provide actionable recommendations to the Illinois Department of Transportation (IDOT). The research methodology involved a comprehensive review of training programs at Illinois community colleges. Additionally, the researchers conducted interviews with key Illinois transit agencies to understand their training challenges and needs. The study also analyzed successful EV training models and partnerships between educational institutions and the transit industry. The study found that community colleges are pioneering in developing EV training programs, while transit agencies face significant challenges in adapting to new technologies due to a reliance on equipment suppliers for training. Collaborative efforts between colleges and transit agencies show potential in developing more comprehensive training programs. However, there is a need for more standardized curricula and better-equipped training facilities. To address these challenges, the report recommends that IDOT support the standardization of EV technician training curricula. IDOT should also facilitate the provision of advanced training equipment to community colleges. Additionally, IDOT should support the establishment of a pilot specialized regional training center at Heartland Community College. This initiative will advance the quality of EV training and serve as a model for subsequent centers across the state. The insights from this report are intended to guide policy development and bolster the collaborative efforts of educational institutions and transit authorities in nurturing a workforce skilled in technology. This endeavor aims to synchronize training programs and curricula across institutions, fostering a cohesive and continuous educational pathway. The collaboration is set to cultivate an extensive partnership among community colleges and with transit agencies that develop standardized curriculum with needed training equipment and apprenticeships.

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EXECUTIVE SUMMARY

This study delved into the changing dynamics of technician training within Illinois' transit industry, with a specific focus on electric bus technology. It aimed to identify existing gaps in training programs for both new entrants and current workers in the field. The primary objective was to assess the preparedness of the state's transit systems for this technological shift and to propose actionable solutions that address the emerging needs of the electric vehicle (EV) sector to overcome the barriers of a skilled and adequately sized EV maintenance workforce.

Illinois' vast public transit network, comprising 63 agencies, facilitates the movement of millions across diverse geographic regions. In 2013 alone, this network supported over 736 million journeys, offering essential connectivity from rural to metropolitan areas and making services accessible in 96 of the 102 counties (Illinois Department of Transportation, n.d.). In northeastern Illinois, the transit network is particularly intensive. The Chicago Transit Authority (CTA) operates the second-largest public transportation system in the United States. The CTA serves the Chicago metropolitan area with an extensive array of bus routes and rapid transit railway lines. Alongside CTA, the commuter rail service, Metra, and suburban bus service, Pace, significantly bolster the region's transit capacity, collectively accommodating hundreds of millions of passengers annually.

This expansive transit system is a testament to Illinois' commitment to public transportation, which is at a crucial juncture of technological transition. Diesel transit buses emit substantial pollution. See the calculation below for particulate pollution from a diesel transit bus (U.S. EPA, 2024).

> According to the U.S. Environmental Protection Agency, the average emissions of particulate matter (PM) from a transit bus equipped with modern emission control technologies (such as diesel particulate filters) can range from 0.01 to 0.04 grams per mile (g/mi).
>
> Assuming a transit bus travels around 30,000 miles per year (a typical estimate for urban transit buses). Using the upper end of the EPA's range (0.04 g/mi), we can calculate the total particulate pollution emitted by the bus in a year:
>
> Total particulate pollution = Emissions rate (g/mi) × Distance traveled (mi/year)
>
> Total particulate pollution = 0.04 g/mi × 30,000 mi/year
>
> Total particulate pollution ≈ 1,200 grams per year

To improve air quality, there is a shift toward EVs in public transit to eliminate these emissions. The adoption of EV buses is driven by environmental concerns and sustainability goals and powered by technological advancements. This study found that successful implementation of EV buses in transit operations necessitates a parallel evolution of skilled technicians adept at maintaining and repairing these advanced EVs.

To understand the impediments to training a skilled workforce for EV maintenance for transit systems, the researchers met with representatives from Heartland Community College, Parkland College, Richland Community College, Olive-Harvey College, and Joliet Junior College. They selected

the colleges based on their industry relationships and expertise in both light- and heavy-duty EV vehicles.

The researchers discussed with community college representatives differentiating training for light- versus heavy-duty EV vehicles and focused on evaluating existing curricula for relevance to heavy-duty EV maintenance. Training programs covered a range of topics from basic EV principles to advanced heavy-duty EV maintenance, with discussions identifying current gaps and potential enhancements. These engagements led to a deeper understanding of the challenges and opportunities in EV training for transit systems, forming ongoing relationships among transit agencies and community colleges.

This dual approach to connect with community colleges and transit agencies provided insights into both the educational framework and the practical challenges technicians face in the field. The research catalyzed the rapid development of investments in the EV industry and the training programs to support it. As the researchers met with transit agencies and community colleges, they were part of the creation of a commitment by the community colleges and transit agencies to collaborate on advancing training capabilities for the EV industry and for the unique challenges of heavy-duty EV vehicles.

The findings revealed significant advancements in EV training programs at community colleges, without yet fully understanding the unique maintenance requirements of work with heavy-duty EV buses. The transit systems seek to develop training programs in conjunction with community colleges given their growing need for EV mechanics. Many agencies still predominantly rely on external suppliers for advanced technology training. Reliance on external suppliers for such training, while beneficial in certain respects, presents several challenges for ongoing training that may potentially hinder the initial commissioning of buses for long-term development and self-sufficiency in the transit agency workforce. The study identified that while significant strides have been made in developing EV training programs at community colleges, a notable gap exists between these programs and the specific training needs of transit agencies.

The researchers provided the Illinois Department of Transportation (IDOT) with the following recommendations. They recommended that IDOT develop a standardized curriculum for EV technician training. There is often a disconnect between the training programs offered by educational institutions and the actual needs of the industry. This misalignment can result in graduates lacking the specific skills that employers in the EV and transit sectors are seeking. Curriculum alignment requires continuous dialogue with industry stakeholders to ensure that the courses offered reflect current technologies, industry standards, and future trends. Without this alignment, there is a risk that students are being prepared for yesterday's jobs, not tomorrow's opportunities.

They also recommended that IDOT provide training equipment to community colleges. Access to the latest tools, diagnostic equipment, and vehicles for training purposes is crucial for an effective learning experience. Many educational institutions struggle with procuring these resources due to high costs and rapid technological advancements. The lack of resources can significantly hinder the learning process, limiting students' exposure to the tools and technologies they will encounter in

their professional lives. This gap not only impacts the quality of education, but also the readiness of graduates to enter the workforce.

Finally, they recommended that IDOT support EV community college and transit agency coalitions. Gaining industry-relevant experience while studying is pivotal for students to understand the context of their training and its application in the real world. Opportunities for internships, apprenticeships, and collaboration with transit agencies and EV manufacturers can bridge this gap. Such experiences enable students to apply their knowledge in practical settings, understand workplace expectations, and build a professional network. The EV sector is characterized by rapid technological advancements, requiring educational programs to be frequently updated to stay relevant. Ensuring regular curriculum updates involves continuous industry engagement, research, and faculty development. Without these updates, there is a risk that the training provided becomes obsolete, leaving graduates unprepared for the latest challenges and innovations in the field.

The community college EV network adopted the above recommendations in conjunction with its application for Rev Up EV! Community College Initiative funding from the Illinois Community College Board (ICCB). ICCB awarded $9.4 million to 25 Illinois community colleges to support job training and technology development programs that advance the state's growing EV industry. Five community colleges—Heartland, Olive-Harvey, Kishwaukee, Triton, and McHenry—are using the ICCB funding specifically to develop heavy-duty EV maintenance training programs for their regions.

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INTRODUCTION

The transition toward sustainable transportation, particularly electric vehicles (EVs), presents opportunities and challenges for workforce development. Recognizing this, community colleges in Illinois have initiated programs to establish EV training programs. These initiatives are tailored to equip a new generation of technicians with the skills necessary for the emerging EV market.

Background and Integration of EV Buses

In the pursuit of sustainable urban development, the integration of EV buses into public transit systems emerges as a cornerstone initiative, aligning with global efforts to mitigate climate change and enhance urban air quality. The advent of advanced battery technologies has propelled EV buses to the forefront as a silent, zero-emission alternative to traditional diesel-powered buses, marking a pivotal shift in urban transportation dynamics. This transition is underpinned by an array of drivers, including the imperative to reduce greenhouse gas emissions, the economic benefits stemming from operational efficiencies, and the positive impacts on public health and the environment.

Technical Aspects and Examples

Central to the adoption of EV buses are the technical considerations that encompass battery capacity, energy consumption, and the requisite charging infrastructure, which collectively dictate the feasibility and performance of EV buses within urban transit networks.

Operational Efficiency of EV Buses

Electric buses are more energy-efficient than diesel buses. The U.S. Department of Energy's Alternative Fuels Data Center (n.d.) reports that electric buses can achieve the equivalent of over 100 miles per gallon of diesel fuel, compared to about 4.8 miles per gallon for a standard diesel bus.The cost of electricity for charging EV buses is significantly lower than the cost of diesel fuel, leading to substantial savings over the life of the bus.

EV buses have fewer moving parts than diesel buses, reducing the likelihood of mechanical failures and the need for repairs. This leads to lower maintenance costs.The regenerative braking systems in electric buses reduce brake wear, further decreasing maintenance needs.

Aber (2016) reported that the total cost of ownership (including purchase, fuel, and maintenance costs) of electric buses is lower than that of diesel buses over the vehicle's lifetime. A study by the National Renewable Energy Laboratory on Foothill Transit's Proterra electric buses showed that maintenance costs were significantly lower for electric buses compared to their diesel and compressed natural gas counterparts (Jeffers & Eudy, 2021).

Transition to Sustainable Transportation

Various factors drive the move toward sustainable transit, especially in buses. Electricity from nuclear and renewable sources powers buses, significantly reducing climate impact compared to internal combustion engines. This necessity for reducing climate impact now becomes a core element of all bus funding, prompting transit agencies to adapt accordingly.

Climate Impact and Air Quality Improvements

Beyond climate change mitigation, electric buses offer the direct benefit of cleaner emissions than internal combustion engines, significantly improving air quality in urban areas.

Increasing Adoption of Clean Buses

Transit agencies are moving increasingly toward the purchase of clean buses, driven by a confluence of legislative mandates, regulatory standards, and supportive funding programs aimed at fostering sustainable transportation solutions. This increased trends not only reflects a growing commitment to environmental stewardship, but also underscores the urgent need for enhanced technician training to maintain and repair these advanced vehicles. By aligning with legislation, adhering to detailed regulations, and leveraging available funding, transit agencies are taking significant strides toward cleaner, more sustainable public transit systems.

Rising Demand for Skilled Technicians

The complexity of clean buses, coupled with the transition to EVs, is creating new demands for skilled personnel. Salaries in transit agencies for these roles are competitive, reflecting the specialized nature of the work.

Need for Department of Labor Apprenticeships

Department of Labor apprenticeships are formal training programs combining on-the-job learning with classroom instruction, providing essential skills for careers in fields like the EV sector. These apprenticeships offer a structured learning pathway that blends theoretical knowledge with practical experience, industry-recognized certification, access to funding, and a direct pathway to employment. Particularly in the rapidly growing EV industry, Department of Labor apprenticeships are instrumental in meeting the demand for skilled technicians; encouraging collaboration between educational institutions, industry partners, and government agencies; and ultimately contributing to workforce development and sector innovation.

Figure 1. Photo. Electric bus in urban transit.

Source: Chicago Transit Authority

OVERVIEW OF COMMUNITY COLLEGE INITIATIVES

Four Illinois community colleges with EV initiatives are briefly outlined below:

- Olive-Harvey College has a partnership with Rivian for hands-on training in EV maintenance.
- Heartland Community College is developing a heavy-duty electric vehicle program tailored for public transit.
- Parkland College offers training that supports local transit agencies with a focus on EV fleet diagnostics and repair.
- Joliet Junior College is collaborating with Lion Electric for practical experience in the latest EV technologies.

Olive-Harvey College's Partnership with Rivian

Olive-Harvey College has initiated a strategic partnership with Rivian, an electric vehicle manufacturer. With flagship models like the R1S SUV and R1T truck, Rivian stands at the forefront of the electric vehicle industry, blending performance with environmental stewardship. The apprenticeship program provides a balanced mix of theoretical knowledge and hands-on experience in EV maintenance, focusing on key aspects of EV technology such as battery management, electrical systems, and diagnostics. This partnership not only equips students with industry-relevant skills, but also aligns them with the growing market demand for electric vehicles, supported by Rivian's innovative approach and commitment to ecological preservation.

Heartland Community College's Heavy-Duty EV Program

Heartland Community College (HCC), a leader in passenger EV training, is developing a heavy-duty electric vehicle program. This program is in its initial stages and aims to address the unique requirements of public transit in the future (Curt Rendall, Heatland Community College, pers. communication). In response to the rapidly growing EV industry, marked by significant developments such as Rivian's expansion in Normal, Illinois, HCC has undertaken strategic initiatives to advance EV training and infrastructure:

- HCC is structuring their curriculum to focus on the skills and knowledge essential for maintaining and repairing heavy-duty electric vehicles, a critical requirement for public transit.

- Students are trained in handling high-voltage systems, which are fundamental to electric buses and trucks. This training includes understanding safety protocols, battery management, and electrical troubleshooting.

- The curriculum covers advanced diagnostic skills for identifying and resolving complex issues in electric powertrains and associated systems. This also involves training in the use of specialized diagnostic tools and software unique to EVs.

- Given the centrality of battery systems in EVs, the program provides in-depth knowledge about different types of EV batteries, their management, charging protocols, and maintenance requirements.

- Students learn about regenerative braking systems, which play a key role in the efficiency of electric buses and trucks. This training includes understanding their operation, maintenance, and integration with the vehicle's overall electrical system.

- The program covers the thermal management systems essential for maintaining optimal temperatures for EV batteries and electronics, which is critical for the longevity and performance of heavy-duty electric vehicles.

- Recognizing the varied needs of public transit, the program tailors training to include sector-specific requirements such as fleet management, route optimization for electric buses, and logistics considerations for electric trucks.

- HCC is collaborating closely with industry partners in public transit to develop the curriculum. This partnership ensures that the training is relevant and up-to-date with the latest industry practices and technological advancements in heavy-duty electric vehicles.

- The program incorporates practical, real-world scenarios and case studies that reflect the challenges and operational environments specific to public transit.

- Given the rapid evolution of EV technology, the curriculum is designed to be dynamic and adaptable, allowing for quick updates and modifications to stay abreast of new developments in the field. HCC is the leader of the Illinois Community College Board Rev Up EV! grant for

developing a common curiculum to train EV bus mechanics. Part of this grant is to expand upon the connections between the colleges and transit agencies such as the Chicago Transit Authority (CTA) and connect to continually update training that meets the needs of transit agencies. Olive-Harvey will have similar internships and apprenticeships with CTA.

- The program includes opportunities for internships and hands-on training with local transit agencies. This exposure to real-world working conditions is crucial for students to gain practical experience and understand the specific demands of these industries. Internships and apprenticeships will enable students to work at a transit agency, where students maintain buses that are operating, enabling them to practice techniques learned in class.

To develop a heavy-duty EV program, HCC is actively engaging with Connect Transit and holding meetings with transit agencies from around the state to ensure that its curriculum is closely aligned with the real-world demands of the EV sector.

- The college regularly convenes panels and workshops that include representatives from transit agencies and EV manufacturers. The forums facilitate direct dialogue on current industry trends, technological advancements, and workforce needs.

- Industry stakeholders play a vital role in shaping the curriculum. They provide insights on the specific skill sets required in the field, suggest relevant technological updates, and advise on the incorporation of new EV models and systems into training modules.

- Collaborating with stakeholders allows the program to incorporate real-world case studies and scenarios into the curriculum. This ensures that students gain an understanding of practical challenges and situations they are likely to encounter in their professional roles.

- Partnerships with industry stakeholders facilitate the creation of internship and apprenticeship opportunities. These programs provide students with hands-on experience in actual work environments, bridging the gap between academic learning and practical application.

- Stakeholders often contribute to the program by providing access to the latest EV maintenance tools, diagnostic equipment, and vehicles. This exposure to industry-standard resources enhances the practical training component of the program.

- Ongoing feedback from stakeholders ensures that the program remains up-to-date and responsive to changes in the industry. This may include regular updates to the curriculum to reflect new technologies, maintenance practices, and regulatory changes.

A workshop held at Heartland Community College has shed light on a critical need: the development of a skilled workforce prepared for the imminent surge in EV-related projects. Please refer to Appendix A for more information.

Electric Vehicle–Energy Storage (EVES) Manufacturing Training Academy

In April 2021, the Illinois Department of Commerce and Economic Opportunity awarded Heartland Community College a $7.5 million capital grant. The grant established the EVES Manufacturing Training Academy in partnership with Rivian Automotive.

The grant facilitated the creation of specialized labs, including a 7,800 sq ft electric vehicle lab and a 1,842 sq ft energy storage lab. The facilities provide practical, hands-on learning experiences for students. HCC also allocated an additional $6 million for the renovation and expansion of five career & technical education (CTE) programs, leading to the formation of the Advanced Manufacturing and Technology Academy (AMTA). The project has significantly expanded HCC's infrastructure, adding 33,036 sq feet of space for various state-of-the-art labs.

EVES offers comprehensive education pathways, including certificates and degrees focused on electric vehicle and energy storage. The curriculum, developed with Rivian's assistance, includes a 60-credit-hour associate of applied science degree in EV technology, complemented by various EV-related certificates. The program has seen significant enrollment success, particularly in attracting minority and women students, aligning with broader diversity and inclusion goals. The EVES program is well-regarded by industry partners, with constructive feedback highlighting areas for improvement such as soft skills development.

Heartland EV Open House and Industry Alignment

The Heartland EV Open House, held June 2023, is a component of a larger, ongoing series of interactions and collaborations that have been instrumental in shaping the trajectory of EV maintenance training programs. The event is part of a continuum of efforts that includes workshops, discussions, and tours that began unofficially on June 9 and continued through subsequent months, outlined below.

1. A series of events and meetings, starting with the initial workshop in June and followed by tours and discussions at CTA bus maintenance facilities and meetings with transit agencies like Connect Transit and MetroLINK, show a pattern of deepening collaboration and dialogue among community colleges, transit agencies, and industry partners.

2. These gatherings, including the Heartland EV Open House, fostered relationships that have led to the creation of networks. They provided platforms for stakeholders to discuss challenges, share insights, and explore opportunities in EV training, going beyond just a single event.

3. The interactions, including direct interviews and meetings, have been vital in gathering feedback from industry partners and transit agencies. This feedback has been a key driver in developing programs that are well-regarded and meet the needs of the industry.

4. The statewide workshop in November 2023, mentioned in the input data, underscores the ongoing commitment to collaboration and improvement, extending the dialogue initiated at the Heartland EV Open House.

5. The involvement with Southern Illinois University's EV degree program, as mentioned in the input data, adds another layer of depth to the training initiatives, aligning them with higher education and broadening the scope of training opportunities.

OneVoice Heavy-Duty EV Proposal

The OneVoice Heavy-Duty EV Proposal aims to meet the growing demand for specialized training for electric vehicle (EV) technicians across multiple sectors, including transit, agriculture, construction, mining, and trucking. An estimated $8.6 to $10 million is sought for capital and equipment to support this initiative. The proposal involves a partnership with Connect Transit, which has already made significant progress toward an electric fleet, and Heartland Community College, which has an established EV technology program. The proposed center would feature training facilities and new equipment, with the potential for expansion to accommodate various EV applications. Highlights are listed as follows:

- Connect Transit's plan to electrically power over half of its fleet by 2024.
- Heartland Community College's pioneering EV technology program.
- The significance of co-locating the training center with a maintenance facility.
- A comprehensive curriculum designed to prepare students for Automotive Service Excellence (ASE) certifications in EV technology.
- The ambition to create a statewide industry sector collaborative and to build a diverse talent pipeline for the EV workforce.

These elements underline the strategic planning and collaborative efforts needed to advance the workforce in line with the EV industry's growth.

Parkland College's EV Training Initiative

Parkland College's EV training initiative is designed strategically to support the evolving needs of local transit agencies as they transition to EV fleets.This program is underpinned by the following two key goals.

The primary goal of Parkland's program is to assist local transit agencies in their shift toward electric fleets. This goal is achieved by offering specialized training focused on EV diagnostics and repair. The training is tailored to address the specific challenges and technical demands associated with maintaining and operating electric buses and other EVs within public transit systems.

The secondary goal is to effectively balance theoretical instruction with hands-on practical training. In class, the students study high-voltage systems expertise, advanced diagnostics and repair techniques, battery technology and management, regenerative braking systems, thermal management of EVs, and industry-specific requirements. Students then work directly with actual EV buses and cutaway and simulation devices that allow them to apply theoretical knowledge to real-world scenarios. This

approach ensures a deep and practical understanding of EV systems, from battery management to electronic control systems.

Joliet Junior College's Collaboration with Lion Electric

Joliet Junior College's partnership with Lion Electric, a manufacturer of zero-emission vehicles, marks a significant advancement in EV technology training. Lion Electric produces all-electric school buses and urban trucks in North America. Several key aspects characterize this collaboration that enrich the educational experience for students. It emphasizes practical skills in EV maintenance, incorporating theoretical knowledge alongside hands-on experience. The focus is on critical areas of EV technology, such as battery management, electrical systems, and diagnostics, ensuring that students gain relevant industry experience. This partnership aligns with the market's shift toward electric vehicles, making graduates job-ready for a future dominated by sustainable transportation solutions.

In-Depth Exposure to EV Technology

- The collaboration with Lion Electric positions Joliet Junior College (JJC) at the forefront of EV technology training, providing students with hands-on experience with some of the most advanced EV technology in the market. Lion Electric's leadership in the field is evident in its pioneering zero-emission vehicles, custom-built components tailored for electric operation, and comprehensive support services that ease the adoption of EVs. Through this partnership, JJC students gain direct exposure to industry-leading practices and technologies, equipping them with the skills necessary to excel in a market progressively dominated by electric vehicles.

- Students gain practical knowledge of EV components, including battery systems, electric motors, and powertrain technology, directly from one of the leaders in EV manufacturing.

Real-World Application and Training

- The program incorporates training on actual electric buses and trucks produced by Lion Electric, offering students real-world context for their learning.

- This training includes understanding the design and functionality of EVs, diagnostic procedures, maintenance techniques, and repair strategies specific to electric vehicles.

Focus on Electric Vehicle Engineering Nuances

- The training allows students to explore areas such as regenerative braking systems, battery management, thermal control systems, and high-voltage safety protocols.

- It provides insights into the latest advancements and innovations in EV technology, ensuring students are up-to-date with industry trends.

Collaborative Curriculum Development

- Lion Electric's involvement extends to assisting in the development of the curriculum, ensuring training aligns with the latest industry standards and technological advancements.

- They design the curriculum to be dynamic, adapting to ongoing developments in the field of electric vehicles.

Career Readiness and Industry Relevance

- Students completing this program are equipped not only with technical knowledge, but also with a deep understanding of the EV industry's current landscape, preparing them for a variety of roles in this rapidly evolving sector.

- The partnership also enhances job readiness, as students gain experience with technologies and systems they will encounter in their professional careers.

Hydrogen Fuel Cells, Electric Vehicles in Transit, and Community College Training Programs

Introduction to Hydrogen as a Fuel Source

Zero-emission hydrogen fuel cells are gaining attention as a promising zero-emission technology in public transportation. They generate electricity through a chemical reaction between hydrogen and oxygen, emitting only water vapor. These fuel cells offer high energy efficiency and rapid refueling capabilities, comparable to traditional internal combustion engines. Hydrogen-powered buses offer longer ranges and faster refueling times than battery-electric buses, making them suitable for longer routes and heavy-duty applications. The main challenges include the need for significant investment in hydrogen production, storage, and distribution infrastructure. Current production methods also raise concerns about greenhouse gas emissions, though renewable energy sources can mitigate this.

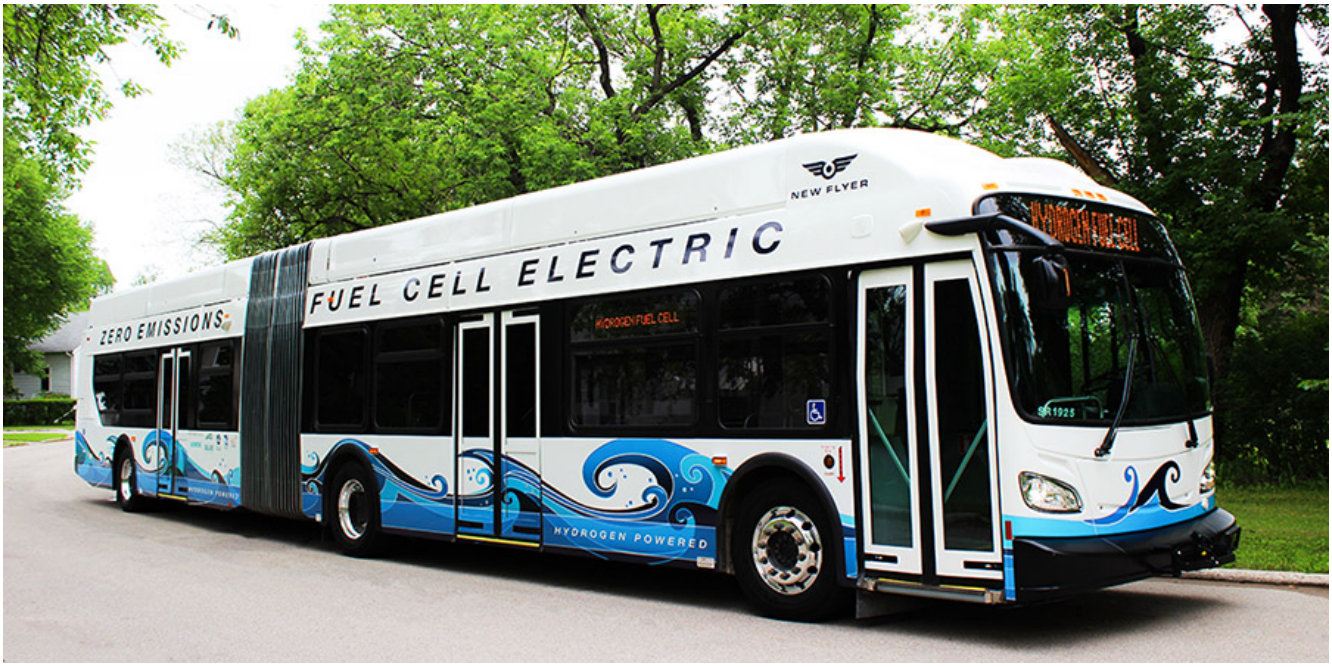

Figure 2. Photo. Hydrogen fuel cell bus pioneering zero-emission transportation.

Source: New Flyer

Case Studies and Implementation

- Various cities, like those in California, have begun integrating hydrogen buses, providing valuable data on operational costs, reliability, and environmental benefits.

- The Los Angeles County Metropolitan Transportation Authority (LA Metro) has been involved in testing and deploying hydrogen fuel cell buses. LA Metro has been a part of the Zero-Emission Bus (ZEB) program, which aims to transition to a 100% zero-emission bus fleet by 2030.

- The Orange County Transportation Authority has introduced hydrogen fuel cell electric buses and installed hydrogen fueling stations to support its fleet.

- The San Francisco Municipal Transportation Agency has explored the use of hydrogen fuel cell buses in an effort to reduce greenhouse gas emissions and to work toward a goal of having an all-electric bus fleet.

- The Alameda-Contra Costa Transit District has been a leader in the adoption of hydrogen fuel cell technology and operates one of the largest hydrogen fuel cell bus fleets in the United States. They have provided extensive data on the operational performance and maintenance needs of these buses.

Each case study offers insights into different aspects of hydrogen fuel cell bus integration:

- Comparison of operational costs with traditional diesel buses, accounting for fuel, maintenance, and potential subsidies or incentives for zero-emission vehicles.

- Data on uptime, range, fueling times, and the longevity of fuel cell buses contribute to understanding reliability.

- Documented reductions in greenhouse gas emissions, improvements in air quality, and noise reduction as environmental benefits of transitioning to hydrogen fuel cell buses.

Community colleges in California, in response to these implementations, have begun developing or adapting their training programs to include curriculum on hydrogen fuel cell technology, preparing the next generation of technicians for careers in maintaining and repairing these vehicles. These programs often work in collaboration with transit agencies and leverage case studies from these cities to inform their training materials.

Figure 3. Photo. Hands-on training session preparing technicians for EV technology held at Heartland Community College.

Source: Heartland Community College

Transit Bus Electric Vehicle Training Programs Support by the ICCB

The Illinois Community College Board requires grantees who receive funding for EV training to participate in the Illinois Green Economy Network-led Illinois EV Network, a collaborative of key stakeholders from industry, higher education, and state agencies guiding the expansion of light- and heavy-duty EV training to satisfy industry demand for high-skill workers.

- Heartland Community College has been proactive in developing EV training programs. They have shown a particular interest in heavy-duty electric vehicles, planning to establish a program tailored to meet the demands of the public transit.

- Olive-Harvey College has demonstrated interest in developing training programs focused on electric vehicles, particularly those suited for the transportation sector.

- Kishwaukee College, Triton College, and McHenry County College have indicated interest in providing training programs for electric buses. Their involvement signifies a commitment to adapting their educational offerings to include emerging technologies in transportation.

These community colleges are strategically positioned to play a pivotal role in preparing a skilled workforce for the electric bus sector in Illinois. Investment by IDOT in these institutions could significantly enhance their capabilities to offer comprehensive and industry-relevant electric bus training programs, thereby supporting the state's transition to sustainable transportation solutions.

Role of Community Colleges—Adaptability and Foresight in Program Development

Illinois community colleges, such as Heartland and Olive-Harvey, have demonstrated adaptability by developing programs focused on EV and hybrid EV technologies. These programs are tailored not only to current industry standards, but also to anticipate future developments in EV technology. Electric buses can be fully electric or hybrids charged by diesel engines or fuel cells powered by hydrogen. It is not yet clear which technology provides the best combination of range and power and charging time. Thus, it is critical for community colleges in the EV network to evaluate different types of fleets.

Academic Robustness and Industry Relevance

The curriculum and training modules offered by these colleges are academically robust, providing a comprehensive understanding of EV systems, maintenance, and repair. This is critical for developing a technically proficient workforce.

Transit Agencies' Movement Toward EVs—Data on Fleet Composition

Information from transit agencies like Connect Transit, CTA, Pace, and MetroLINK indicates a significant shift toward EV and hybrid EV fleets. For instance, Connect Transit' plans to have half of its fixed-route fleet as electric vehicles by the end of 2024.

Training Needs Beyond Bus Providers' Scope

Transit agencies, including those like the CTA, Pace Suburban Bus, and Connect Transit, have identified that the training offered by bus manufacturers focuses mainly on the initial deployment of buses. This recognition has highlighted a crucial gap in ongoing, specialized training essential for the effective maintenance and operation of EV fleets.

In-depth training, as envisioned by these agencies, would encompass a broader spectrum of skills and knowledge areas beyond basic vehicle operation. This includes advanced diagnostics, battery management systems, electrical and electronic systems troubleshooting, and repair techniques specific to EV technology. Additionally, it would cover safety protocols for high-voltage systems, sustainability practices, and potentially updates on emerging technologies and innovations within the EV sector.

To meet these comprehensive training needs, dedicated educational institutions like community colleges are in a unique position to develop and offer specialized curriculums. These programs would not only provide foundational knowledge on EV technology, but also ensure continuous learning opportunities for technicians through advanced courses, workshops, and certification programs. Such an approach would support the transit agencies' move toward a more sustainable, efficient, and technologically advanced public transportation system.

Critical Role of State Support

Given the substantial commitment of transit agencies to heavy-duty EV systems, state support for community colleges is crucial in meeting the burgeoning demand for skilled technicians. The state's involvement could include funding, policy development, and creating partnerships between transit agencies and educational institutions. The collaboration between state, transit agencies, and community colleges is essential to develop a workforce that is not only trained in current EV technologies, but also prepared for future advancements in the sector.

CONCLUSION

Community colleges play a pivotal role in shaping the workforce for the EV sector. Their adaptability in program development, coupled with the significant movement of transit agencies toward EV and hybrid EV fleets, underscores the need for comprehensive training programs. The state's support in enhancing these educational initiatives is critical to ensure that the transit industry's shift toward sustainable solutions is supported by a skilled and well-prepared workforce. This collaboration is key to addressing the growing demand for technical expertise in the evolving landscape of public transportation.

CHAPTER 2: TRANSIT AGENCIES AND THEIR CHALLENGES IN ADVANCED TECHNOLOGY TRAINING

INTRODUCTION

As the transit industry rapidly integrates advanced technologies like electric vehicles (EVs), hybrids, and fuel cell buses, transit agencies face significant challenges in adapting their training programs. This chapter outlines the specific challenges encountered in Illinois by agencies such as the Chicago Transit Authority (CTA), Connect Transit, MetroLINK, and Champaign-Urbana Mass Transit District (MTD).

Consultations with Transit Agencies

To understand the needs for a skilled workforce for EV maintenance for transit systems, the researchers met with representatives from Pace, CTA, Connect Transit, MetroLINK, and Champaign-Urbana MTD. The researchers chose agencies based on fleet size and EV adoption plans, with a focus on larger transit agencies as key maintenance workforce demand indicators. They conducted multiple structured consultations, including workshops and tours, to understand the challenges and needs for EV training, particularly for heavy-duty vehicles. The durations of the consultations varied, and they were structured around predetermined questions and objectives (Appendix C). The discussions revolved around challenges in EV transition, heavy-duty EV maintenance training needs, and agency readiness for technological shifts.

Transition to Electric Buses Strategic Overview

Connect Transit

Connect Transit (2022) in Bloomington-Normal, Illinois, in collaboration with Proterra, has embarked on the Zero-Emission Fleet Transition Plan. They have taken strategic steps since 2017, with federal and state investment making new technologies attainable, to shift from fossil fuels to zero-emission vehicles. The fleet management strategy adheres to the Federal Transit Administration's (n.d.) guidelines that has sections on fleet transition, facility modifications, power energy mangement, financial and budget plans, workforce transition plan and equity environment justice. It is detailed in a vehicle maintenance plan attached to the Zero-Emission Transition Plan.

The transition encompasses deploying 43 zero-emission buses, enhanced by two depot chargers and 10 on-route chargers, amounting to an estimated $40 million, leveraging grants and local match funds. This initiative enjoys robust local support, partly due to the community's positive response to Rivian Automotive's presence, which has bolstered local economic development and spurred support for Connect Transit's green initiatives.

Addressing the growing demand, Connect Transit has recognized the need to expand its facilities to accommodate an electric fleet, including a new storage facility for microtransit and paratransit vehicles. This facility will serve multiple functions, providing office space, meeting and training rooms to foster workforce development, and integrating charging infrastructure for the zero-emission fleet.

Furthermore, this plan incorporates community feedback and strategic partnerships, ensuring that the transition not only aligns with the region's environmental objectives, but also fortifies the local economy and job market.

According to Denham (2022), Connect Transit received a $13 million federal grant to enhance its transportation services in the Bloomington-Normal community. This funding will allow the acquisition of five new electric buses to replace old diesel buses—nearly half of the fleet will be electric. Additionally, it covers electric vans for a new microtransit service and a new training and storage facility. The microtransit service, similar to Uber but shared, aims for a 10–15 minute wait time, enhancing accessibility for the community.

Champaign-Urbana Mass Transit District

The Zero-Emission Transition Plan for the Champaign-Urbana MTD (2023) focuses on transitioning to a fully zero-emission fleet by 2038, emphasizing the adoption of fuel cell electric buses (FCEBs) and battery electric buses. The plan outlines infrastructure development, workforce training, and partnerships to support this transition. It aims to leverage renewable energy sources, particularly solar power, to ensure sustainability. Funding strategies involve tapping into federal, state, and local resources, and the current policy and legislative environment are conducive to implementing the transition without significant barriers.

As of March 2023, Champaign-Urbana MTD has a total of 118 buses in its fleet, including 40- and 60-foot buses. The fleet is currently 98% diesel-electric hybrid and 2% FCEBs. By the end of 2023, the MTD will have added 10 more FCEBs to the fleet, making it 90% diesel-electric hybrid and 10% FCEBs. They intend to expand the hydrogen fuel production station and continue to expand the FCEB fleet near the capacity of that expansion, approximately 60–80 buses or 50%–70% of the fleet.

As part of the transition to a fully zero-emission fleet, 2026 will be the last year the MTD purchases diesel-electric hybrid buses. With this timeline, the district anticipates retiring the last diesel-electric hybrid bus in 2037 and becoming a fully zero-emission bus fleet in 2038. They intend to delay the introduction of battery electric buses until 2035 to minimize the number of years the maintenance department will need to maintain three different types of fueling technology. Waiting until 2035 will provide more time for the MTD's maintenance department to become more proficient with FCEB technology, and it will also provide more time for the optimization of battery electric technology for transit applications.

Pace Bus

Pace's Zero-Emission Bus Transition Plan (2022) is a comprehensive initiative to convert Pace's entire fixed-route bus fleet to battery electric buses (BEBs) by 2040, aligning with environmental sustainability goals. Key points from the plan are listed as follows.

- Pace's transition to a zero-emission fleet is a part of its strategic vision to innovate and improve public transit while addressing climate change. This initiative is reinforced by the adoption of electric buses and the transition from diesel and compressed natural gas buses.

- The transition began with Pace deploying hybrid electric buses in 2012, transitioning to compressed natural gas in 2016 and introducing BEBs in 2022 with plans to continue in phases. The initial delivery includes Pace's first BEB with an additional 20 BEBs expected, indicating a phased approach to fleet electrification.

- Pace has 1 in-service BEB and 21 on order, with a future fleet of roughly 650 buses, including a mix of BEB and hydrogen fuel cell buses.

- Pace is committed to operating 100% zero-emission vehicles by 2040, with a planned mix of 70% battery electric and 30% hydrogen fuel cell buses.

- Key to the transition is the modification of facilities to accommodate BEBs, including the expansion of capacity and the support for zero-emission electrification efforts. Workforce training to operate and maintain new equipment is integral to the plan, ensuring a smooth transition to new technologies.

- Securing funding for infrastructure upgrades and bus acquisitions is crucial. The plan outlines the need for significant capital funding from state, federal, and regional entities to support the transition, with cost estimates for acquiring 616 zero-emission buses totaling approximately $1.047 billion.

- Collaborations with utility providers, such as Commonwealth Edison (ComEd), are essential to ensure adequate power supply for the fleet. These partnerships aim to develop a charge management strategy and secure a public utility rate for transportation providers, highlighting the importance of inter-agency cooperation.

- Federal mandates and state legislation support the plan by promoting zero-emission transit, underscoring the alignment of Pace's transition plan with broader environmental and sustainability goals.

In summary, the Pace Zero-Emission Bus Transition Plan represents a forward-thinking approach to public transportation, focusing on environmental sustainability, strategic planning, infrastructure upgrades, funding acquisition, and partnerships to achieve a fully electric bus fleet by 2040.

Chicago Transit Authority

Chicago Transit Authority's current fleet comprises 22 Proterra electric buses and 2 New Flyer electric buses. They aim for all bus procurements to be electric (battery electric or fuel cell electric) starting 2026, requiring an average of 150 buses a year for fleet replacement. Figures 4, 5, and 6 detail the CTA plans for the transition to an EV fleet over the years. The CTA acknowledges feasibility challenges with battery electric buses and the influence of infrastructure construction timelines on procurement rates. Technological advancements and other unknowns present difficulties in planning and execution.

Sangamon Mass Transit District

According to Crawford (2023), the Sangamon Mass Transit District (SMTD) has received nearly $6 million from the U.S. Department of Transportation's Low-No Emissions Bus program. This funding will support the replacement of eight diesel buses with four natural gas and four hybrid electric/diesel buses, marking a significant step toward SMTD's goal for a low-emission fleet. Currently, SMTD operates 34 diesel and 22 compressed natural gas buses. With this initiative, over 50% of their fleet will consist of low-emission vehicles for the first time. Cost estimates for hydrogen fuel cell buses and BEBs exceed a million per bus, nearly double the current cost of a diesel vehicle, which is why SMTD is moving in a measured, deliberate manner. Much of the funding for the fleet transition is expected to come from federal grant funds.

MetroLINK

The Rock Island County Metropolitan Mass Transit District (MetroLINK) has unveiled a climate action plan (2021) aimed at achieving zero emissions by 2028. This initiative marks MetroLINK's first formal environmentally focused effort, targeting climate change, air quality improvements, and other sustainability issues. Key steps include a pilot program testing renewable plant-based diesel fuel in their locomotives, aiming for a reduction in greenhouse gas and criteria pollutant emissions. MetroLINK has also replaced all its Tier 0 trains with 39 Tier 4 trains, meeting the Environmental Protection Agency's air quality standards. The agency is committed to sustainable practices, having integrated green standards in their administrative and maintenance facilities, which have achieved significant energy consumption reductions and received LEED certification for sustainability.

MetroLINK has been a pioneer in sustainability, transitioning from diesel to exploring biofuels and then adding compressed natural gas vehicles to their fleet. Their journey toward zero-emission transit continued with the adoption of electric buses, particularly leveraging Proterra's extended-range Catalyst E2 models, which were tested on a dedicated route to gather analytics. This initiative was part of their strategy to embrace emerging sustainable technologies, including setting up innovative charging solutions like ceiling-mounted systems in their garage to manage space efficiently and to enhance safety. MetroLINK also explored microtransit services, launching a mobile app-based service in Milan to offer more flexible and efficient transportation options.

Challenges in Transition to EV Buses

All agencies listed above demonstrate a strong commitment to transitioning to zero-emission fleets, albeit with different timelines and fleet composition strategies.

CTA faces challenges related to the feasibility of battery electric buses and the dependency of procurement rates on the development of necessary infrastructure. The procurement of getting enough charges with power from the grid to support the number of buses and getting enough trained mechanics are key challenges, along with keeping pace with the changing surrounding technological advancements.

MetroLINK's immediate plans for acquiring additional electric buses are contingent on completing a restructuring with Proterra, indicating a cautious approach to expansion until certain operational issues are resolved. Proterra's bankruptcy filing in early August is a significant stumble on the road to

electrifying heavy-duty transportation (De Socio, 2023). The California bus maker announced it had filed for Chapter 11 bankruptcy protection in an effort to maintain operations and restructure to better address “macroeconomic headwinds.” They were bought out by Phoenix Motor (Lewis, 2024).

The development of electric charging stations is a critical factor for all agencies, impacting the pace and scale of electric bus adoption. Infrastructure uncertainties revolve around the ability of the grid to provide sufficient power to charge fleets of buses and technological uncertainties, including the rapid evolution of EV technologies and the specific challenges of battery and hydrogen fuel cell technologies, requiring flexible and adaptive planning.

The relationship with bus manufacturers like Proterra and New Flyer is crucial. Without their training support during the commissioning of the buses, the agencies would not have the skills to maintain the buses. This is seen in MetroLINK’s current pause in acquiring new buses pending restructuring due to the uncertainity of providing the needed training. Thus, the limit of skilled technicians requires that the bus providers provide a significant amount of commissioning support and training. This underscores the importance of strong partnerships in navigating the transition to electric buses.

The transition to zero-emission bus fleets among these transit agencies illustrates a broader trend toward sustainable public transportation. Despite the enthusiasm for this shift, agencies must navigate significant challenges, including technological uncertainties, infrastructure readiness, and strategic partnerships with manufacturers. The adoption of mixed fleet strategies, involving a combination of fully electric buses, hybrids charged by diesel engines, and those powered by hydrogen fuel cells, showcases transit agencies’ flexibility and responsiveness to evolving technologies. This approach allows for a comprehensive evaluation of different types of fleets to identify which technology offers the optimal balance of range, power, and charging efficiency. Varying timelines and proactive planning approaches reflect both the complexities and the committed efforts to achieve a more sustainable and clean transit system in the coming decades. Electric buses can be fully electric or hybrid charged by diesel engines or fuel cells powered by hydrogen. It is not yet clear which technology provides the best combination of range and power and charging time. Thus, it is critical to evaluate different types of fleets.

Exploring the availability of alternative fuel transit vehicles broadens the scope for creating a more sustainable and efficient public transportation system. Beyond electric and hybrid buses, there are vehicles powered by natural gas, biodiesel, and propane, each offering distinct advantages in terms of emissions reduction and fuel efficiency. Integrating these alternative fuel options into the transit fleet allows agencies to tailor their strategies to specific operational needs and environmental goals. This diversified approach not only mitigates reliance on any single fuel source, but also paves the way for leveraging advancements across different technologies. By evaluating and incorporating a variety of alternative fuel vehicles, transit systems can significantly enhance their sustainability profile while ensuring operational flexibility and resilience.

Transit Agency Training Gaps

Transit agencies experience the following training gaps:

- Many transit agencies lack in-house programs that cater to the specialized needs of electric vehicle maintenance, particularly in areas like high-voltage systems, battery technology, and electronic diagnostics.
- The pace at which EV technology is evolving outstrips the ability of many agencies to keep their training programs up-to-date, resulting in a skills gap.
- Transit agencies often face budgetary and resource constraints that limit their ability to develop comprehensive training programs internally.
- Given the high-voltage nature of EVs, there is an acute need for safety-focused training, which is currently not adequately addressed in many existing programs.

Specific Challenges at the Chicago Transit Authority

As one of the largest transit agencies in the United States, the Chicago Transit Authority is at the forefront of evolving public transportation toward a sustainable future. The primary challenge the CTA faces is scaling up its training programs to match the pace of new EV and hybrid technologies being introduced into its fleet. With a strategic plan in place to transition to an entirely electric bus fleet by 2040, CTA is working to navigate the complexities of this transition, particularly for workforce development. Refer to Appendix B for more information about the CTA.

The integration of EV and hybrid technologies demands an overhaul of the skills traditionally possessed by CTA's technicians. According to survey results from a meeting held at Heartland Community College, the increasing proportion of diesel-electric hybrids, transitioning to hydrogen fuel cells, and ultimately to a fully battery-electric fleet, brings forth challenges associated with complex electrical systems, advanced battery management, and software-driven diagnostics. As depicted in the fleet composition over the years, there is a phased reduction in diesel-electric hybrids in favor of electric models, culminating in a 100% electric fleet by 2040. Comprehensive and ongoing training programs are crucial to enable technicians to maintain and repair these advanced vehicles effectively. Specialized training must encompass electrical system expertise, safety protocols for high-voltage components, and the ability to troubleshoot intricate software systems that are integral to electric buses.

The extent of training required is substantial, as the entire technician workforce must become proficient in these new technologies. The facility upgrade timeline reveals the need for infrastructure improvements at various garages to support the electric fleet, which aligns with the training needs. As the transition progresses, CTA must synchronize planning and implementation phases of these upgrades—ranging from the Chicago Avenue Garage to the significant modernization of the 77th Street Garage—with the training initiatives to ensure that technicians are prepared for the technical demands of the upcoming electric bus models. Notably, facility upgrades are staged with equity

considerations and to mitigate disruptions from construction, reflecting the careful planning required to support both the physical and human elements of CTA's electrification journey.

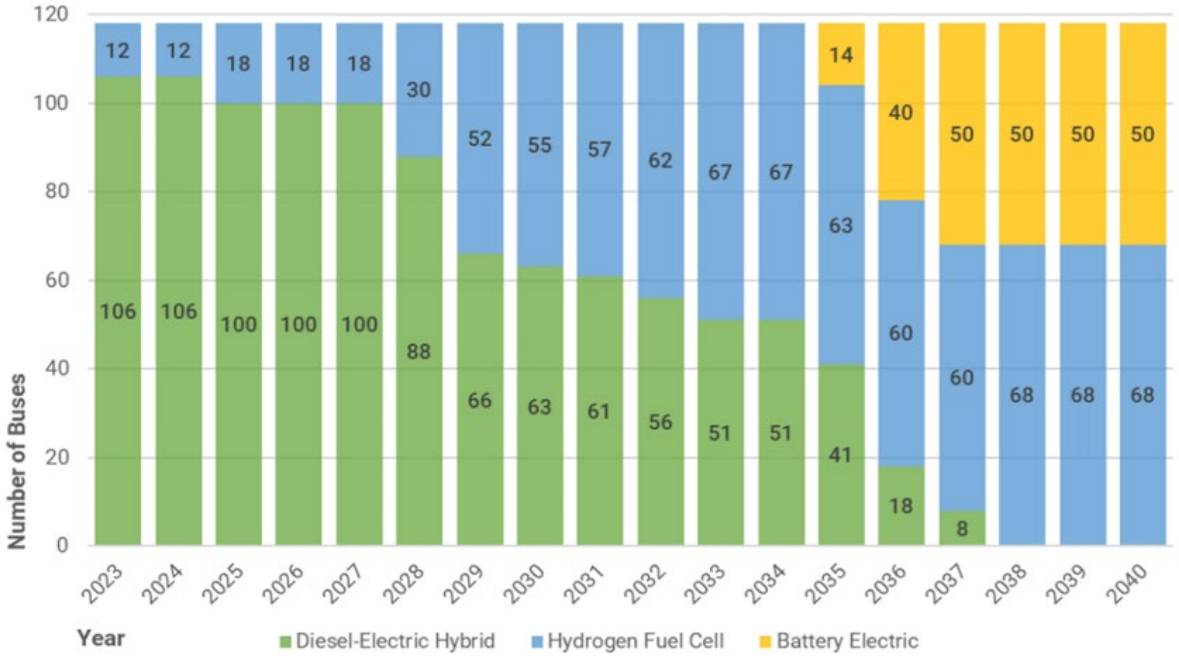

Figure 4. Bar Chart. Projected transition of CTA's bus fleet.

Source: Chicago Transit Authority

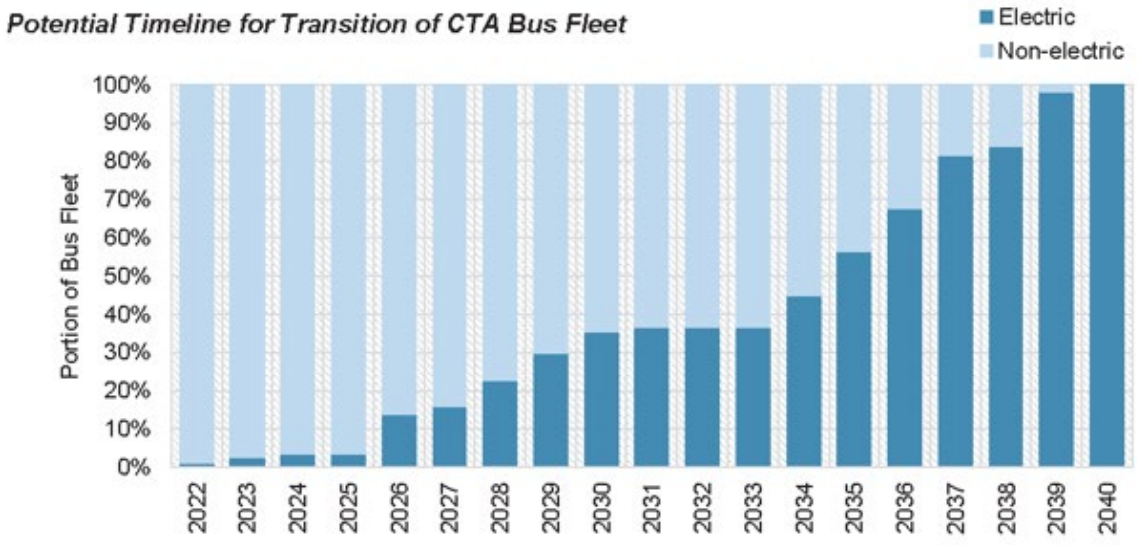

Figure 5. Bar Chart. Potential timeline for transition of CTA bus fleet.

Source: Chicago Transit Authority (2022)

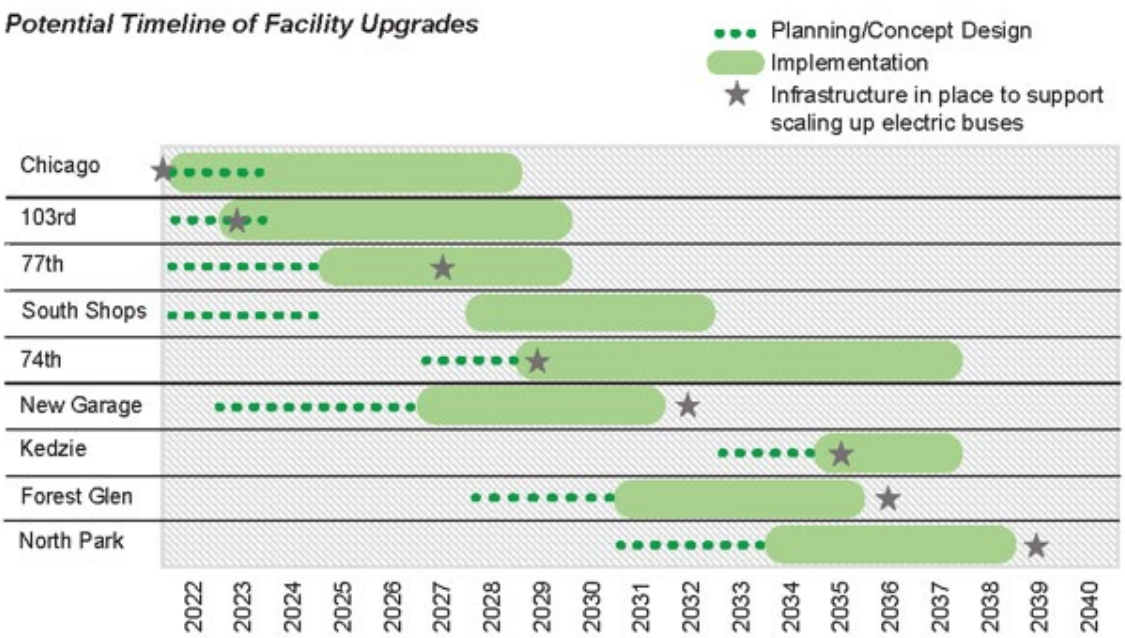

Figure 6. Bar Chart. Potential timeline for CTA facility upgrades.

Source: Chicago Transit Authority (2022)

Specific Challenges at Connect Transit

Connect Transit has made strides in adopting EV buses. However, the agency is in the nascent stages of expanding its technician training programs. To bolster its training capabilities, it is exploring partnerships with community colleges.

Connect Transit's methodical approach to integrating EV buses, beginning with a foundational order of four buses, followed by an expansion with five additional buses, exemplifies a strategic, phased adoption process. This approach allows the agency to validate the performance and integration of the new technology into its existing fleet operations incrementally. Such a deliberate expansion is essential for smooth adaptation to EVs, ensuring reliability and service continuity for the community.

Connect Transit is in the process of expanding its technician training programs to include specialized training for electric vehicle maintenance and repair. This involves creating an "EV Group" within the organization to review employee performance and aid in ongoing training, assessing baseline skills, and identifying gaps in the training program.

Specific Challenges at MetroLINK

MetroLINK is addressing its training needs by engaging with local educational institutions. The agency acknowledges the importance of continuous learning to stay abreast of technological advancements. Based on the current and ordered vehicles, the percentage of electric buses in the fleet will exceed 50% by 2024, as more than half of the fixed-route fleet will be electric-powered.

MetroLINK is working in collaboration with Black Hawk Community College for training in the heavy-duty EV sector. This partnership aims to build a state-of-the-art heavy-duty EV training, regional EV maintenance, and bus storage facility. The training program is designed to prepare students for the automotive service excellence (ASE) T3–T8 exams, leading to ASE Medium/Heavy Truck Technician certification. The curriculum is intended for both traditional mechanics interested in gaining certification in heavy-duty EVs and for individuals new to the industry.

Heartland Community College is leading multiple projects to develop statewide curriculum in EV-aligned areas, including light- and heavy-duty electric vehicles, EV infrastructure, and energy storage systems. These efforts aim to create a statewide industry sector collaborative and build a diverse, highly skilled talent pipeline for the EV workforce.

Specific Challenges at Champaign-Urbana Mass Transit District

Champaign-Urbana MTD is working toward a fully electric, zero-emission fleet. This transition includes stepping away from hybrid buses and incorporating more hydrogen fuel cell buses and, eventually, battery electric buses into their fleet. The agency is investing in workforce development to ensure its technicians are proficient in EV maintenance and repair.

Champaign-Urbana MTD acknowledges the challenges associated with low or no emission technology, including cost and complexity. Their long-term fleet planning involves introducing battery electric buses, with a focus on waiting for improvements in range and technology before fully implementing them. The current approach is to use hydrogen fuel cell buses for their extended range and performance, especially on more demanding routes.

Maintenance for Champaign-Urbana MTD's fleet is managed through a system that tracks mileage and creates work schedules and preventive maintenance based on mileage. This system helps to efficiently manage the maintenance needs of the diverse fleet as they transition to more advanced technologies.

Challenges on Equipment Suppliers for Training

A common theme across the agencies is the reliance on training provided by equipment suppliers. While useful, this approach is often insufficient for ongoing training needs and lacks the depth required for specialization. There is a growing recognition that a more comprehensive and standardized training approach is needed. Training from equipment suppliers is highly customized to their products but often lacks the comprehensive scope required for technicians to fully understand the broader EV ecosystem. Dependence on suppliers for training can create a bottleneck, limiting the flexibility to rapidly scale up training as new technologies are adopted. While supplier-provided training is a cost-effective solution for introducing new equipment, it may not be sustainable financially or logistically for ongoing training needs.

Need for Comprehensive Training Programs

The rapid evolution of transit technology has outpaced the development of in-house training programs within these agencies. There is a clear need for more comprehensive, structured, and consistent training programs that can adapt to the changing landscape of transit technologies.

Advancements in Transit Technology

The transition to electric and hybrid buses has brought about several technological advancements and challenges. Below are key points highlighting these advancements and their implications for transit agencies:

- The shift from traditional diesel buses to electric and hybrid buses represents a significant technological leap. This includes battery electric buses, hybrid diesel-electric buses, and hydrogen fuel cell electric buses. Each technology introduces new complexities in maintenance and operations.

- The adoption of electric buses requires the development of charging infrastructure and energy storage solutions. This includes high-capacity electric charging stations and the management of large-scale battery systems.

- Modern buses are equipped with advanced telematics and diagnostic systems. These systems provide real-time data on vehicle performance, requiring technical staff to be skilled in data analysis and digital troubleshooting.

- The shift from traditional diesel buses to electric buses introduces a suite of new technologies that many existing technicians are not familiar with. This includes electric drivetrains, battery management systems, and advanced electronic control systems.

- Many agencies have a mixed fleet of diesel, hybrid, and fully electric buses, each requiring different maintenance expertise. This diversity adds complexity to training and operations.

- As the EV market is still emerging, there is a lack of standardization in EV technologies across different manufacturers, making it challenging for technicians to gain expertise that is universally applicable.

- Rapid advancements in EV technology mean that training materials and programs can quickly become outdated, necessitating continuous updates and revisions.

- Working with high-voltage systems in electric buses poses new safety risks, requiring specialized training to ensure technician safety.

Impact on Training

The adoption of new technologies in transit vehicles has significant implications for the training of mechanics and technicians. Below are key points highlighting these impacts:

- The new technologies require mechanics and technicians to have specialized skills in electrical systems, battery management, and software diagnostics, which are significantly different from traditional diesel engine maintenance.

- Electric and hydrogen fuel cell vehicles involve high-voltage systems and flammable materials, necessitating specialized safety training for handling, maintenance, and emergency situations.

- The fast-paced development in EV technology, including improvements in range, efficiency, and charging technology, requires ongoing education and training to keep the workforce up-to-date.

To address these challenges, there is an emerging consensus on the value of collaboration with community colleges and other educational institutions. Such partnerships can provide a more diverse range of training resources and facilitate the development of standardized curricula that better meet the specific needs of transit agencies.

The challenges encountered by transit agencies in Illinois, particularly in bus maintenance programs, highlight the urgent need for a strategic overhaul in technician training. As the industry gravitates toward sustainable and technologically advanced transit solutions, the training of technicians needs to evolve correspondingly.

Responses from Transit Agencies

Transit agencies are adopting various strategies to address the training needs associated with new electric and hybrid bus technologies. Below are some notable examples:

- CTA's approach to adopting electric bus technology indicates a need for updated training programs for their workforce to handle these new technologies.

- Connect Transit through its Zero-Emission Transition Plan has shown an approach to workforce development, including initial maintenance training from vehicle original equipment manufacturers (OEMs) and an internal "EV Group" for ongoing training.

- The partnership between MetroLINK and Heartland Community College for training in heavy-duty EV technology suggests an approach toward addressing the training needs arising from new technologies.

- Champaign-Urbana MTD's transition to a diverse fleet including hybrids and hydrogen fuel cell buses implies a need for specialized training for their maintenance and operation.

Figure 7. Photo. Advanced technology training addressing industry challenges at a Heartland Community College workshop.

Source: Heartland Community College

Required Skills for Electric Bus Technicians

Technicians who work on electric buses should have the required skills listed below:

- Proficiency in handling high-voltage systems, battery packs, and electric motors is essential.
- Technicians need advanced diagnostic skills to identify and troubleshoot issues in electronic control systems and software that are integral to EV operation.
- Understanding the intricacies of battery chemistry, charging cycles, and thermal management systems is critical for maintaining the health and efficiency of EV batteries.
- Knowledge of how regenerative braking systems function and their integration into the vehicle's overall electrical system.
- Comprehensive training on safety protocols for working with high-voltage systems, including emergency response procedures in case of battery fires or electrical hazards.

CONCLUSION

The challenges faced by transit agencies in Illinois underscore a critical need for the transit industry to rethink and revamp its approach to technician training. As the industry moves toward more sustainable and advanced technologies, equipping technicians with the right skills and knowledge becomes paramount. There is a clear opportunity for transit agencies to collaborate more closely with educational institutions to develop comprehensive training programs that are in step with technological advancements.

CHAPTER 3: COLLABORATIONS BETWEEN COLLEGES AND TRANSIT AGENCIES

INTRODUCTION

With the rapid integration of electric vehicles and other advanced technologies into public transit, the collaboration between community colleges and transit agencies has become increasingly crucial. The Illinois Community College Board funding of the Reimagining Energy and Vehicles (REV) Program, organized by the Illinois Green Economy Network, builds a network of community colleges to collaborate on EV training and heavy EV training much as the diesel tech partnerships among community colleges. This chapter focuses on how these collaborations are enhancing training programs and facilitating the development of a workforce skilled in heavy-duty electric vehicle maintenance and repair.

Collaborative Training Initiatives: Pros, Cons, and Needs

Heartland Community College is developing a program to provide specialized training in heavy-duty EV technologies. Below are the pros, cons, and needs of this proposed program:

- Pros: The program addresses critical skills gaps, offers specialized training in EV technologies, and aligns with industry needs.
- Cons: As it is in the early stages of development, it may not yet fully meet the rapidly evolving demands of the sector.
- Needs: The program requires continuous updating of the curriculum to keep pace with technological advancements and expansion of hands-on training facilities.

Below are the pros, cons, and needs regarding collaboration between the colleges (Joliet Junior College, Parkland, and Olive-Harvey):

- Pros: Shared expertise and resources can lead to more robust and diverse training programs. Standardized curricula ensure consistency in skill development across the sector.
- Cons: There are coordination challenges and potential discrepancies in resource allocation between institutions.
- Needs: Collaboration requires enhanced communication and collaboration frameworks, development of joint programs that leverage the strengths of each institution, and shared funding mechanisms.

Community Colleges' Enhancing Training Programs

Heartland Community College's Heavy-Duty EV Program

In the early stages of developing a curriculum framework for a heavy-duty EV program, Heartland Community College is aligning its efforts with the needs of public transit and other industries. The program is designed to equip technicians with specialized skills for maintaining and repairing electric buses and heavy trucks, addressing a critical skills gap in the industry.

Collaborative Training Initiatives

Other colleges, including Joliet Junior College, Parkland, and Olive-Harvey, have shown a keen interest in collaborative efforts to share expertise and resources. There is a growing consensus among these institutions on the necessity of a standardized curriculum that can cater to the specific needs of transit agencies and the EV sector at large.

Transit Agency Challenges and Collaborative Solutions

Transit Agencies' Training Gaps

Transit agencies like the CTA, Connect Transit, MetroLINK, and Champaign-Urbana MTD have struggled to provide sufficient training programs for their mechanics, with the skills necessary for the maintenance and repair of heavy-duty EVs and other advanced transit technologies. These challenges are particularly pronounced in the following areas:

- Heavy-Duty EV Specific Training: Many transit agencies have incorporated or are in the process of incorporating heavy-duty electric buses into their fleets. However, there is a notable gap in training programs specifically designed for the maintenance and repair of these EVs, which are fundamentally different in technology and operation from traditional diesel buses.

- Hybrid and Fuel Cell Technology: Alongside pure electric buses, hybrid and fuel cell buses are also becoming more prevalent. These technologies require specialized knowledge and skills, which are currently not sufficiently covered in many agencies' training programs.

- Consistency and Depth of Training: There is a need for more consistent and in-depth training programs that comprehensively cover the complexities of heavy-duty EV systems, battery management, electric drivetrains, and fuel cell technology.

- Safety Training for High-Voltage Systems: As heavy-duty EVs involve working with high-voltage electrical systems, there is an increased risk that needs to be addressed through specialized safety training.

Emphasizing the Focus on Heavy-Duty EVs

The primary focus of this study and the subsequent recommendations is on addressing the gaps in training for heavy-duty EVs and associated advanced technologies in public transit. While hybrids and fuel cell buses are also considered, the emphasis is on ensuring that transit agency technicians are

prepared adequately for the unique challenges posed by heavy-duty electric buses. This includes both the technical aspects of EV maintenance and the safety considerations unique to electric vehicle systems.

Collaborative Solutions

To bridge these training gaps, the report advocates for enhanced collaboration between transit agencies and educational institutions, specifically targeting the development of specialized heavy-duty EV training programs. Such collaborations can lead to the following items:

- Development of training modules that are directly tailored to the needs of transit agencies' heavy-duty EV fleets.
- Leveraging the resources and expertise of educational institutions to provide practical, hands-on training experiences for technicians.
- Ensuring that the training programs remain up-to-date with the latest technological advancements in heavy-duty electric buses.

By focusing on these areas, transit agencies can significantly improve their capability to maintain and operate advanced heavy-duty EV fleets, thereby supporting the broader transition to sustainable public transit solutions. Traditionally, agencies have relied on training from equipment suppliers, which, while beneficial, is not comprehensive enough for ongoing training and specialization.

Benefits of Collaboration with Colleges

Benefits of collaboration between community colleges and transit agencies involve bridging the training gap and developing a specialized workforce. Partnerships with community colleges are a viable solution to bridge this gap, leveraging the colleges' evolving EV programs to offer more specific and comprehensive training. These collaborations are instrumental in developing a workforce that is not only technically proficient, but also adaptable to the rapidly changing technology landscape in the transit industry.

Forward-Looking Collaborative Efforts

A key way to expand the scope of collaboration involves establishing specialized regional training facilities, such as a proposed EV maintenance center and a medium- and heavy-duty EV training facility in Bloomington-Normal. These centers could result from partnerships between community colleges, transit agencies, and other stakeholders, offering a centralized training resource for the entire state.

Statewide Coalitions and Networks

The Illinois Green Energy Network and the Community College REV EV are colloborating to form a statewide coalition of community colleges, which would work collaboratively to develop and share resources, standardize curricula, and apply for funding opportunities. Heartland Community College is a key institution in the development of EV training programs. They are leading multiple projects to coordinate the development of a statewide curriculum in EV technology and related areas. In the

following subsections, we discuss the community colleges and their initiatives in providing electric bus training programs.

Heartland Community College

In August 2021, Heartland Community College launched the nation's first associate of applied science in electric vehicle technology. They developed this program in partnership with Rivian Automotive, which was supported by a $7.5 million state grant to build a comprehensive electric vehicle lab and an energy storage lab. Heartland Community College is expanding its program to meet the workforce demand in the heavy-duty EV space. This expansion includes forming an intergovernmental partnership with Connect Transit to build a state-of-the-art heavy-duty EV training, regional EV maintenance, and bus storage facility. The training program at Heartland aims to deliver a curriculum for zero-emission bus and hybrid technicians. This program is designed to prepare students for the automotive service excellence (ASE) T3–T8 exams, leading to ASE medium/heavy truck technician certification.

Statewide Collaboration

Heartland Community College is leading efforts to create a statewide industry sector collaborative involving educational institutions, state agencies, and community-based organizations. This collaborative aims to scale light- and heavy-duty electric vehicle, EV infrastructure, and energy storage system training programs to meet government and industry standards. This effort led to the Illinois Community College Board, through its Rev Up EV! Community College Initiative, awarding $9.4 million to 25 Illinois community colleges to help support the state's growing EV industry through job training and technology development programs. Five of the community colleges are using this funding to specifically develop heavy-duty EV maintenance training programs: Heartland, Olive-Harvey, Kishwaukee, Triton, and McHenry. The initiative focuses on scaling a common curriculum with technical instruction and competency-based outcomes. This approach is intended to serve as a statewide model for EV-aligned training programs.

Broader Impact

These efforts are aimed at building a diverse, highly skilled talent pipeline for the EV workforce. They emphasize creating high-wage, high-growth career pathways, particularly focusing on underserved and under-resourced communities throughout Illinois. In conclusion, Heartland Community College is at the forefront of developing electric bus training programs in Illinois, with a particular emphasis on heavy-duty EV technology. Their efforts, in collaboration with industry partners and other educational institutions, are setting the stage for a comprehensive and standardized approach to training in this rapidly evolving field. Linking these efforts with networks like the Illinois Green Economy Network and the Illinois EV Network could provide additional support and alignment with broader state initiatives in sustainable transit.

Illinois Green Economy Network

The Illinois Green Economy Network (IGEN) is a statewide initiative that unites all 48 Illinois community colleges in a collaborative effort to support sustainable economic development. It focuses on promoting sustainability, environmental protection, and green workforce development. IGEN

engages in activities such as green curriculum development, energy efficiency projects, renewable energy installations, professional development for faculty and staff, and community outreach and education on sustainability issues. IGEN has been successful in implementing numerous sustainability initiatives, including the installation of renewable energy systems on college campuses, development of green curricula, and facilitating energy efficiency projects. These initiatives have contributed to environmental conservation and the promotion of green jobs in Illinois.

Illinois Electric Vehicle Network

The Illinois EV Network focuses on promoting and supporting the adoption of electric vehicles in Illinois. Its activities include advocacy, public education, policy development, and support for EV infrastructure development, such as charging stations. The network may also collaborate with government agencies, private sector companies, and other stakeholders to facilitate the growth of the EV market in the state. The size of the Illinois EV Network can vary based on its membership and partnerships. It could include a diverse range of stakeholders from different sectors committed to advancing EV adoption in Illinois. The network operates within Illinois, possibly with connections and activities concentrated in areas with higher EV adoption rates or potential.

The success record of the Illinois EV Network would depend on its specific initiatives and outcomes. This could include measures like increased EV adoption rates, expanded charging infrastructure, and successful advocacy for supportive EV policies. Integrating community college efforts with these networks could significantly enhance the impact and reach of EV training programs. IGEN's focus on sustainability and environmental stewardship, coupled with the Illinois EV Network's commitment to advancing EV adoption, provides a synergistic platform for developing comprehensive EV training programs aligned with state sustainability goals. This collaboration can leverage the networks' expertise, resources, and statewide presence, contributing to a more sustainable and green economy in Illinois.

Evidence of Effective Collaboration

Heartland Community College's Heavy-Duty EV Program

Heartland Community College's associate of applied science in EV technology program directly aligns with the needs of public transit, demonstrating a successful model of collaboration between academia and industry. The first cohort of apprenticeships in the Industrial Maintenance Technician Registered program graduated at the end of 2022. The college is expanding its program to meet the workforce demand in the heavy-duty EV space, a response to the rapid adoption of electric vehicles across various sectors. This expansion includes building a state-of-the-art training facility in partnership with Connect Transit, illustrating the effectiveness of collaborative initiatives in addressing training needs.

Statewide Curriculum Development by Heartland Community College

Heartland Community College is leading efforts to create a statewide curriculum in EV-aligned areas, including light- and heavy-duty electric vehicles, EV infrastructure, and energy storage systems. This initiative aims to create a collaborative between educational institutions, state agencies, and

community organizations, which can serve as a model for developing a future-proof workforce in the EV sector.

Collaborative Training Initiatives across Community Colleges

Collaboration among colleges, such as Joliet Junior College, Parkland, and Olive-Harvey, for sharing expertise and resources indicates a growing trend of statewide cooperation in developing standardized EV training programs. This consensus among educational institutions highlights a strategic approach to workforce development in the EV sector.

Collaborative Advancements in EV Training and Technology in Illinois

The collaborative endeavors within Illinois are markedly advancing the development of specialized training programs for EVs and other advanced transit technologies. This collaboration is a testament to the state's proactive approach in addressing both the current and future training needs essential for the sustainable evolution of the transit industry.

The Illinois EV Network exemplifies this collaborative spirit. It is an informal consortium of colleges engaged in EV training, which has collectively applied for the EV Workforce and Education Exchange (WEX) under the Rev Up! EV Community College Initiative. This initiative seeks program funding to position Illinois as a global leader in EV education and workforce development. Furthermore, the IGEN, established in 2008 through intergovernmental cooperation, underscores the commitment of Illinois community colleges and their partners to foster the clean energy economy and green workforce development. Supported by the Department of Commerce and Economic Opportunity, the Governor's Office, and the Illinois Community College Board, IGEN mobilizes resources to support a consortium of 39 Illinois community college districts, with 35 active members. Governed by a Presidents' Steering Committee, IGEN's mission and vision focus on harnessing the collective strength of Illinois community colleges to drive the growth of the clean energy economy and prepare a workforce for a sustainable future. Funding through IGEN supports community colleges in eight critical areas: building sciences, energy, food, manufacturing, natural resources, transportation, waste, and water. These concerted efforts between community colleges and transit agencies are pioneering the establishment of specialized training programs that cater specifically to the nuances of EV and advanced transit technologies. By fostering such strategic partnerships, Illinois is not merely responding to the immediate demands for skilled technicians but is also proactively preparing for the challenges and opportunities that lie ahead in the transit sector. This collaborative framework not only enhances the state's educational capacity in sustainability and technology, but also ensures that the workforce is ready to contribute effectively to the green economy. Consequently, Illinois is poised to lead the transformation of the economy and education toward a sustainable future, with community colleges playing a central role in this endeavor.

CONCLUSION

Over the last few years, these coalitions have created a platform of collaborations among community colleges and with transit agencies to advance the practice of the training for EV mechanics. Thus, there is an opportunity for IDOT to leverage this work to ensure the successful transition to electric buses at the state's transit agencies.

CHAPTER 4: RECOMMENDATIONS FOR IDOT

Illinois stands as a pioneer in developing specialized training for electric vehicles and advanced transit technologies, owing to collaborative efforts between community colleges and transit agencies. Transit agencies are committed to transitioning their fleets to EV buses, which poses unique challenges in terms of training mechanics for commissioning and maintaining these buses. Recognizing this need, community colleges have actively engaged in building training programs for the EV industry, including transit EV buses. These entities have formed a collaborative platform to address these needs effectively. The researchers recommend the following actions for the Illinois Department of Transportation.

DEVELOP A STANDARDIZED CURRICULUM

- A balanced approach, combining a standardized core curriculum with flexible, specialized training modules, can effectively meet the diverse needs of the EV sector in Illinois. This approach ensures uniformity in foundational skills while accommodating specific requirements of different EV technologies and regional variations.

- A core standardized curriculum guarantees that all technicians receive a foundational level of knowledge and skills applicable across various types of electric vehicles and transit technologies.

- Early education initiatives, including outreach programs in schools, are essential to attract younger talent to the heavy-duty EV field. Introducing students to the field through interactive workshops and hands-on experiences can cultivate a new generation of passionate and proficient technicians.

- Specialized training modules offer flexibility to address the specific requirements of different vehicle types, technologies, and regional needs.

- Short-term, intensive training programs provide a pragmatic route to upskilling for professionals already in the workforce. For example, a 45-day curriculum can accommodate working professionals' schedules while providing critical knowledge for transitioning into the heavy-duty EV sector.

- Entry-level technician training programs offer foundational knowledge and skills essential for new entrants into the transit system workforce.

- Education and advocacy efforts are necessary to dispel myths surrounding EV safety and reinforce the message that EV technology is environmentally sound, safe, and reliable.

- Core curriculum topics include basic electrical principles, safety procedures for high-voltage systems, fundamentals of battery technology, basics of electric vehicle diagnostics, and environmental considerations in EV technology.

- Specialized modules cover advanced diagnostics for specific EV models, maintenance procedures for different types of battery systems, specialized training for hydrogen fuel cell vehicles, and modules focused on emerging technologies like autonomous transit systems.

- The methodology involves a blend of theoretical classroom-based learning and practical, hands-on experience, with the inclusion of virtual simulations and e-learning tools to enhance the training experience.

PROVISION OF TRAINING EQUIPMENT

- IDOT should assist in providing necessary training equipment, such as cutaways and trainers, to community colleges to enhance practical training aspects.

- Hands-on learning experiences facilitated by this equipment are crucial for understanding the intricacies of EV technology.

- Initial focus should be on advancing a medium- and heavy-duty EV training facility in conjunction with Heartland College's new EV training center, including simulation training tools. Smaller transit agencies could attend training events at this centrally located facility.

EV COMMUNITY COLLEGE AND TRANSIT AGENCY COALITIONS

- IDOT should support the Rev Up! Community College Collaboration, a statewide coalition of community colleges formed to apply jointly for funding opportunities and collaborate on key EV initiatives.

- Strengthening training programs through IDOT's engagement can foster a robust exchange of ideas and best practices, shaping comprehensive training programs tailored to heavy-duty EV maintenance and repair.

- Leveraging resources by collaborating with these networks could unlock additional funding, expertise, and technology crucial for the scalability of heavy-duty EV training programs.

- A long-term strategy involving IDOT, the Illinois Green Economy Network, and the Illinois EV Network could integrate sustainable practices into the transportation sector's workforce development, aligning with state and federal goals for reducing carbon emissions and promoting clean energy.

- Reporting and analytics supported by IDOT would ensure that training programs are informed by accurate data and analytics from the Illinois Green Economy Network and the Illinois EV Network, enhancing the effectiveness of these programs.

- Opportunities for internships, apprenticeships, and collaboration with transit agencies and EV manufacturers can bridge the gap between education and practical application, enabling students to build a professional network and understand workplace expectations.

The recommendations outlined in this chapter underscore the crucial role of standardized curriculum development, provision of training equipment, and collaboration among community colleges and transit agencies in advancing the adoption of electric vehicles and related technologies in Illinois. By embracing these recommendations, IDOT can catalyze the growth of a skilled workforce equipped to address the challenges and opportunities presented by the evolving landscape of heavy-duty EVs. Through concerted efforts and partnerships, Illinois can position itself as a leader in sustainable transportation, driving innovation, reducing carbon emissions, and fostering economic growth in the green economy sector.

REFERENCES

Aber, J. (2016). *Electric bus analysis for New York City transit*. Columbia University. https://www.columbia.edu/~ja3041/Electric%20Bus%20Analysis%20for%20NYC%20Transit%20by%20J%20Aber%20Columbia%20University%20-%20May%202016.pdf

Champaign-Urbana Mass Transit District. (2023). *Zero emission transition plan*. https://mtd.org/media/4004/zero-emission-transition-plan-2023-update-20230322.pdf

Chicago Transit Authority. (2022). *Charging forward: CTA bus electrification planning report*. https://www.transitchicago.com/assets/1/6/Charging_Forward_Report_2-10-22_(FINAL).pdf

Crawford, S. (2023). SMTD gets federal help to reduce bus emissions. *NPR Illinois*, January 18. https://www.nprillinois.org/illinois/2023-01-18/smtd-gets-federal-help-to-reduce-bus-emissions

Denham, R. (2022). Connect Transit will add electric buses, micro-transit vans with 'system changing' $13 million federal grant. *WGLT*, August 16. https://www.wglt.org/local-news/2022-08-16/connect-transit-will-add-electric-buses-micro-transit-vans-with-system-changing-13-million-federal-grant

De Socio, M. (2023, October 6). What the Proterra bankruptcy means for the electric bus industry. *GreenBiz*. https://www.greenbiz.com/article/what-proterra-bankruptcy-means-electric-bus-industry

Federal Transit Administration. (n.d.). Zero-Emission Fleet Transition Plan. Last modified November 7, 2022. https://www.transit.dot.gov/funding/grants/zero-emission-fleet-transition-plan

Illinois Community College Board. (2024, January 10). Illinois community colleges receive Rev Up Initiative grant funding to support the growing electric vehicle industry in Illinois. https://www.wandtv.com/news/community-colleges-get-rev-up-ev-grant-funding-to-support-growth-of-electric-vehicle-industry/article_c2ffcc8a-afdc-11ee-8477-2fb678d91d78.html#:~:text=Community%20College%20Initiative%20awarded%20%249.4,EV%2Dspecific%20advanced%20manufacturing%20fields.

International Transportation Learning Center. (n.d.). Transit workforce center. Resources and best practices for a zero emission-workforce fleet transition plan. https://www.transportcenter.org/zeb

Illinois Department of Transportation. (n.d.). *Transit system*. Retrieved April 15, 2024, https://idot.illinois.gov/transportation-system/network-overview/transit-system.html

Jeffers, M., & Eudy, L. (2021). *Foothill transit battery electric bus evaluation: Final report* (Report No. NREL/TP-5400-80022). National Renewable Energy Laboratory.

Lewis, M. (2024). Phoenix Motor is now the official owner of bankrupt Proterra Transit. *Electrek*, January 12. https://electrek.co/2024/01/12/phoenix-motor-is-now-the-official-owner-of-bankrupt-proterra-transit/

Pace Suburban Bus. (2022). *Zero-emission bus transition plan*. Retrieved April 1, 2024, https://www.pacebus.com/sites/default/files/2023-01/Pace%20ZEB%20Transition%20Plan_January%2027%202023.pdf

Rock Island County Metropolitan Mass Transit District. (2021). *Climate action plan: The link to a zero emission future*. https://metrolinktrains.com/globalassets/about/agency/sustainability/climate-action-plan.pdf

State of Illinois. (n.d.) State EV Support. Retrieved April 1, 2024, https://ev.illinois.gov/illinois-commitment/state-ev-support.html

U.S. Department of Energy. (n.d.) Alternative Fuels Data Center. https://afdc.energy.gov/conserve/public-transportation

U.S. Department of Transportation. (2023). Budget estimates fiscal year 2024. https://www.transportation.gov/sites/dot.gov/files/2023-03/FHWA_FY_2024_President_Budget_508.pdf

U.S. Environmental Protection Agency. (2024). GHG emission factors hub. https://www.epa.gov/climateleadership/ghg-emission-factors-hub

APPENDIX A: WORKSHOP SURVEY ANALYSIS AT HEARTLAND COMMUNITY COLLEGE

INTRODUCTION

The workshop held at Heartland Community College (HCC) included a comprehensive survey designed to gather insights on the needs and priorities for heavy-duty electric vehicle (EV) training and development. This chapter analyzes the survey results, providing a detailed view of the key areas of focus and recommendations for enhancing EV training programs.

Survey Methodology

The survey used the "dotting activity" method, where participants placed dots to prioritize different aspects of EV training. Figure 8 and 9 show the survey results of a workshop that took place at Heartland Community College.The diverse group of participants included administrators, faculty, industry representatives, and government officials, ensuring a well-rounded perspective.

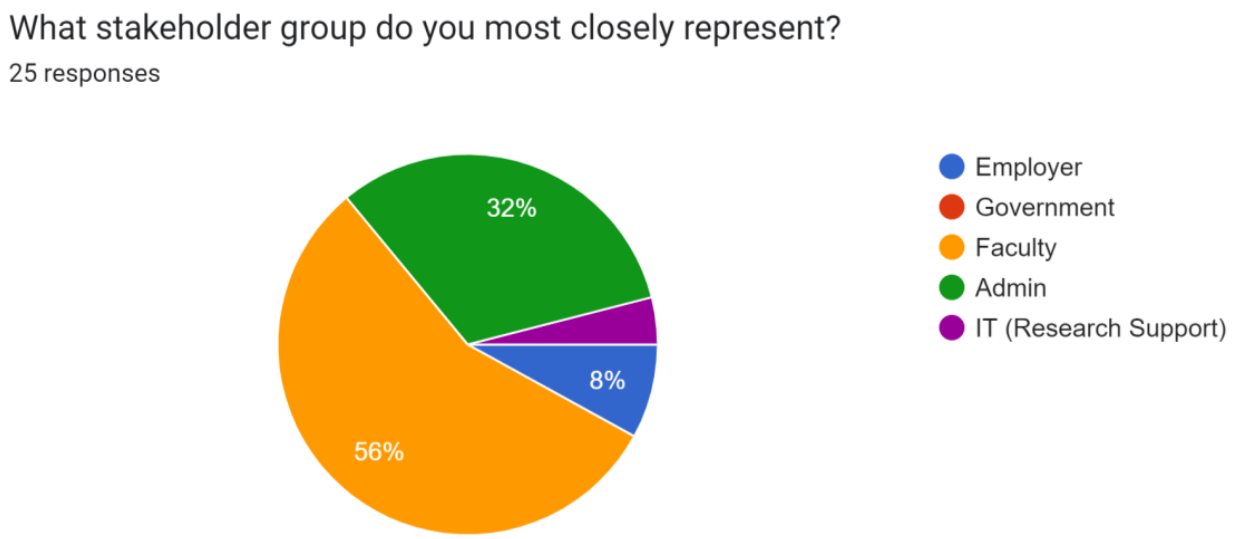

Figure 8. Pie Chart. Summary of priority rankings from the heavy-duty EV training needs and priorities survey.

Source: Curt Rendall, Heartland Community College

Analysis of Key Priorities

Access to Facilities and Equipment

The most emphasized need was for sufficient facilities and equipment to deliver effective EV training programs. This finding highlights the importance of practical, hands-on training environments.

Entry and Completion of Training Programs

Respondents gave significant attention to ensuring a sufficient number of individuals enter and complete training programs. This finding reflects the necessity of both attracting and retaining students in EV-related educational paths.

Streamlined Hiring Processes

The survey indicated a need for streamlined processes connecting trainees with employers. This finding suggests the importance of developing efficient pathways for employment post-training.

OEM Diagnostic Resources and Professional Development

The survey identified access to proprietary OEM diagnostic software and cutting-edge professional development as crucial. This finding underlines the need for current and industry-relevant training materials and methods.

Technician Pay and Benefits

Respondents noted concerns regarding technician pay and benefits, pointing to the need for competitive compensation to attract skilled professionals in the EV sector.

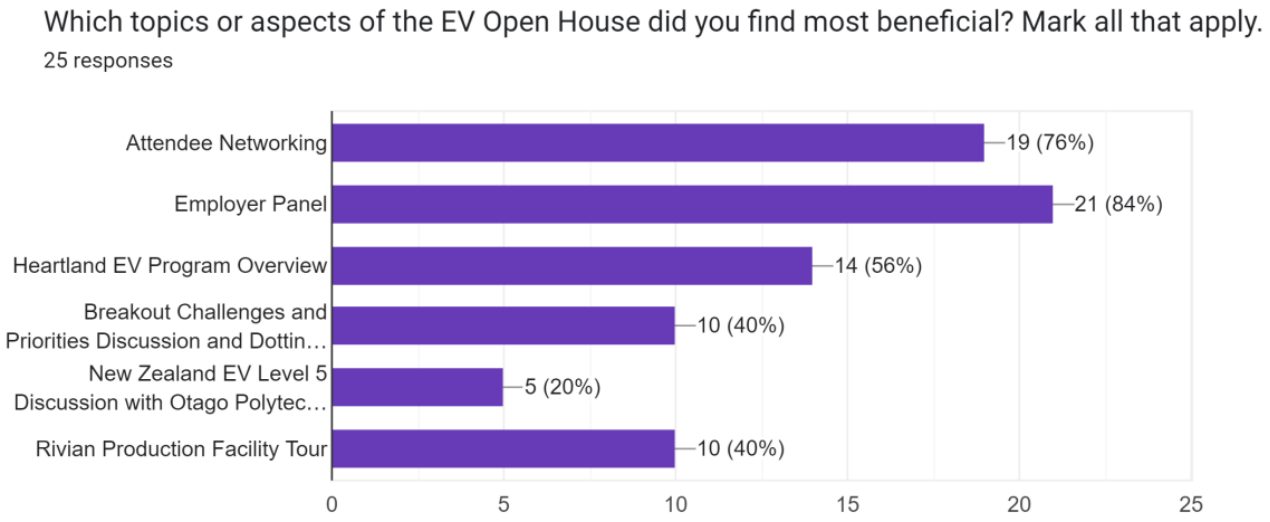

Figure 9. Bar Chart. Most beneficial aspects of EV open house.

Source: Curt Rendall, Heartland Community College

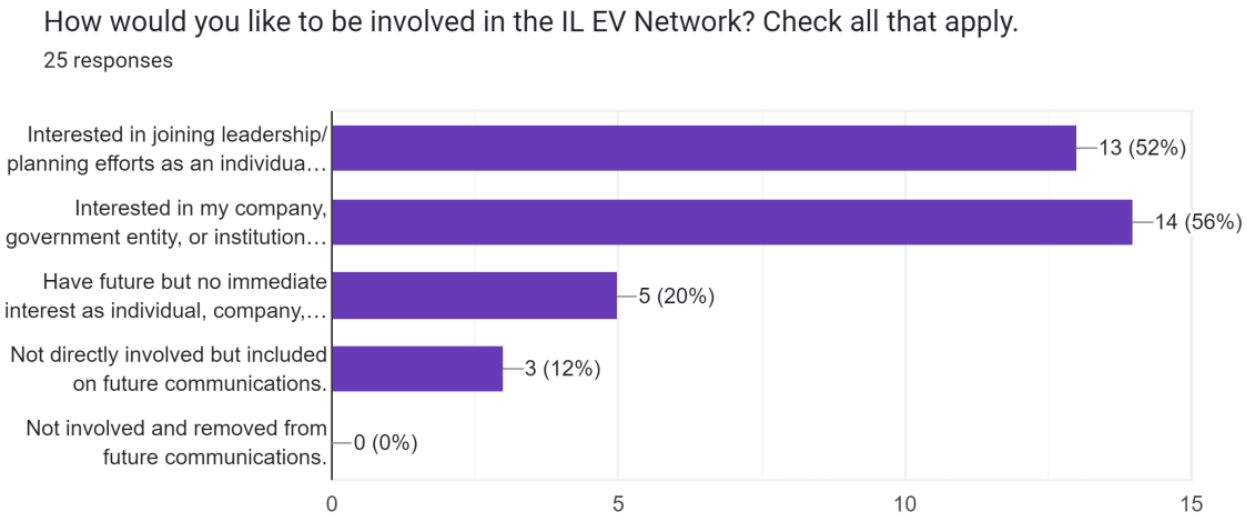

Figure 10. Bar Chart. Illinois EV network.

Source: Curt Rendall, Heartland Community College

Recommendations for Enhancing EV Training Programs

Based on the survey findings, several recommendations emerge:

- Enhance the quality of training by investing in state-of-the-art facilities and equipment.
- Implement targeted outreach and improved program visibility to attract more students and ensure their successful completion of the programs.
- Develop close ties with industry players for practical training experiences and smooth transition into employment.
- Ensure access to the latest OEM tools and resources, and continually update the curriculum to keep pace with industry changes.
- Work with industry partners to ensure competitive compensation packages for EV technicians.

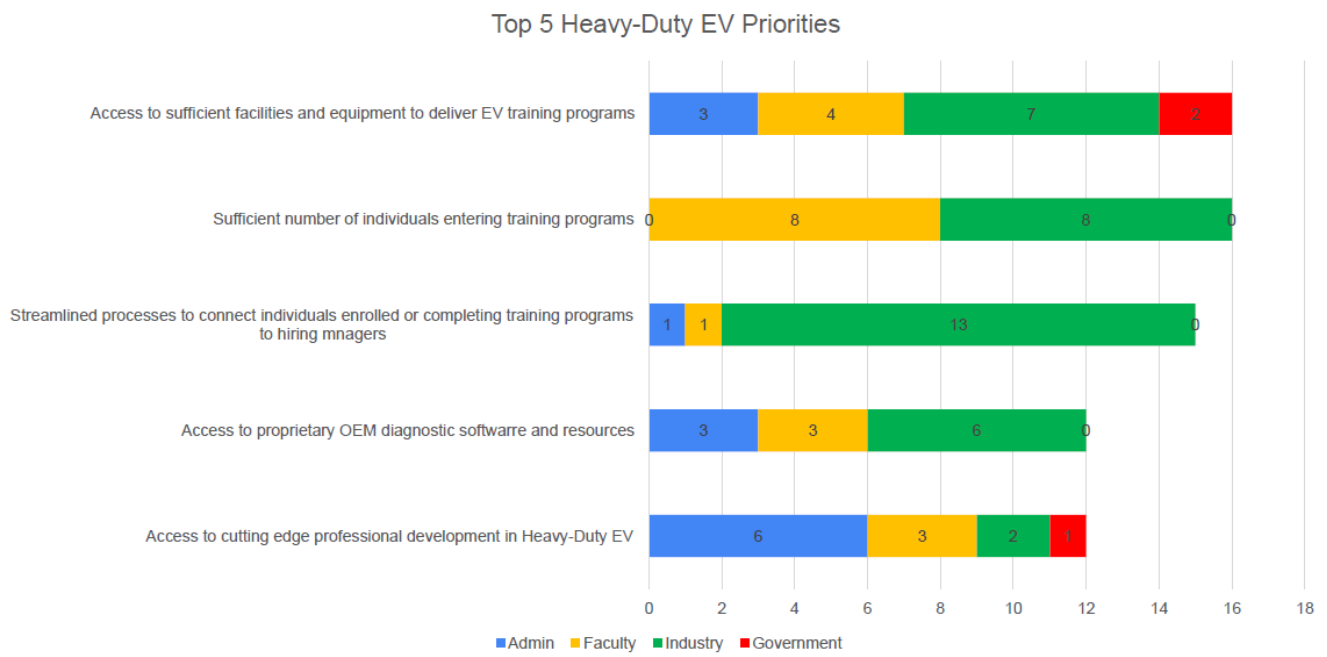

Figure 11. Bar Chart. Top five prioritized topics identified by stakeholders.

Source: Curt Rendall, Heartland Community College

CONCLUSION

The workshop survey at HCC provides valuable insights into the current state and future needs of EV training programs. Addressing the identified priorities will be key to developing effective and responsive training programs, crucial for supporting the growing EV industry. This analysis underscores the need for continuous evaluation and adaptation of EV training programs to meet evolving industry demands.

APPENDIX B: CHARGING FORWARD—CTA BUS ELECTRIFICATION PLANNING REPORT

The Chicago Transit Authority's *Charging Forward* report (2022) provides a comprehensive plan toward the full electrification of its bus fleet by 2040. This strategic planning study encapsulates various facets of the transition to electric buses (EV buses), highlighting the technical, operational, economic, and social considerations pertinent to this transformative shift. The report details analyses vital for major decisions in CTA's bus fleet electrification strategy, including equity and environmental justice assessments, modeling of electric bus technology performance with current schedules, and different approaches to charging buses on-route and at garages. Below are the key insights and components of the report.

- The report prioritizes electrification in areas disproportionately affected by air pollution, particularly Chicago's south and west sides, to address health vulnerabilities.
- The study indicates that with current electric bus technology and limited on-route charging, about 66% of CTA's weekday service could be covered by electric buses, potentially reaching 88% with technology improvements.
- The study recommends centralizing charging at bus garages with limited on-route charging to extend operational mileage where most needed.
- Electrification is projected to significantly reduce CO_2e, NO_x, and $PM_{2.5}$ emissions from CTA buses, contributing to improved air quality and reduced greenhouse gas emissions.
- The report discusses the rapid improvement in electric bus technologies, including battery capacity and charging mechanisms.
- It covers bus purchasing timelines, equity analysis, schedule compatibility, garage charging strategies, and facility upgrade needs, highlighting the operational and economic implications of transitioning to electric buses.
- The study outlines cost and emissions projections for various electrification scenarios, considering factors such as technology advancements, charging infrastructure, and operational efficiency.

KEY COMPONENTS AND FINDINGS

Key components and findings of the report are listed below:

- The report identifies the need for increased capital investment to support the transition, including bus and facility upgrades, emphasizing the role of grant funding and policy support.

- It highlights potential operational savings due to lower electricity costs compared to diesel fuel, despite higher upfront costs for electric buses and charging infrastructure.

- The report mentions cities like Shenzhen, Amsterdam, and London as success stories in EV bus integration and notes initiatives by community colleges in Illinois to establish EV training programs for workforce development.

- The report discusses the challenges related to scheduling, charging infrastructure, and facility upgrades, recommending a phased approach to electrification with a focus on equity, technological adaptability, and operational efficiency.

This document serves as a roadmap for CTA's goal to transition its bus fleet to electric power by 2040, aligning with broader objectives of sustainable urban development, environmental justice, and technological innovation in public transit.

APPENDIX C: IDOT SURVEY

Name:

University:

1. How many people are you training each year to be a general mechanic to work on your buses?

2. How many people are you training each year in specialized training for working on EV or hybrid buses?

3. Do you conduct this training in house?

4. Are you working with your community college to support this training?

5. Would you find it helpful to develop a formal apprenticeship?

6. Would you find it helpful if your community college had a specialized training program in general mechanics for buses?

7. Would you find it helpful if your community college had a specialized training program in hybrid and EV mechanics for buses?


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