EV training programs: A global review

CHIHUAHUA CHARGING FORWARD

MARCH 2024

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SECRETARÍA DE INNOVACIÓN Y DESARROLLO ECONÓMICO

I²C INSTITUTO DE INNOVACIÓN Y COMPETITIVIDAD

WILLIAM DAVIDSON INSTITUTE AT THE UNIVERSITY OF MICHIGAN

About this report

This report reviews electric vehicle (EV) training programs in Michigan and in select low- and middle-income countries (LMICs) to provide higher education institutions and other stakeholders with an overview of emergent training efforts from around the world. In the midst of the global transition to electric mobility (e-mobility), educational and training organizations have a crucial role to play in preparing the talent pipeline to enable the transition to EVs. This report intends to serve as a reference tool for stakeholders interested in developing their own training programs for EVs.

This work is part of the Chihuahua Charging Forward project implemented by the William Davidson Institute at the University of Michigan (WDI) in collaboration with the Secretaría de Innovación y Desarrollo Económico and the Instituto de Innovación y Competitividad of the state of Chihuahua in Mexico.

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The Chihuahua Charging Forward project seeks to help Chihuahua create a path to success in the transition to e-mobility by supporting academic institutions and other stakeholders interested in preparing the local workforce with relevant tools and resources, helping companies understand and tap into EV-related opportunities, and facilitating collaborations and expertise around e-mobility.

The Secretaría de Innovación y Desarrollo Económico (SIDE) fosters and facilitates the economic development of Chihuahua. Working closely with a wide range of stakeholders, SIDE seeks to increase the competitiveness of local businesses through innovation to generate wealth and employment, thereby enhancing the quality of life for the people of Chihuahua.

The Instituto de Innovación y Competitividad is a government agency that seeks to strengthen and promote scientific, technological and innovation capabilities through strategic research, technological development, and innovation projects to improve productivity and competitiveness across the state of Chihuahua.

About WDI

We are a research and educational non-profit affiliated with the University of Michigan. Our mission is to equip economic decision makers in low- and middle-income countries (LMICs) with the tools for commercial success. In the energy and mobility space we:

- Conduct research and provide consulting services to help innovators and entrepreneurs tap into new opportunities;
- Develop tools and resources to highlight business innovations and disseminate knowledge; and
- Craft and implement partnerships across sectors and markets to advance the energy transition in LMICs.

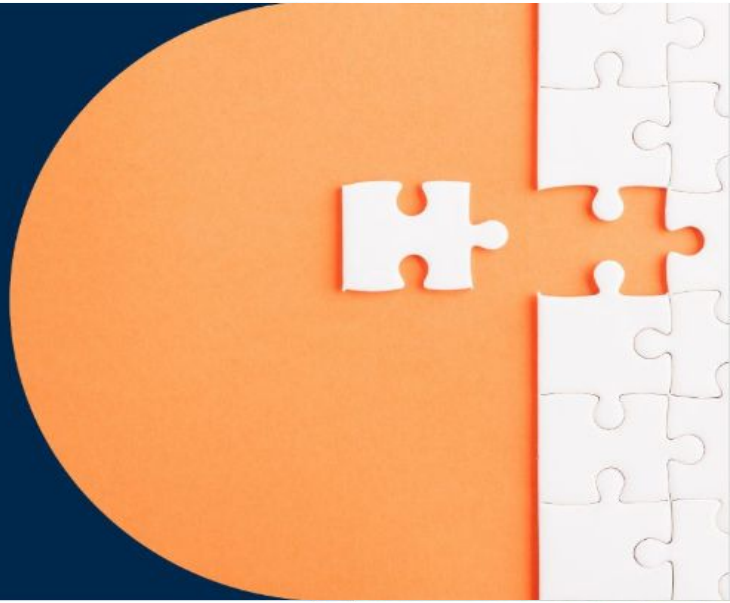
Overview

The objective of this report is to help inspire and inform new initiatives related to EV training in low and middle-income countries seeking to develop the talent pipeline for the transition to e-mobility.

The report is organized as follows: We first set the stage and explain the background that led to the development of this research, and then present **20 different EV training programs** from **8 organizations** from different geographies— the U.S., Costa Rica, Ghana, South Africa, Chile and Kenya —highlighting features and insights about their development. We then analyze all programs to identify key characteristics as well as elements of their business models. Last, we summarize takeaways for organizations of all types seeking to update existing programs or develop new ones. We describe our methodology and sources in the appendix.

BACKGROUND

Why does this matter?



The transition to e-mobility

Electric mobility (e-mobility), refers to the systems, services, and equipment that support the movement of passengers and goods by electric-powered means of transport* – from electric scooters to e-rickshaws and electric cargo bikes, to cars, trucks, buses, and even aircraft. In battery electric vehicles, instead of a traditional, internal combustion engine, a motor powered by electricity stored in batteries moves the vehicle.

When the electricity used to produce and power these vehicles comes from clean sources, their potential as a lever to decarbonize transport and combat climate change is fully realized. This is a key factor driving the transition to e-mobility.

Transitioning to producing and using EVs of all kinds requires a fundamental shift and brings many implications for businesses, government, academia, and other stakeholders. This is true across geographies, for countries with well established automotive manufacturing capacity, those with critical minerals needed for battery manufacturing – and also for those seeking to engage in the global EV value chain for the first time, or develop innovative e-mobility products and solutions for their local context.

*Sustainable Mobility for All Initiative

Key challenge: talent pipeline

Among these implications, the need for new skill sets, an expanded knowledge base to include energy topics, and a shift in mindset to enable constant innovation loom large. Preparing the talent pipeline to design, produce, assemble, test, charge and maintain EVs, regardless of the vehicle segment, is indeed a key enabler of the transition. This will require efforts to upskill or reskill the traditional automotive workforce focused on the internal combustion engine, as well as efforts to equip future graduates with the skills needed for the shift to EVs.

To do so, existing programs must be updated to align better with rapidly evolving industry needs, and new programs need to be designed and delivered in thoughtful ways. In this context, universities, community colleges, mobility innovation hubs, government entities, businesses and other types of training organizations all have a role to play in equipping individuals with the knowledge and skills needed all along the new EV value chain.

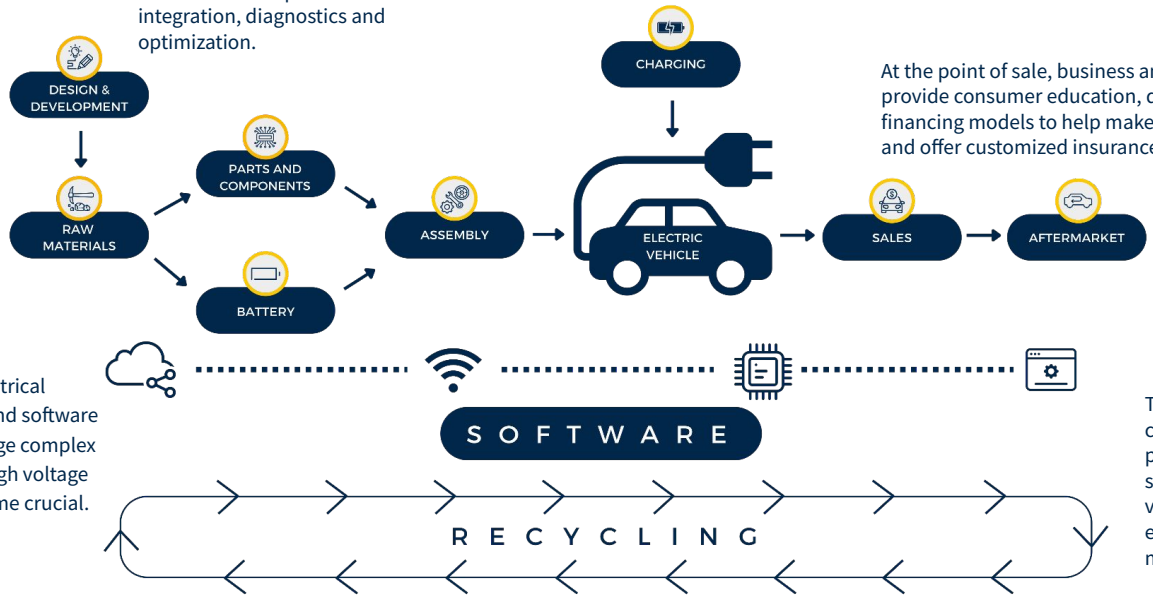
We highlight some of those skills in the following slide.

New value chain for EVs, new skills: a non-exhaustive overview

Upstream, new principles around vehicle design call for enhanced product design and integration skills, while the critical minerals needed for batteries call for knowledge of chemistry and material science.

Electric motors and power electronics become more prominent, requiring knowledge of electrical components integration, diagnostics and optimization.

Once the vehicle is in production, skilled professionals, operators and technicians are needed to build and maintain charging infrastructure, including public charging stations, battery swapping stations, and more.



At the point of sale, business and marketing skills help provide consumer education, develop innovative financing models to help make EVs more affordable and offer customized insurance schemes.

Specialized technicians are needed to provide maintenance for EVs.

Advanced electrical engineering and software skills to manage complex battery and high voltage systems become crucial.

These new systems present safety challenges, so training around proper handling in different scenarios – such as servicing these vehicles, responding to an emergency in case of accidents, and more – is crucial.

All along the process software is central to building, operating and maintaining EVs.

New skills are needed to ensure that batteries and other components are handled properly, reused, repurposed or recycled at end of life.

A starting point…

As universities and other educational institutions begin to consider updating their existing curricula or developing new programs to train the future professionals and technicians that will enable the transition to EVs, they need not start from scratch.

Through our research and work in both Michigan and in select low- and middle-income countries we have chosen a set of 20 training programs related to EV technology and engineering offered by universities, community colleges, mobility hubs and other entities in very diverse markets and contexts.

In the following section, we present background information about each of the featured organizations, a description of their current or upcoming training programs related to EVs, and key details about the process they followed to develop such programs.

We hope this information will be valuable for organizations that are now embarking on a similar journey.

PROGRAMS

What types of programs can we learn from?

Overview of programs included (1)

In this report we feature and analyze **20** different EV-related programs as listed below:

Organization Type	Name	Programs	Location
Universities, community colleges and technical institutes	University of Michigan	• MSE Mechanical Engineering • BSE Electrical and Chemical Engineering • Engineering of Electrified Vehicular Systems Certificate • Professional Development	United States
	Lawrence Technological University	• Electric Vehicle Certificate	United States
	Macomb Community College	• Electric Vehicle Certificate • Associate Degree Program on EV Technology	United States
	Colegio Universitario Instituto CEA	• E-mobility Specialization Program (PEEM) • E-mobility Diploma • E-mobility Technician Program	Costa Rica
	Kwame Nkrumah University of Science and Technology	• BSc Automobile Engineering • MPhil Auto Engineering • Technician Certificate	Ghana

Overview of programs included (2)

Organization Type	Name	Programs	Location
Mobility hubs and centers	Emasa Mobility Hub	• Introduction to E-mobility • Specialized E-mobility Trainings • Charging Infrastructure	Chile
	uYilo	• Introduction to EV Technology • Electric Vehicles Infrastructure Technology	South Africa
	Advanced Mobility Center	• Electric Mobility Technical Training Program	Kenya

Programs at Universities, Community Colleges and Technical Institutes

University of Michigan

Background

Located in Ann Arbor, Michigan (with campuses also in Dearborn and Flint), the University of Michigan (U-M) offers more than 20 undergraduate and master's-level courses related to electric vehicles, including on battery materials, manufacturing and management, EV electrical components and grid power systems. We present some of U-M's programs in the following slide.

- **EV-related activities:** With a $130 million investment from the State of Michigan, U-M established a new Electric Vehicle Center (EVC) in 2023. The EVC focuses on accelerating collaborative technology R&D, developing a highly skilled workforce, and expanding U-M facilities to support both research and education. Additionally, the U-M Battery Lab is a full-service battery cell fabrication and testing facility—open to any academic or industry user, which was established in 2015. At Michigan Engineering, Nexus supports continuing education by offering professional education certificates and designing and supporting online degree programs, several of which are related to vehicle electrification.
- **Examples of relevant partnerships:** U-M has extensive partnerships with industry—automakers in particular. The Ford Robotics Building, for example, is a collaboration between Ford Motor Company and U-M. Ford leases the fourth floor to perform robotics research and engineering in collaboration with U-M and other industry leaders. Moreover, Ford invested $2.1 million in the Battery Lab when it opened a decade ago.

Programs

Program	Mechanical Engineering (MSE)	Electrical and Chemical Engineering (BSE and MSE)	Engineering of Electrified Vehicular Systems Certificate	Professional Development
Description	U-M offers several graduate short courses on topics related to electric vehicles, including Lithium Battery Engineering & Life Management; Battery Controls; and Hybrid and Electric Vehicle Advanced Powertrain.	Relevant courses include Embedded Control Systems, Electric Machinery and Drives, Control Systems Analysis & Design, Electrochemical Engineering, Analysis of Electric Power Distribution Systems and Loads, among others.	This certificate program provides fundamental principles of vehicle electrification, with emphasis on application of these principles to emerging automotive technologies. It covers such topics as automotive powertrain, vehicle electronics, battery technology, electric and hybrid drives.	Nexus at Michigan Engineering offers a variety of courses on topics related to vehicle electrification, including Battery Manufacturing, Battery Management and Safety, and Vehicle Electrification.
Audience	Graduate engineering students enrolled at U-M	Undergraduate and graduates engineering students enrolled at U-M	Graduate engineering students enrolled at U-M Dearborn	Industry professionals, faculty, general public
Duration	Varies depending on the program.	Semester-long courses that are part of full degree programs.	Requires 12 credit hours, which can be selected from a variety of courses. Can be completed online, in-person or hybrid.	Varies - some online modules can be as short as 4-6 hours, some in-person programs are 3-days long.
Status	Open	Open	Open, U-M Dearborn	Open

Process

U-M follows a different process for initiating and updating EV-related training programs depending on the program type, instructors involved, and audience.

- Nexus at Michigan Engineering created their standard mobility course offerings several years ago, and regularly evaluate and update them in response to market demand. For custom offerings, Nexus staff and U-M faculty work with clients to determine specific areas of interest and then create and conduct custom offerings either virtually, on campus or on-site at the client company.
- The EVC is working to expand the number and reach of training programs offered on campus. They are convening an advisory board composed of government and industry leaders to set the agenda for workforce training and technology roadmapping.
- Many of the courses offered by various departments for enrolled students at U-M are developed and updated following set university processes that involve faculty-driven efforts considering learning outcomes and pedagogical implications, and committees to review proposed changes.

Lawrence Technological University

Background

Located in Southfield, Michigan, Lawrence Technological University (LTU) is one of 13 private, technological, comprehensive doctoral universities in the United States. LTU's College of Engineering includes departments of Biomedical Engineering, Civil and Architectural Engineering, Electrical and Computer Engineering, Engineering Technology, and Mechanical, Robotics and Industrial Engineering.

- **EV-related activities:** LTU's Centrepolis Accelerator supports the growth of Michigan's advanced manufacturing, innovative hardware entrepreneurs and small manufacturers by providing access to funding, experts and key business and product development resources. Centrepolis offers programs focused on various areas, including clean energy and mobility. Moreover, LTU developed and launched a new engineering EV Certificate in early 2024.
- **Examples of relevant partnerships:** LTU engages industry in a variety of ways, and is developing partnerships with EV-related companies for students to access their facilities as part of their new EV certificate program.

Programs

Program	Electric Vehicle Certificate
Description	The certificate is focused on EV development and manufacturing. It's comprised of two core courses (EV architecture and systems, EV safety) and choices for three electives (battery applications for EVs, electric machines, power electronics, vehicle sensing and controls, thermal management in EVs, EV testing and data acquisition). The certificate includes a hands-on lab component in conjunction with online and in-classroom instruction.
Audience	Graduate engineering students, qualified senior undergraduate students and industry professionals.
Duration	15 credits (five courses); number of semesters depends on how many courses are taken at a time.
Status	Launched January 2024. Planning to expand the number of courses available and explore online/hybrid options to scale beyond Michigan.

Process

- To develop this new certificate, LTU undertook a process spanning a couple of years that involved updating courses that were being offered in the existing Automotive Engineering program and creating new courses.
- In addition to having LTU leadership support for establishing this new certificate, engaging LTU's existing industry advisory group was key. LTU tapped into a subset of advisory group members (25-30 people) representing companies involved in different parts of the EV value chain in Michigan and surveyed them to understand the key topics that should be included as well as the viability and differentiators for such a program.
- In addition to collaborating with industry for curriculum development, LTU engages industry practitioners (including retirees) as adjunct faculty in some of the courses, and is developing partnerships through which students will gain access to select companies' facilities as part of the practical component of the program.
- Curriculum topics will continue to evolve based on new needs and also on the availability of qualified teachers at LTU.

Macomb Community College

Background

With several campuses located in Macomb County, Michigan, Macomb Community College offers over 200 degree and certificate programs across a variety of areas, along with workforce development and continuing education programs. Macomb hosts the Michigan Technical Education Center (M-TEC℠), which helps business and industry stay competitive, and the Center for Advanced Automotive Technology (CAAT), established in 2010 to support the automotive industry.

- **EV-related activities:** CAAT's mission is to prepare students for careers in emerging advanced automotive technologies, create academic and industry partnerships, and support curricula creation, adaptation and reform. Macomb was the first community college in Michigan to develop an EV certificate, which was first offered in 2013. In 2023, Macomb established the first community college EV lab in the state, which can accommodate up to 25 students, and began teaching courses there in January 2024.
- **Examples of relevant partnerships:** Macomb Community College is a leading partner of the EV Jobs Academy (EVJA) a statewide initiative in Michigan that identifies EV-related occupational skill needs and develops postsecondary credentialing programs to prepare the talent pipeline for the EV transition.

Programs

Program	Electric Vehicle Certificate	Associates Degree Program on EV Technology
Description	This program is designed to upskill the existing workforce and consists of four courses and two laboratory practices, including: introduction to electric/hybrid vehicles, EV high voltage safety, lab - working safely with hybrid and electric vehicles, EV motor controls and drives, and EV batteries & energy storage systems, followed by hands-on lab module on EV components, propulsions systems, and batteries.	This will be a comprehensive program that will provide an introduction to automotive technology but focused on EVs. It will include EV safety, diagnostics, electric motors controls and drives, electric storage systems and batteries, and servicing. In addition, it will include topics such as embedded C (used to develop embedded systems for EVs) and cybersecurity.
Audience	Product development technicians working at proving grounds or test laboratories, and mechanical engineers and incumbent workers seeking to learn about EVs. Graduates are eligible to receive an SAE certification credential levels; 1, 2, & 3 if they pass the certification exams.	Undergraduate students. The program will have two specializations, one intended to support the automotive service industry (technicians in auto repair shops), and another one geared towards product development and design jobs (proving grounds, automotive companies, suppliers).
Duration	9 days total, including 6 days of lectures / classroom teaching, 2 days of lab modules, and an exam day.	This is a program that can be independent of, or part of other existing programs at Macomb.
Status	Open enrollment program. It has been offered three times and has reached 56 people so far.	The for-credit version of this program is under development, expected to launch in Fall 2025.

Process

- EV Certificate:
  - This program was initially developed for an automotive supplier and later revamped to be more generic. Macomb worked with industry and a research partner to update the curriculum and make it more applicable across the industry, with funding and support from the EVJA.
  - Through the EVJA, Macomb and other members have access to 29 active corporate partners and 56 other active companies from the automotive industry, which enables them to access industry expertise and also helps with program promotion.
  - With funding from the Michigan Economic Development Corporation, Macomb is able to offer the EV certificate program for free to a number of students and to reimburse companies signing up their workers for 50% off the program cost.
- Associate Degree:
  - Funding from the US National Science Foundation is enabling Macomb to develop this new EV associate degree program, which will be rolled out across the state of Michigan once available.
  - To develop the curriculum, Macomb is working with EVJA partners and with an industry advisory committee composed of automotive companies, suppliers, dealerships and independent auto shops.

Colegio Universitario Instituto CEA

Background

Located in San José, Costa Rica, Instituto CEA trains technicians in automotive mechanics, automotive mechatronics and motorcycle mechanics. The Colegio Universitario, created in 2022, expanded CEA's automotive educational offerings to focus on e-mobility training, aiming to support the evolution of automotive technicians from informal, empirical learners to professionals with more comprehensive technical knowledge and understanding of the latest tools and equipment related to EVs.

- **EV-related activities:** Instituto CEA started organizing events to raise awareness about e-mobility in 2008, and established its research center on EVs and clean transportation technologies in 2018. In the past few years, Colegio Universitario has developed three different programs related to e-mobility, filling a gap in the market and growing the momentum around this transition in Costa Rica—a leader on clean energy production and EV market share in Latin America.
- **Examples of relevant partnerships:** In addition to the programs described below, Colegio Universitario offers international custom trainings and certifications focused on EV diagnostics and maintenance in partnership with the Hudson Valley Community College in Albany, NY. These programs run twice a year.

Programs

Program	E-mobility Specialization Program (PEEM)	E-mobility Diploma	E-mobility Technician Program
Description	PEEM was the first e-mobility program launched by CEA. It includes three online modules (20 hours each) plus 60 hours of self-directed study, in addition to a fourth module of in-person training. It attracts an international audience and has reached over 100 people.	Designed as a post-high school, higher education degree to prepare e-mobility professionals, this is the first program of its kind in Costa Rica. It is focused on developing technical skills in automotive electronics and mechatronics with emphasis on hybrid and EV technologies, their batteries, components and charging stations. It also develops employability skills by including design thinking, entrepreneurship and innovation as well as technical English.	This program is designed to train automotive professionals in systems related to EVs and charging infrastructure. It seeks to develop hard skills and competencies in automotive electronics, energy management systems, electric propulsion systems and charging systems. It includes online modules and a practical component in a lab.
Audience	Industry professionals in the field of automotive, electronics, electricity, electrical engineering, vehicle mechanics, and in general those interested in the transition to e-mobility.	This program is geared towards students who graduated high school and want to specialize in e-mobility either as an alternative to college or a precursor. Colegio Universitario is working to develop accreditation partnerships with select universities so that the courses taken as part of this program could count towards an engineering degree in the future.	Industry (workshop owners, technicians and informal mechanics).
Duration	120 hours	2 years, part time	1 year, part time
Status	Has been running since 2020	Launched May 2022	Launched January 2024

Process

- The curriculum for these three programs has been developed by Colegio Universitario. Instructors are industry professionals who have firsthand knowledge of industry needs and gaps in terms of talent development.
- Running the PEEM, the first program they developed, helped Colegio Universitario identify other areas of need for future programs, leading to the development of the Diploma and the Technician programs.
- A key strategy to develop the curriculum for the Diploma, their most comprehensive program, was to conduct hundreds of interviews with industry to better understand their needs. This helped them identify key topics for the program, and informed their decision to also include design thinking and entrepreneurship to encourage students to focus on idea generation and to consider starting their own businesses.
- Colegio Universitario is exploring opportunities to design additional programs on e-mobility and related areas in the future.

Kwame Nkrumah University of Science and Technology (KNUST)

Background

Located in Kumasi, Ghana, the Kwame Nkrumah University of Science and Technology (KNUST) is the country's premier science and engineering university. KNUST is well positioned to support Ghana's goal to become a competitive industrial hub for the automotive industry in West Africa, which requires an expanded local skills base for modern automotive assembly and component manufacturing.

- **EV-related activities:** KNUST has developed three programs that incorporate EV training: a Bachelor of Science in Automobile Engineering with two EV-focused courses, a Masters in Philosophy in Automobile Engineering, and a Mechatronics Technician program. The latter is intended to serve as a national curriculum template, open for adoption and adaptation by other training providers across Ghana.
- **Examples of relevant partnerships:** KNUST has developed strong relationships with industry stakeholders, local startups across the EV ecosystem, and government entities driving e-mobility policies in Ghana. These partnerships ensure that new programs incorporate input from all key stakeholders.

Programs

Program	BSc Automobile Engineering	MPhil Auto Engineering	Technician Certificate
Description	The program is designed to give graduates the necessary skill sets as general Automobile Engineer to meet the rapidly-changing automobile industry. KNUST has updated the curriculum for this program to include two courses focused on EVs in the final year, one on EV design and one on EV technology.	The MPhil. Automobile Engineering combines principles from electrics, electronics, control, power, automation and robotics to design, manufacture and test smart mobile vehicles/ devices, powered by clean electricity. It aims to provide a comprehensive understanding of design processes and the ability to generate innovative designs for products, systems or components.	This program was developed to bridge the gap between industry demands and vocational training delivery. It comprises 15 modules and includes an On-the-Job training component. The program offers four different certification pathways: 1. Drivetrain technology 2. Body, chassis, and drive assist technology 3. Worker/ Machinist/ Repairer /Mechanic /Electrician 4. Battery technician
Audience	Undergraduate students	Graduate students	Industry (technicians and informal mechanics)
Duration	4 years	24 months	6-8 months, depending on current competencies
Status	Has been running since 2019	Will launch in November 2024	Will launch in August 2024

Process

- Engaging key stakeholders to develop and update curricula was an integral part of the process followed by KNUST.
- KNUST developed the curriculum for the MPhil program in collaboration with the Technical University of Munich (TUM), as part of a broader partnership that includes seminars, student exchange and research collaboration.
- To develop the curriculum for the technician program, KNUST engaged a variety of stakeholders in the following ways:
    - Worked with auto dealerships and the auto assemblers association in Ghana to ensure that the resulting program would have industry buy-in
    - Surveyed mechanics throughout the country to assess their interest and identify potential hurdles to their participation in such a program
    - Engaged local EV startups to review the curriculum and ensure it was aligned with their needs
- KNUST received financial support from GIZ, a German service provider in the field of international cooperation for sustainable development to develop this technician program.

Programs at Mobility Hubs or Centers

Emasa
Mobility Hub

Background

Located in Santiago de Chile, the Emasa Mobility Hub aims to enable a sustainable mobility future by leveraging four key macro trends: e-mobility, connectivity, autonomous vehicles and shared mobility. The hub fosters collaboration among diverse sectors to address future mobility challenges in the region.

- **EV-related activities:** The Emasa Training Center within the hub offers trainings across seven key themes: e-mobility, charging infrastructure, ADAS, basic vehicle systems, telematics and fleet management, IoT communications and green hydrogen. The center offers 52 modules and customized training programs in various formats (online async, online sync, and in-person) for different audiences. It also includes a fully equipped workshop for servicing EVs and hands-on training. Moreover, Emasa has developed a mobile application for affiliated workshops to access online records to track servicing and maintenance needs of EVs.
- **Examples of relevant partnerships:** The hub brings has developed relationships with startups, SMEs, corporations, investors, accelerators, government, academia and innovation centers seeking to play a role in the future of mobility. It offers a wide range of services to cater to a wide range of players across the local ecosystem.

Programs

Program	Introduction to E-mobility	Specialized E-mobility Trainings	Charging Infrastructure
Description	This is an introductory course designed for beginner knowledge. It covers the basics around e-mobility, including its key implications and the global and national context behind this transition. It also reviews EV types and main characteristics, key components, charging system and safety protocols.	Available modules under this topic include: e-mobility for executives, safety, maintenance and diagnostics for EVs, low and high voltage diagnostics for EVs, introduction to e-conversion, micromobility autonomous EVs and rules and standards for EVs.	This is an advanced course. Available modules under this topic include: national energy grid, energy generation and legal framework, storage and recovery energy systems, EV charging process and smart grid, energy efficiency and PV, and charging station installation, safety and regulations.
Audience	General public, anyone with an interest in learning about e-mobility.	Open to general public but caters to industry professionals seeking more in-depth knowledge about e-mobility.	This course is best suited for industry professionals with some knowledge of energy systems and EVs.
Duration	Varies depending on the delivery mode, from 10 to 32 hours.	Varies depending on the delivery mode and selected modules. The hub can also customize based on needs.	Varies depending on the delivery mode and selected modules. The hub can also customize based on needs.
Status	Open	Open	Open

Process

- Emasa Mobility Hub developed a wide range of course topics from the start, to address needs related to retraining the workforce (including technicians) and to help individuals develop new skills.
- The comprehensive course catalog allows the hub to cater to diverse audiences, including individuals with technical expertise, company managers or leadership, government and ecosystem players in Chile, and the general public.
- To develop the courses, the hub conducted extensive national and international market research to create a development path for the courses based on technological advancements in key components and emerging regulations. This helped the hub identify key topics for each course and ensured they align with current technological needs and the medium to long-term trends related to energy and mobility.
- The hub also leveraged its workshop, which was created very early on, to service EVs and identify key topics that needed to be covered by hands-on trainings based on the needs of their workshop customers. Coupling services with research enables the workshop to develop service manuals, maintenance guidelines, process improvements, and component guides, adding more value to the hub's offerings.
- The hub used part of their sizable initial investment to develop many of the training programs.

uYilo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Background

uYilo is a comprehensive e-mobility program hosted at the Faculty of Engineering, the Built Environment and Technology (EBET) at Nelson Mandela University in Port Elizabeth, South Africa. Started by South Africa's national government in 2013, uYilo is primarily funded by the country's Technology Innovation Agency. uYilo's activities include government lobbying (policies, regulations and standards), industry engagement (from multi-national OEMs to start-ups), pilot projects, business support services, and training for capacity development.

- **EV-related activities:** uYilo was designed to prepare the country for the introduction of e-mobility. Its technical facilities include battery and materials testing, electric vehicle systems, and a live testing environment for EVs and the smart grid. In 2021, uYilo started offering introductory, non-technical trainings on e-mobility to national and local government officials to raise awareness about key implications of this transition, as part of a grant-funded program. uYilo is launching two new short courses in 2024: introduction to electric mobility and electric vehicle infrastructure technology. uYilo plans to offer additional short courses on e-mobility and energy storage in the near future.
- **Examples of relevant partnerships:** As a multi-stakeholder program, uYilo works closely with partners across sectors, including regional and national governments, companies, startups and academia via their relationship with Nelson Mandela University.

Programs

Program	Introduction to EV Technology	Electric Vehicles Infrastructure Technology
Description	This is an introductory training session on electric vehicles. The training covers the following topics: the need for electric vehicles, the transition to e-mobility, essential components of electric vehicles, driving electric vehicles, and electric vehicle safety.	This training session covers a broad range of topics including an introduction to e-mobility, transport electrification, electric vehicle infrastructure and the grid. The training also includes a tour of the uYilo Knowledge Transfer Hub facilities to gain insights into the rapidly evolving technology landscape of e-mobility.
Audience	Industry professionals and students with an interest in e-mobility.	Industry professionals and students with an interest in e-mobility.
Duration	1 day (8-16 hours).	1-2 days (8-16 hours), including an assessment.
Status	The course launches end of February, 2024.	The course launches end of February, 2024.

Process

- uYilo's affiliation with Nelson Mandela University facilitates collaboration with the Faculty of EBET and initiatives from across the university, which has bolstered their ability to develop training programs.
- uYilo's Introduction to EV Technology and Electric Vehicles Infrastructure Technology courses were developed with funding support from the Automotive Industry Development Centre Eastern Cape.
- uYilo Nelson Mandela University staff have received specialized training, including at the United Kingdom's Institute of the Motor Industry, to equip them for the delivery of e-mobility courses.
- The courses are in the process of being accredited through the Engineering Council of South Africa so that their short courses can count as continuing education credits for industry professionals, thus helping upskill the existing workforce.

Advanced Mobility Center

Background

The Advanced Mobility Center (AMC) is a for-profit organization in Nairobi, Kenya, established in 2020. It has the mission to change the fleet management & road safety challenges in Kenya into a success story. AMC also promotes the adoption of new mobility solutions such as connected, autonomous, shared and electric vehicle technology.

- **EV-related activities:** Training is a big part of what AMC does. In January 2023, AMC began offering advanced driver EV trainings for electric bus manufacturers. In May 2023 and January 2024, AMC was engaged by Africa New Energy Vehicles (AfricaNEV), and organization based in Ghana, as the local partner to organize a comprehensive e-mobility program intended to raise awareness about e-mobility. This training has reached 100 people so far, with future trainings currently being planned.
- **Examples of relevant partnerships:** AMC partners with AfricaNEV and local companies to utilize their facilities for hands-on training.

Programs

Program	Electric mobility technical training program
Description	Introduction to electric mobility for the general public via a one-day masterclass webinar covering topics such as EV history, chemistry, charging, electronics, myths, transition, business opportunities, networks, and future outlook. Participants can take only the webinar, or also attend the 6-day technical training which includes additional content, site visits to nearby companies and technical disassembly and reassembly of an EV.
Audience	General public (participants have included policy makers, utility companies, insurance industry, independent garages) and personnel from partner companies.
Duration	1 day for webinar, 5 days for in-person technical training.
Status	Training programs launched in 2023. Aiming for significant scale in Kenya and across the African continent.

Process

- The curriculum for this intensive program was developed by AfricaNEV; AMC is developing shorter programs for future offerings across the country.
- AMC started with pilot training programs to assess market response and have grown their offerings based on that. Their focus on introductory topics related to EVs reflects the need to raise more awareness about e-mobility in Kenya. AMC expects to develop more technical trainings in the future.
- AMC engaged an international expert to teach this training; in the future they expect to reprise some elements of this training and teach it themselves, which will help reduce program costs.
- AMC started by developing partnerships early on, as buy-in from a wide range of stakeholders is crucial. This included reaching out to e-mobility companies, associations, insurance companies, utilities and government.
- Most AMC staff work for companies in the e-mobility ecosystem, which helps them stay abreast of industry developments and needs.
- AMC plans to develop trainings in other related areas, including on electric two-wheelers and a dedicated program for women in e-mobility.

ANALYSIS

What does this all mean?

Making sense of it all

The programs we reviewed are diverse in their focus, content, audience, mode of delivery, and goals. The organizations offering them are just as diverse – public and private universities, a community college, a specialized technical institute, and various mobility hubs and centers. Their contexts are unique in many ways and yet they are all taking action to advance the e-mobility transition.

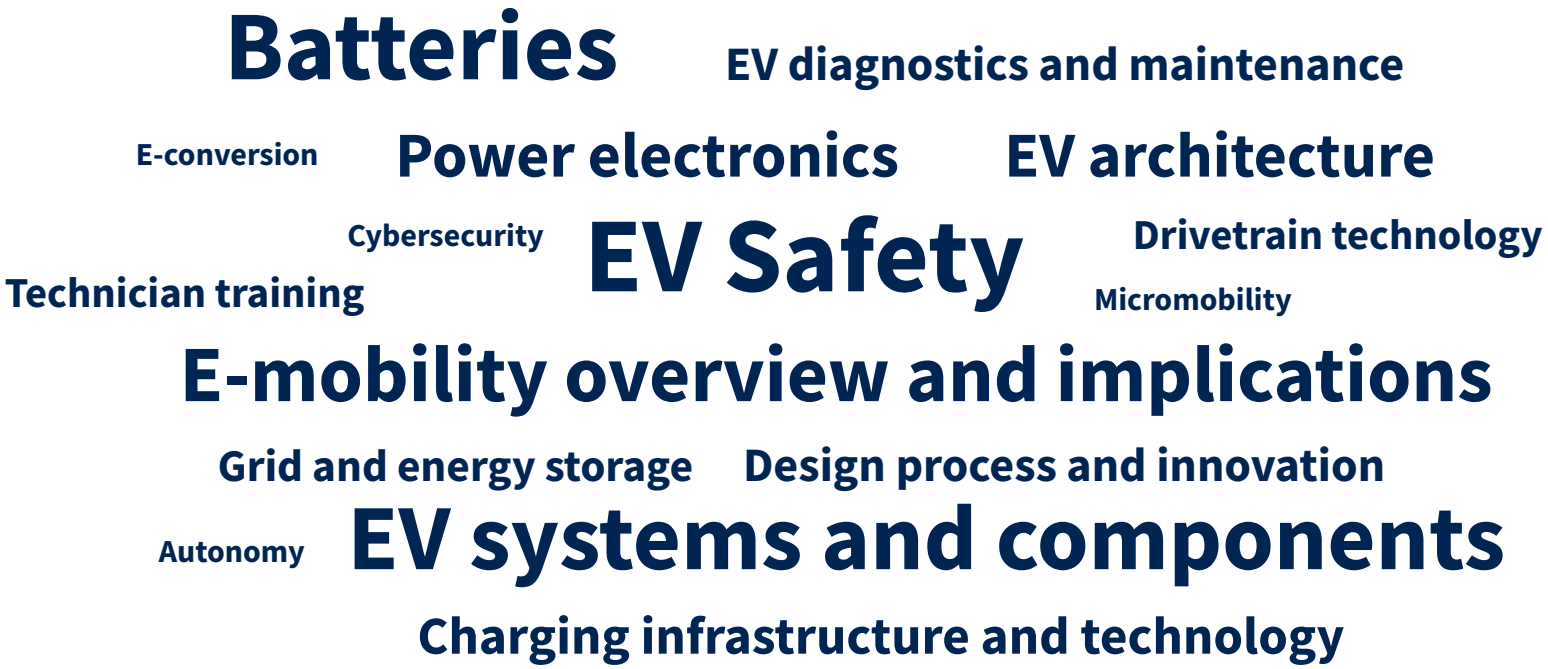
To help interested organizations make sense of this information, we summarize key characteristics of the programs reviewed next, identifying the most common topics, unique features, and challenges faced in their development or implementation. We then analyze the programs based on the business model used to deliver them, shedding light on the key elements that will be needed to launch and sustain similar programs successfully.

Our analysis intentionally does not connect specific lessons to individual programs or organizations but it is rooted in insights and experiences shared by the experts we interviewed.

Key Program Characteristics

Topics covered in training programs

This word cloud represents a non-comprehensive list of the key topics covered in training programs. The size of the words corresponds to the popularity of the topic across program offerings.



Unique program features

A few interesting features that organizations can find useful as they prepare to develop their training programs are:

- **Scaffolding:** To accommodate different levels of knowledge among applicants to a program, some institutions have integrated a competency based structure into their programs. They may provide “leveling” courses prior to the program start for participants that require additional training, or offer different tracks to suit a wider range of profiles.
- **Resourcing:** Some institutions are using or considering how to use digital tools such as VR to complement theoretical training, especially when resources for extensive labs or equipment are limited.
- **Differentiating:** As organizations engage industry in the development of their programs, securing accreditations or specialized certifications from relevant associations helps them differentiate their offerings and provide more value to participants.
- **Scaling:**
    - Some organizations are engaging entities in other locations to host the in-person component while they retain implementation of the online content, allowing them to reach participants beyond their communities in a resource-effective way.
    - Some institutions have developed programs with support from a broad group of stakeholders and have designed the curriculum for easy adoption by other institutions at the regional or national level.

Common challenges

Launching new training programs or updating curricula to address new needs can present challenges. For the organizations we feature in this report, some of the challenges have included:

- **Initial investments:**
  - Investing time for the curriculum development process, which can generally be lengthy
  - Securing initial capital to purchase equipment, for space, and for staff
  - Orchestrating the development of the physical infrastructure (EV lab equipment) with the training content and available expertise to teach it. In addition, defining the type of equipment needed can also be challenging.
- **Curriculum development:** Building internal expertise to get started and identifying industry champions that can provide input into program development
- **Staffing:** Finding qualified professionals locally who have the right expertise and availability/interest in teaching
- **Implementation:**
  - Staying focused on priority programs to avoid diluting efforts and resources across too many offerings
  - Devising strategies to increase reach beyond local communities, considering that hands-on, in-person training component is crucial
  - Ensuring a steady stream of applicants and continuous improvement so the program can be successful

Additional areas for future trainings

In addition to the programs described in this report, many organizations are already considering additional areas for future programs, in line with current and emerging market trends and local needs. These include:

- Energy storage
- Battery recycling and second life
- Energy systems
- Hydrogen
- Specialized trainings for women in e-mobility
- Smart microgrids for EVs
- Driver assist systems

Analysis of Business Models for Training Programs

A helpful lens: business model

To help inform the thinking of stakeholders interested in developing training programs related to EVs, we examine the business models of the programs we examined. Whether these are offered by educational institutions, mobility hubs, or other organizations – and whether they are set up as for-profit or non-profit endeavors – consideration of the business model is necessary for the programs' success and long term sustainability.

For this exercise, we look at the following elements from the widely referenced Business Model Canvas tool: key partnerships, key activities, value proposition, customers, key resources, channels, revenue streams, and cost structure.

In the following slides we present findings related to common features in business models and differences by organization type across all programs examined in this report.

Later, in the next section, we offer a series of concrete takeaways for organizations seeking to develop their own EV training programs, also organized around the Business Model Canvas.

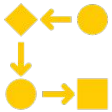
Business model: most common features across programs

Key partnerships
Industry, other educational institutions, government entities.

Key activities
Range of short or long duration programs, resulting in certificate or degree.

Value proposition
Mix of awareness building, broader topics related to EVs, and specific technical areas.

Customers
Industry professionals and technicians, current students, government officials and other stakeholders, general public in some cases.



Key resources
All programs need equipment, lab space, other infrastructure. Funds for curriculum development, and qualified staff for teaching.

Channels
In-person, hands-on component is crucial. Online-only is feasible for intro programs.

Revenue streams
Internal or external funds to cover initial investment, then supported by tuition/registrations or subsidized by other sources.

Cost structure
Many rely on donations or in-kind or subsidized arrangements for equipment and space, often employ part-time instead of full-time employees and teachers.

Business model: commonalities by organization type

Organization type offering program	Initial investments	Operating expenses	Revenue streams
Universities, community colleges, specialized institutes (typically non-profit)	Faculty/staff time to develop curriculum, incremental enhancements to existing facilities and equipment	Faculty/staff time (using existing faculty and/or hiring adjunct or part-time instructors), operations/maintenance of infrastructure, marketing for recruitment	Tuition – from students enrolled in degree program and/or taking select courses, grants, donations, services provided to industry/others
Mobility hubs (typically for-profit)	Staff time to develop curriculum, facilities and equipment (often shared with other hub services or programs)	Staff time (typically part-time), maintenance of facilities, marketing for recruitment	Tuition - from companies and students, sponsorships, equipment monetization, sometimes grants, sometimes subsidization from other hub services

TAKEAWAYS

What can we conclude?

Designing programs for success

By sharing information about existing and emerging EV training programs from around the world, we hope to help inspire organizations interested in playing a role in the transition to e-mobility. In this section we present key takeaways, also organized around key aspects of a business model, for interested organizations to consider as they prepare to design new programs or update existing ones.

Overview of takeaways

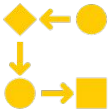
These high-level takeaways are explained in greater detail in the following slides.

Key partnerships
Industry partnerships are crucial and should be multifaceted. Don’t overlook partnerships with non-industry players.

Key activities
Non-technical, introductory trainings are low-hanging fruit.

Value proposition
Align with local context and players, but keep in mind global market trends.

Customers
Start focused, then consider different types of customers to enable scale and diversify revenue sources.



Key resources
Equipment should be suited to offerings and contexts, and there are several acquisition strategies.

Channels
Making diverse and flexible programs available that have hands-on components is key.

Revenue streams
Diversification is important; think of training programs as part of broader plan.

Cost structure
Start small and scale strategically.

Key partnerships

Industry partnerships are crucial and should be multifaceted. Engaging companies and industry players can be done in various ways. Also, don’t overlook non-industry partnerships that can add different types of value.

- **Industry engagement models:**
  - Advisory board or committee that provides input and feedback on curriculum as it is developed
  - Access to equipment through donations or use of current equipment on-site at partner companies
  - Site visits to companies to add value to training programs for students to see processes in action
  - Use of industry champions to make connections with key players and experts, and also to create a recruitment pipeline for graduates
- **Special value in engaging with startups:**
  - Mutually beneficial relationship as students understand innovations in local context, training partner and startup collaborates for on-site classes, and startup offers students opportunities for internships and future employment
- **Ecosystem thinking when developing partnerships:**
  - Beyond industry, players from other sectors can add value through initial funding (grants, in-kind), for recruitment purposes (reaching new audiences such as for general awareness building), credibility and increased visibility

Key activities, channels, and customers

In terms of programs offered by the featured organizations, as well as their channels of choice and key customers, we can conclude the following:

- **Start with general awareness building on the topic:**
  - Basic information about what e-mobility is and the key implications of this transition are very much in demand and particularly helpful to raise awareness across a wide range of stakeholders
  - These are also easier to staff than more technically specialized programs that require more advanced expertise
  - Offering intro programs for government officials, executives and other decision makers can help build awareness and garner support for the development of more advanced programs
- **Stepping stone to technical programs tailored to specific audience needs:**
  - Programs catering to mechanics and technicians have growth potential through partnerships with workshops, dealerships and organizations engaged in workforce development
  - Most programs include hands-on component, with training on safety around EVs and batteries as precursor to other content
  - Flexibility is key for industry programs - provides for modular/customization and tailoring based on competencies, and takes into account schedule of full time workers.
- **At launch and when scaling, consider all different potential customers and what you can offer to each:**
  - Students or industry professionals individually; companies wanting to train their workers or recruit new staff, larger organizations that could fund programs (e.g. grant makers, government, economic development organizations, etc.); and other institutions looking to train their trainers and/or license content

Value proposition

Takeaways that can assist interested stakeholders in building a strong value proposition around EV training programs are:

- **Know your market**
  - Start by conducting market research to understand in which stage of the transition the local market is, what the needs of local players are, and what already exists in terms of trainings
  - Take into account plans or priorities from different sectors in the development of training offerings – does the government have an e-mobility policy, are educational institutions already developing EV programs, is local industry already engaged in the EV value chain and to what extent?
  - Awareness raising about the e-mobility transition is fundamental, especially in early markets. This can be done by developing resources and content that are widely disseminated, as well as by organizing free events to convene key stakeholders around e-mobility topics
- **Identify and leverage your distinct advantage**
  - Leverage first mover advantage by developing a small pilot program first, then iterate based on market response
  - Identify and partner with local or regional organizations with complementary assets to get pilots off the ground more quickly
  - Seek differentiator via specialized training focus based on a particular local need, by providing a unique credential or certification, or by offering increased flexibility and modularity in your programs

Key resources

When it comes to key inputs needed to offer training programs, staff and equipment were the top resources highlighted through our research.

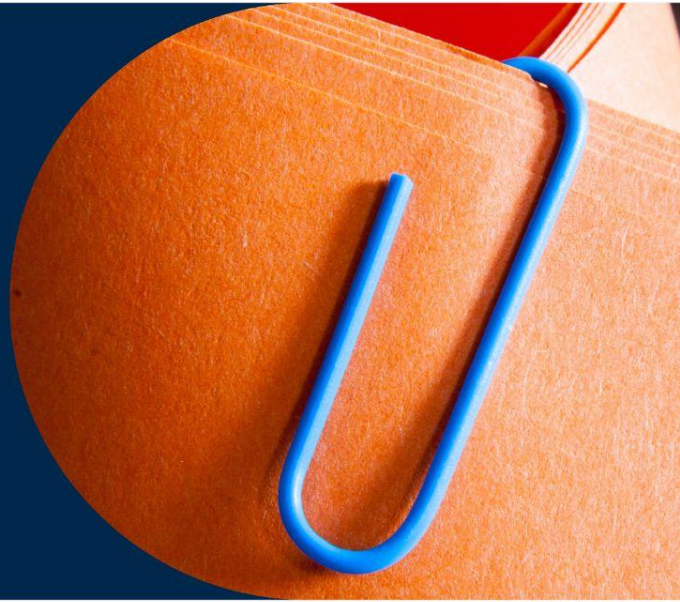
- **Identifying or training the necessary staff**
  - Staffing a new program can begin with one person with EV expertise, for example individuals with traditional automotive experience who developed an interest in hybrid and EVs and received training in other places, or by engaging experts from other regions to train local trainers for future offerings. These can also be done in parallel
  - Organizations can also tap industry practitioners or recent retirees part-time faculty and instructors, helping ensure that offerings remain aligned with rapidly changing needs
- **Create incremental equipment strategy vs. shopping list**
  - Since EV equipment is notoriously expensive, organizations first need to determine the right equipment for their goals. For example, they may decide to prioritize equipment that can have industrial applications (such as for specialized testing) and monetize the use of this equipment as a way to offset its cost
  - In other cases, secondhand or older equipment can be well suited for the needs of a new lab, and in some instances donations can be made by industry partners. Startups, for example, can donate smaller EV parts and get in-kind support or help with recruitment
  - In all cases, having appropriate safety equipment should be a priority
  - When having an EV lab or workshop is not feasible, tapping into industry partners to secure the use of their facilities can help address this need, as mentioned above

Revenue streams and cost structure

Thoughtful consideration should be given to the cost structure and anticipated revenue streams of any EV training program. Some takeaways include:

- **Getting started**
  - Regardless of organization type, there is a need to consider initial investment, revenue model, operating expenses from the start
  - Consider larger organizational context and goals in making business model for training programs - how does it fit within the current setup? How does it complement other activities and services? How long will it take to break even and reach profitability?
  - Pilot program developed in partnership with other ecosystem players can be a more feasible entry point and part of a phased investment when it makes sense
- **Leveraging existing resources and managing risk**
  - Trainings can offer new ways to utilize existing infrastructure (e.g. train using equipment that companies also pay to use for different purposes), help develop relationships and with new players, and build momentum that can benefit other services
  - Diversifying the revenue sources to reduce risk is also important, regardless of organization type. Different sources may come with their own costs and strings (e.g. sponsorships, grants); it is also possible to have multiple sources of revenue for a single course or program

APPENDIX



Methodology

For this review of EV training programs, WDI defined the scope in collaboration with partners in Chihuahua. We then created a framework for program inclusion and analysis, and identified training programs around the world through desk research and our networks. The programs featured in this report were selected out of a larger group based on their offerings of current or imminently-planned training programs related to EVs, geographic and institutional diversity, and availability of information. While this is a global review it is not intended to be exhaustive, and we acknowledge that many new programs are being created in this rapidly moving space.

To develop this report we gathered information via desk research, and then conducted key informant interviews with individuals noted on the following slide to fill gaps and better understand the process, lessons, and challenges related to developing and running EV training programs in different markets and in different institutions. The WDI team then analyzed all data and shared with key experts to review and provide input before publishing.

In parallel, WDI has been developing a similar report on mobility hubs and their business models in different markets. As training programs offered by mobility hubs are featured in this report, some of the desk research and key informant interviews are related to both reports.

List of interviewees and contributors

This report would not have been possible without the valuable insights generously shared by the following individuals interviewed or consulted by the WDI team. We extend our gratitude for their time and support.

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