CALIFORNIA ENERGY COMMISSION

CALIFORNIA NATURAL RESOURCES AGENCY

California Energy Commission

Clean Transportation Program – IDEAL ZEV Workforce Pilot

FINAL PROJECT REPORT

ZEV SEED Project

(Zero-Emission Vehicle Sustainable Equitable Employment Destination)

Prepared for: California Energy Commission

Prepared by: Community Resource Project

CRP SERVING THE COMMUNITY FOR 50+ YEARS

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PREFACE

Assembly Bill 118 (Núñez, Chapter 750, Statutes of 2007) created the Clean Transportation Program. The statute authorizes the California Energy Commission (CEC) to develop and deploy alternative and renewable fuels and advanced transportation technologies to help attain the state's climate change policies. Assembly Bill 8 (Perea, Chapter 401, Statutes of 2013) reauthorizes the Clean Transportation Program through January 1, 2024, and specifies that the CEC allocate up to $20 million per year (or up to 20 percent of each fiscal year's funds) in funding for hydrogen station development until at least 100 stations are operational.

The Clean Transportation Program has an annual budget of about $100 million and provides financial support for projects that:

- Reduce California's use and dependence on petroleum transportation fuels and increase the use of alternative and renewable fuels and advanced vehicle technologies.
- Produce sustainable alternative and renewable low-carbon fuels in California.
- Expand alternative fueling infrastructure and fueling stations.
- Improve the efficiency, performance, and market viability of alternative light-, medium-, and heavy-duty vehicle technologies.
- Expand the alternative fueling infrastructure available to existing fleets, public transit, and transportation corridors.
- Establish workforce-training programs and conduct public outreach on the benefits of alternative transportation fuels and vehicle technologies.

To be eligible for funding under the Clean Transportation Program, a project must be consistent with the CEC's annual Clean Transportation Program Investment Plan Update. The CEC issued GFO-21-602 to demonstrate community and employer engagement and a path toward ZEV jobs in the State. In response to GFO-21-602, the recipient submitted an application which was proposed for funding in the CEC's notice of proposed awards February 22, 2022, and the agreement was executed as ARV-21-054 on June 3, 2022.

ABSTRACT

The Zero-Emission Vehicle Sustainable Equitable Employment Destination (ZEV SEED) Project, initiated by Community Resource Project, Inc. with funding from the California Energy Commission, aimed to address the acute shortage of skilled workers in California's ZEV sector. Targeting low-income and disadvantaged communities in Sacramento County, the project aimed to provide specialized training and job placement in clean mobility fields. Spanning from May 2022 to March 2024, the initiative delivered a tailored training program focused on the technology and maintenance of electric vehicles and the installation and diagnostics of electric vehicle chargers.

The program successfully graduated 71 individuals, enhancing their employability and understanding of electric vehicle technology. The ZEV SEED Project exemplifies the efficacy of targeted training programs in bridging the skills gap in the green economy, highlighting the need for continued and expanded efforts to meet the surging demand for electrification and clean energy skills.

Keywords: Workforce training, zero-emission vehicle, ZEV, EVSE, electric vehicle, EV, EV charger maintenance, EV maintenance, EV battery, community outreach, refugees, women, young adults, upskilling, hands-on training, clean technology jobs, disadvantaged communities, job placement, overcoming language barriers, trainee support services, accessible job training, environmental justice, equity

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EXECUTIVE SUMMARY

In May 2022, Community Resource Project, Inc. secured funding from the California Energy Commission for the Zero-Emission Vehicle Sustainable Equitable Employment Destination (ZEV SEED) Project, aimed at equipping residents of two priority communities in Sacramento County with zero-emission vehicle job training and placement opportunities.

The ZEV SEED Project was born out of a critical need, underscored by three significant challenges:

- The acute shortage of skilled workers within the ZEV sector in California
- High unemployment and underemployment rates in low-income and disadvantaged communities
- The uneven distribution of job opportunities exacerbated by various barriers

These factors collectively highlighted the pressing demand for specialized training programs tailored to the unique needs of these communities, connecting them to the rapidly growing zero-emission vehicle industry.

Before embarking in the ZEV SEED program, the team developed a needs assessment report that detailed seven strategies for developing electric vehicle curricula for the target groups. In the end, Community Resource Project, Inc., and its partners created a training program focused on clean-mobility exploration with a high-tech and high-touch approach.

Over six months, the ZEV SEED Project graduated 71 individuals from diverse backgrounds in a wide range of electric vehicle-related topics. Beyond technical skills, the program enriched participants with versatile skill sets, preparing them for a wide spectrum of future job prospects, and gave students a better understanding of the current state of electric vehicle technology. Graduates have gone on to secure jobs, further their education in related fields, or gain internships supporting and developing other zero-emission vehicle related programs.

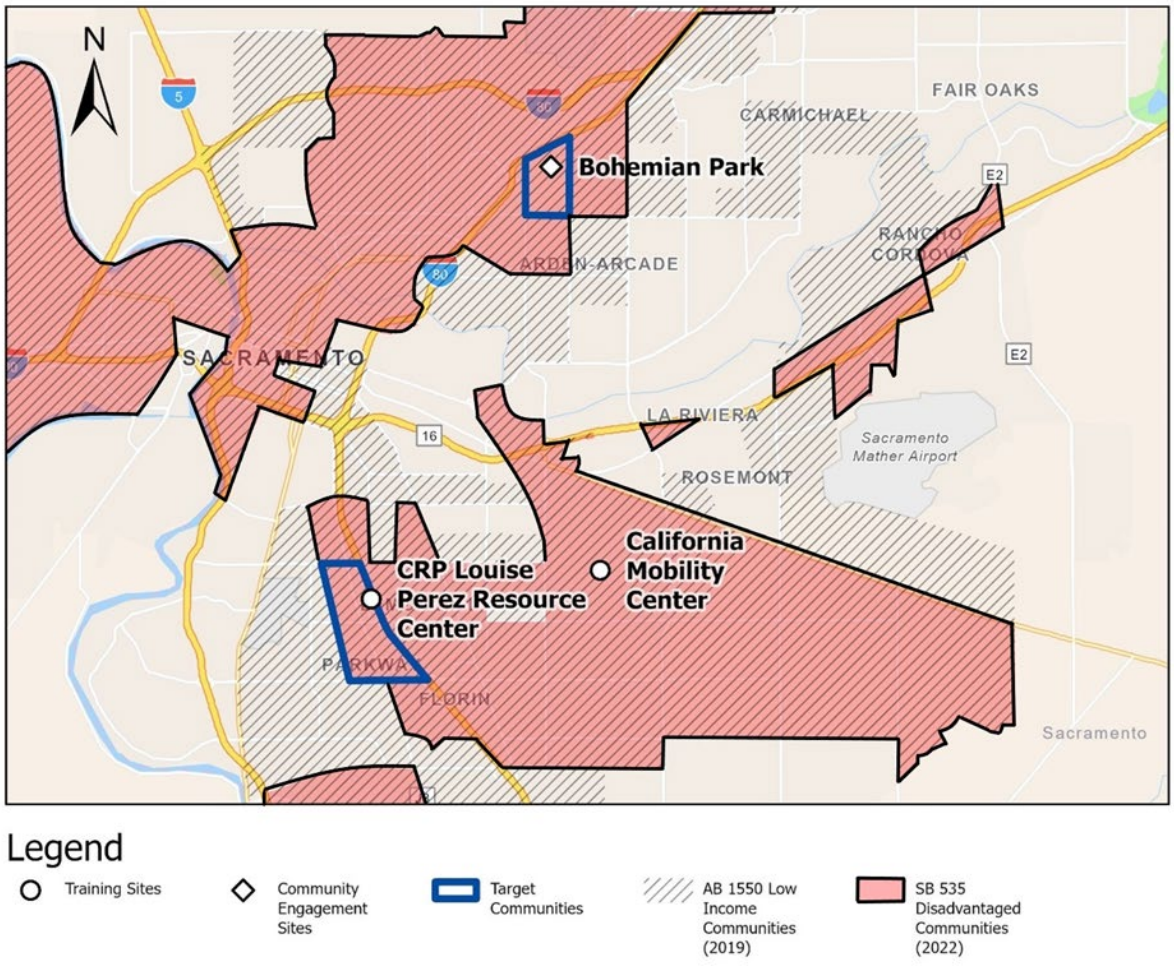
The project serves as a testament to the potential of targeted training initiatives like ZEV SEED in bridging the skills gap within the green economy. However, it also highlights the journey ahead. As the demand for electrification surges, there is a compelling need for more programs like ZEV SEED, alongside greater collaboration across sectors. The goal is not only to meet the current market demand, but also to expand the project team's vision — preparing a workforce capable of supporting the domestic production of electric vehicles and renewable energy components like batteries, motors, chargers, and energy storage systems. Future programs should focus on automation, manufacturing, quality control, and other related skills to support and encourage industry to manufacture domestically and use a large and willing workforce. This initiative marks a significant step forward, but it is just the start of a transformative journey toward a sustainable and inclusive future in the zero-emission vehicle industry.

CHAPTER 1:
Introduction

On October 1, 2021, the California Energy Commission (CEC) released a grant funding opportunity (GFO-21-602) titled "IDEAL ZEV Workforce Pilot." This competitive grant solicitation is intended to support training in zero-emission vehicle (ZEV) industries and priority communities.

In response to GFO-21-602, Community Resource Project, Inc. (CRP) — in partnership with the California Mobility Center (CMC), Aura Planning (Aura) and other organizations — applied to launch the ZEV SEED Project. The team intended the project to provide training and ease job placement in the ZEV industry for two low-income (Assembly Bill 1550, Gomez, Chapter 369, Statutes of 2016) and disadvantaged (Senate Bill 535, De León, Chapter 830, Statutes of 2012) communities in Sacramento, as shown in Figure 1.

Figure 1: Project Target Region



Map shows the target regions and the training locations.

Source: CalEnviroScreen 4.0

Funding of $500,000 was subsequently awarded for the ZEV SEED Project in February 2022, and project implementation officially began in May 2022 and is slated to conclude in May

2024. The 18-month project consisted of roughly 6 months of curriculum development, 6 months of job training, and 6 months of monitoring and evaluation. This report outlines the project outcomes.

The report begins with a brief background on the project and team, followed by an overview of curriculum development, the screening and recruitment process for trainees, and overall training outcomes. The report concludes with recommendations for future ZEV training programs and CEC funding opportunities.

Project Background

The goal of the ZEV SEED Project was to train 100 individuals and facilitate job placement for at least 75 trainees from two low-income (AB 1550) and disadvantaged (SB 535) communities in Sacramento County — Lemon Hill and Arden-Arcade. This goal was pursued through the development and delivery of a "Clean Mobility Exploration Program" covering:

- Electric vehicle (EV) charger installation.
- EV maintenance and service.
- EV operation and driving.

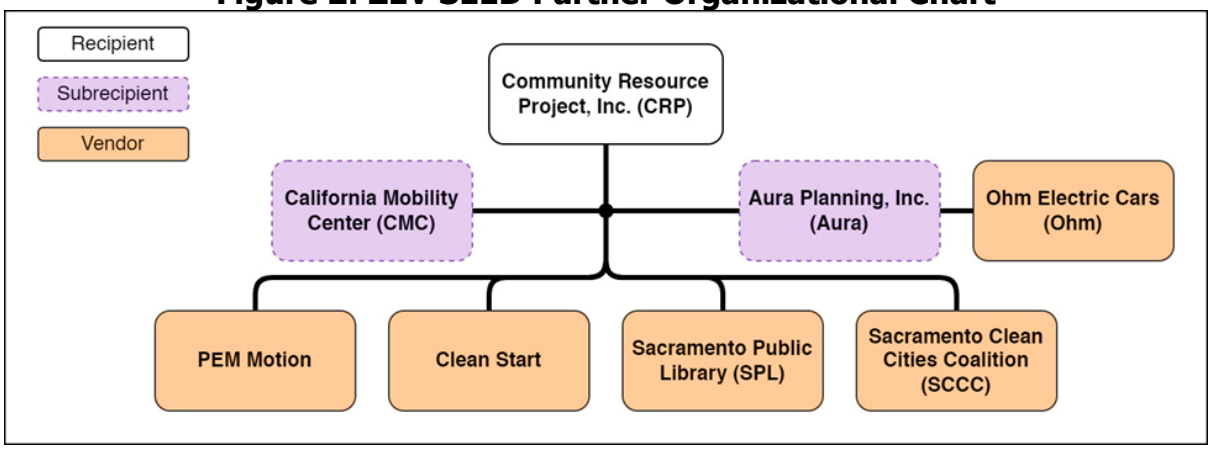
The training was delivered in two parts — classroom training and hands-on training. Classroom training consisted of virtual reality (VR) training, live in-class demonstrations, soft-skills lessons, site tours and field trips to potential employers, industry guest speakers, and group activities. Hands-on training consisted of activities where the students became intimate with electric vehicle charger installation, electrical vehicle battery replacement, electrical workplace safety, and vehicle maintenance and inspection techniques, among other things.

In total, five rounds of training were offered to five cohorts of refugees, women, automotive industry workers, construction industry workers, and young adults of 18–25 years of age. Each round of training was tailored to each cohort's needs to ensure the best possible learning outcomes. Training was delivered between January and August 2023.

Project Team

The ZEV SEED Project team consisted of a diverse group of nonprofit organizations, public agencies, and private companies. The team's expertise was equally diverse, encompassing community advocacy and engagement, education and training, workforce development, and clean energy. Figure 2 shows the relationship among all partners.

Figure 2: ZEV SEED Partner Organizational Chart



The chart above shows the type of partner and relationship among all partners.

Source: Community Resource Project

Community Resource Project, Inc.

Community Resource Project, Inc. (CRP) is the Sacramento-based 501(c)(3) nonprofit organization that led the ZEV SEED Project. With more than 50 years of experience in addressing the needs of priority communities in energy efficiency, health, and education, CRP was a natural fit for the project lead role. In its capacity as project lead, CRP played a pivotal role in project management and the delivery of classroom training. Today, CRP serves more than 60,000 individuals across four counties and in more than nine languages.

California Mobility Center

The California Mobility Center (CMC) is a public-private collaborative whose goal is to accelerate innovation and commercialization of new products, services, and technology in the clean mobility space. The CMC's goal is to create an ecosystem of entrepreneurs, large and small businesses, investors, and academia to build world class companies. For the ZEV SEED Project, the CMC served as a subrecipient, responsible for delivering hands-on training and coordinating job placement.

Aura Planning, Inc.

Aura Planning, Inc (Aura) is a Sacramento-based, woman-owned, small business and consultancy, founded in 2020 with the aim of revitalizing priority communities through innovative clean mobility, community engagement and workforce development strategies. For the ZEV SEED Project, Aura played an instrumental role in project management, community engagement, and curricula development. Aura also developed and deployed the VR training experiences for the ZEV SEED program.

Sacramento Public Library

The Sacramento Public Library (SPL) is the fourth-largest library system in California, serving 1.4 million residents annually through 28 branches and an electric bookmobile. For the ZEV SEED Project, SPL was essential to community engagement, program promotion, and trainee recruitment. For each cohort's classroom training, SPL presented the benefits and challenges of its electric bookmobile and raised awareness on their many other services available to students.

PEM Motion USA, Inc.

PEM Motion is an engineering consulting firm, focused on business consulting, production optimization, product development, and workforce training. PEM Motion is headquartered in Germany and has an office in Sacramento. For the ZEV SEED Project, PEM Motion played a pivotal role in curricula development and the delivery of classroom and hands-on instruction.

CleanStart

CleanStart is a regional nonprofit setup to accelerate the development of clean technology ventures in Northern California. CleanStart provides support to clean-tech start-ups in the form of education, connections, and access to capital. It has also worked with several institutes to create educational and networking programs. These factors made CleanStart an excellent partner for the ZEV SEED Project, where it was instrumental in program promotion and trainee recruitment.

Sacramento Clean Cities Coalition

Sacramento Clean Cities Coalition (SCCC) is a nonprofit organization affiliated with the U.S. Department of Energy's Clean Cities Program. SCCC focuses on engaging and supporting stakeholders and local fleets in adopting alternative fuel vehicles, including providing information on vehicles, funding, fueling, and safety. For the ZEV SEED Project, SCCC was responsible for coordinating site tours and field trips and instrumental in connecting trainees to employers.

Ohm Electric Cars

Ohm Electric Cars (Ohm) is an electric vehicle conversion company based in Dixon (Solano County). With more than 25 years of practical experience rebuilding, restoring, enhancing, racing, and fabricating vehicles, Ohm Electric Cars was a perfect partner for the ZEV SEED Project. Ohm played a critical role in curricula development, as well as the delivery of classroom and hands-on training.

CHAPTER 2:
Curricula Development

Over a six-month period from June to December 2022, the ZEV SEED curricula were developed through a series of collaborative meetings that included project partners, ZEV employers, community-based organizations, and local residents. In addition to these meetings, a needs assessment was conducted in the first phase of this program to ensure the curricula were closely aligned with the community's needs, leading to the identification of seven guiding strategies. Figure 3 shows a glimpse of the wide array of the activities the students engaged in.

Figure 3: ZEV SEED Students

Students from Cohorts 1-4 engaging in classroom training, tours, and hands-on training.

Source: Community Resource Project

Strategy 1: Custom Training Cohorts

Instead of using a one-size-fits-all model for training, the project team selected specific subsets of the community and customized the training curricula, schedule, and support services to meet their unique needs. This resulted in five distinct cohorts composed of individuals with similar backgrounds, interests, schedules, and requirements. The five cohorts were focused on the following subgroups:

- Cohort 1 — Refugees
- Cohort 2 — Women
- Cohort 3 — Automotive Industry Workers
- Cohort 4 — Construction Industry Workers
- Cohort 5 — Youth Aged 18–25

This approach fostered rapport and understanding among trainees and enabled more focused recruitment. As a result, mothers with similar schedules and childcare responsibilities were grouped together and provided tailored support. Likewise, individuals with English barriers or who had advanced electrical and automotive knowledge or experience were grouped together and provided the needed support.

Supported by CleanStart, the program began by enlisting community ambassadors. These ambassadors were motivated through incentives to engage with their communities and promote the ZEV SEED program. Concurrently, the Sacramento Public Library facilitated student recruitment and raised program awareness by participating in community events and employing diverse advertising strategies. Prospective students were individually followed up via phone calls to assess their interest, employment status, and other relevant details. Notably, one student, upon learning about the program, even relocated to the Sacramento area to participate in the ZEV SEED program.

Strategy 2: Multilingual Support

To accommodate the linguistic diversity of the first cohort, which included refugees from Afghanistan and Ukraine, the project team translated all training materials into Dari and Russian. The team also employed translators and incorporated audio and written translations into its VR applications. To assist trainees with limited English proficiency further, the team paired them with individuals who have stronger English skills in the classroom. Furthermore, the team used the Microsoft PowerPoint built-in live translation and captioning feature, along with YouTube plug-ins capable of translating presentations and videos into two languages simultaneously, enhancing accessibility and comprehension.

Strategy 3: Flexible Training Schedules

Following feedback from community members who were unable to attend training sessions during working hours because of other commitments, the project team revised its training schedule to increase flexibility. As a result, Cohorts 1, 3, and 4, which included refugees, automotive, and construction industry workers, were conveniently offered training sessions after working hours. In contrast, Cohorts 2 and 5, consisting of women and youth, received their training during working hours. Moreover, the training for Cohort 5, specifically designed for high school graduates, was thoughtfully scheduled during the summer break to accommodate their availability.

Strategy 4: Tours and Field Trips

Recognizing a burgeoning interest in ZEV jobs among women and youth, our curriculum was enriched with site tours and field trips. This initiative was launched following an introduction to ZEV topics, providing students with a tangible glimpse into potential careers. Through these tours, participants had the firsthand opportunity to explore job settings and engage with industry professionals, fostering a deeper understanding and connection with the field. The Siemens tour (shown in Figure 4), for example, showed students the complexity and multidisciplinary teams involved to make a rail car.

Figure 4: Siemens Tour

Students and an instructor on a tour of Siemens train manufacturing facility in Sacramento.

Source: Community Resource Project

Fieldtrip locations included Siemens' rail car manufacturing facility, American River College's automotive technology lab, Sacramento Municipal Utility District's (SMUD) Power Academy, and Ohm Electric's EV conversion shop.

Strategy 5: Target Specific Employers

Building on the momentum of the tours, the CMC, CleanStart, and SCCC proactively engaged with regional employers to identify the skills most pertinent to securing jobs within the sector. This effort led to collaborations with notable local employers such as Siemens, SMUD, Lion Electric, and University of California, Davis fleet services, aiming to tailor the educational experience to meet the specific demands of the industry. This strategic approach not only prepared students for the workforce but strengthened the program's ties with key industry players that led to student interviews, job offers, and employment.

Strategy 6: Complement Existing Training Programs

Drawing from the foundation of existing ZEV education and training initiatives in Sacramento, the project team crafted the ZEV SEED Program to serve as an introductory training. This approach strategically positions it as a stepping stone to the more comprehensive programs provided by institutions like American River College and Universal Technical Institute. By aligning the program in this manner, the team ensures that the ZEV SEED training acts as a complement rather than a competitor, paving the way for trainees to advance to the specialized programs of their preference. The alignment proved to be valuable, with several students expressing keen interest in furthering their education through the automotive technology programs available at these institutions.

Strategy 7: Tailor Curricula to Market Needs

CEC data divide ZEVs into three categories: plug-in hybrid electric vehicles (PHEVs), fuel cell electric vehicles (FCEVs), and battery-electric vehicles (BEVs). In response to regional trends, the ZEV SEED Program specifically tailored the curriculum and training toward BEVs, the most prevalent type. The program centered primarily on the Nissan Leaf because of the popularity and affordability of the model, although it also covered other technologies, including those used in Tesla's vehicles. In addition, training on electric vehicle supply equipment (EVSE) was incorporated, addressing a vital area of interest for the students. This inclusion was particularly relevant given reports of a 72.5 percent uptime for EV chargers,[1] highlighting the importance of this knowledge in the current landscape. Figure 5 and Figure 6 show the deep hands-on training students were exposed to like electrical work, installing EV chargers, and working directly on EVs.

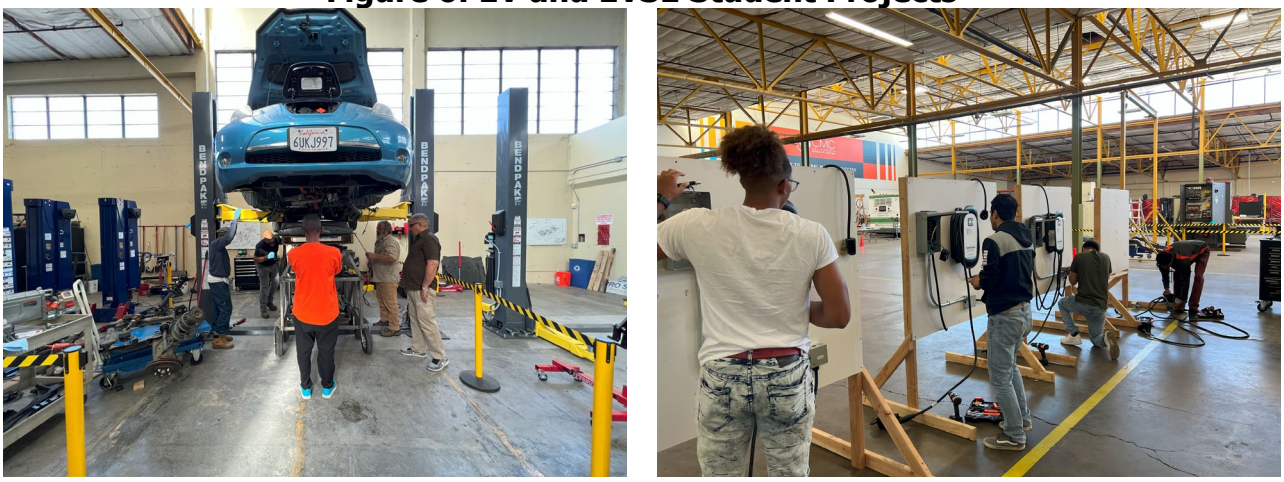
1 David Rempel, C. C. April 7, 2022. "Reliability of Open Public Electric Vehicle Direct Current Fast Chargers." Retrieved from https://ssrn.com/abstract=4077554.

Figure 5: EVSE Electrical Work

Cohort 5 (young adults) students learn to bend conduit to route electrical wiring.

Source: Community Resource Project

Figure 6: EV and EVSE Student Projects



(Left to right) Students pull out battery pack from underneath a Nissan Leaf. Students install EV chargers on faux practice walls.

Source: Community Resource Project

CHAPTER 3:
Training Outcomes

Classroom sessions were conducted at two locations — CRP's Community Center in Arden Arcade and its Louise Perez Resource Center in Lemon Hill. The curriculum included lectures, in-class interactive demonstrations, site tours, field trips, industry guest speakers, VR training, soft skills lessons, and group activities.

Figure 7: Student Graduation

Cohort 1 students graduate from the ZEV SEED program.

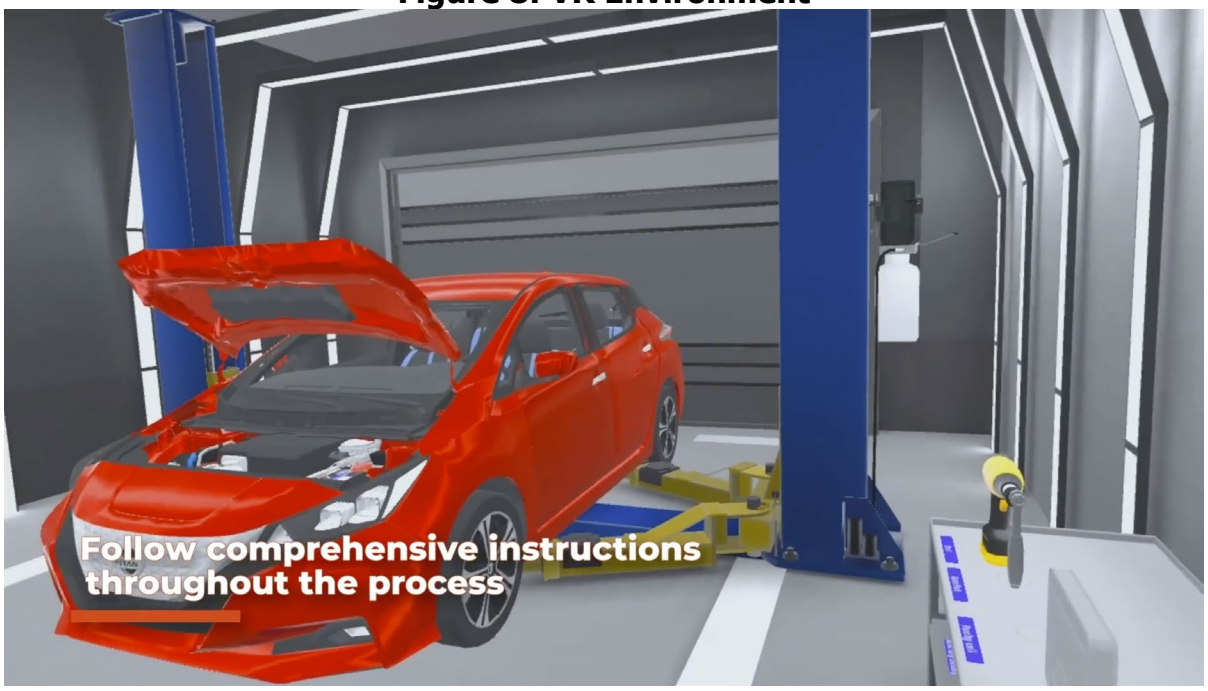
Source: Community Resource Project

Following the classroom phase, trainees proceeded to hands-on training at the CMC's Ramp Up Facility. This practical component expanded on classroom topics and involved activities such as electric vehicle battery replacement, workplace safety, EV charger installation, and many more topics. After completion of the training, graduation ceremonies were held to award

certificates of completion to the students. Figure 7 shows images of the first cohort's graduation ceremony.

VR training played a significant role in classroom and hands-on training, offering a 3D and 360-degree learning environment and providing a safe space for trainees to practice electrical procedures without real-life consequences. Moreover, VR training served as a means for familiarizing trainees with the tools, processes, and terminologies essential for working on electric vehicles (shown in Figure 8). The success of the VR application was apparent when students had a good sense of what to do when it came to actually removing a battery pack during the hands-on training (as shown in Figure 9) or installing a real EV charger on a wall.

Figure 8: VR Environment



A view of the 3D VR environment students worked in which replicated the actual vehicle and equipment used to remove the battery pack during hands-on training.

Source: Community Resource Project

Figure 9: EV Battery Removal

Cohort 3 preparing to lower the battery pack from a Nissan Leaf EV that is on a car lift.

Source: Community Resource Project

Each cohort of the ZEV SEED training program spanned about four weeks (60 hours) of classroom training and six weeks (84 hours) of hands-on training.

The ZEV SEED program graduated a total of 71 (47 men and 24 women) students. The breakdown of students per cohort is shown in Figure 10.

Figure 10: Student Participation

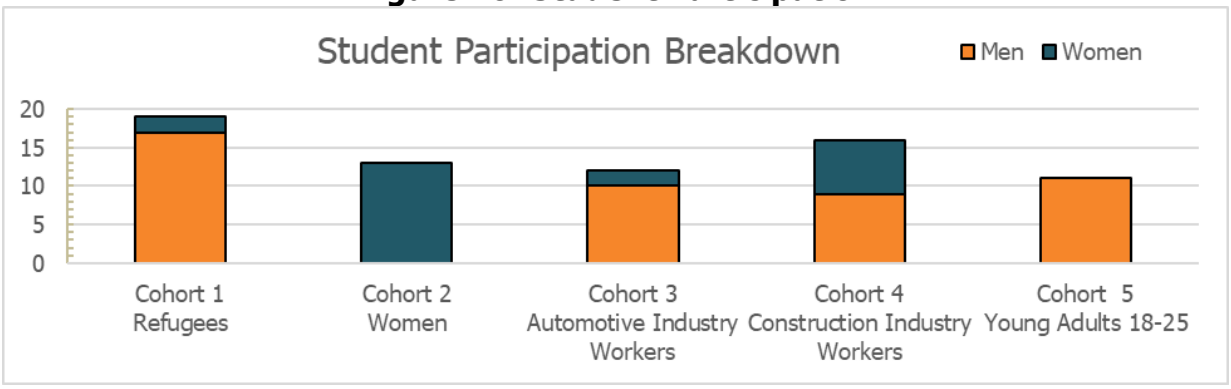
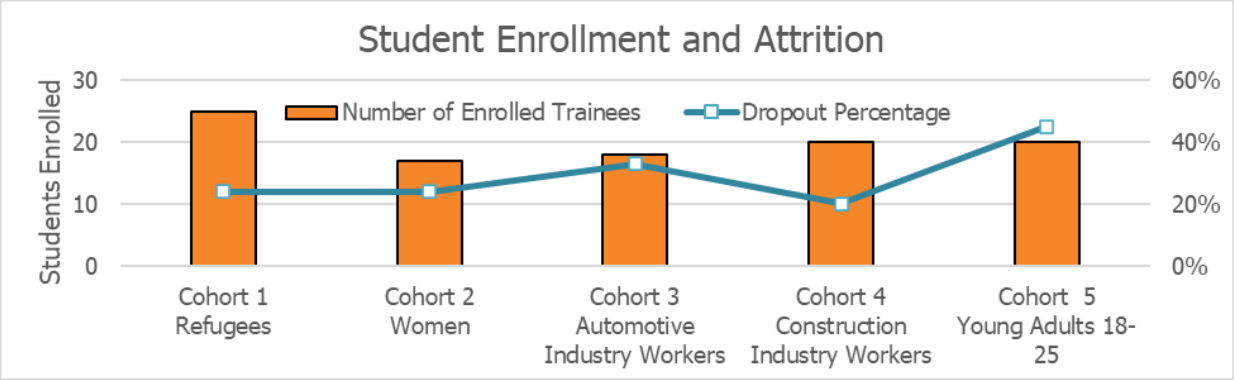


Chart shows the number of graduates and gender breakdown of each cohort.

Source: Community Resource Project

Figure 11 shows dropout rates ranging from 20 percent to 45 percent, depending on the cohort, with the highest dropout rate seen in the young adult cohort. These rates show that new tactics for better engaging and retaining young adults must be made.

Figure 11: Student Attrition Rates

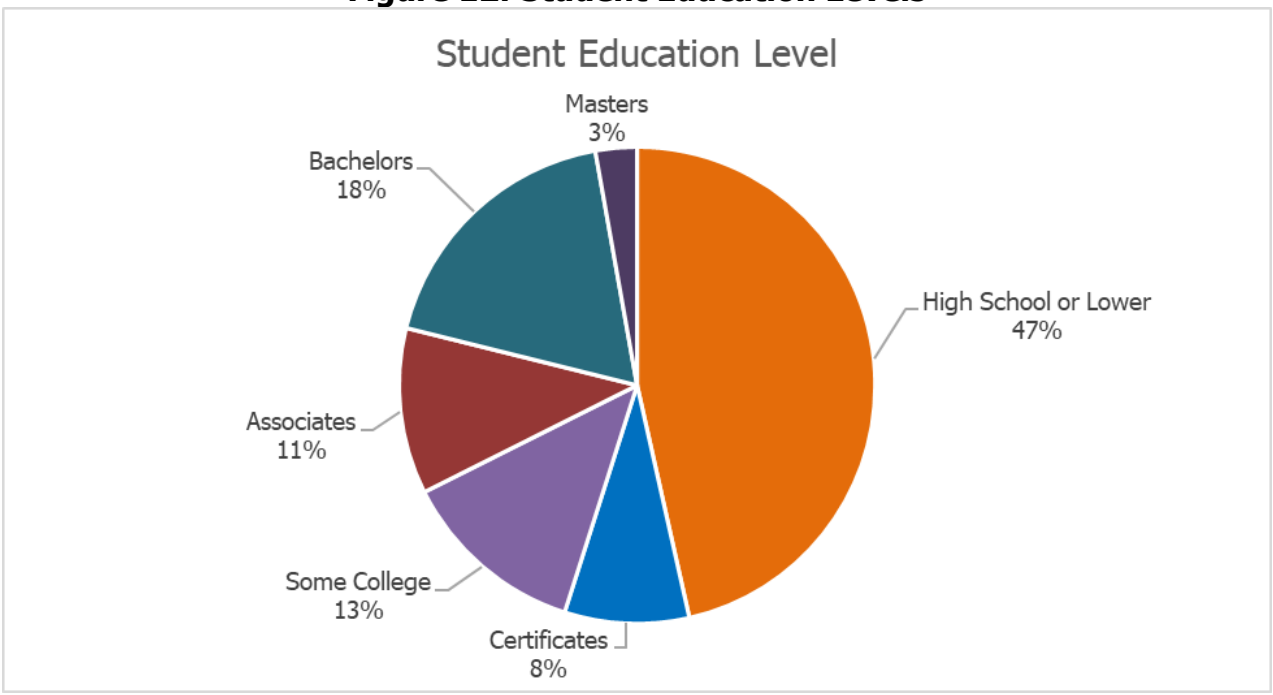


The chart shows the number of initially enrolled students and the dropout percentage of each cohort.

Source: Community Resource Project

Figure 12 shows that 47 percent of ZEV SEED students had no more than a high school education. It also shows that there was deep interest in EV topics from those with higher educational levels.

Figure 12: Student Education Levels



The chart shows the education level breakdown of all graduated students from ZEV SEED.

Source: Community Resource Project

Training Topics

The program was marked by a dynamic evolution, as instructors navigated the unique challenges and varied skill sets presented by each new cohort. With adept customization, they adjusted their teaching strategies to resonate with the distinct backgrounds of their learners, ensuring optimal information delivery.

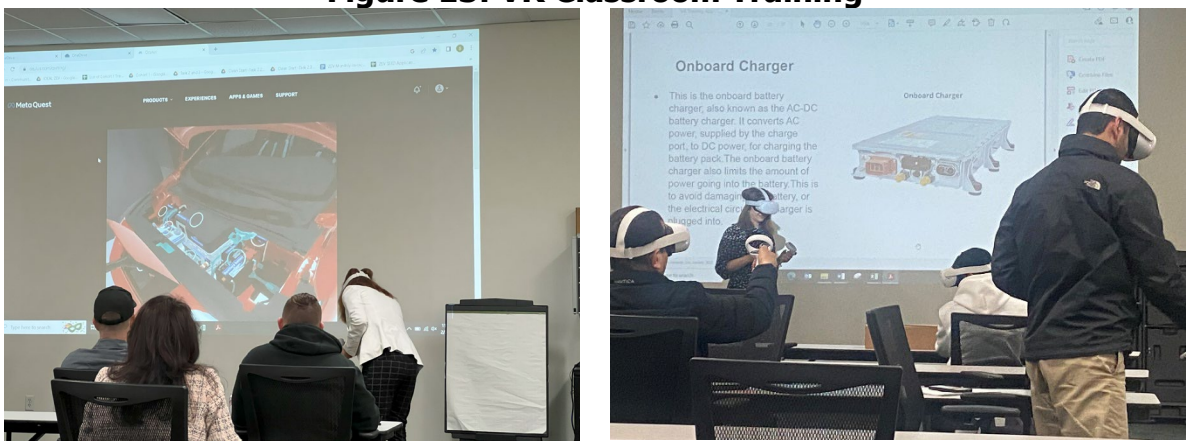
Training encompassed a broad spectrum of subjects, primarily focusing on EVs and EVSEs alongside engineering topics. This comprehensive approach not only broadened students'

knowledge, but opened new career pathways and deepened their understanding of the engineering process.

Classroom Training Topics

- Basics of power and energy
- EV architecture
- Electric motors (DC and AC motors)
- Battery technology (battery management systems, chemistries, series and parallel configurations, capacity)
- Regenerative braking
- EVSE (120VAC, 240VAC, and direct current fast chargers)
- EVSE monitoring
- EVSE installation
- VR EV system and component exploration as shown in Figure 13
- VR EV battery pack removal
- VR EVSE 240VAC Level 2 charger installation

Figure 13: VR Classroom Training



(Left to right) Instructor shows students capabilities of the VR training system. Students using the VR headsets to undergo their training during classroom training.

Source: Community Resource Project

Hands-On Training Topics

EVSE

- Multimeter usage
- Disassembly and assembly of a Level 2 AC charger
- Installation of the charger on a framed wall section
- Installation of an electrical panel and junction boxes
- Bending of conduit to make connections between the junction box and the load panel
- Routing of wiring and landing connections in a breaker panel
- Splicing of a 240VAC test cable
- Performed EVSE diagnostics to check power output, communication signal, cable

function, and more

EV Training

- Battery pack removal as shown in Figure 14
- Component review and lectures
- Vehicle onboard diagnostics (OBD) scanning and diagnostic trouble code (DTC) retrieval
- Tire pressure inspection
- Vehicle inspections
- Conversion of a bike to an ebike as shown in Figure 14 and Figure 15 and the space shown in Figure 16

Figure 14: Active Hands-On Training

(Left to right) Students approach an open high-voltage battery system wearing arc flash personal protective equipment (PPE). Students test their ebike conversion.

Source: Community Resource Project

Engineering and Fabrication

- Product development
- Computer-aided design (CAD) (software used was Fusion 360)
- Design of a machinable part, computer-aided manufacturing (CAM) training, and operation of a computer numerical control (CNC) machine as shown in Figure 15
- Design of a 3D printable part, 3D print slicing, and 3D printer operation
- Design of a flat part, prepare files for laser cutting, and operation of a laser cutter
- Welding
- Sheet metal fabrication
- Woodworking and building of framed wall sections (for EV charger installation)
- VR electricity training room to learn about high-voltage safety, battery configuration, and electrical loads

Figure 15: Select Student Projects

(Left to right) A CNC machine cutting a student designed project. Students converting a bike to an ebike.

Source: Community Resource Project

Figure 16: Ebike Area Tour

The CEC Site Tour (Mabel Lopez visiting the Ebike conversion area at the CMC).

Source: Community Resource Project

Collaboration

Students across all cohorts enjoyed the camaraderie of working in groups and meeting new people. In cases where language barriers existed, this sense of fellowship was even stronger, as students rallied together to help each other grasp the material more effectively.

Student Job Opportunities

During the ZEV SEED program, select students were chosen and compensated to serve as in-class translators, aiding peers with queries. This initiative was part of a broader success story, with many participants securing employment upon completing the program. The CMC played a pivotal role by offering paid internships to ten students, enabling them to contribute to future CMC programs, which allowed students to put updated experience on their resumes and use managers and staff as potential job references. A participant from the women's cohort (shown in Figure 17) was hired as a part-time intern, assisting with hands-on training in following ZEV SEED classes. Among these interns, one group notably developed a hydraulically actuated battery pack removal cart to facilitate the installation and removal of vehicle battery packs (shown in Figure 18).

Figure 17: CMC Intern

CMC intern recruited from ZEV SEED Women's Cohort

Source: Community Resource Project

The program also opened doors to interviews at Siemens for several students, with some securing full-time job offers. One CMC intern transitioned to a full-time role at an auto parts store, leveraging the experience gained from the program and internship. Aura hired two

students for internships focused on community-related EV projects, with one of them advancing to secure a position at the local International Rescue Committee, providing services for refugees. Another student achieved a promotion within CRP, thanks to the EV insights gained from the course.

Figure 18: Hands-On Training Tour at the CMC

Showing Mabel Lopez of the CEC the EV battery pack lift completed by ZEV SEED interns (July 10, 2023).

Source: Community Resource Project

In total, the program promoted employment opportunities for about 20 individuals, underscoring the effectiveness in bridging the gap between education and employment in the evolving EV sector.

Upskilling, Further Education, and EV Awareness

Students entered the program with a diverse array of goals. While some were keen to deepen their understanding of ZEV technology, others, already employed, aimed to prepare for the EV transition within their current roles. Several students were motivated by a desire to weigh the pros and cons of EV ownership, whereas others saw an opportunity to explore the potential of starting a business centered around this emerging field. In addition, there were students who sought exposure to this technology as a foundation for further education in STEM fields. A notable few even progressed to community college, pursuing degrees in engineering or automotive technology.

Furthermore, the CMC facilitated practical skill development, certifying 10 ZEV SEED students in forklift operations.

One promising student secured a scholarship and stipend to participate in a lineworker training program offered by SMUD, marking another success story of the broad-reaching effect of the program.

Job Support

As each cohort neared its conclusion, staff from CRP and Aura played a crucial role in updating students' resumes, equipping them to pursue new opportunities. WhatsApp groups were established for each cohort, where 10–15 job opportunities were shared weekly. This ongoing support system ensures that students continue to have access to instructors, CRP, and Aura for guidance, assistance, and access to posted related programs.

CHAPTER 4:
Lessons Learned and Recommendations

During the project, the project team acquired a wealth of valuable insights that the team is eager to apply and integrate into the team's new vision for future projects, aiming to amplify the effect on the community. The team is excited to continue working alongside government agencies to enact positive change within the community. The team has pinpointed several strategies to improve the program and formulated recommendations that could prove beneficial for future projects funded by the CEC.

Student Feedback Sessions

At the conclusion of each cohort, a feedback session was conducted by program facilitators, rather than the instructors, to ensure unbiased responses. The feedback covered a range of topics, highlighting both strengths and areas for improvement in the program.

Classroom Size

Some participants noted that the classroom sizes were occasionally too large during hands-on portions of the program, particularly when many students required individual attention and support to complete their tasks effectively.

Knowledgeable Instructors

Students highly valued the real-life experiences brought by instructors from engineering and trade backgrounds. This practical knowledge greatly enhanced the learning experience and allowed for a free flow of curious questions.

Facilitator Engagement

The ZEV SEED coordinator was present at all classroom trainings and played a crucial role in fostering meaningful connections with the students. Her efforts to make students feel valued and provide resources significantly helped maintain high attendance and engagement levels throughout the program.

Training Resources

The provision of travel stipends and childcare was greatly appreciated by the students. Class hours were scheduled to accommodate the maximum number of students and their schedules, as the program was offered in morning and evening options.

Some students also praised the job support efforts, including resume updates facilitated by CRP and Aura, and a WhatsApp group that featured weekly job postings. Students facing challenges such as language barriers or prior convictions expressed that they would've liked more job and employment support from the program.

The VR training received positive feedback for helping students better understand what is involved in working on an EV or installing an EVSE. The option to use multiple languages and the opportunity to experiment in VR without real-world consequences significantly boosted their confidence for the hands-on training portion of the program.

Instructional Content

Overall, students found the instructional content interesting and engaging. Most were able to comprehend the course material effectively. However, there were some exceptions; a few students found the content too challenging and some, not challenging enough.

Lessons Learned for ZEV SEED

Seven strategies laid out in the Curricula Development section were critical seeds to develop this program. After delivering instruction and better understanding the wide array of challenges the project students face, there are newfound lessons for the project team's future programs.

Program-Specific Lessons

Assessments and Learning Reinforcement Strategies

Assessments were designed to be inclusive and encouraging to maintain student attendance. For example, students were asked to identify names and functions of different EV components using VR tools. In addition, the project team incorporated engaging in-class activities like "Jeopardy," with questions tailored to the class content. In instances where attendance was a concern, students were tasked with writing essays on EV-related topics. Primarily, hands-on projects proved to be the most effective method for assessing student understanding.

In future programs, the team wants to include assessments and homework, assignments, worksheets, and so forth. Granted, these inclusions need to be done to be sensitive to the limitations of language and educational backgrounds. These inclusions will better reinforce the class lessons. Another approach the team would like to implement is the use of peer-to-peer teaching, which will reinforce the lessons for certain students who understand the material but also help students hear similar content in different ways. The use of better-defined group projects over guided projects would also allow students to do some discovery and reinforce learning of topics on their own rather than listening and directly implementing.

VR Improvements and More Training Delivery Options

Although the VR training app was an excellent tool for training people in different languages, the app should have also offered a method of learning in a mixed style that could help them land a job. For example, learning component names in English but having explanations and descriptions in the students' native language would prove more useful for employment opportunities later on. Other improvements to the VR training apps are adding a room where you are not being trained but simply are introduced to the controls of the app and learn to adjust the headset for maximum comfort. Some students were not used to being in the virtual 3D environment; thus, new content delivery methods should be developed like PC or mobile apps so students can experience the environments and content in different ways.

Resource Constraints

Addressing the constraints related to hands-on experience with EVs, a key focus moving forward will be enhancing resource allocation and refining the team's educational framework. By investing in a greater number of vehicles, possibly including those requiring diagnostics and repairs, the project team aims to offer students a more comprehensive, practical experience. This approach not only promotes a deeper understanding of EV technology through direct interaction but allows for the development of critical thinking and problem-solving skills as students diagnose, repair, and verify vehicle functionality. Implementing more structured

lesson plans will further support this objective, ensuring a well-rounded and effective learning environment that prepares students for the realities of the field.

Evolving Trends in Charging

Building a program around a moving target is uncommon, yet over the past year, the adoption of the North American Charging Standard, spearheaded by Tesla, has been on the rise. This shift necessitates an adaptation in training to keep pace with the new trends being embraced by a range of vehicle manufacturers. It's crucial to anticipate upgrades to the project team's diagnostic tools and refresh the training materials to cover the differences in communication protocols.

Moreover, the team's training concentrated on Level 2, 240VAC chargers. However, to ensure students are well-prepared for the evolving landscape of charger technology, the team must expand the curriculum to include DC fast chargers. This expansion would cover the intricacies of power conversion, the unique maintenance and diagnostic requirements of these systems, and an understanding of the various subsystems that enable operation.

Group-Specific Lessons

Language Barriers

Language barriers presented a significant challenge for the team's refugee group, emphasizing the need for initial focus on overcoming these hurdles to encourage discussions on more technical topics and improve employment prospects. For the future, the team needs to direct students to language learning resources.

Participation From Young Adults

Young adults exhibited the lowest attendance rates, highlighting an urgent need for creative engagement strategies or further exploration into the factors behind their low participation. This issue affects not only the effectiveness of the program, but also the future career prospects of these young adults in the clean technology sector. Initiating programs that target students at a younger age, and both genders equally, such as during middle and high school could serve as an early introduction to these careers. By familiarizing them with clean technology and related job opportunities from an earlier stage, the project team aims to cultivate their interest and ensure a higher level of engagement by the time they reach young adulthood.

Additional Methods of Employment Support

The program encountered students with challenging backgrounds, including those with prior convictions, histories of drug abuse, or experiences of physical abuse. This vital subset of participants necessitates the provision of additional support, whether through job coaching or mental health resources, to aid in their successful integration and progress into the workforce.

Leveraging Current Skills

The program must recognize the untapped potential of students from diverse educational backgrounds, such as those with degrees from overseas, who could accelerate more swiftly into the workforce. This observation underscores the importance of identifying and leveraging the unique skills and talents of each participant to ease their rapid and effective transition into employment, further emphasizing the need for a nuanced approach to support and engagement tailored to individual circumstances and strengths.

Recommendations for Future Programs Focused on Upskilling for Clean Technology Jobs

Future programs aimed at preparing individuals for the evolving clean technology sector should prioritize comprehensive training that encompasses a wide range of clean energy vehicles and technologies, including EVs, PHEVs, and hybrid electric vehicles (HEVs). Given the rapid adoption of these technologies and the increasing demand for servicing, programs must offer training that provides a broad skill set, catering not only to EVs, but to hybrids which serve as a bridge between conventional internal combustion engine (ICE) vehicles and fully electric systems.

The IDEAL ZEV workforce pilot program highlights the importance of upskilling community members for careers that contribute to environmental sustainability. To enhance the effectiveness of such programs, the following strategies are recommended.

Align Training With Local Workforce Demands

To ensure the relevance and effectiveness of training programs, it is essential to collaborate with industry stakeholders to grasp the precise current and future demands of the local workforce. This collaborative approach should guide the development of a curriculum that addresses domain-specific needs and teaches transferable skills that benefit participants across a range of sectors within California. Furthermore, the curriculum should be designed to not only ease entry into new fields, but support career advancement and promotion within participants' current professions.

Support for Disadvantaged Communities

Ongoing efforts must be made to comprehend and address the unique challenges faced by disadvantaged groups, including refugees. These efforts include providing comprehensive guidance and support services that span across housing, healthcare, childcare, and more, ensuring these individuals can fully participate in training programs without having to prioritize between essential needs.

Holistic Approach to Services

Adopting a "one-stop-shop" model can significantly enhance accessibility to training and other critical services offered by local community-based organizations. Such an approach ensures individuals can easily find and engage with the training programs and support services best suited to their needs and career desires.

Tailored Pathways for Diverse Groups

Acknowledging the varied backgrounds and needs of participants, programs should offer flexible and varied training pathways. These pathways include accommodating the schedules of parents, providing language training for nonnative speakers before technical training, and recognizing and leveraging the qualifications of participants with degrees from their home countries.

Addressing the Skills Gap in Clean Technology

With the push toward electrification, there's an ongoing skills gap that needs continuous attention. An organized effort to bring together unions, industry, and training partners is crucial for rapidly developing the skills of individuals eager to enter this burgeoning field.

Quick Skill Development Programs

Offering targeted grants for specialized skill development programs can provide individuals with the critical skills needed for immediate employment. These programs could include OSHA 10, forklift training, high-voltage safety (NFPA 70E), pathway to electrical trainee (ET) card, technical English courses, and project management. These programs and are designed to be short and focused, minimizing disruption to participants' current job or family commitments. Funding organizations could mandate using third-party labor market analytics tools to identify and address regional skills gaps.

Certification and Broader Recognition

To boost the standing and credibility of training programs within the industry, organizations like the CEC should officially endorse programs financed by grants. Setting and enforcing specific standards and requirements will imbue these programs with a level of trust and recognition, ensuring employers of program quality and thereby easing the transition of graduates into the workforce. Programs that receive such endorsement are likely to be met with greater confidence from the industry, encouraging employer engagement and promoting a more seamless employment process for students. Moreover, forging partnerships with local community colleges and universities to offer college credit for participation in these practical courses could add real-life context to the in-class experience.

Employer Collaboration Requirements

Grants should emphasize the importance of employer involvement by incorporating and budgeting for incentives for industry partners to contribute input on training and workforce requirements, expertise, and resources. This approach ensures training programs are aligned with the current needs of the region’s job market and builds employer trust in the value of these programs. Initiatives could then also include subsidized internships or job-shadowing opportunities, enhancing students’ employability in specialized fields.

Support for Small Business and Clean Technology

Allocating funds to support small businesses in underprivileged areas, especially those focused on deploying clean technologies, can foster local economic growth and job creation. Offering incentives for these businesses to hire locally trained individuals can create a symbiotic relationship between training programs and small business development. In addition, acting as incubators for small businesses, these initiatives can help leverage cutting-edge technologies to ensure the associated success and sustainability in the evolving marketplace.

By implementing these recommendations, future programs can more effectively prepare participants for the dynamic and growing field of clean technology jobs, ensuring they are well-equipped to contribute to environmental change and sustainability.

GLOSSARY

ALTERNATING CURRENT (AC) — Flow of electricity that constantly changes direction between positive and negative sides. Almost all power produced by electric utilities in the United States moves in current that shifts direction at a rate of 60 times per second.

BATTERY ELECTRIC VEHICLE (BEV) — Also known as an "all-electric" vehicle (AEV), BEVs use energy that is stored in rechargeable battery packs. BEVs sustain power through the batteries and therefore must be plugged into an external electricity source to recharge.

BATTERY MANAGEMENT SYSTEM (BMS) — Systems encompassing not only the monitoring and protection of the battery, but also methods for keeping it ready to deliver full power when called upon and methods for prolonging battery life. This system includes everything from controlling the charging regime to planned maintenance.

CALIFORNIA ENERGY COMMISSION (CEC) — The state agency established by the Warren-Alquist State Energy Resources Conservation and Development Act in 1974 (Public Resources Code, Sections 25000 et seq.) responsible for energy policy. The Energy Commission's seven major areas of responsibilities are:

1. Advancing State Energy Policy
2. Achieving Energy Efficiency
3. Investing in Energy Innovation
4. Developing Renewable Energy
5. Transforming Transportation
6. Overseeing Energy Infrastructure
7. Preparing for Energy Emergencies

COMMUNITY RESOURCE PROJECT, INC. (CRP) — The primary award winner and administrator of the ZEV SEED Project.

COMPUTER-AIDED DESIGN (CAD) — Also known as computer-assisted design, it is the use of computers to aid in the creation, modification, analysis, or optimization of a design.

COMPUTER-AIDED MANUFACTURING (CAM)[2] — Refers to software that takes the geometric design authored with CAD software as input and outputs manufacturing instructions that are downloaded to automated equipment such as a computer numerically controlled (CNC) machine tool.

COMPUTER NUMERICAL CONTROL (CNC)[3] — In machining, numerical control, also called computer numerical control, is the automated control of tools by means of a computer.

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2 Computer-aided Manufacturing. (n.d.). Retrieved from Wikipedia: https://en.wikipedia.org/wiki/Computer-aided_manufacturing.

3 Numerical Control. (n.d.). Retrieved from Wikipedia: https://en.wikipedia.org/wiki/Numerical_control.

DIAGNOSTIC TROUBLE CODES (DTC)[4] — Also referred to as *fault codes*, they help technicians pinpoint the location and cause of the specific system experiencing a problem.

DIRECT CURRENT (DC) — A charge of electricity that flows in one direction and is the type of power that comes from a battery.

ELECTRIC VEHICLES (EV) — A broad category that includes all vehicles that are fully powered by electricity or an electric motor.

ELECTRIC VEHICLE SUPPLY EQUIPMENT (EVSE) — Infrastructure designed to supply power to EVs. EVSE can charge a wide variety of EVs including BEVs and PHEVs.

FUEL CELL ELECTRIC VEHICLE (FCEV) — A zero-emission vehicle that runs on compressed hydrogen fed into a fuel cell "stack" that produces electricity to power the vehicle.

HYBRID ELECTRIC VEHICLE (HEV) — A vehicle that combines an internal combustion engine with a battery and electric motor. This combination offers the range and refueling capabilities of a conventional vehicle while providing improved fuel economy and lower emissions.

INCLUSIVE, DIVERSE, EQUITABLE, ACCESSIBLE, AND LOCAL ZERO-EMISSION VEHICLE (IDEAL ZEV) — The workforce pilot program funded by the California Energy Commission of which ZEV SEED was a part.

INTERNAL COMBUSTION ENGINE (ICE) — The ignition and combustion of the fuel occur within the engine itself. The engine then partially converts the energy from combustion to work.

ONBOARD DIAGNOSTICS (OBD) — The self-diagnostic and reporting capability of a vehicle.

PLUG-IN HYBRID ELECTRIC VEHICLE (PHEV) — PHEVs are powered by an internal combustion engine and an electric motor that uses energy stored in a battery. The vehicle can be plugged into an electric power source to charge the battery. Some can travel nearly 100 miles on electricity alone, and all can operate solely on gasoline (similar to a conventional hybrid).

SOFT SKILLS — Non-technical skills needed to succeed in the workplace, such as communication and time management.

VIRTUAL REALITY (VR) — A 3D virtual environment where someone can enter and interact with objects through the use of a VR headset that displays the environment to the user. Usually, the headset is paired with two controllers for each hand to allow the interaction with objects in 3D space.

ZERO-EMISSION VEHICLE (ZEV) — Vehicles that produce no emissions from the onboard source of power (for example, an electric vehicle).

ZERO-EMISSION VEHICLE SUSTAINABLE EQUITABLE EMPLOYMENT DESTINATION (ZEV SEED) — The program administered by Community Resource Project and the primary topic of this report.

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