CADMUS

Contra Costa County Workforce Training Program Framework & Strategic Plan

Training for Auto Mechanics

July 10, 2019

Prepared for:

Contra Costa Transportation Authority

2999 Oak Road, Suite 100

Walnut Creek, CA 94597

Prepared by:
Gerald W. Bernstein, Stanford Transportation Group
Pamela Gutman, Stanford Transportation Group
Philip Kreycik, Cadmus

CADMUS

Table of Contents

Introduction

Since the rollout of the General Motors EV1 electric car in 1996, California has been a leader in crafting policy in support of electric vehicle (EV) adoption. Today, California continues its role by setting ambitious goals to reduce greenhouse gas emissions through electrification of the transportation sector.

As adoption of EVs has increased, so too has the need for skilled EV mechanics. As part of developing its EV Readiness Blueprint, the Contra Costa County Transportation Authority (CCTA) aims to bring work and jobs related to EVs to Contra Costa County residents, with special interest given to people from underinvested communities. Integral to ensuring the county's EV readiness is to prepare its workforce.

This document presents the framework and strategic plan for a workforce training program focused on ensuring that the financial and job security benefits of servicing the growing number of EVs flow to local workers, particularly those from underinvested communities. The program is also intended to encourage young students and people interested in changing careers or wanting to rejoin the workforce to direct their studies toward this exciting new technology. The workforce training program takes advantage of adult education programs and training institutions to provide equitable access to these skillsets.

To develop this framework and plan, the authors evaluated training needs and explored training curricula and relevant topics to address them. To assess current EV readiness, the authors interviewed workforce professionals, school district personnel, community college auto program faculty and administrators, and independent technicians.[1] The authors studied national and proprietary county-level data to estimate the current size and training needs of the automotive technician workforce and identified where deficiencies might arise regarding the ability of these technicians to maintain EVs driven by county residents, now and in the future.

Independent mechanics and shops account for 40% of all mechanics in Contra Costa County. The authors concluded that the current supply appears to match demand. However, as more EVs enter the market (and as they lose dealer support with age), independent mechanics and shops will need additional training for EV systems in general and for model-specific EV maintenance. In addition, although conventional hybrid vehicles are not within the scope of the EV readiness plan, hybridization of conventional internal combustion engine vehicle drivetrains is also increasing in the county. Including content for hybrid vehicle maintenance in the training program will maximize interest, attendance, and usefulness for automotive mechanics.

---

[1] Entities consulted include Contra Costa College and Los Medanos College community college auto program managers, Pittsburg Unified School District administrators, the Contra Costa County Workforce Development Board, municipal fleet managers, and members of the two chapters of the Automotive Service Councils of California (ASCCA chapters) active in Contra Costa County.

Intent of this Document

This document provides a framework for a workforce training initiative in Contra Costa County that will give auto mechanics the skills and knowledge they need to support and maintain EVs and hybrid vehicles. The framework identifies the skills and knowledge mechanics need to meet the demands of a changing vehicle market. It also reviews existing resources and programs that may be incorporated, both from private programs and publicly funded programs.

Agencies and individuals within Contra Costa County are served by a variety of automotive maintenance and training organizations with diverse needs and challenges. This framework focuses on the organizations that need the most assistance in achieving a greater readiness to support and maintain EVs. By building on existing local training and resources, the framework helps ensure that the associated job benefits remain in the county.

Preserving quality automotive technician jobs for underinvested communities in the county is particularly important. As more vehicles electrify and need relatively minimal routine maintenance compared to internal combustion engine vehicles, the demand for these services lessens. EVs require no periodic oil changes, brakes last much longer because of regenerative braking, electric motors do not get serviced as do internal combustion engines, and there is no exhaust system to maintain and replace.[2]

On the other hand, hybrids and plug-in hybrid electric vehicles (PHEVs) have more complex systems and interactions, and all vehicles are coming with more intricate electrical systems, computing needs, and sensors. These factors further amplify the need for promoting robust training so the local workforce can adapt to these substantial changes.

In this report, we use the following definitions.

- **Hybrid vehicles** combine an internal combustion engine with a battery and electric motor.
- **Plug-in hybrid electric vehicles (PHEVs)** are similar to traditional hybrids but are also equipped with a larger, more advanced battery that allows the vehicle to be plugged in and recharged in addition to refueling with gasoline.
- **Battery electric vehicles (BEVs)** run entirely on electricity stored in batteries and have an electric motor rather than a gasoline engine.
- **Plug-in electric vehicles (PEVs)** include PHEVs and BEVs.

For simplicity's sake, we will use the term EVs to refer to PEVs throughout this document.

---

[2] The reduction in the total volume of routine service work available will be somewhat mitigated to the extent which PHEVs and hybrids maintain their popularity relative to full battery electric vehicles. Hybrids and PHEVs are more complex as they operate with both an internal combustion engine system and an electric drive system; this adds an electric motor, battery, controller elements, and unique transmission to standard internal combustion engine automotive systems.

Training Needs

This section identifies the training needed to equip technicians to handle a growing volume of EVs and hybrids in Contra Costa County. This section also provides estimates of the size of the workforce in need of training and the anticipated demand for future skills. The authors utilized interviews and previous experience to convert data on the size of the auto technician workforce, turnover, and employers to estimate the number of individuals who will require training (either entry level maintenance skill training or upskilling for experienced mechanics), and the approximate number of appropriate training sessions.

What Will Auto Technicians Need to Learn?

Vehicle technologies are evolving rapidly, which complicates projections of training needs for vehicle mechanics in the decades ahead. For example, vehicles powered by internal combustion engines already require skills in computer technology and demand for these skills will only increase with connected vehicle and passenger systems. Hybrid and EV systems are being added to training curricula as technicians are increasingly encountering these vehicles. Colleges and other training programs are challenged to find the funding, equipment, trained faculty, and vehicles to meet this rapidly evolving demand. Meanwhile there remain systems such as wheels, tires, body repair, and other systems common to all vehicles.

The following are some of the important aspects of EV systems that need to be incorporated into a vehicle mechanic training program (a more comprehensive hybrid and EV curriculum is presented in *Appendix A*):

- EV system vocabulary and components, including cooling systems, inverters, high-voltage battery, motor, and regenerative braking systems
- Architecture of hybrids, PHEVs, and BEV systems—that is, how the components of these systems work individually and together
- Diagnostic system codes and testing, along with troubleshooting techniques for problems not fully defined by the diagnostic system
- Proper electrical safety procedures for high voltage systems

The workforce training program also needs to be designed so working technicians have the opportunity and flexibility to add skills while maintaining their commitments to employers and family.

What Is the Demand for County-Provided Training?

A workforce training program focused on EVs and hybrid vehicles must consider the current size of the workforce in the county, the skills and training already acquired by this workforce, and the degree of readiness for additional training. Some employers independently provide hybrid vehicle and EV training, so it is important to gather information about these employers and trained technicians and the level of hybrid and EV exposure this workforce already has.

How Big Is the Auto Technician Workforce?

The authors identified the size of the county's auto technician workforce and its expected changes by researching labor market information hosted by the Centers of Excellence for Labor Market Research and available on a restricted basis by the California Community Colleges System.[3] This commercial database provides employment estimates and forecasts (2017–2022) for county-level workforces at the five-digit Standard Occupational Classification (SOC) code level.[4] The federal government and state do not track employment information at this detail.

Table 1 summarizes auto technician employment for Contra Costa County. The Automotive Service Technicians and Mechanics classification (SOC 49-3023) is the most pertinent, with 2,008 currently employed in the county. Jobs in this category are expected to grow to 2,140 by 2022. Between 2017 and 2022, 1,055 will remain in the workforce and 1,085 will be newly hired. The authors believe these 1,085 newly hired technicians and mechanics can be viewed as a conservative estimate of the total workforce that should be trained with EV and hybrid vehicle skills.

Table 1. Current and Forecasted Automotive Employees in Contra Costa County

SOC Code & Title	2017	2022	5-Year Change	Currently Employed and Will Remain in Workforce	5-Year New + Replacement Workers [a]
49-3021 Autobody & Related Repairs	429	453	24	221	232
49-3023 Auto Service Technicians & Mechanics	2,008	2,140	132	**1,055**	**1,085**
49-3031 Bus & Truck Mechanics	570	626	56	308	318
Total	3,007	3,219	212	1,584	1,635

Source: Centers of Excellence for Labor Market Research. Accessed February 2019. www.coeccc.net

[a] This column adds an estimate of retiring workers (who need to be replaced) to the estimate of 5-Year Change (growth).

Many employees in the other two classifications—Autobody Repair Technicians (SOC 49-3021) and Bus & Truck Mechanics (SOC 49-3031) —will also need to know how to safely maintain, replace, and repair EV and hybrid systems. However, the authors believe this percentage will be low because personnel servicing buses and trucks usually work for fleets or specialize in fleet types and require manufacturer and vehicle-specific training. These groups, therefore, are not part of this analysis.

The authors determined that a substantial share of the current workforce is expected to retire during the five-year forecast period, in keeping with industry reports about a large impending wave of baby boomer retirements affecting numerous professional groups. This is an opportunity for Contra Costa County to partner with employers in workforce training and pipeline development activities. As the

---

[3] Centers of Excellence for Labor Market Research. Accessed February 2019. www.coeccc.net

[4] The Standard Occupational Classification is a system used by U.S. federal government agencies to classify occupations uniformly across agencies.

authors have observed, Bay Area auto dealers are increasingly engaging with college programs to strengthen ties with the students who will be their future employees.

Who Employs Auto Technicians in the County?

A variety of employer types provide different levels of training on EV and hybrid vehicle maintenance to their technicians, which should be accounted for in estimating countywide training needs. In general, dealerships and fleets provide or obtain their own training,[5] whereas independent shops and self-employed technicians often do not.

The authors did not find county-specific data, but the U.S. Bureau of Labor Statistics (BLS) provides a useful proxy to assess the breakdown of auto technicians by employer type. As of March 2019, BLS' online Occupational Outlook Handbook identified the following composition of employment for Automotive Service Technicians and Mechanics (SOC Code 49-3023):

- 31% dealers
- 27% repair and maintenance businesses
- 13% self-employed
- 9% parts stores, accessory shops, tire repairers
- 20% other

Employers in the "other" classification are probably a mix of government (city and County) maintenance shops (including transit), postal and express service maintenance facilities, and electrical providers (such as PG&E). For the purposes of this plan, the authors assumed this 20% comprises mostly these fleet employers.

What is the Approximate Need for Training in the County?

The authors used information about the automotive workforce to calculate a lower and an upper bound for basic training needs over the next five years in Contra Costa County. The authors applied percentages for employment composition provided by BLS to the anticipated workforce in 2022 (Table 1) to estimate the size of the technician workforce employed by dealerships, repair facilities, self-employment, parts stores, and fleets (Table 2).

---

[5] For dealers, the original equipment manufacturer (OEM) provides model-specific training to dealership maintenance personnel. For fleets, the training situation is more complex. For bus and truck fleets, the OEM is often obligated to provide training as part of the purchase agreement (along with other forms of product support). For light duty fleets, there may be no training component except for ongoing maintenance—dealer personnel will provide support (through warranty or purchase contract) for several years. But as warranties and contracts expire, fleet technicians take increasing responsibility for diagnostic and repair work in addition to ongoing maintenance. Therefore, some portion of fleet technicians need training, but this is already recognized and addressed by fleet managers.

Table 2. Calculating Auto Service Technician Training Needs in Contra Costa County

	Technicians Expected in Five Years			Newly Hired Technicians Already Trained Through Local Community Colleges Over Five Years	Unaddressed Five-Year Training Need		
	Newly Hired	Existing	Total		Newly Hired	Existing	Total
Dealers (31%)	336	327	N/A	217	N/A	N/A	N/A
Repair Facilities (27%)	**293**	**285**	**578**	**189**	**104**	**285**	**389**
Self-Employed (13%)	**141**	**137**	**278**	**91**	**50**	**137**	**187**
Part Stores and other (9%)	98	95	N/A	63	N/A	N/A	N/A
Fleets & Other (20%)	217	211	N/A	140	N/A	N/A	N/A
Total	**1,085**	**1,055**	**860**	**700**	**154**	**422**	**576**

About 51% of technicians work for (or will be hired by) employers who independently provide training (31% dealers plus 20% fleet), and 9% will work at parts stores and therefore not need training.

The 40% of technicians who work at an independent repair facility or who are independently employed are of particular interest to this training plan. This group includes existing technicians (approximately 285 at repair facilities and 137 self-employed) and newly hired technicians (forecasted to number approximately 293 at repair facilities and 141 self-employed by 2022), for a total of approximately 860 auto technicians who will need training to maintain EVs and hybrid vehicles.

Many in this newly hired group are assumed to be graduates of the automotive technology programs at the two local colleges (see *Contra Costa County Community Colleges* section). As shown in Table 2, these two programs are expected to train about 700 students over five years (at 140 students per year),[6] and these students receive basic EV and hybrid vehicle instruction and can, therefore, be subtracted from the total unaddressed training need.

The final projection is that approximately 580 technicians will need training in EV and hybrid vehicle maintenance over five years, including about 150 newly hired technicians who did not graduate from a local community college and about 420 technicians who need to update their skills. It is important to distinguish between new hires and existing technicians. New hires may be the prospective employees the County is most interested in serving. Furthermore, a significant fraction of the existing technicians may not seek training since they are already employed and may not be motivated to enhance their skills.

The authors conclude that Contra Costa County could target a lower bound of 150 students over the course of five years, or 30 per year, to enroll in a County-sponsored EV and hybrid vehicle training

[6] This five-year estimate of 700 students is based on enrollment data. The typical student is half-time and will graduate in three years. Approximately 425 auto technician students are enrolled in any given year and, assuming one-third of students move on each year, about 140 would enter the workforce. The authors' calculations also assume that there is no net attrition of students trained in the Contra Costa Community College District (e.g., these students do not go on to other types of jobs and the number of trained students who leave the county is roughly equivalent to the number of trained students who enter).

program to receive basic instruction and possibly model-specific and more advanced instruction. The authors note that some fraction of currently employed technicians may seek training, implying an upper bound of 580 students over five years, or approximately 115 per year for the training.

Furthermore, although calculations adjusted for community college students who already received basic EV and hybrid instruction, some may not be fully qualified to perform major diagnostic and repair work so may seek more advanced training if offered in the county. Existing technicians may also seek more advanced training. The County could determine the need for advanced training courses after the initial training program is established.

What is the Current Level of EV Readiness in the Workforce in the County?

Many automotive shops and fleets will need new skills to be ready for the greater number of EVs and hybrid vehicles in the county. Compared to conventional internal combustion vehicles and BEVs, hybrids and PHEVs are particularly complex because they add an electric motor, battery, controller elements, and unique transmission to the standard internal combustion engine automotive systems. Technicians need to be comfortable with EV systems and components, the various architectures, diagnostic and troubleshooting skills, and electrical safety for high voltage systems.

To understand the current state of EV readiness of the Contra Costa County workforce, the authors interviewed officers and members of local chapters of the Automotive Service Councils of California (ASCCA).[7] The authors also interviewed members of the East Bay chapter (representing businesses on the bay side of the county, such as in Richmond) and the Mount Diablo chapter (representing businesses on the east side of the Oakland Hills, such as in San Ramon, Walnut Creek, Concord, and Pittsburg).

The authors heard a relatively consistent message from all interviewees:

- **The need for more skills with hybrids is increasingly apparent and recognized.** Independent mechanics need more skills in hybrid maintenance. More of these vehicles are showing up at shops as more are purchased, as more age out of warranties, and as owners move away from dealer support. Some technicians and shops have made the effort and investment to obtain the skills and equipment needed to service the popular hybrid vehicles.
- **There is a lower level of awareness of the impending need for servicing full battery electric vehicles.** Technicians report they do not yet see many BEVs come to their shops. Most BEVs are still under warranty and serviced by the dealerships. Consequently, these independent shops and technicians have not invested in BEV training, tools, equipment or vehicles, but many believe that they will need BEV training going forward.

---

[7] Founded in 1940, ASCCA is the largest independent automotive repair organization in California, with more than 800 members statewide. Its membership represents all areas of the automotive repair industry, including mechanical, auto body, supplier, and educators. Contra Costa County is divided between two multicounty chapters: Chapter 16 (East Bay) and Chapter 20 (Mount Diablo).

- **The availability of support currently meets the needs of hybrid and EV owners, but more capacity will be needed as these vehicle types grow in popularity.** This conclusion is reached based on discussions with the suppliers of service, not with owners of vehicles. Regardless of the current level of support, there is general recognition for the need to increase future capacity to handle these vehicle types.
- **Many industry actors believe training costs will need to be subsidized.** Interviewees said they expect this training will cost at least twice what most of them are able to pay. They often mentioned $600 as the preferred price for a training program, comparable with other continuing education courses they are accustomed to paying for. They said continuous training and skill enhancement opportunities are always welcome, especially if at an affordable or subsidized price and on a conveniently timed schedule.
- **There is a certain segment of the market that is relatively uninterested in training.** Some technicians have decided not to seek hybrid or EV maintenance training as they believe the predominance of non-hybrid vehicles will guarantee steady business for the balance of their careers. Some of these technicians are nearing retirement and have decided not to invest time or resources in a new area.
- **Keeping up with the maintenance needs of the expected flood of new EV and hybrid models will be a real but manageable challenge.** This challenge will not be unmanageable once appropriate training is made available. Training should include general skills, as well as specific instruction on popular makes and models. Periodic training for newer employees and training focused on specific automobile models is desirable. They said a low to moderate number of sessions per year would be adequate, a conclusion that is compatible with the calculations in the *Training Needs* section of this document.
- **Municipal fleet managers should be encouraged to continue their current high level of EV readiness.** This will likely involve working with OEMs regarding heavy duty EV readiness and training and support needs. With the California Air Resources Board (CARB) Innovative Clean Transit rule and future regulations, these needs will only grow.
- **New and enhanced high school and community college courses related to hybrids and EV maintenance, self-driving car services, and connected vehicle systems are needed.** The industry is in a period of rapid change. Technicians will need not just conventional mechanic skills but also increased computer and electrical system diagnostics.

Continued skill enhancement training is always needed in auto maintenance, and the current network of independent mechanics and shops in Contra Costa County will need to become familiar with a growing variety of hybrids and EVs, including model-specific training.

The next section, *Potential Collaborators and Resources*, discusses the county's current network of training providers that can help assure EV readiness.

Potential Collaborators and Resources

This section addresses the existing suppliers of training related to hybrid and EV maintenance in Contra Costa County or that could be provided in the county. These include college programs, other publicly funded training programs, and private fee-based programs that offer training at diverse locations around the United States.[8]

Local Programs Currently Involved in Hybrid and/or EV Training

Contra Costa County is fortunate to have several local automotive technology training programs that may provide useful collaborators in the development and expansion of hybrid and EV training for local students. Training is offered through Los Medanos College, Contra Costa College, the Pittsburg Unified School District, and the Advanced Transportation and Logistics (ATL) Program.

Contra Costa County Community Colleges

Contra Costa County is home to two community colleges that provide auto-related courses to students. The day, evening, and weekend availability of these courses makes them accessible to traditional full-time students as well as working technicians who want to upgrade their skills in a single target area. The college programs award certificates for completing modules (e.g., engine repair, brake and suspension, transmission specialist) and prepare students to take a national exam administered by Automotive Service Excellence (ASE) to earn an industry-recognized certificate in approximately 10 similar specialties. These certificates require completion of approximately four courses (varies by college and program). Full-time, two-years of study can result in an associate in science degree.

At this time, the automotive programs at both colleges offer some level of hybrid instruction as part of their existing training. Both college programs are currently at capacity and have little opportunity to expand without significant investment. Before launching the workforce training program, Contra Costa County should consult again with the colleges to learn if capacity constraints have changed.

Contra Costa College

Contra Costa College offers associate degrees in auto service and auto collision repair technology. It also offers six auto service and collision repair certificates, including an Automotive Hybrid Technician Certificate of Achievement upon completion of four courses.

According to data compiled in LaunchBoard (a California community college source for college and program statistics and labor supply and demand data), Contra Costa College appears to focus its efforts

---

[8] Internal training that occurs at dealerships is not addressed as part of this plan; this is a significant source of training, but it is already well managed by auto manufacturers and their local dealerships to support their customers. As new models are introduced, dealer personnel are “factory-trained” to support these vehicles regardless of motive power (internal combustion engine or electric).

on attracting and retaining full-time students rather than those taking individual courses. Students who are retained are increasingly taking multiple courses and likely are more career-oriented.

These data are consistent with the authors' interview findings. Contra Costa College's Automotive Program has recently become an affiliate of Toyota's T-Ten training network. This achievement reflects a higher level of professionalism in the program, providing the college with resources while requiring that it maintain Toyota-established training standards. In the near-term, the affiliation consumes faculty time and attention, diminishing their ability to address hybrid/EV program enhancements. Fortunately, this is somewhat mitigated because the T-Ten program includes training on Toyota's hybrid vehicles.

Los Medanos College

Los Medanos College (LMC) offers an associate degree in automotive technology and certificates in emission control, engine diagnosis, electrical and body communication, tune-up, brakes, suspension systems and hybrid/EV safety. According to data compiled in LaunchBoard, the LMC program is larger and more stable than the program at Contra Costa College. The number of full-time equivalent and total students (who take at least one class) has remained stable over the past three years.

Interviews with LMC faculty and administrators highlight that the auto program is fully subscribed at this time, using all available faculty time, shop space, and classroom space. There is no room for expansion of the existing program and very limited space for additional specialized courses for working technicians; at most, one course on a weekend day may be feasible. Before teaching any future EV classes, LMC faculty will require hybrid/EV professional development training (both on general topics and for specific makes and models), and the LMC program will need to acquire the appropriate hybrid/EV cars, tools, and diagnostic equipment.

Pittsburg Unified School District

Pittsburg Unified School District (USD) also has a basic auto program. The district is focused on developing an electric and autonomous vehicle program. Implementation of this broad program will depend on grant support, the success of which Pittsburg USD will learn in June 2019. Pittsburg USD is also planning investments in its basic auto program and is in discussion with LMC to coordinate the development of its auto program with the college.

Advanced Transportation and Logistics Program

The Advanced Transportation and Logistics Program (ATL) is part of the California Community College Economic and Workforce Development Division, which provides grant-funding and support to all 14 Bay Area Automotive Maintenance programs.[9] ATL is hosted at City College of San Francisco (CCSF) and can also facilitate hybrid and EV training as part of its Contract Ed program throughout the Bay Region. The ATL has a 20-year history supporting transportation, energy, and logistics-related college programs and employers in the 12-county Bay Area. Its support for auto-related programs has been continuous. A brief

[9] Advanced Transportation and Logistics Program (ATL) was previously known as the Advanced Transportation and Renewable Energy program (ATRE).

history of ATL's recent programs, including the cost structure of its recent training, is included in Appendix B.

ATL continues its participation as a board member of the Municipal Equipment Maintenance Association to which all the regional fleets (including Contra Costa County's fleet) belong. It also partners with community colleges around the state, sharing curriculums, instructors, and funding, and is therefore a key resource for the county as it develops its hybrid and EV training plans.

Other Potential Collaborators

Currently, the following organizations have less of a direct connection to local training plans but have the potential to become strong collaborators or to provide facilities, curriculum, business models, and ideas for the training program, if needed. However, unlike the programs described above, they do not have a hybrid/EV curriculum, would require bringing experts in from more distant locations, or would require students to travel in order to receive the training. Follow-up conversations with each of them would be required to establish any future value in partnerships.

Local Entities Without Current Hybrid/EV Programs

Although the current programming and curriculum of the following two entities are not aligned with the county's identified training needs, these entities do have sites and connections with possible students and may be interested in expanding their offerings in partnership with County departments.

Diablo Valley College

Diablo Valley College (DVC) is located in Contra Costa County but has no automotive program. It does however, have an extensive electrical program, which might be of use as a site for short-duration (e.g., one or two-day or evening) training sessions that focus on systems (such as battery repair) if vehicle access is not required. This possibility would need to be explored with college administrators as needed.

TecHelp

TecHelp is a private local company based in Concord and has been in business over 25 years. It offers a series of courses focused on a variety of smog certification, air conditioning systems, engine control systems and electrical systems topics. These courses appear to offer a basic understanding of the related systems and understanding of how to use diagnostic equipment to assess problems. However, the training program website does not identify any courses specific to hybrid or electric motor systems.

Entities with Relevant Programs that Are Not Currently Offering Local Training

Several entities provide hybrid and/or EV courses for a fee. These courses are intended to give automotive technicians a better understanding of advanced electric vehicles. The courses typically cover some mix of electrical fundamentals, hybrid and/or EV system design, diagnostic techniques, and a variety of related topics. They combine classroom lecture and shop exercises focusing on diagnostics and repair. Exercises may include major component removal and replacement; battery diagnostics, removal, and reinstallation; and at times, motor-generator disassembly and diagnostics.

Contra Costa County could explore partnering with these entities to bring in external instructors to provide local training and send local community college instructors to expand local training capabilities and to compare notes on curriculum and training needs.

Universal Technical Institute

Currently, the closest private program is the Universal Technical Institute (UTI) program in Sacramento.[10] UTI is a nationwide provider of diverse technical educational training. This program includes basic auto (and heavy duty) vehicle maintenance and selected dealer-specific trainings. The program offers one introductory course titled Hybrid Vehicle System Maintenance, which teaches students how to service hybrids.

National Alternative Fuel Vehicle Training Center

In recent years, NAFTC has offered classes at sites accessible to technicians in Contra Costa County. However, since it is not headquartered in the Bay Area, training may be located in other parts of the country unless a collaboration is formed to bring training back to the Bay Area. As of March 2019, the only relevant course listed on NAFTC's website is Electric Drive Vehicle Automotive Technician Training at Ferris State University in Big Rapids, Michigan, for four days in March. The cost of this course is $995 per attendee, not including travel or hotel.

Nonetheless, the curriculum developed by NAFTC may be useful. NAFTC has created an Advanced Electric Drive Vehicle Education (AEDVE) Program hosted at West Virginia University. Its audiences include automotive technicians, consumers, first responders, secondary school educators and students, charging infrastructure engineers and installers, and fleet operators.

Automotive Career Development Center

In recent years, ACDC has offered classes at sites accessible to technicians in Contra Costa County. However, since it is not headquartered in the Bay Area, training may be located in other parts of the country unless a collaboration is formed to bring training back to the Bay Area.

ACDC offers hybrid and EV courses similar to those offered by NAFTC with a mix of classroom and hands-on training that vary from three to seven days with the cost per student ranging from $3,000 (three-day) to $5,000 (five and seven days) per course. Courses scheduled as of March 2019 are located at ACDC's facility in Worchester, Massachusetts; Cary, North Carolina (in conjunction with an Auto Service and Technology Expo); and The Netherlands. The cost of the Worchester and North Carolina courses includes hotel and meals, but not ground or air travel.

---

[10] Until recently, another private company, Wyotech (a division of the private Corinthian College Corporation) had been the most active private auto-technician training program with hybrid classes in the Bay Area. However, it closed its Fremont campus without notice in April 2015. Another provider that formerly provided training in the Bay Area, Perfect~Sky, is no longer conducting training as of the preparation of this report.

Suggestions for the Vehicle Mechanic Training Program

Components, Planning, and Logistics for Each Audience

Contra Costa County's workforce training program should consider the training needs of technicians at independent repair facilities, self-employed technicians, and fleet technicians. These technicians need relatively similar training, and it is not expected that separate tracks or curriculums would be needed to for light duty vehicle maintenance, diagnostic, and repair needs because all need to be familiar with hybrids and EVs.

For any of these technicians, the training program will require:

- Trained instructors and training materials
- Vehicles on which to work
- Diagnostic and test equipment appropriate to the vehicles being used
- Shop space

The biggest difference for trainees in the program is in the logistical elements. For example, training for a fleet operator would require the workforce training program provide only the instructor(s) and training material because the other three elements are provided by the fleet's facility.

When training independent or self-employed maintenance personnel, the logistics are a bit more complicated. Nevertheless, in the discussion with ASCCA members, it appears a sufficient number of independent shops would be willing to make space available (with advance notice) to accommodate some level of periodic training. In these cases, the workforce training program would need to arrange for instructors and training material, diagnostic and testing equipment (if not already available at the hosting shop), and possibly vehicle(s). Some interviewees said they could make vehicles available at a hosting shop.

The authors recommend that, each year, the workforce training program contact the two ASCCA chapters representing technicians in Contra Costa County to check their members' interest in general or vehicle-specific classes during the coming year.[11]

Curriculums appropriate to the identified training need will need to be developed or obtained. An outline of a general curriculum that would be appropriate for introductory or refresher training is provided in *Appendix A*. Based on interviews, some training should focus on a specific subject (for example, battery servicing and replacement), while other training should focus on servicing specific models of vehicle. Curriculums for these topics will need to be customized by local trainers or obtained

[11] The names and contact information of the officers of Chapter 16 (East Bay) and Chapter 20 (Mount Diablo) are maintained at https://www.ascca.com/chapters.

from specialized industry training sources such as those identified above in the *Potential Collaborators and Resources* section or from vendors of dealer diagnostics.

The authors have found scheduling flexibility is one key element of program design and an advantage of sourcing trainings locally. Courses can be taught in a single three-, four- or five-day block or spread over time. Many working technicians may prefer to attend one or two days per week over several weeks. If no out-of-region travel is required for the instructors or for the students, the course can more easily spread out over time. This also allows the trainee to continue employment commitments and have time between classes to absorb the information provided, while the employer avoids major staffing gaps.

Indicative Exploration of Potential Costs

Developing a robust and self-sustaining workforce training program will require ongoing programmatic costs, which would need an ongoing funding source, and costs per course, which could be entirely covered by student fees.

Program Costs

Training programs will reliably happen only if part of someone's job is to develop and maintain a vision for the program and regularly coordinate with employers, trainees, training providers, and other partners to ensure the program is responsive to current and anticipated needs. For example, local dealers should be consulted to identify ways they could help strengthen the college programs and other training programs. In turn, these dealers will be motivated by having a dependable local supply of future skilled employees.

The local community colleges and adult education programs will periodically refine and enhance their current program, and some central coordination could help them identify areas of collaboration. Therefore, the workforce training program would benefit by assigning duties to a qualified County staff member, possibly for one-quarter or one-third FTE on an ongoing basis. Staffing would likely not exceed $40,000 per year (including compensation, travel, and benefits) and could be covered with grants, workforce development funds, County department resources, or even fees from course offerings if willingness to pay is sufficiently high and courses are provided economically.

If no staff were hired or instructed to oversee the program local entities such as ATL or the community colleges could help with coordination. However, given funding limitations of these organizations and the activity required to maintain the existing automotive technology programs at the campuses, coordinating with dealers, industry, and other training allies may be one of the first elements to fall through the cracks.

The best option is to assign staff funded by a County department to guide a higher level of EV readiness and provide the assurance and accountability that necessary training is scheduled and delivered successfully.

Additional ongoing costs include the need for Contra Costa County's colleges to continue to expand and update their EV-related courses and training capabilities. As the authors observed, the colleges need faculty training, vehicles on which to work, diagnostic equipment and tools, and (possibly) shop and/or

classroom space. All of this has costs that colleges cannot usually provide from normal operating budgets. Colleges and regional programs like ATL therefore seek outside grant funds to strengthen college programs and faculty skill. However, availability of and competition for such grants are impossible to predict or plan on.

To strengthen college training capabilities, the workforce training program coordinating staff should meet with ATL and local college faculty and administrators to develop a strategy for keeping the college programs current with industry needs. With a minimum investment, faculty could attend one or more appropriate NAFTC or ACDC programs at a cost of $2,000 to $6,000 per person per training, including travel costs. One annual training for at least one faculty member from each of the two auto programs would be a minimum goal.

Per-Course Costs

The two audiences for training enhancement are existing workers and students. As described above, a training program for existing workers requires four components (trained instructors and training materials, test vehicles, diagnostic and test equipment, and shop space). If conducted in conjunction and coordination with the local ASCCA chapters, space could likely be arranged at a local member's shop.

The major cost is for trainers and can be estimated based on recent ATL training experience (see *Appendix A*). Two instructors providing a two-day training (on consecutive days or over two weeks) for a maximum of 25 students would cost $15,000. Training focused on advanced topics or specific vehicles should cost approximately $7,500 per day (again for two instructors, maximum of 25 students).

This assumes instructors are college faculty. Private industry instructor costs are likely to be higher. These estimates assume faculty would provide all necessary training materials and appropriate diagnostic and test equipment as part of their effort. Use of local faculty provides training at lower cost per attendee and on a more flexible basis than training provided by commercial sources based outside the region. The ATL program works with local faculty and might be able to suggest who could be available for any particular training program.

Vehicles will be needed for participants to work on. If a relatively common and available model, these could be provided by the hosting shop or faculty. If an unusual model is needed, there may be added costs to obtain one from a training supplier.

In interviews with ASCCA members, the authors learned that a training program cost of about $600 was considered affordable by most technicians. At an enrollment of 25 participants, a two-day, $15,000 training program would coincidentally cost $600 per participant. Therefore, in theory, courses could be offered at no cost to the County beyond time to coordinate faculty, collect fees, and make hosting arrangements and payments. Realistically, many classes will not be full for various reasons. To avoid cancelling a class (which, if this happens repeatedly would undermine the credibility of any training effort), the County should consider an investment in each class, possibly up to 25% of the cost of offering the training as a contribution from County or external sources. This investment may not be needed in all cases but could provide greater certainty that training would proceed regularly.

If the estimates provided in the *Training Needs* section are accurate (between 30 and 115 students per year for basic training), the training needs for the next five years could be met by offering courses roughly quarterly. If one hybrid and EV course were offered quarterly for 25 participants each, and the County were to need to invest 25% per $15,000 course as a revenue guarantee for enrollment and dropout risks, the total annual cost to the County of such training would be $15,000, not counting any program costs as described above.

Preliminary discussions with the Workforce Development Board indicate that the training costs for students and tools for participants may be a good match for Workforce Development funding, but the costs of training the trainers, curriculum development, and the programmatic costs described above may need to be funded through other mechanisms. Fortunately, the curriculum is already available that could be taken advantage of and the train the trainers costs are relatively low.

Conclusion

This is a dynamic time in the automotive support industry. Two challenges—accelerating changes in technology and an aging workforce—are causing stress for employers nationwide. In the Bay Area, the challenge is amplified by the early adoption of electric-powered vehicles and the high cost of living, which makes it difficult for technicians to live close to where they work.

Current vehicle maintenance training intended to cover well-established and understood technology cannot keep up with the pace of change. This is a national problem as well as a local problem. These problems lead to higher maintenance costs for owners of hybrid vehicles and EVs and a disincentive for others to purchase these environmentally favorable vehicles.

There is no one solution. Dealers deal with labor scarcity by hiring technicians from one another at increasing salaries. Forward-looking independent shops and technicians obtain training when available and affordable. Colleges struggle with the costs of adding new capabilities and finding well-trained and competent faculty.

For Contra Costa County, this is an opportune time to improve the quality and stability of its auto maintenance workforce, while adding the new skills needed to properly maintain the growing number of EVs. While dealers and fleet operators already invest in workforce training, the County is in a position to help meet the training challenges for independent shops and technicians. The investments by County departments may be modest because the number of individuals needing and seeking training each year is in the low hundreds. The primary impediment is logistics and cost—who provides the training, where, and for how much. These difficulties can be resolved by the County and its partners with planning and strategic sourcing and allocation of a limited amount of funds.

Slightly more challenging is assuring that training for local students at community colleges and affiliated high schools keeps pace with new technologies. This is both a statewide and national problem, but one the County can influence locally with targeted investments in training and equipment and through facilitating closer college-dealer relationships. County stakeholders are currently exploring grants and opportunities to expand their efforts to enable their students to keep pace with these changes, which includes not just electrification but also connected and autonomous vehicles and increasing digital complexity in vehicles.

In implementing a future-proofed and adaptable hybrid and EV training program, Contra Costa County would become a model for other jurisdictions struggling with the transition to the future of electric transportation.

Appendix A. Example 16- or 24-Hour Hybrid and Electric Vehicle Technician Training Program Outline

A. Introductory Principles
   1. Hybrid and EV Vocabulary
   2. Hybrids and EVs in Production
   3. Types of Hybrid Systems – Architecture of Basic Hybrids and PHEVs
      a. Series
      b. Parallel
      c. Series/Parallel
      d. Mild and Assist Hybrids
      e. Plug-in Hybrids
   4. Electrical Theory and BEV Architecture
      a. Electrical Basics
      b. Architecture of BEVs

B. Safety Practices
   1. Personal Safety, Personal Protective Gear (PPG)
   2. Tools and Equipment
      a. Mega-ohm meter
      b. Scanners (e.g., Toyota Technical Information System/TIS)
      c. Using appropriate fluids
   3. Safety Procedures (Shop)
      a. Depowering High Voltage (HV) System
      b. Importance of ensuring auto in shutdown mode
      c. Repowering HV System
   4. Safety Procedures (Test Driving)

C. Motor and Generator Basics
   1. Basic Motor Operations
      a. Series
      b. Parallel
   2. Generators
   3. Motor Generators (MG)
   4. Controllers

D. Battery Basics
   1. High-Voltage (HV) System Batteries
      a. NiMH
      b. Li-Ion
      c. Other new battery technologies
      d. Importance of High Voltage battery state-of-charge
   2. Battery pack control component diagnosis, disassembly and repair
   3. Charge cord diagnostics, interface and implications

E. Hybrid and PHEV System Components and Operation

1. System Components
    a. Internal combustion engines (ICE) and MG
    b. Battery Pack
    c. Inverters and Converters
    d. Cables, Switches
2. Battery Charging
3. Regenerative Braking
4. Hybrid and PHEV transaxle drive operations
5. Advanced hybrid and PHEV onboard diagnostic data, diagnosis and repair
6. Driving

F. Toyota (Full Hybrid) Systems -- AS EXAMPLE*
1. Routine Maintenance (unique to this type of hybrid system)
    a. System-specific Fluids
    b. Inverter Cooling Systems
    c. Coolant Heat Storage systems
    d. Emission Control systems
    e. 12-volt charging system operations
    f. Other System-specific requirements (e.g., Brakes)
2. Diagnostics (focus on Hybrid-system related problems)
    a. Types and use of test equipment
    b. Diagnostic Software: Toyota TechStream
    c. Reading data codes, Interpreting diagnostic data
3. Methods of repair

* OTHER SPECIFIC MODELS ADDRESSED DEPENDING ON TECHNICIAN INTEREST

Appendix B. History of Relevant Activities of the Advanced Transportation and Logistics (ATL) Program

ATL was noted as a resource and potential partner above. Additional detail about its history is included here. In 2007, ATRE (which later became ATL) conducted public workshops related to converting gas-powered cars to electric power. As hybrids became more widespread, ATRE obtained and managed a three-year U.S. Department of Energy (DOE) Advanced Electric Drive Vehicle Education grant in 2009 for CCSF to train community college faculty and incumbent workers first in San Francisco, then around the Bay Area, and then in other parts of California. The training in San Francisco had three target audiences: students, fleet maintenance personnel, and independent technicians/shop owners. A unique curriculum was developed for each group. ATRE then used grant funds to support similar courses in the East Bay (same three target groups), and then in 2011-2012 in Southern California.

In subsequent years, both the organization developed cooperative relationships with San Diego Miramar College, Rio Hondo, Cerritos, and College of the Desert to share in California Energy Commission (CEC) funding of similar courses. As part of this effort, a two-day session was conducted in Martinez in June 2017 that included personnel from Walnut Creek and Contra Costa County fleets.

Most recently (November 2017 – February 2018), ATL provided two- and three-day hybrid and EV maintenance training to 125 technicians from 15 municipal fleets in Northern California and 65 technicians from 10 fleets in Southern California. Northern California municipal fleet hosts included those in the cities of San Francisco, San Jose, and Oakland; and fleets in Alameda, Sonoma, and Sacramento counties.

The cost of these programs has varied based on grant requirements, but on average costs have been about $4,000 - $5,000 for instructor and support charges (such as handouts and documentation) per day. Thus, a three-day class with as many as 20 students costs $12,000 - $15,000, or $600 - $750 per student for the class; with half as many students, only one instructor is needed so the cost is still $600 - $750 per student. These costs can increase if additional resources are required such as software provided to the hosting location and cars need to be leased from other sources.