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Alternative Fuels in Transportation: Workforce needs and opportunities in support of reducing reliance on petroleum fuels

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The UNIVERSITY of VERMONT
TRANSPORTATION RESEARCH CENTER

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The Northeast Alternative Fuel Workforce Network

The Northeast Transportation Workforce Center (NETWC) was established through a Federal Highway Administration grant to help create opportunities in transportation workforce development. In 2016 NETWC facilitated the creation of the Northeast Alternative Fuel Workforce Network, a working partnership with 13 Clean Cities Coalitions. The U.S. Department of Energy funds Clean Cities Coalitions to advance private and public sector strategies and efforts that reduce dependence on imported and petroleum-based fuels in U.S. fleets. The Clean Cities mission is consistent with the goals of the federal Energy Policy Act of 1992, the Energy Policy Act of 2005 and the Energy Independence and Security Act of 2007. In the Northeast, with the support of Clean Cities Coalitions, several regional agreements have served to mobilize extensive efforts to convert to non-petroleum fuels for transportation and build out the infrastructure that would support such a transition (see *Appendix A* for a list of these agreements).

The Clean Cities Coalitions working in partnership on the Northeast Alternative Fuel Workforce Network are:

Capital Clean Cities of Connecticut (CT)
Norwich Clean Communities (CT)
Greater New Haven Clean Cities Coalition (CT)
Greater Washington Region Clean Cities Coalition (DC)
Delaware Clean Cities Coalition (DE)
Maine Clean Communities (ME)
New Jersey Clean Cities Coalition (NJ)
Capital District Clean Communities (NY)
Clean Communities of Central New York (NY)
Genesee Region Clean Communities (NY)
Eastern Pennsylvania Alliance for Clean Transportation (PA)
Ocean State Clean Cities Coalition (RI)
Vermont Clean Cities Coalition (VT)

Through the work and efforts of Clean Cities Coalitions and their many stakeholders in the public and private sectors, two key questions have arose concerning the future workforce that will be needed to carry the various alternative fuel industries forward:

1. How will the transportation workforce be affected as fleets and individuals continue to adopt alternative fuels?
2. What evolution of training and education is needed for the workforce to continue to support the growth of alternative fuels in transportation?

This paper seeks to address these questions and create a resource for Clean Cities Coalitions and other industry actors as they continue to encounter barriers to alternate fuel adoption that result from an undertrained workforce.

Goals

- Explore workforce impacts related to the growth in alternative fuel usage and supporting
- Address changes to the skills and knowledge base of future workers to meet demands of an alternatively fueled transportation system.
- Clarify which workforce needs are greatest as described by Clean Cities Coordinators and stakeholders.
- Identify current programs and resources that are available to train the workforce.
- Suggest what is required to create an adequately trained and well-equipped workforce.
- Determine where future investments might be most valuable.

NOTE: While there is a focus on the Northeast region the findings and future directions are relevant for any region in the county.

Introduction

Alternative Fuels in the Transportation Sector

An overreliance on foreign oil and the negative impacts of using petroleum fuels on the world's climate have prompted energy policies that support the diversification of transport fuels and aggressive work to transition to non-petroleum options. There are strengths and drawbacks to each type of alternative fuel, but overall, in comparison to petroleum-based fuels, alternative fuels advance a stronger local economy and reduce our collective impact on the environment. Supported by public policy and advanced developments in technology, the U.S. is rapidly changing the landscape of how fuels are produced and used in vehicles. As we continue to adjust to and improve technologies related to alternative fuel use, we will have to adjust how our workforce responds to new fuel production, infrastructure build-out, vehicle and infrastructure maintenance, fueling, and vehicle operations.

The transportation sector accounts for two-thirds of U.S. petroleum consumption. Of that amount, on-road vehicles account for 85% of the usage (DOE, 2016). The U.S. spends nearly $1 billion a day on foreign oil and the average family spends a fifth of their household budget on transportation, making it the second highest expenditure after housing. With transportation contributing more than half of the carbon monoxide and nitrogen oxides, and almost a quarter of the hydrocarbons emitted into our air, the U.S. Department of Energy has determined two pathways for action: increase the efficiency of conventional fuel use, and replace conventional fuels with domestically-produced alternatives (See Appendix B for an overview of alternative fuel legislation) (Union of Concerned Citizens, 2014). Actions taken toward these two goals will improve the Nation's energy security, reduce greenhouse gas emissions, and strengthen U.S. global economic competitiveness (DOE, 2016).

Alternative fuels, for the purposes of this paper, shall be defined as deriving from domestic resources other than petroleum. Alternative fuels can be broken down into three main types (for more in-depth definitions of each alternative fuel see Appendix C):

1. Fossil fuels (e.g. compressed natural gas, liquefied natural gas, propane);
2. Biofuels (e.g. ethanol, biodiesel, renewable natural gas); and
3. Electric (e.g. hydrogen fuel cell, hybrid-electric).

Original equipment manufacturers (OEMs) have designed vehicles in all duty classes to run on alternative fuels. In addition, OEM vehicles that were designed to run off a single alternative fuel, there is a growing market for converting (or retrofitting) traditional internal combustion vehicles to dual-fuel applications, typically in propane and natural gas hybrid formats. Dual-fuel vehicles can operate off either fuel, reducing operator anxiety surrounding fuel availability or pricing.

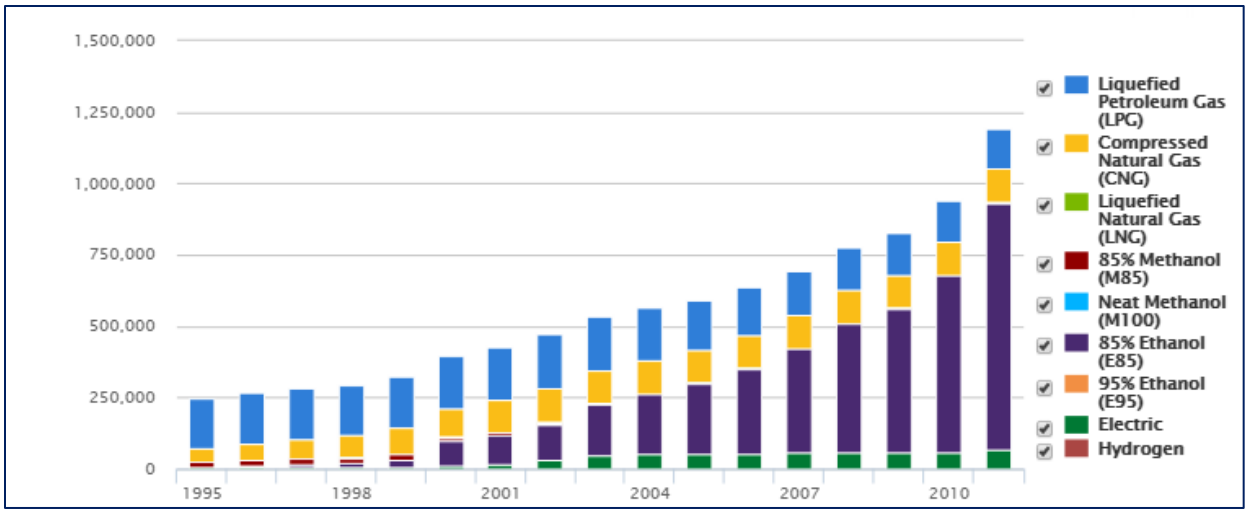

Figure 1: Use of AFV's Over Time.

Biodiesel, CNG, and propane are often used to substitute fuel in vehicles that run on diesel (most commonly medium- and heavy- duty vehicles). Ethanol and electricity are often used in replacement of traditionally gas-powered vehicles (light-duty). Hydrogen introduction has been limited to the light-duty vehicle market, and is still very early in its entrance as a transportation fuel. Figure 1 shows the growth of alternative fuel use over the last two decades.

Alternative Fuel Workforce

The alternative fuels workforce is defined as those who are responsible for:

- the production of alternative fuels;
- the distribution of the alternative fuels;
- the production of vehicles that run on alternative fuels;
- the development and deployment of alternative fueling infrastructure; and
- the accessory workforce (e.g. those who maintain and repair vehicles and those involved in emergency response).

As we see the expansion of alternative fuel use, the demands on the associated workforce will evolve. Developing each alternative fuel requires a workforce to cultivate or capture the fuel, as well as a workforce to process, distribute, and dispense it. This requires both a skilled workforce that can manufacture the equipment and build the infrastructure for the fuel, as well as run the operations. To better understand how these demands impact the workforce, career pathways can be broken down into three levels: the production of the fuel, the development of the infrastructure, and the accessory workforce

Figure 2 outlines the first category of production workforce operations required to take each fuel from the raw material to the fueling station. Note that each fuel has a unique chain of operations that result in a usable on-road fuel.

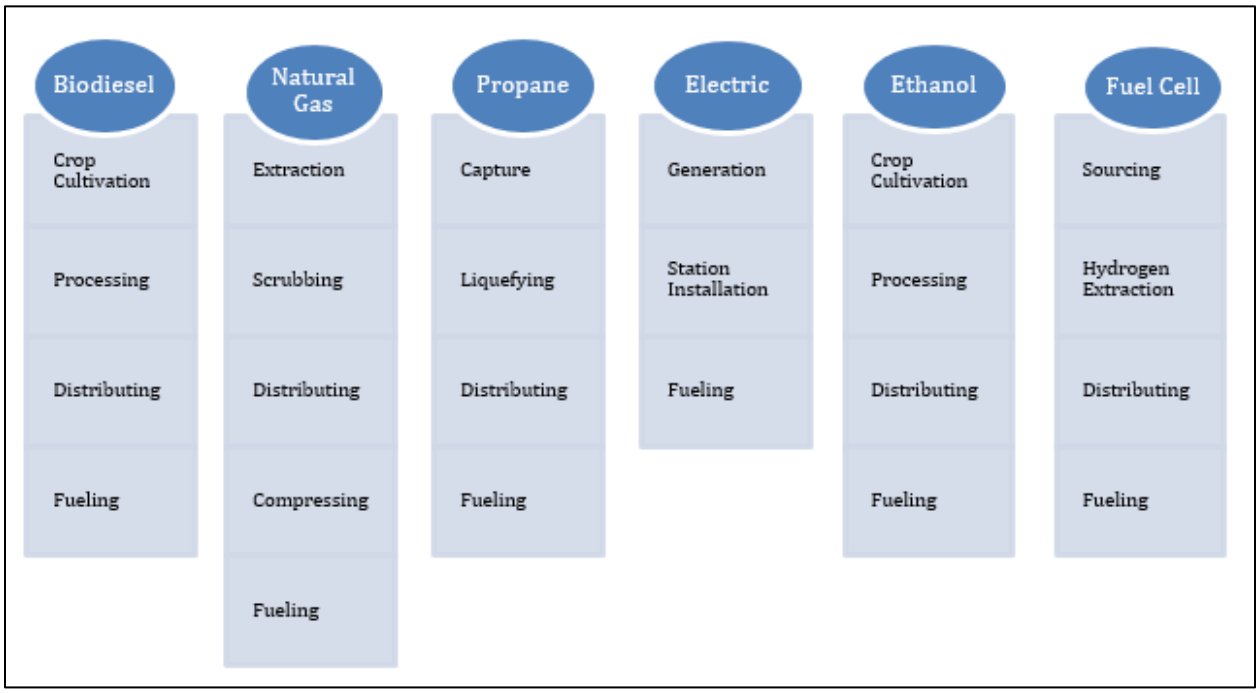

Figure 2: Alternative Fuel Production Workforce Operations**.**

Along with the workforce required to run the operations, a workforce is needed to manufacture the equipment and supplies needed to extract, distribute, store and fuel vehicles. Figure 3 shows the variability of equipment needed based on the fuel. For any of these steps in the sequence, there is a workforce creating and maintaining the equipment.

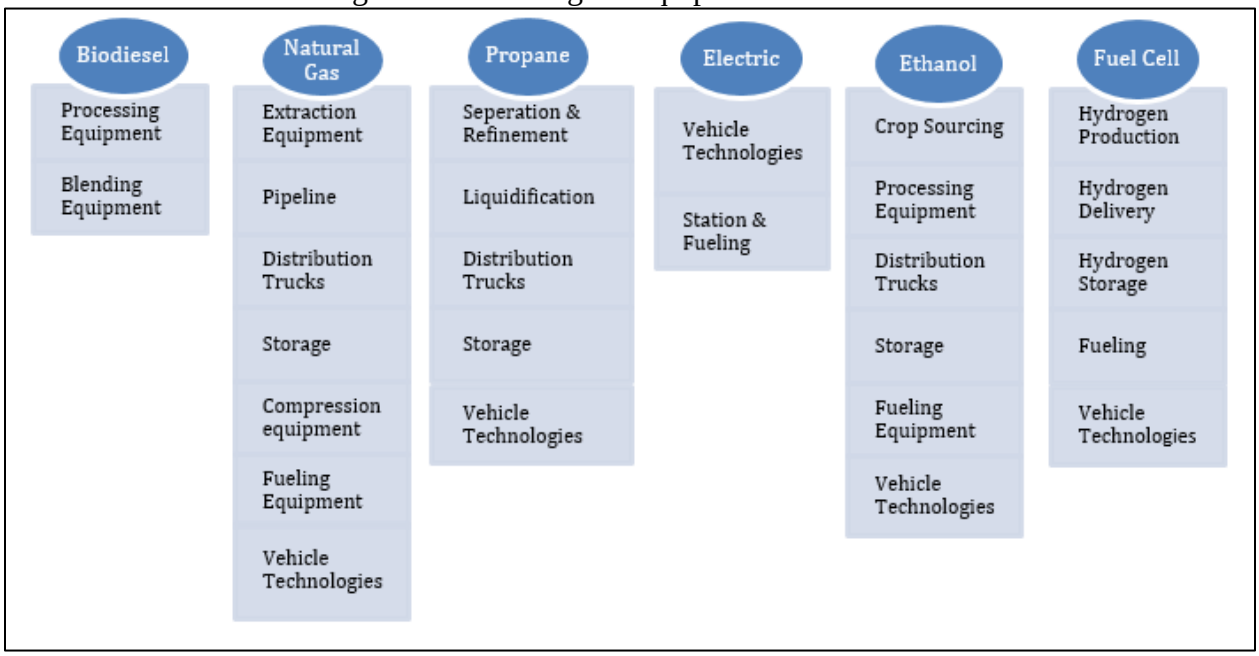

Figure 3: Equipment and Support Infrastructure Workforce

Lastly, the accessory workforce represents jobs that entail many duties not directly related to alternative fuels, however workers possessing at least a cursory understanding of these fuels will be necessary for the growth of both career paths in the fields represented by these fuels, as well as the alternative fuel industry itself. As discussed later, this category of workforce has received the most emphasis in regard to alternative fuel trainings. These professions include auto mechanics, emergency responders, governmental officials, sales representatives and waste disposal operators.

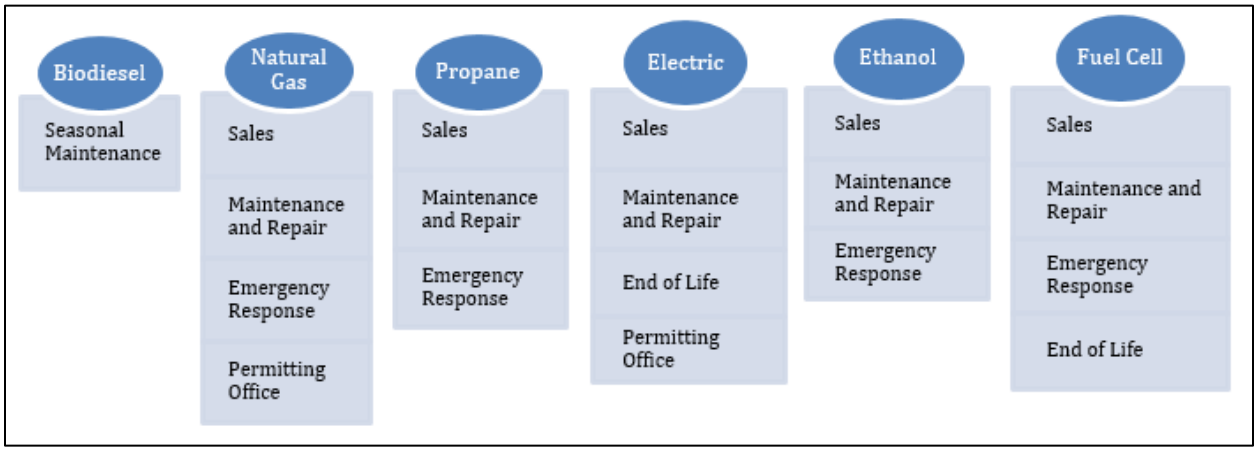

Figure 4: Accessory Workforce within Alternative Fuels.

Since many of these fuels operate outside of traditional internal combustion engine (ICE) processes, the knowledge of the existing workforce is typically not transferable to alternative fuels. One instructor likened the re-training of the existing automotive workforce on alternative fuels as allowing them to go through the *five stages of grief* until they ultimately accept the conclusion that an entirely new skillset is required to work on AFVs (SEED, 2011). The re-training of the existing workforce presents challenges that are not present when training the up-and-coming workforce. Alternative fuel education can and should start as early as grade school so that young people grow up with the awareness of alternative fuels and an understanding of how they work.

Methods

In order to gather information on the current state of the alternative fuel transportation workforce, NETWC utilized and targeted the Department of Energy's Clean Cities Coordinators and stakeholders. Data was collected through surveys, phone interviews and a webinar discussion with both coordinators and stakeholders.

In Fall 2015 NETWC released a survey for all Clean Cities Coalitions Coordinators to answer questions about the workforce needs in their regions. This survey was readapted from a survey conducted by the California Community College Chancellor's Office Center of Excellence in 2014 focused on the alternative fuel landscape in California (Coleman et al., 2014). The survey was distributed to Coordinators through email. Completed surveys from 43 (out of 80) coalitions

were received. One hundred percent of the Northeastern Coordinators responded. Coordinators were then asked to share a similar survey with their stakeholders in order to expand the breadth of the demographics represented and to gain an alternative perspective from individuals even more directly involved in the alternative fuel workforce. Forty-one diverse stakeholders from around the country responded to the survey.

NETWC presented a closed webinar of the survey results to the Coordinators in the Northeast region and opened up discussion to glean more specific information about the alternative fuel workforce needs in the region. Additionally, Coordinators from across the country with more direct workforce development experience were interviewed about their efforts, and asked to explain any challenges and successes they had experienced.

Lastly, a database of K-12, STEM and CTE, community college, technical college, university, and professional development programs that relate to alternative fuel workforce training was compiled (see Appendix F). This database was developed through research, informational interviews, and the use of other similar previously created databases. This list was then used to identify themes, opportunities, and challenges within the existing supply of AFV workforce education at a range of different levels.

Results

Factors Driving and Depressing Growth in the AFV Sector

The initial survey, designed for Clean Cities Coordinators, received responses from 43 Coalitions, or 54% of all Coalitions, and had broad representation nationally. The follow-up survey, designed for Coalition stakeholders, received 41 responses, the majority of which came from the Mid-West and Southwest regions. Figure 5 provides a visual representation of the location of all survey respondents. As shown in Figure 6, stakeholder respondents represented several different industries related to alternative fuels. Nearly 70% of the stakeholder respondents indicated that they manage an automotive fleet.

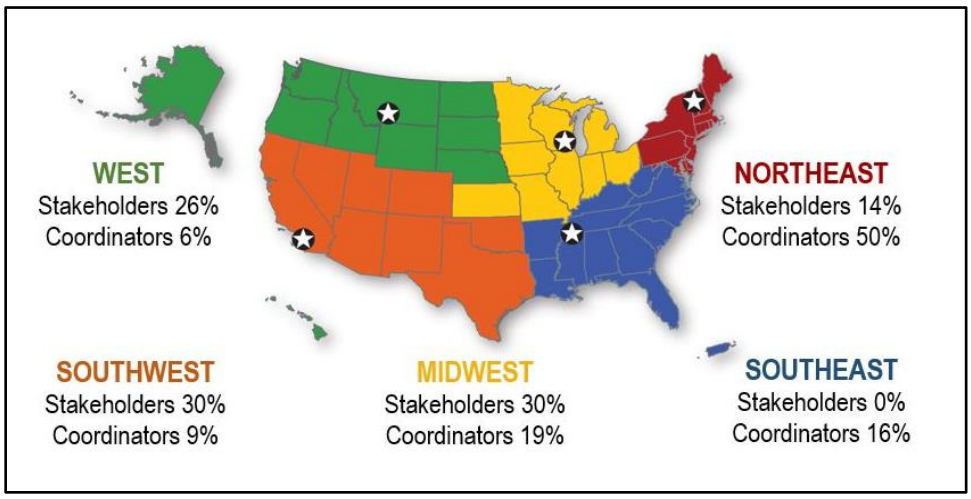

Figure 5: Clean Cities Survey Responses by Transportation Workforce Center Regions

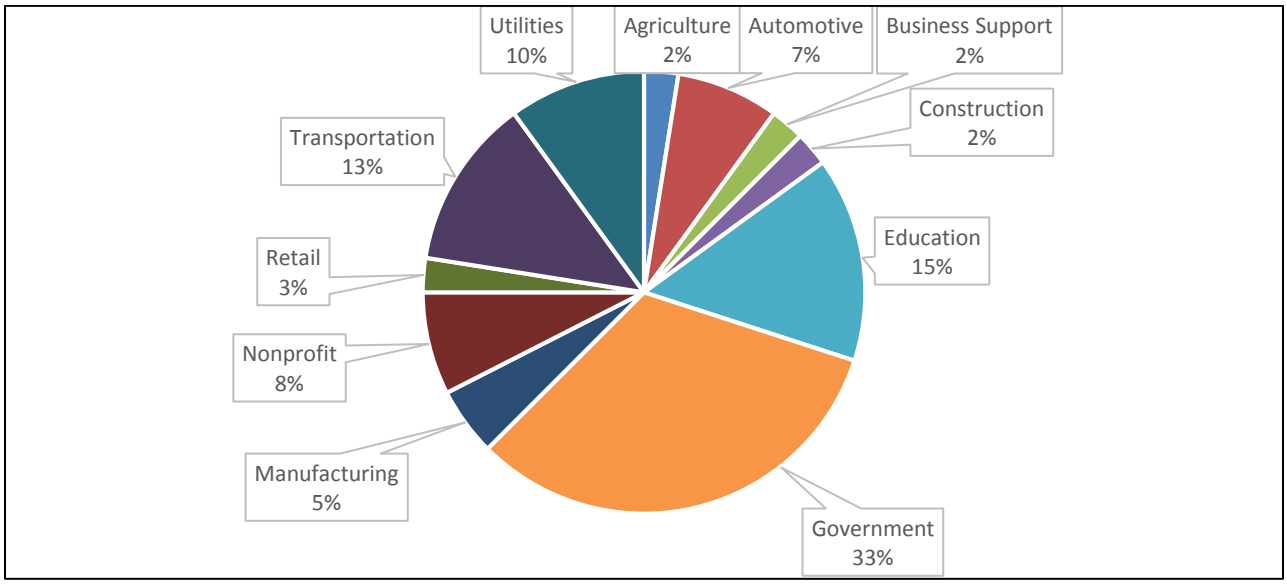

Figure 6: Industry of Clean Cities Stakeholder Respondents

Overall, electricity (78%) and CNG (82%) were reported to be the most commonly used and produced alternative fuels. Coordinators indicated propane was the next most used fuel, while fleets indicated ethanol. The latter could be indicative of the regional bias of the stakeholder respondents, many of whom are from corn-belt states. The alternative fuel vehicles that appeared to be the focus of the most widespread research were hydrogen and electric vehicles, while vehicle production was most common in CNG, electricity, and propane technologies.

The top two influences that were seen as driving growth in the alternative fuels and advanced transportation industries were market factors (i.e. fuel supply, stability, and price) and legislative policies. The breakdown by respondent type is shown in Table 1.

Table 1
Percentage of Clean Cities coordinators and stakeholders who identified categories as a factor driving growth in alternative fuels

Factor	Clean Cities Coordinators	Clean Cities Stakeholders
Market factors in fuel pricing	91%	80%
Legislative policies	78%	60%
Technology and innovation	73%	57%
Demand/ consumer preference	60%	37%
Environmental factors	58%	57%
Natural resource costs	33%	37%
Human capital and workforce	9%	7%
Offshoring and outsourcing	2%	3%

Note. Total number of responses was 75.

Additional comments elaborated that growth was due to AFV costs decreasing, more fueling infrastructure becoming available, governmental mandates for renewables, jurisdictional preference towards locally sourced fuels, personal guilt over petroleum use, peer-pressure, and stationary midstream processing. Some respondents predict much of the growth in alternative vehicles will be in the form of electric vehicles and hybrid-electric vehicles.

Many of the same factors that drive growth can also depress growth. For instance, the most commonly cited depressor of AFVs is the current low gas and diesel prices. On the other side, when these prices normalize it is expected that alternative fuels again will become the economically attractive option. Both Coordinator and stakeholder responses closely aligned on this topic as shown in Table 2.

Table 2
Percentage of Clean Cities coordinators and stakeholders who identified categories as a factor depressing growth

Factor	Clean Cities Coordinators	Clean Cities Stakeholders
Market factors in fuel pricing	77%	70%
Legislative policies	49%	41%
Technology and innovation	28%	19%
Demand/ consumer preference	65%	44%
Environmental factors	5%	0%
Natural resource costs	19%	29%
Human capital and workforce	35%	15%
Offshoring and outsourcing	5%	15%

Note. Total number of responses was 70.

Respondents mentioned a lack of promotion and affordability of the alternative fuel vehicles and a lack of fueling infrastructure and inconsistent permitting. Additionally, a fear of trying new things amongst consumers and fleet managers and the constantly changing array of technologies were identified as factors affecting the AFV sector growth. Uncertainties about incentives for AFVs, stations and fuels, conversion costs, tax breaks and subsidies for the oil industry are among other concerns addressed in the survey. Lastly, misinformation from petroleum and food companies and a general lack of credible information and education, coupled with a lack of customer experience with the vehicles was also mentioned as factors depressing growth.

Short-term and Long-term Outlook for Workforce Demands

In the short term (1-2 years), 38% of stakeholders expected that the workforce specific to their organizations would grow and 54% expect it to stay constant. Similarly, 56% of Coordinators expect that employers will add workers and 41% expect employers to maintain current staffing levels. Specifically, those working in government, public institutions, or utilities thought that the employment levels would stay the same.

Of those respondents that indicated workforce growth, comments emphasized the rapid growth of the EV market, optimism about the economy, federal and state incentives introduced to

support alternative fuels, an expectation to add instructors as technologies evolve, and a prediction that more conversions to clean fuels will happen as oil prices normalize.

Overall, only 13% thought that the workforce would be reduced. These respondents cited mass retirements of baby boomers, questioned the influence of the current administration on the business environment, highlighted the trend toward falling gas prices, and discussed the ability of technology to replace human workers.

In the longer term (3-5 years), 63% of stakeholders and coordinators thought that workforce would increase, 27% thought that workforce numbers would stay the same, and 11% thought that workforce would be reduced. Comments about growth included the expectation that future petroleum prices will rise and therefore encourage the switch to alternative fuels and the advancement of technologies resulting in a more mainstream adoption of these fuels. Comments from governmental stakeholders were predicting the workforce would stay the same because of strict workloads. As for reductions in workforce, more people referenced retirements and a prediction that more vehicle conversions will mean newer fleets with less work needed on the vehicles.

When asked about what posed as significant challenges to the alternative fuel workforce, respondents cited that keeping current workers up-to-date, recruiting entry-level and higher-level workers, and retaining current workers amidst competitor recruitment were of significant concern. Keeping current workers trained was weighted slightly higher by stakeholders and recruiting experienced trained employees was weighted slightly higher by Coordinators.

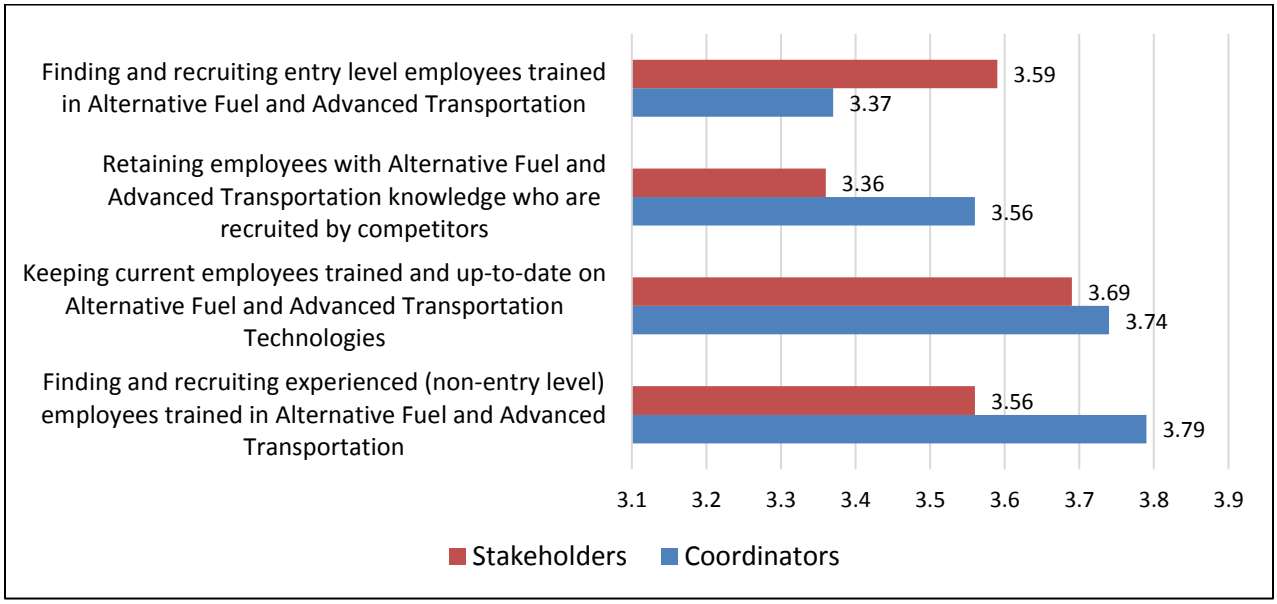

Figure 7: Alternative fuel workforce experience levels in highest demand as perceived by Clean Cities Coordinators and stakeholders ranked on a scale of 1 to 5 in terms of significance.

Other noteworthy comments included the assessment that mechanics and commercial driver's license (CDL) drivers, in general, were hard to find regardless of whether they had been trained in alternative fuels. There is also a general concern with investments made to training workers in

high turnover positions, with companies preferring to bring in outside contractors to help with alternative fuel maintenance and infrastructure rather than training staff who may then leave the company in the short-term to work for competitors. Lastly, market fluctuations and alternative fuel policies were noted as influencing personnel decisions because of their unpredictable and inconsistent nature.

Role of Regional Transportation Workforce Centers

When asked about how a dedicated transportation workforce center could help address the challenges facing the alternative fuel workforce, respondents ranked potential tasks the workforce centers could do in order of importance. This information is presented in Table 3.

Table 3

Potential tasks for regional workforce centers ranked in order of importance by stakeholders and coordinators

Clean Cities Coordinators	Clean Cities Stakeholders
1. Identifying regional job needs and priorities	1. Identifying regional job needs and priorities
2. Creating partnerships to address gaps identified in available training and education programs	2. Establishing regional stakeholder groups to work collaboratively to identify primary workforce issues
3. Developing an inventory of existing training and education programs	3. Creating partnerships to address gaps identified in available training and education programs
4. Creating one-stop-shop for regional transportation workforce information	4. Conducting regional listening sessions with stakeholders on workforce issues
5. Establishing regional stakeholder groups to work collaboratively to identify primary workforce issues	5. Creating one-stop-shop for regional transportation workforce information
6. Conducting regional listening sessions with stakeholders on workforce issues	6. Developing an inventory of existing training and education programs

Note. Results were weighted based on all the rankings from coordinators and stakeholders.

Stakeholders and Coordinators identified further tasks that could be carried out by the regional workforce centers that they believe would be beneficial to bolster the alternative fuel workforce:

- Coordinate regional trainings on safety/maintenance of AFVs (specifically CNG).
- Assist in placement of displaced employees during workforce reductions and create a better employee network at the working level.
- Facilitate more partnerships between employers and local automotive vocational schools.
- Capitalize off of existing mechanics training and mechanics training processes, including those at the vocational and high school level.

- Create resources to specifically address fleet buy-in. Outline tools that help fleets understand return on investments.
- Identify long-term needs and trends to prepare our workforce for the future.
- Offer online trainings to reach a national audience.
- Facilitate work across regions based on shared infrastructure, goals, climates, or impacts.
- Start education on alternative fuels at the grade school level.
- Establish long-term priorities and groups focused on alternative fuels that stay in place even when government leaders change.
- Compile a database of training and education programs related to alternative fuels.

Closed Webinar Discussion and Specific Coordinator Interviews

The diverse themes in alternative fuel workforce development that were discussed in the interviews and discussions are explored more thoroughly in this section.

Challenges surrounding CNG as a transportation fuel

CNG tends to be a challenging fuel because it has a large upfront cost for station installation. Large fleets can get around this because there is a successful business model for large companies that specialize in CNG fueling operations; these companies will install the station for free if the fuel consumption of the fleet is large enough. Investment return is made off of selling the fuel for a slightly higher price. This is an attractive model for large fleets, because of the reduced risk and the margin of savings from diesel, even with the slightly higher CNG pricing. The implications for the workforce is that these private companies take on the technical needs of the stations, and fleets only have to worry about training their drivers about CNG trucks. This model does not help drivers who have long hauls in areas where servicing is not reliable along a route. In turn, managers of long haul fleets are less likely to purchase CNG vehicles. One coordinator was aware of a fleet that travels cross-country regularly and would not switch over to CNG because of the lack of qualified service centers along the route.

Availability of technicians who can maintain AFVs

Another Coordinator reported that the supply of CNG/Propane technicians needed to keep up with the vehicle inspections and maintenance requirements is currently not available. While the fueling and infrastructure operations are often done by companies specializing in this process, the maintenance tends to fall on the shoulders of individual fleets. Many coordinators cited that there is a lack of trained and educated technicians to fill this increased need for AFV maintenance.

Uncertainty in pricing affecting more widespread propane adoption

The main challenge that Coordinators identified with propane is the uncertainty in pricing, as propane pricing fluctuates depending on application and contract terms. The advantage of this fuel is that fleets find the use and fueling on the vehicle relatively straightforward, but the uncertainties around pricing keep from higher levels of adoption.

Range anxiety affecting growth of electric vehicles

Electric vehicles can be challenging because of the limited range of the battery pack, the limited and high cost for heavy-duty applications, and the lack of general awareness of the vehicles.

Coordinators identified that the workforce tends to be relatively well prepared for electric vehicles, and may just need some retraining of certain skills. Colleges are beginning to offering more courses in electric vehicle technology, building off of courses for hybrid vehicles. Coordinators also noted that car sales personnel tend to be less knowledgeable about electric vehicles and do not have an incentive to sell them, as they require less maintenance than internal combustion vehicles (ICEs).

Clean Cities Coordinators can fill gaps in AFV training
The role of Clean Cities Coordinators in bolstering the alternative fuel workforce can vary region to region. Often a coordinator is well positioned to help facilitate connections to qualified trainers or to become trainers themselves. If a Coordinator can get the training for a certain fuel and offer it to area fleets, they can serve to supplement the class-based trainings. Clean Cities Coordinators are a gateway into their regions alternative fuel economy and are continuously facilitating partnerships and determining needs and interests of their stakeholders.

Finding funding for alternative fuel trainings can be challenging.
Often trainings will need to be presented in a variety of contexts to suit workforce needs. Some companies may need training on-site, while others may be willing to send their employees off-site to attend a class. If the company prefers not to train their own staff, they will find outside contractors to come in to do the necessary maintenance and inspection work. Coordinators identified that collaborating with utilities has been an effective way to offer trainings. Often propane, gas, and electric utilities have certified technicians who can offer train-the-trainer programs. They may also be able to provide a location, training books and other funding in some circumstances.

Alternative fuel education in grade school
A common theme among Coordinator responses were that awareness building about alternative fuels should start early. While technical high schools and colleges have been the focus of most workforce training, exposing youth in early grade school would allow understanding and standardization of alternative fuels knowledge. Lesson plans exist that complement math and science classes in K-12. Another opportunity is to utilize local science centers to share information on alternative fuels. The middle school age is already accessing these Centers, and Coordinators or Center staff could incorporate a lesson on alternative fuels or have a section of the center be devoted to a display of the alternative fuels.

Workforce Board engagement on AFV workforce issues and opportunities
There is an opportunity to expand the role that workforce boards are playing in AFV workforce development by have Clean Cities Coordinators and stakeholders collaborate with local workforce boards. These boards exist in all fifty states and are tasked with directing federal, state, and local funding to workforce development programs. Due to the fact that alternative fuels are still relatively uncommon, many workforce boards do not have the level of awareness to see how alternative fuels fits in with their planning. The workforce boards can be hard to engage with due to their tendency to focus priorities on a given sector; this focus is often guided by legislative edicts. Rarely do they have the resources to expand efforts beyond the immediate priorities. Regional and statewide studies that focus on the connection between AFV workforce

developments and economic development should be pursued in order to spark the attention of those setting the focus of workforce boards.

One Coordinator found success collaborating with the area workforce boards by simply applying to be on the approved vendor list for available trainings. Once on the list, they were able to work together to identify connections with certain occupations and it opened up funding opportunities, including "Quick Response Training" funds that are available to meet upcoming demands of a region. For example, in Florida, when the Kennedy Space Center had several layoffs, Central Florida Clean Cities was able to work with the regional Workforce Board to retrain the workers in clean energy and clean transportation applications.

Technologies change quickly requiring adaptability of schools and employers
In order to move alternative fuels forward, education and industry must advance together. One Coordinator collaborated with community colleges to determine course offerings. He stated that the community college system is robust in his area, but it can take several years to get classes certified. When technology is advancing quickly, classes or programs can become outdated before they are even offered. Schools and colleges need to build partnerships with employers to ensure the relevancy of a skill or course topic. Another Coordinator mentioned that colleges are receptive to Clean Cities Coordinators bringing in the trainings if they have room in their schedule. Coordinator-led trainings are better attended when offered through schools. Continuing education training is as important as on-the-job training, and opportunities for both need to be developed as alternative fuels progress.

Opportunities and Challenges in AFV Education and Training

The categories below explain the current state of affairs for each level of education in terms of the availability of AFV education and training.

K-12

Alternative fuel education at the elementary, middle, and high school level is mainly focused on promoting awareness about the career options in the sustainable transportation sector. Building this awareness at the K-12 level is important to the development of the alternative fuel workforce because it introduces transportation as a viable career path in the eyes of young students. Currently, the majority of alternative fuel curricula offered at the K-12 level in the northeast is in the form of optional or additional project-based curricula that students can elect to enroll or apply to enroll. These courses often provide engaging experiences for students, but there is a limited supply of this type of curricula in the northeast.

Due to the fact that the majority of K-12 alternative fuel curricula is offered in this optional format, it is likely that students who already have expressed some interest in the field of sustainable transportation or transportation in general will be the majority of those participating in the current opportunities. Integrating an introductory level conversation about alternative fuels and sustainable transportation into course work that all students are enrolled in is the next step in promoting wider awareness among the next generation of the workforce.

> *Case Study: Clarkson University, K-12 'Sustainable Transportation Fuels' Partnership Program*

This program is part of a project-based learning program that places Clarkson University and St. Lawrence University fellows in local K-12 schools to teach STEM subjects. The program goal is to promote sustainable transportation fuel as an important subject in the eyes of young students. The fellows first teach the students about the problems with current petroleum transportation fuels, then introduce them to alternative fuels, and finish with a culminating hands-on project.

Case Study: *Transportation Careers Lesson Plans*
FHWA, in partnership with the US Department of Education and Advance CTE, the association of State CTE Director, supported a program to develop lesson plans in transportation across the K-12 continuum, now housed with the NETWC on its educator webpage. This web site provides a series of grades 6-12 curriculum units that will introduce students to careers, skills, and concepts one would need to succeed in the transportation industry. All lesson plans were developed by teachers for teachers with input from their industry partners and are free for everyone to use. This content will enable teachers to expand, enhance and reinforce academic content and as a result improve transportation education as well as academic achievement.

STEM and CTE Programs

Within K-12 education, there are special opportunities to teach about alternative fuels with a CTE (career and technical education) and/or STEM focus. These programs can range from offering a basic introduction to the different fuels to having a more technical focus on a particular fuel. For example, some programs provide a high level overview of alternative fuels in a classroom setting, while others offer a more hands-on approach, such as building an electric car.

Case Study: SWITCH Vehicles
The SWITCH Lab, based out of California, performs trainings for teachers on how to incorporate electric vehicle technology into their classrooms and curricula. The program curriculum is adaptable by grade level and offers both middle school and community college lesson plans. In addition, the company produces SWITCH vehicle *kits* available for purchase. At $32,000 per kit, the cost may seem prohibitive for some schools, however the SWITCH Lab works with each school to find opportunities to secure funding. The kit is advertised to provide solutions for training tomorrow's electric vehicle technicians.

The company formed in response to a problem that schools were having procuring vehicles on which students could learn. An assessment of training programs found that one of the most significant challenges they face is finding the resources for new training equipment or getting the equipment donated (California Community Colleges Chancellor's Office, 2013). SWITCH currently operates in six high schools, five community colleges, and one middle school in California. Through a grant, the SWITCH Lab Curriculum is being added to another five California community colleges by the end of 2016. By 2017, SWITCH is anticipated to be in 25-30 California community colleges. In addition, partnerships are being added in Oregon, Illinois, Wisconsin, and Canada, where the curriculum will reach both high school and college levels.

Community College

Currently the main focus of community college alternative fuel curricula is on AFV maintenance. Most often an alternative fuels course has been integrated into an automotive technology degree. The alternative fuel courses are occasionally offered as a core requirement, but most often they appear to be elective courses. These courses are commonly generalized introductions to all alternative fuels. Some community colleges also offer alternative fuels as an option for specialization under an automotive technology degree. Specializations are either general or fuel specific, and the majority of fuel specific specializations are offered in EV and Hybrid technologies. Community college course offerings in alternative fuels are currently focused on the accessory workforce, specifically aimed at preparing students pursuing careers in automotive technology with base level of knowledge about AFV's.

Compared to other regions of the U.S., the northeast does not have a large number of community college automotive programs that include an alternative fuel course or specialization. There are many models already in practice across the U.S., the challenge now is successfully generating interest in replicating them in Community Colleges in the northeast, and making alternative fuels a topic of the core curriculum of automotive technician degrees. In the future, the field will benefit from community college efforts to create courses and programs that cater to not only the accessory alternative fuels workforce, but also the manufacturing workforce and the equipment and support infrastructure workforce.

> *Case study: Alfred College, 'Shop Management and Enhanced Systems' course*
> This course is part of an Automotive Service Technician degree; it lasts five weeks, consists of both labs and lectures, and gives a general overview of all types of alternative fuels. The course was integrated into the Automotive Service Technician degree program in the early 2000's, to accommodate the emerging AFV market. Since then, the student interest in alternative fuels has grown, and the program has obtained several AFV's of their own. Due to the rural location of the program, the students previously did not have access to AFV's because very few consumers in the area have adopted alternative fuel technologies. The program was able to obtain their AFV's through grant programs and donations, and now provide their students with hands on experience with a range of AFV technologies.

Technical Colleges

Technical colleges are similar to community colleges in that they house much of the alternative fuel training that is aimed at educating the accessory workforce. Technical colleges also commonly offer training certificates that upskill the current accessory workforce. Technical colleges will also occasionally offer fuel specific trainings or programs that give students proficiency not just on the mechanical technology of the AFV's, but also on the fuel production technologies. It is essential to build out these course so that the production of alternative fuels continues to grow.

The challenge to growing these technical college courses focused on the production and use of alternative fuels is the fluctuation in demand for specific fuel types. Technical colleges will not continue to offer a course or training that is not resulting in job placement for their students, so until a large direct alternative fuel job market is identified to get students hired post training, the

course offerings will continue to be inconsistent. Collaborating with industry is key to continue forward momentum with this type of training.

> *Case study: Vermont Tech, 'Introduction to Biodiesel' course*
> This two-day course designed to inform professionals involved with or interested in becoming involved with biodiesel. The course covers biodiesel standards, engine systems, biodiesel blends, and biodiesel production. It also includes a demonstration of fuel-making equipment. This course attracts a variety of participants, ranging from fleet drivers to farming students because it tackles relevant information across the biodiesel supply chain. The program offers more in depth curriculum including a Biofuels Operations Online Training Program.

University

The majority of alternative fuel university programs currently in place across the U.S. are focused on engineering. Mechanical and chemical engineering programs often have courses that are alternative fuel or sustainable transportation focused. These courses train students who make up the division of the alternative fuel workforce that will engineer equipment, infrastructure, and fuel technologies. Within these departments, the most common alternative fuels that are being researched and taught about are biofuels, hydrogen fuel cell, and electric. Many universities also choose to offer alternative fuel courses under departments that are sustainability themed. These courses tend to be less technical and more informative.

Both types of courses are needed, the technical engineering courses help to grow the equipment and support infrastructure workforce, while the informational courses help to educate the general population of students about alternative fuels. As of now, the technical courses at the university level are more abundant than the informative courses, though it will be necessary to further develop both as alternative fuels continue to penetrate the transportation market. Due to the fact that the university is detached from the productive workforce and the accessory workforce, not many programs aimed at these two divisions of the workforce are seen at universities. If a course or certification aimed at educating students from these two workforce divisions is offered through a university, it is usually through their extension programing.

> *Case Study: Kettering University, 'Alternative Energy Specialty' in the Mechanical Engineering Department*
> This specialization is offered to undergraduate mechanical engineering students. The program consists of five courses, three of which directly relate to alternative fuel vehicle technology. These three courses cover fuel cell engineering, methods for processing fuels for fuel cells, hybrid electric vehicle propulsion, biodiesel extraction from algae, and ethanol production. This specialty program has a goal of preparing STEM students for careers in the alternative energy-engineering sector.

Professional Development

Professional development trainings that cover alternative fuel topics are currently aimed at upskilling the accessory members of the workforce that interact with new AFV technologies on the road. Many of these programs are short certifications or trainings that help mechanics, first

responders, electricians, and other members of the accessory workforce meet the needs of the alternative fuel industry as it begins to overlap with other trades. Often professional development programing is offered through the trades themselves, or organizations that are involved with the industry. It is also common to see this type of programing offered through online platforms, to make it even more accessible to their target audience.

The availability of these trainings is growing, and the commonality of online platforms makes the programs easy to share across different U.S. regions. The challenge comes in conveying the importance and benefit that trades will gain by upskilling their workforce with alternative fuel professional development curriculum. There are many trainings available; the next step is promoting awareness of the existence and importance of the trainings, so that the accessory workforce increases their preparedness to interact with the changing infrastructure and technology.

> *Case study: Electric Vehicle Infrastructure Training Program (EVITP)*
> This program provides training and certification for electricians, teaching them to install electric vehicle supply equipment. The training program is an industry collaborative offered to licensed electricians through a network of electrical industry training centers and community colleges. The curriculum covers the installation of current electric vehicle infrastructure technologies and includes a section on emerging technologies. EVITP encourages companies from the industry to become involved with the program, and provide the training to their employees.

Conclusion

Although low gas prices are depressing growth now, state and federal policies and initiatives addressing climate change continue to press for development in alternative fuels and advanced vehicle technologies. As petroleum fuel prices rise again, it is expected that the foundation laid now will encourage rapid adoption of these fuels later. It is the objective of NETWC to address the challenges related to developing a workforce to design, establish, operate and maintain the infrastructure to support an alternative fuel fleet while these fuels are a small percentage of the market share. Building awareness, creating active partnerships with industry and educational entities, and advancing policy initiatives to help grow opportunities to use these clean fuels are efforts that need to be simultaneously and immediately advanced.

To date, the bulk of external training has been placed on the role of the accessory workforce and their ability to adopt alternative fuel technical expertise and knowledge into their existing capacity. This workforce includes emergency first responders, sales teams, and automotive technicians. The workforce training more specific to each fuel (i.e. operations and equipment) has been primarily provided by the fuel industry itself. These industries have relied on internal trainings of employees, however as they grow and more companies begin working with alternative fuels, having a trained pool of students entering the workforce will become essential.

This paper attempts to start the conversation around the makeup of the current alternative workforce and existing educational landscape, and endeavors to identify where workforce growth is likely and training is needed to support the future proliferation of alternative fuels across a number of types of employers and industries. In this process, we identified actionable steps for that can be advanced in partnership with our stakeholder partners:

- Utilize existing trainings, expertise, and financial resources offered by industry and utility partners to expand the AFV knowledge base in your region;
- Engage workforce development groups by demonstrating how AFVs directly relate to job growth and economic prosperity;
- Identify and formalize partnerships with community colleges/CTE programs to host AFV programs or incorporate AFV education into existing programming;
- Align school and industry developments to complement one another;
- Learn how industry partners train their workforce and what kind of worker is sought after for recruitment and use that knowledge to advance complementary educational programs;
- Advocate for AFV education to be introduced in early grade school and provide opportunities to explore career pathways for older students;
- Increase opportunities for online training to improve access to quality AFV education regardless of locale;
- Promote policies that increase predictability in alternative fuels pricing and availability, and invest resources to help improve access to technologies;
- Support the creation of clean fuel corridors to allow for alternative fueling/charging stations along major routes between cities and regions to increase adoption and awareness.

In addition to considering the action steps above your continuing input is essential for this work to continue forward. Please communicate your ideas and information to the NETWC, especially concerning training and education programs and initiatives by responding to this survey.

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Appendix A

Northeast Regional Agreements that Mobilize Efforts to Reduce Petroleum Use in Transportation

- Compact of States and Regions – Members (Vermont, Connecticut and New York are among the signatories) are investing in a low-carbon future which drives economic development and helps build resilience to climate change. Specific action plans in these states are:
    - VT Zero Emissions Vehicles (ZEV) Action Plan
    - NY Climate Action Plan
    - Connecticut Climate Change Policies
- Clean Fuels Standard
- Northeast Electric Vehicle Network - The Network was launched in late 2011 as a project of the Transportation and Climate Initiative. States in the Network will continue to build a robust network of charging stations throughout the region, with already more than 1,700 charging stations publicly available.
- State by state laws, regulations and incentives: http://www.afdc.energy.gov/laws/
- Regional Greenhouse Gas Initiative – RGGI is the first market-based regulatory program in the United States to reduce greenhouse gas emissions. RGGI is a cooperative effort among the states of Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New York, Rhode Island, and Vermont to cap and reduce CO2 emissions from the power sector.

Appendix B

Alternative Fuel Legislation

Alternative fuel and fuel economy legislation dates back to the Clean Air Act of 1970, which created initiatives to reduce mobile sources of air pollutants. Following the Clean Air Act of 1970, in 1975 the Energy Policy and Conservation Act established Corporate Average Fuel Economy (CAFE) standards that required the distribution of fuel economy information to consumers. To incentivize alternative fuel vehicle development, the Alternative Motor Fuels Act of 1988 created vehicle manufacturer incentives in the form of CAFE credits (see Figure A1). Under the Energy Policy Act of 2005, congress created the Renewable Fuel Standard (RFS) program that requires a certain volume of renewable fuel to replace or reduce the petroleum-based transportation fuel, heating oil or jet fuel. Most recently, the Consolidated Appropriations Act of 2016 extended and reinstated a number of the alternative fuel tax credits from the Tax Increase Prevention Act of 2014 (Alternative Fuels Data Center, 2016).

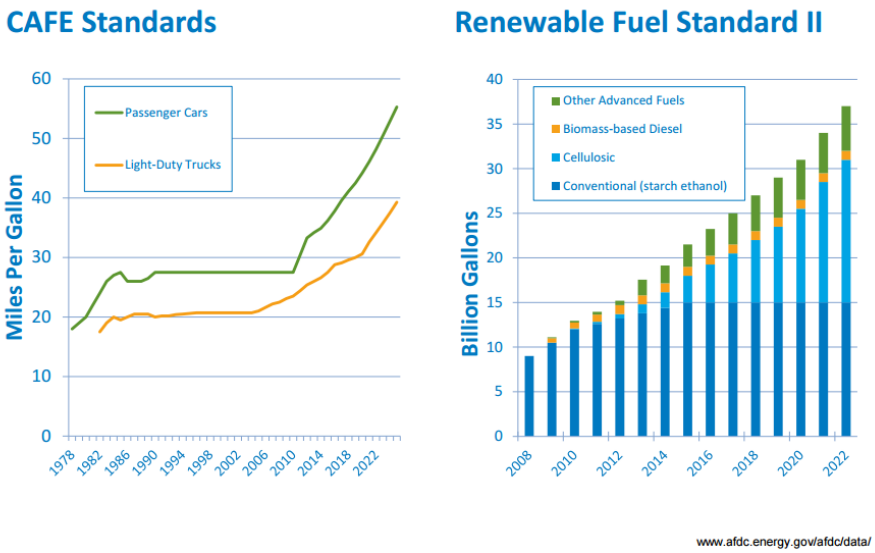

Figure A 1: National Policies Shaping the Alternative Fuel Market (NREL, 2013).

States have also implemented their own incentives, laws, and regulations to support the alternative fuel and advanced vehicle markets with a localized focus (see Figure 3 and 4) For example, many states offer Alternative Fuel Vehicle (AFV) and battery electric vehicle (BEV) project funding and car purchase rebates, as well as favorable tax rates on alternative fuel production and use (Alternative Fuels Data Center, 2016).

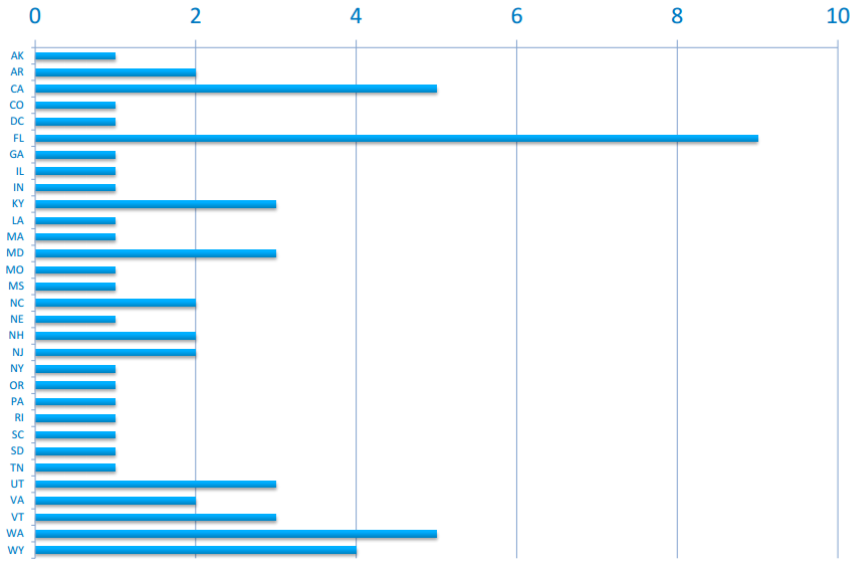

Figure A 2: 2012 Laws, Regulations and Incentives by State (NREL, 2013).

Appendix C

Types of Alternative Fuels

Fossil fuels

- Natural gas is a fossil fuel that is extracted from shale formations and coalbeds, and most commonly found in heavy-duty vehicle applications. Natural gas vehicles emit 27% less carbon dioxide than diesel (US Energy Information Administration, 2016). In addition, because CNG fuel systems are completely sealed, the vehicles produce no evaporative emissions (Alternative Fuels Data Center, 2016). Natural gas comes in two formats: compressed natural gas (CNG) and liquefied natural gas (LNG). Because of economic constraints, nearly all natural gas fueling stations are connected to the pipeline.
- Propane, also called liquefied petroleum gas (LPG), is a domestically abundant fossil fuel with a wide variety of vehicle applications. Compared with vehicles fueled by conventional diesel and gasoline, propane vehicles can produce lower amounts of some harmful air pollutants and greenhouse gases, depending on vehicle type, drive cycle, and engine calibration (Alternative Fuels Data Center, 2016).

Biofuels

- Ethanol is produced domestically from corn and other crops and produces, on average, 40% less greenhouse gas emissions than conventional fuels. This reduction increases to 105% when cellulosic feedstocks are used. Currently ethanol is used in the same class of vehicles as gasoline.
- Biodiesel is derived from vegetable oils and animal fats and is a cleaner-burning replacement for diesel fuel. Newer applications can be derived from algae and other non-traditional vegetable oils (Abishek, M, Patel, J, & Rajan, A., 2014).
- Renewable Natural Gas (RNG) is essentially biogas—the gaseous product of the decomposition of organic matter—processed to purity standards. Capturing biogas from landfills and livestock operations reduces emissions by preventing methane, a pollutant 25 times as potent as carbon dioxide, from being released into the atmosphere (Alternative Fuels Data Center, 2016).

Electric or Zero Emission Vehicles (ZEVs)

- Electric vehicles (EVs), prevalent in the light-duty market, receive their power from an electrically charged battery. The life cycle emissions of an EV or PHEV depend on the sources of electricity used to charge it, which vary by region (Alternative Fuels Data Center, 2016).
- Hydrogen can be produced from domestic resources and is still in its infancy as a transportation fuel. One of the challenges of using hydrogen as a fuel is the ablity to efficiently extract hydrogen from compounds such as water (H2O), hydrocarbons (such as methane, CH4), and other organic matter. A fuel cell electric vehicle running on hydrogen emits water vapor and warm air as exhaust and is considered a zero-emission vehicle (Alternative Fuels Data Center, 2016).

Appendix D

Additional AFV Workforce Development Resources

There are a variety of existing programs targeted toward developing the alternative fuel workforce both on the national and local levels. The following is a list of national programs that provide resources about AFV workforce development:

- Northeast Transportation Workforce Center: http://netwc.net/
- National Alternative Fuels Training Consortium (NAFTC): http://www.naftc.wvu.edu/
- National Automotive Technician Education Foundation (NATEF): http://www.natef.org/
- NFPA: http://www.nfpa.org/
- National Biodiesel Board (NBB)'s Biodiesel Automotive Technician Training Program: http://www.biodieselautomotive.org/
- Renewable Fuels Association Education and Training: http://www.ethanolrfa.org/pages/students-and-teachers-education-and-training
- Ethanol Emergency Response Coalition: http://www.ethanolresponse.com/
- List of Electric Vehicle Workforce Education & First Responder Training: http://www.afdc.energy.gov/vehicles/docs/ev_training_and_education.xls
- Certified Electric Vehicle Technician (CEVT) Training Program: http://www.cleantechinstitute.org/Training/CEVT.html
- NGVAmerica (now includes Clean Vehicle Education Foundation): http://www.ngvamerica.org/media-center/technical-and-safety-documents/
- Natural Gas Vehicle Institute (NGVi): http://www.ngvi.com/
- National Institute for Automotive Service Excellence: https://www.ase.com/Home.aspx
- Alternative Fuel Data Center: http://www.afdc.energy.gov/
- Alternative Fuel Training Network: http://www.afvtraining.net
- Sustainability Education & Economic Development (SEED) Center – Transportation & Fuels: http://www.theseedcenter.org/Resources/Resource-Center?catid=14
- Center for Advanced Automotive Technology (CAAT): http://autocaat.org/Home/

Appendix E

Alternative Fuel Green Job Classifications

Job classifications were collected from several different published studies about green jobs and existing databases of green jobs. Two studies from the Bureau of Labor Statistic titled 'Careers in Biofuels' and 'Careers in Electric Vehicles' were used. One database from Career One Stop titled 'Green Careers: Transportation' was used. One study published by Jobs for the Future, titled 'Greenprint: A Plan to Prepare Community College Students for Careers in the Clean Economy' was used. One database from Virtual Career Network, titled 'All Green Careers' was used. All the information gathered from the above mentioned sources was matched with Standard Occupational Classifications (SOC) from the Bureau of Labor Statistics 2010 list of SOC occupations.

Engineering Occupations	Drafters, Engineering Technicians and Mapping Technicians	Scientific Occupations	Agricultural Workers	Construction and Extraction Occupations	Business, Sales and Financial Operations Occupations

• Chemical engineering
• Electrical engineering
• Electronics engineering
• Industrial engineering
• Materials engineering
• Mechanical engineering
• Agriculture engineering
• Civil engineering
• Environmental engineering
• Operating engineering
• Locomotive engineering
• Aerospace engineering
• Automotive engineering
• Fuel cell engineering
• Logistics engineering
• Transportation engineering
	• Electrical engineering technician
	• Automotive engineering technicians
	• Mechanical engineering technicians
	• Environmental Engineering Technician
	• Mechanical drafters
	• Fuel cell technicians
		• Physical
		  • Chemist
		  • Material scientist
		  • Chemical technicians
		• Life
		  • Biochemists and biophysicists
		  • Microbiologists
		  • Biofuels Processing Technician
		  • Biomass Plant Technician
		• Social
		  • Urban and regional planners
			• Farmworkers and laborers, crop nursery and greenhouse
			• Agriculture equipment operators
			• First-Line Supervisor of Agricultural Crop and Horticultural Worker
			• Agricultural Technician
			• Precision Agriculture Technician
				• Electricians
				• Construction equipment operators
				• Carpenter
				• Construction and Building Inspector
				• Pipe Fitter and Steamfitter
				• Rail-track laying and maintenance equipment operators
					• Buyers and purchasing agents
					• Logisticians
					• Energy Auditor

					Sales and Related Occupations • Retail salesperson • Wholesale and manufacturing sales representatives
Management Occupations	**Installation, Maintenance, and Repair Occupations**	**Transportation and Material Moving Occupations**	**Production Occupations**	**Office and Administrative Support Occupations**	**Computer Occupations**
• Industrial production managers • Farmers, ranchers and other agriculture managers • Transportation managers • Logistics manager • Supply chain managers • Marketing managers • Biofuels Production Manager • Construction Manager	• Electrical power-line installers and repairers • Industrial machinery mechanics • Automotive specialty technicians • Electrical Power-Line Installer and Repairer • Electrical and Electronics Repairer, Powerhouse, Substation, and Relay • Welder, Cutter, and Welder Fitter • Automotive Technician	• Bus drivers, transit, and intercity • Bus Drivers, School, or Special Client • Freight forwarders • Industrial truck and tractor operators • Railroad conductor and yardmasters • Truck drivers, heavy and tractor-trailer • Transportation vehicle, equipment and systems inspectors • Transportation planners	• Electrical and electronic equipment assemblers • Electromechanical equipment assemblers • Engine and other machine assemblers • Machinists • Chemical equipment operators and tenders	• Customer service representatives • Dispatchers • Shipping, receiving and traffic clerks • Sustainability Specialist • Farm and Home Management Advisor	• Software developers • Computer-controlled machine tool operators • Computer Numerically Controlled Machine Tool Programmer
					Arts and Design Workers • Commercial and industrial designers

Figure E 1: Alternative Fuel Job Titles by Occupation type

AFC Careers matched with Bureau of Labor Statistics SOC's:

17-2000 - Engineers
17-2041 – Chemical Engineers
17-2071 - Electrical Engineers
17-2072 - Electronics Engineers
17-2112 - Industrial Engineers
17-2131 - Materials Engineers
17-2141 - Mechanical Engineers
17-2021 - Agriculture Engineers
17-2051 - Civil Engineers
17-2081 - Environmental Engineers
17-2199 - Operating Engineers
17-2199 - Locomotive Engineers
17-2011 - Aerospace Engineers
17-2199 - Automotive Engineers
17-2199 - Fuel cell Engineers
17-2199 - Logistics Engineers
17-2199 - Transportation Engineers

17-3000 – Drafters, Engineering Technicians and Mapping Technicians:
17-3027 – Electrical engineering technician
17-3029 – Automotive engineering technicians
17-3027 – Mechanical engineering technicians
17-3025 – Environmental Engineering Technician
17-3013 - Mechanical drafters
17-3-29 - Fuel cell technicians

12-2000 - Physical Scientists:
19-2031 - Chemist
19-2032 - Material scientist
19-4031 - Chemical technicians

19-1000 - Life Scientists:
19-1021 - Biochemists and biophysicists
19-1022 - Microbiologists
19-4099 - Biofuels Processing Technician
19-4099 - Biomass Plant Technician

19-3000 - Social Scientists:
19-3051 - Urban and regional planners

51-000 - Production Occupations:
51-2022 - Electrical and electronic equipment assemblers
51-2023 - Electromechanical equipment assemblers
51-2013 - Engine and other machine assemblers
51-4041 - Machinists
51-9011 - Chemical equipment operators and tenders

11-0000 - Management Occupations:
11-3051 - Industrial production managers
11-9013 – Farmers, ranchers and other agriculture managers
11-3071 - Transportation managers
11-9199 - Logistics manager
11-9199- Supply chain managers
11-2021 - Marketing managers
11-9199 - Biofuels Production Manager
11-9021 - Construction Manager

49-0000 - Installation, Maintenance, and Repair Occupations:
49-9051 - Electrical power-line installers and repairers
49-9041 - Industrial machinery mechanics
49-3020 - Automotive specialty technicians
49-9051 - Electrical Power-Line Installer and Repairer
49-2095 - Electrical and Electronics Repairer, Powerhouse, Substation, and Relay
49-9099 - Welder, Cutter, and Welder Fitter
49-3029 - Automotive Technician

47-0000 - Construction and Extraction Occupations:
47-2111 - Electricians
47-2070 - Construction equipment operators
47-2031 - Carpenter
47-4011 - Construction and Building Inspector
47-2152 - Pipe Fitter and Steamfitter
47-4061 - Rail-track laying and maintenance equipment operators

13-0000 - Business and Financial Operations Occupations:
13-1021 - Buyers and purchasing agents, farm products
13-1-81 - Logisticians
13-2011 - Energy Auditor

41-0000 - Sales and Related Occupations:
41-2031 - Retail salesperson
41-4010 - Wholesale and manufacturing sales representatives

15-1100 - Computer Occupations:
15-1130 - Software developers
51-4012 - Computer Numerically Controlled Machine Tool Programmer
51-4011 - Computer-controlled machine tool operators

27-1000 - Arts and Design Workers:
27-1021 - Commercial and industrial designers

43-0000 - Office and Administrative Support Occupations:
43-4051 - Customer service representatives
43-5030 - Dispatchers
43-5070 - Shipping, receiving and traffic clerks
43-9199 - Sustainability Specialist
43-9199 - Farm and Home Management Advisor

45-2000 - Agricultural Workers:
45-2092 - Farmworkers and laborers, crop nursery and greenhouse
45-2091 - Agriculture equipment operators
45-1011 - First-Line Supervisor of Agricultural Crop and Horticultural Worker
45-2099 - Agricultural Technician
45-2099 - Precision Agriculture Technician

Transportation and Material Moving Occupations:
53-3021 - Bus drivers, transit, and intercity
53 -3022 – Bus drivers, school, or special client
53-7062 - Freight forwarders
53-7051 - Industrial truck and tractor operators
53-4031 - Railroad conductor and yardmasters
53-3032 - Truck drivers, heavy and tractor-trailer
53-6051 - Transportation vehicle, equipment and systems inspectors
11-3071 - Transportation planners

Appendix F

Catalogue of Alternative Fuel Training & Education Opportunities

Table F 1

K-12 Alternative fuel curricula and programing

School	Program	Fuel	State
Analy High School	Automotive technology (Switch Labs)	Electric	CA
Petaluma High School	Automotive technology (Switch Labs)	Electric	CA
Archbishop Hanna High School	Automotive technology (Switch Labs)	Electric	CA
Santa Rosa High School	Automotive technology (Switch Labs)	Electric	CA
Lompoc High School	Automotive technology (Switch Labs)	Electric	CA
Healdsburg Junior High School	Automotive technology (Switch Labs)	Electric	CA
Garden Grove Unified School	Automotive technology (Switch Labs)	Electric	CA
Washington DC Electric Vehicle Grand Prix	Electric car building competition	Electric	DC
Junior Solar Sprint	Students design, build and race solar powered cars	Solar	DC
Minuteman High School	Automotive technology including alt fuel vehicles	All	MA
Md Bio Foundation	Mobil biodiesel lab for middle and high school students	Biofuel	MD
University of Maine	STEM program for young girls	Biofuel	ME
Rockwood Summit Biodiesel Project	STEM biofuel program, students grow feedstock and produce biofuel	Biofuel	MO
Clarkson University	Students explore solutions to make current transportation system sustainable	Biofuels, Electricity, Hydrogen	NY
The Workshop School	Hybrid X program, students design and build an EV	Hybrid	PA

Table F 2

Community college alternative fuel programs, degrees, and courses

School	Program	Fuel	State
San Bernardino Community College	Automotive technology with classes on electric car repair	Electric	CA
Marin Community College	Automotive technology with classes on AFVs	Electric, other	CA
Saddleback Community College	Alternative fuel vehicle specialist certificate	Electric	CA
Kern Community College	Automotive technician training for alternative fuels	CNG, propane, electric	CA

American River College	Alternative fuels and green technology certificate	Biodiesel, electric, hybrid	CA
Los Angeles Trade-Tec Comminty College	Hybrid and electric vehicle technology certificate	Hybrid, electric	CA
Gateway Community College	AFV technology certificate	All	CT
Kansas City Kansas Community College	Automotive hybrid and electric vehicle technical certificate	Hybrid, electric	KS
Kalamazoo Community College	Automotive technology for hybrid and advanced technology vehicles	Hybrid	MI
Henry Ford Community College	Course on alternative automotive propulsion systems	Hybrids, electric, hydrogen-ICE	MI
Lansing Community College	Introduction to Alternative Fuels	All	MI
Washtenaw Community College	Automotive service program with courses on AFVs	All	MI
Macomb Community College	Alternative fuels certificate program	Hybrid, electric	MI
Wayne County Community College	Alternative fuels technology certificate program	Electric, hydrogen, hybrid, diesel	MI
Miles Community College	Energy technology degree	All	MT
Martin Community College	Automotive technology with course introducing AFVs	All	NC
Central Carolina Community College	Automotive systems technology with courses on sustainable transportation	CNG, biofuel, hydrogen, hybrid, electric	NC
Piedmont Biofuels Educational Venture	Downloadable educational resources for high school and community college teachers	Biofuel	NC
Central New Mexico Community College	Transportation technology with alternative fuels course	All	NM
Sante Fe Community College	Biofuels program	Biofuel, electric	NM
Bronx Community College	Automotive technology and Mechanics with courses in alternate fuel systems	Ethanol, CNG, LNG, LPG, hydrogen, electric	NY
CUNY Bronx Community College	Automotive technology with specialization in alternative fuels	All	NY
Hudson Valley Community College	Automotive fuels certificate program	All	NY
Oklahoma City Community College	CNG equipment technician certification	CNG	OK
Linn-Benton Community College	Alternative fuel training courses	CNG, propane, electric	OR
Cedar Valley College	Automotive technology with course on alternative fuels	All	TX

Table F 3
University and college alternative fuel programs, degrees, and courses

School	Program	Fuel	State
Clean Cities Workforce Development Program	Internships for students interested in alternative fuels transportation outreach	All	All
Arizona State University	Sustainable energy technologies course, half of which focuses on fuels	Biofuels, and other	AZ
Rio Hondo College	Automotive alternate fuels program	Electric, hybrid, fuel cell, CNG, LNG	CA
College of the Desert, Palm Desert	Automotive alternative fuels certificate	CNG, LPG, Biodiesel, hybrid, electric	CA
California State University	Transportation concentration with course on electric, hybrid, and AFVs	Electric, hybrid, and others	CA
University of California	Graduate program with courses on fuel cells	Fuel cell	CA
Long Beach City College	Advanced transportation technology with AFV courses	Fuel cell, hybrid, electric and others	CA
Chabot College	Automotive technology degree with AFV courses	Hybrid	CA
College of the Desert	Automotive Alternate Fuels Certificate	CNG, LPG, hybrid, fuel cell, biodiesel	CA
Saddleback College	Alternative fuel vehicle technician certificate	Hybrid, LNG, CNG, LPG, fuel cell	CA
Humboldt State University	Hydrogen and fuel cell safety and awareness training	Hydrogen, fuel cell	CA
City College of San Francisco	Automotive alternative fuel technology certificate	All	CA
UC San Diego Extension	Biofuels processes certificate (transitioning to focus on biofuels and medicine)	Biofuels	CA
University of the District of Columbia	Automotive technology, includes training with vehicles that run on alternative fuels	Ethanol and electric	DC
Morton College, Cicero	Automotive technology with courses on CNG conversion and alternative fuels	CNG, Hybrid, Electric, and other	IL
Morton College	Alternative fuels certificate	CNG, electric, hybrid, others	IL
Tufts University	Chemical, biological, and mechanical engineering with courses on alternative fuels	All	MA
University of Massachusetts: Lowell	Energy conversion certificate	Charging stations	MA
University of Massachusetts: Lowell	Renewable energy engineering with course in green combustion and biofuels	Biofuels	MA
University of Maryland	Sustainable energy masters degree	Fuel cell, electric	MD

Washington Academy	Coastal ecology program with special topic area in biodiesel	Biodiesel	ME
Ferris State University	Alternate fuel and vehicle systems	Hybrid, electric and other	MI
Jackson College	Hybrid technology course	Hybrid	MI
Northwestern Michigan College	Hybrid technology specialist program	Hybrid	MI
Wayne State University	Electric-drive vehicle engineering	Electric	MI
Wayne State University	Electric transportation technology degree	Electric, fuel cell, hybrid	MI
Kettering University	Mechanical engineering with automotive engineering design specialty	Fuel Cell, hybrid, biodiesel, other	MI
Northwestern Michigan College	Automotive hybrid technology specialist certificate	Hybrid	MI
Appalachian State University	Department of technology and environmental design offers courses in sustainable transportation and biofuels	Biofuel, and other	NC
CUNY City College	Sustainable transportation course	Electric, fuel cell, CNG	NY
Morrisville State College	Alternative fuels course as part of renewable energy bachelor of technology	Hybrid electric, electric, biofuels, fuel cell	NY
Canton State University of New York College of Technology	Course on alternative renewable fuels derived from biological sources	Biofuels, and other	NY
University of Northwestern Ohio	Alternate fuels technology degree	M85, E85, electric, propane, CNG, biofuel, other	OH
Pierce College	Automotive advanced level hybrid diagnostic and alternative automotive diagnostic technician	Hybrid, and other	PA
Southwest Texas Junior College	Diesel technology program	Diesel	TX
The University of Texas at El Paso	Engines and alternative fuels research lab	All	TX
Texas A&M University at Kingsville	Natural gas engineering	Natural gas	TX
West Virginia University	First responder safety for electric vehicles (part of NAFTC)	Electric	VA
West Virginia University	National alternative fuels training consortium (NAFTC), implement classes and workshops	All	WV

Table F 4
Technical college alternative fuel programs, degrees, and courses

School	Program	Fuel	State
Pulaski Technical College	Alternative fuels certificate of proficiency	LPG, CNG	AR
Griffin Campus Technical College, Thomaston	Automotive technology degree with class on AFVs	All	GA
Ivy Tech	Alternative fuels, electric and hybrid vehicle certificates	Hybrid, electric, CNG, LPG	IN
Benjamin Franklin Institute of Technology	Alternative fuels part of automotive technology degree	Hybrid, others	MA
Minuteman Technical Institute	Advanced automotive technology postgraduate training program	Electric	MA
Michigan Tech	Several programs under mechanical engineering	Hybrid, fuel cell, electric	MI
New England Institute of Technology	Automotive technology degree with electronics courses	All	RI
Orangeburg Calhoun Technical College	Automotive technology with courses in alternate technology vehicles and alternate fuels	All	SC
Vermont Tech Green Trainings	First responder safety for electric vehicles course	Hybrid, electric	VT
Vermont Tech Green Trainings	Introduction to biofuels course	Biodiesel	VT
Vermont Tech Green Trainings	Introduction to natural gas course	Natural gas	VT

Table F 5
Professional development alternative fuel training

School	Program	Fuel	State
Electric Vehicle Infrastructure Training Program	Training and certification for electricians installing electric vehicle supply equipment	Electric	35 States
National Biodiesel Board	Course on biodiesel and biodiesel blends for automotive instructors and service technicians	Biofuel	All (Online)
Clean Cities University	Courses and webinars online	All	All (online)
Clean Cities TV	Informative videos about alternative fuel developments	All	All (Online)
Clean Cities Learning Proram (NAFTC)	Online courses about a range of alternative fuels topics and technologies	All	All (Online)
National Fire Protection Association	AFV safety training program	All	All (Online)
Ethanol Emergency Response Coalition	Training guide to ethanol emergency response	Ethanol	All (Online)

Energy Management Institute	Biofuels course for interested professionals and students	Biofuels	All (Online)
Educational Technologies Group	Biofuels technician training with section on transportation fuels	Biofuel	All (online)
Natural Gas Vehicle Institute	Courses on safety practices, CNG fuel system inspector training, fueling station operation, etc.	CNG, LNG	All (online)
San Joaquin Valley	Alternative fuel mechanic training	CNG, LNG, hybrid, fuel cell	CA
Clean Tech Institute	Certified Electric Vehicle Technician (CEVT) Training Program	Electric	CA, NY
Renewable Fuels Association	Periodically host trainings and webinars	Ethanol	DC (also online)
Massachusetts Institute of Technology	Professional development short program that focus on sustainable transportation	All	MA
Massachusetts Institute of Technology	Professional development short program that focus on future of vehicular transportation	All	MA
2012/2013 Alternative Fuel Market Project Awards	Projects with aspects of AFV workforce training	All	Many
NAFTC	AFV training programs across the US at participating community colleges and other partners	All	Many
Propane Autogas (NAFTC)	Automotive technicians training on propane autogas technology	Propane	Many
NC Clean Energy Technology Center	AFV first responder training	CNG, propane, biofuels, electric	NC
New Community Corporation	Automotive technician course on hybrid maintenance	Hybrid	NJ
Allience Autogas Training and Safty	In-house autogas education for technicians, drivers, or others	Propane	OH