



California Energy Commission Clean Transportation Program

FINAL PROJECT REPORT

Northwest California Alternative Fuels Readiness Project

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Prepared by: Redwood Coast Energy Authority and Schatz Energy **Research Center at Humboldt State University**





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PREFACE

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

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

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

To be eligible for funding under the Clean Transportation Program, a project must be consistent with the CEC's annual Clean Transportation Program Investment Plan Update. The CEC issued PON-13-603 to develop alternative fuel readiness plans that will provide strategies for the deployment of alternative fuel infrastructure and encourage the adoption of alternative fuel vehicles. In response to PON-13-603, the recipient submitted an application which was proposed for funding in the CEC's notice of proposed awards on December 16, 2013 and the agreement was executed as ARV-13-012 on March 21, 2014.

ABSTRACT

The Northwest California Alternative Fuels Readiness Project developed a comprehensive alternative fuels readiness plan for the Northwest California region through detailed analysis and coordinated outreach and engagement with regional stakeholders. Efforts were focused on identifying challenges and opportunities related to the adoption of alternative fuels, including hydrogen, biofuels, natural gas, and electricity. Key tasks included the development of a strategic plan for alternative fuel markets, the development of materials and strategies for mobilizing regional actors to take action toward alternative fuel markets, development of an ongoing network of regional decision-makers for promoting alternative fuels, and the delivery of targeted outreach to key entities throughout the region.

It was found that the Low Carbon Fuel Standard 2020 goal of reducing carbon intensity is technically feasible, though very ambitious. In addition, it is heavily dependent upon effective outreach, education, policy, and coordinated regional efforts to establish a low-carbon fuels network. A unique methodology was developed to analyze the role that each alternative fuel could play in the region towards achieving the carbon intensity reduction goal. This analysis indicates that electric vehicles should play a central role in the region's alternative fuels strategy, but that other technologies are needed as well. In addition, solutions were identified to address the alternative fuels market barriers unique to the Northwest California region.

Keywords: California, alternative fuels, alternative fuel vehicles, advanced transportation technologies, Northwest California, regional transportation planning, AB 118, AB 109

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EXECUTIVE SUMMARY

Introduction

Funded by the California Energy Commission, the Northwest California Alternative Fuels Readiness Project was launched to develop strategies for the deployment of alternative fuel infrastructure and identify activities to encourage the adoption of alternative fuel vehicles in rural, northwest California. The anticipated outcome of this project is an established and engaged network of public and private stakeholders throughout the Northwest California region that can foster the successful deployment of alternative fuel vehicles, wise and effective deployment of alternative fuels infrastructure, and the development of a robust market for alternative fuels.

The Northwest California Region was defined for the purposes of this project as comprising five contiguous counties in California's north coast and upstate area: Del Norte, Siskiyou, Humboldt, Trinity, and Mendocino. As a rural area, Northwest California faces unique alternative fuel adoption issues as compared to more metropolitan areas of the country. As such, infrastructure and markets necessary to achieve federal and state goals must be developed in a manner that recognizes local and regional nuances, as well as the context-dependent strengths and weaknesses of different fuel pathways.

Project Approach

The first step in the planning process involved creating a snapshot of the current status of alternative fuels in the Northwest region. This snapshot includes an overview of state and federal legislation, a review of state and regional planning documents, an assessment of currently available alternative fuels and vehicles, and identification of key stakeholders.

The second step involved considering various scenarios of alternative fuel portfolio deployment in the region and evaluating them against a baseline "business-as-usual" projection for transportation systems. This analysis allowed us to determine the alternative fuel portfolio pathways that would enable attainment of the state's Low Carbon Fuel Standard goals for 2020 at the least cost to society.

The final step involved conducting a strategic assessment of the barriers to, and market opportunities for, regional adoption of alternative fuels. Extensive stakeholder outreach was conducted in order to include multiple perspectives and identify key challenges. Multiple stakeholder working groups provided feedback on the actions recommended in the strategic plan.

The timeframe for the strategic plan is short, stretching less than five years from today through 2020. The targets in the plan are based on commercially available vehicles and fuels that can penetrate across all classes of on-road vehicles. Off-road vehicles and mass transit were not addressed in this project, although many of the fuels and technologies apply to these sectors as well. Other modes of transportation such as bicycling are not included, as they do not directly relate to alternative fuel use.

Project Results

Current Status of Alternative Fuels

For the year 2020, the Northwest California Region is projected to have ~67,000 gasoline and ~1,000 diesel vehicles on the road. Annually, the region is expected to consume 128 million gallons of gasoline and 42 million gallons of diesel fuel. Alternative fuels are just starting to emerge in the five-county region with nearly 70 electric vehicle charging stations, four biodiesel fueling stations, and one hydrogen fueling station.

On the local level, all of the counties in the Northwest region have individually undertaken some level of planning effort to prepare for the adoption of electric vehicles, and many of the regional partners have Climate Action Plans and General Plans that include "Energy Elements" calling for specific actions to increase the availability and use of alternative fuels. The fuelsrelated planning goals in the region range from general criteria pollutant emissions reduction goals, to "greening" the public agency fleets and encouraging pedestrian and bicycle travel.

On the community level, the Northwest region is home to many committed key players integral to the successful implementation of the strategic plan. Key stakeholders are broadly categorized into five main groups: government agencies, fuel distributors, vehicle fleets, supporting services and the general public. Supporting services include firefighters, law enforcement, ambulance services, roadside assistance services, County Offices of Emergency Services, fueling Station owners, fleet operators, dealerships, auto-repair shops, and community colleges.

Commercially available alternative transportation fuels include biodiesel, electricity, ethanol, hydrogen, natural gas, renewable natural gas, propane, and renewable diesel. Renewable diesel is a "second generation" diesel fuel made entirely from plant and waste oils like biodiesel, but without the gelling or engine performance issues of the first-generation biofuels. Alternative fueling infrastructure currently offered in the project region includes 28 Level 2 electric vehicle charging stations, four biodiesel fuel pumps, and one hydrogen fueling station.

There are already a significant number of commercially available alternative fuel vehicles on the market. These include:

- Hybrid Electric Vehicles
- Multi-fuel Vehicles
- Flexible Fuel Vehicles
- Battery Electric Vehicles
- Compressed Natural Gas and Propane Vehicles
- Fuel Cell Hybrid Vehicles

The number of available models of alternative fuel vehicles on the market is expected to continue to rise. Currently, the strongest growth in the alternative fuel vehicle market is flex-fuel (E-85), diesel (biofuels), and electric/hybrid electric vehicles.

Least-Cost Low Carbon Fuel Standard Pathway Analysis

In an effort to identify the most efficient approach to reducing greenhouse gas emissions from the transportation sector, this project focused on developing a least-cost path to foster a local

vehicle and fuel market that meets the Low Carbon Fuel Standard goal of reducing the carbon intensity of the total fuel mix by 10 percent by 2020. This least-cost path is one of many possible pathways the region can pursue. It should be used as a benchmark to provide regional stakeholders a sense of the potential impact that can be achieved in the transportation sector.

A modeling effort was undertaken to identify the lowest "incremental societal cost" mix of fuels and vehicles needed to meet the regional target of a 10 percent reduction in transportation carbon emissions, or 240 kilotons of carbon dioxide equivalent carbon dioxide equivalent emissions avoided annually. The model used vehicle cost, fuel infrastructure cost, and fuel cost (including distribution) to determine the total incremental lifecycle cost to society per unit of energy for each fuel and technology compared to the baseline cost for the fossil fuel that it would displace.

Results of the modeling analysis indicate that the average marginal cost of implementing the least-cost fuel mix portfolio is \$180 per metric ton of offset carbon dioxide equivalent emissions (in 2014 dollars). The total incremental cost of achieving a 10 percent reduction in the fuel mix is estimated to be \$43 million, representing a 4 percent increase over the total cost of the business-as-usual scenario. It should be noted that most of these costs are borne by private entities – mostly fuel distributors and vehicle owners – not by public agencies. This study evaluated them on the basis of their aggregate cost to society, rather than to any one group of actors or decision-makers. It should be emphasized that this approach of least-cost analysis is intended to help inform future decision making but is not meant to be interpreted as projections or specific targets for vehicle and technology adoption.

The model also estimated the quantity of alternative fuel vehicles that would be needed to meet the least-cost fuel mix portfolio by 2020. Model results show that light duty electric vehicles overwhelmingly comprise the largest quantity of low-carbon fuel vehicles (19,400) in the least-cost scenario. Although the upfront capital cost is currently relatively high for EVs, the low cost of fuel and fueling infrastructure results in their dominance in the least-cost solution.

The remaining portion of the least-cost fuel mix portfolio includes 4,000 new light and heavyduty 15 percent ethanol (E-15) fueled vehicles, and 1,650 heavy-duty renewable diesel vehicles. Plug-in hybrid electric vehicles, 85 percent ethanol (E-85) fuel vehicles, and light duty renewable diesel and hydrogen fuel cell vehicles make up a smaller portion of the 2020 regional vehicle stock (1,250 vehicles combined). Under this least-cost scenario, the conversion to alternative fuels is projected to replace 17 percent of all light duty vehicles and 2.7 percent of heavy-duty vehicles.

The total gallons of fossil fuel that must be offset annually in order to meet the Low Carbon Fuel Standard target by 2020 are estimated to be 17 million gallons/year of gasoline and 4 million gallons/year of diesel fuel. There are numerous combinations of low-carbon fuels and vehicles that can meet the Low Carbon Fuel Standard target, some having a higher incremental cost than others. Under the least-cost scenario, the mix of low-carbon fuels that would be required is 131,100 megawatt-hours of electricity, 806,100 gallons of renewable diesel, 425,100 gallons of E-15 fuel, and 249,700 gallons of E-85 fuel. Hydrogen is expected to have only a small share of the transportation market in the near term, and therefore only 73,100 kilograms of hydrogen is anticipated to be required.

The quantity of fueling stations needed in the region was estimated based on the projected quantity of low-carbon fuels demanded in 2020. The results of the analysis show that the vast majority of fueling infrastructure needed under the least-cost scenario are home electric vehicle charging stations (20,000) and public electric vehicle charging stations (339). It is estimated that the region would also need thirteen renewable diesel fuel stations, six ethanol fuel stations, and five hydrogen fuel stations.

From a full portfolio perspective, total estimated incremental cost above business-as-usual is \$43 million (in 2015 dollars) between 2015 and 2020. On a per-vehicle basis, this cost is roughly \$1,600 per alternative fuel vehicle, across all fuel and vehicle types modeled. The model results indicate that Ethanol (to a blend of E-15), biodiesel, and renewable diesel have the lowest amortized incremental costs, as these fuels can utilize existing fueling station infrastructure and do not require a new vehicle purchase. Electric vehicles have a high amortized incremental vehicle cost; however, electric vehicles also have a low total incremental cost as the fuel is markedly less costly. Plug-in hybrid-electric vehicles, flex-fuel vehicles, and hydrogen vehicles have the highest overall amortized incremental cost; over three times the incremental cost of their drop-in fuel and electric vehicle counterparts.

The average marginal greenhouse gas abatement cost (\$ / ton of carbon dioxide equivalents) of the different alternative fuel pathways was also modeled. Battery electric vehicles used cooking oil biodiesel, and tallow-based renewable diesel all had the lowest abatement cost of approximately \$70 - \$180 / ton of carbon dioxide equivalents. Hydrogen, flex-fuel vehicles running off of sorghum ethanol and soy based renewable diesels had the highest abatement cost of over \$600 / ton of carbon dioxide equivalents.

Assessment of Barriers and Stakeholder Engagement

While alternative fuel vehicles and fuel supply are the primary components needed to establish a low-carbon transportation market, it is also important to engage the numerous industries that support the auto industry. These include government planning and inspection agencies, first responders, dealerships, maintenance and repair businesses, towing and salvage businesses, fleet operators, and fuel distributors. Information about low-carbon fuels permitting challenges and alternative fuel training needs was gathered through stakeholder interviews and working group meetings were held to identify practical strategies to reduce permitting barriers. Key findings from this research are:

- Collaboration between city/county planning and permitting staff, public safety agencies, and fuel providers can lead to increased awareness of existing codes and regulations for low-carbon fuels.
- Modernized land use codes and low-carbon fuels-specific permitting requirements can provide fleet operators and fuels distributors with opportunities to help accelerate the development of a low-carbon fuels market.
- Sufficient materials are available to train technicians and permitting officials as well as educate key decision makers and the general public regarding alternative fuels and alternative fuel vehicles.

- Many free safety-training materials on alternative fuels are available, including an official 16-hour course through the National Fire Academy that is recognized by the state and local fire departments.
- Firefighters are the most likely to encounter alternative fuels and vehicles in an emergency situation, and some have had alternative fuel training in the past, in particular with electric vehicles, but considerably more training is needed. All other first responder and safety stakeholder groups have received little-to-no training on alternative fuels.
- There is a lack of alternative fuel training for mechanics, safety and first responders, and towing/salvage service companies.

The following key barriers associated with the uptake of low-carbon fuel vehicles were identified:

- Higher capital cost
- Limited driving range
- Limited product offerings
- Long charging times
- Customer risk aversion, inertia, and lack of awareness

The following key barriers associated with alternative fuel infrastructure development were identified:

- Lack of public fueling infrastructure
- Lack of fuel production and distribution infrastructure
- Lack of standardization in public charging infrastructure

Key challenges with the fuels themselves were also identified, including:

- The "blend wall," which is the maximum percentage of ethanol that can be blended into gasoline for non-flex-fuel vehicles per the Environmental Protection Agency's regulation.
- Lower energy content per gallon in liquid biofuels resulting in reduced vehicle range and increased fuel consumption.
- Poor public perception due to an awareness that some first-generation biofuels, like cornbased ethanol, do not offer much environmental benefit.

Conclusions and Recommendations

Key Conclusions

Conventional vehicles can be difficult to unseat; consumers know their attributes and are accustomed to buying, driving, and fueling these vehicles. Additionally, petroleum-based fuels have a long history of externalized societal costs, which sustains an artificially low price point for this incumbent fuel. Alternative fuel vehicles, on the other hand, have many different operational characteristics, but also have new benefits with which drivers and other stakeholders must become familiar. It is expected that technology and costs will change significantly over the next five years, opening doors for some fuels and closing them for others. Regardless of the ultimate fuels mix, the switch to low-carbon fuels presents an opportunity to create a universal costing system for transportation fuels that includes all

lifecycle costs and levels the playing field for clean fuels to take hold in our local energy economy.

The barriers to increasing the diversity of low-carbon fuels are mainly related to the relative newness of alternative fuels and are not tied to the efficacy of the fuels and technologies themselves. Many of these barriers can be surmounted through outreach, education, thoughtful policy, and coordinated regional efforts to establish a low-carbon fuels network.

Reducing emissions from the transportation sector is integral to achieving ambitious greenhouse gas emissions reductions targets and reduced health impacts from air pollution. With the magnitude of this opportunity in mind, state and local government agencies, and all key regional stakeholders must commit to implementing the recommended actions in the immediate near term to pave the way for alternative fuels to flourish in Northwest California.

Key Recommendations

The following list summarizes key recommendations to promote the increased use of alternative fuels in the Northwest region:

- Provide financial assistance to overcome the incremental cost increase in replacing fleet vehicles with alternative fuel vehicle technologies. Ensure that assistance is available to all regions and fleet sizes throughout the state.
- Work actively to transition publicly owned fleets to alternative fuel vehicles.
- Work with local and state financing entities to create, or to increase access to, AF vehicle financing.
- Provide free or convenient parking for alternative fuel vehicles in publicly owned lots and meters.
- Collaborate on the installation of alternative fuel fueling infrastructure along major highway corridors, facilitating both intra- and inter-regional travel.
- Advocate for government funding for alternative fuel fueling infrastructure in Northwest California. Given the low population density and economic circumstances in the region, private markets may not provide for this infrastructure. However, its presence in the region would provide a public good, both to local residents and to others who may want to travel to Northwest California, warranting government investment.
- Subsidize critically located but underutilized fueling stations to ensure adequate geographic coverage.
- Collaborate regionally on development of model permitting and zoning processes to ease deployment of alternative fuel infrastructure.
- Establish a service that assists fuel sellers in claiming emissions credits for alternative fuel sales. Leverage tools that assist fuel sellers and buyers in assessing additional social and environmental benefits of the different fuel feedstock sources.
- Encourage the production and use of renewable diesel fuels that have no blend wall limit thereby eliminating fuel compatibility issues with existing diesel vehicles, equipment, and infrastructure.
- Support efforts to bring all fuels, including petroleum-based fuels, onto a level pricing playing field that internalizes environmental impacts by implementing some form of a carbon tax.

Amending zoning codes and updating the permitting process presents an opportunity to proactively support and accelerate the deployment and use of alternative fuels. Key recommendations for streamlining the permitting process are summarized as follows:

- Leverage existing codes when drafting codes specific to alternative fuel stations.
- Form a Uniform Code Committee where members of nearby cities and counties collaborate to standardize permitting and inspection fees for alternative fuel infrastructure.
- Provide a clearinghouse of permit process information and where to go to get more information.
- Make online and over-the-counter permitting available for basic alternative fuel installations and upgrades such as creating an "electric vehicle charging station permit" even if it is the same permit needed to install a washing machine in garage.
- Consider passing policy to wave requirements for other improvements for alternative fuel infrastructure upgrades at existing fueling facilities.
- Develop and/or amend codes to provide specific requirements for all types of alternative fuels infrastructure.
- Allow for flexibility in the zoning code; eliminate the need for new building permits for straightforward alternative fuel infrastructure.
- Allow flexibility in parking space requirements when the facility owner installs alternative fuel fueling / charging infrastructure.
- Require new construction permits to have electric vehicle charging conduit and/or prewiring installed in all structures, meeting or exceeding California building code.

The following recommendations summarize key actions that address the alternative fuel training needs of first responders, auto support industry stakeholders, and the general public.

- Actively engage with first responder training material development organizations to encourage the creation of time-scalable alternative fuel and alternative fuel vehicle courses.
- Identify a state or local agency that is capable of centralizing training material resources across all safety and first responder stakeholder groups.
- Work with the local office of emergency services to coordinate and channel funding for training across safety and first responder stakeholder groups.
- Invite fire inspectors from a jurisdiction that already has alternative fuel infrastructure to participate in local fire and first responder trainings to share experiences and answer questions.
- Promote alternative fuel vehicle trainings for independent mechanics, towing companies, and salvage companies.
- Bolster the alternative fuel training capacity of local community college automotive technology programs.
- Explore ways to encourage auto manufacturers to offer trainings on their alternative fuel vehicles in the local region.
- Explore ways to create a local lending library of tools and technical manuals needed by mechanics.

• Conduct and coordinate extensive alternative fuel vehicle outreach and education campaigns in local communities throughout the region.

Next Steps

The project team has identified an opportunity to leverage the framework and resources of the United States Department of Energy's Clean Cities Program in order to move forward with alternative fuels readiness efforts in the region. Clean Cities Coalitions provide a framework for businesses and governments to work together as a Coalition to enhance markets, coordinate activities, identify mutual interests, develop regional economic opportunities, and improve air quality. The tools and support available through the Clean Cities program will enhance the impact and effectiveness to regional efforts to accelerate the use of alternative fuels.

The Department of Energy indicates that receiving official designation as a Clean Cities Coalition is a multi-year process that requires a clear organizational structure, funding for the Coordinator position, and an active stakeholder group that meets regularly and has defined roles. The Clean City Coalition structure includes a Steering Committee, Working Groups, and a Coordinator.

Proposed goals for a Northwest California Clean Cities Coalition include increasing the number of alternative fuel vehicles and hybrid-electric vehicles on the road each year and increasing the number and diversity of fueling stations in the region. Funding the Coordinator position and Coalition activities for the first three to five years (and beyond) could come from several avenues. Currently, the alternative fuel readiness project leads, the Redwood Coast Energy Authority and the Schatz Energy Research Center, have multiple active contracts that align well with Clean Cities Program goals and can be leveraged to provide initial funding to launch a coalition.

CHAPTER 1: Introduction

1.1 Problem Statement

The State of California has set ambitious goals for reducing greenhouse gas emissions through the adoption of a low carbon fuel standard (LCFS) and the promotion of renewable and alternative fuels for transportation. However, the infrastructure and markets necessary to achieve these goals must be developed in a manner that recognizes local and regional nuances, as well as the context-dependent strengths and weaknesses of different fuel pathways.

In the Northwest region, a variety of barriers exist that currently hinder the successful adoption of alternative transportation fuels. Examples of these barriers include:

- Market Two prominent market gaps are a lack of existing infrastructure (thereby discouraging adoption of alternative fuel vehicles) and a lack of knowledge amongst consumers, fleet owners/operators, planners, and decision-makers about the economic and environmental implications of alternative fuels, the commercial and technical availability of alternative fuel vehicles (AFVs) and alternative fuel infrastructure (AF) infrastructure, and some of the existing AFV / AF infrastructure incentives for which they might qualify.
- **Institutional** Due to a lack of experience with AF infrastructure, local municipalities and permitting agencies may have onerous or costly permitting regulations in place. For example, California jurisdictions charge a wide range of fees for permitting residential electric vehicle supply equipment, from \$50 to \$650 (California Plug-in Electric Vehicle Collaborative, 2012).
- **Environmental** The environmental consequences of adopting alternative fuels for transportation are highly fuel-specific. Careful attention must be given to the full lifecycle carbon intensity of any fuel under consideration. There has been extensive research in the area of lifecycle assessment of alternative fuel pathways, but the results of these analyses have yet to be rendered in a local context, where geographic idiosyncrasies (such as local travel patterns or the electric grid-mix) are included in a comparative analysis.
- **Financial** Consumers are reluctant to purchase vehicles with higher up-front costs, even when the lifecycle cost of ownership may be lower. Planners, decision-makers, and entrepreneurs are reluctant to make large-scale investments in AF infrastructure when there is still considerable uncertainty about the long-term prospects for alternative fuel vehicle adoption. There is an urgent need for region-specific analysis to give local entities a clear understanding of the actual risks and rewards of moving toward sustainable transportation.

These barriers have not yet been properly addressed by the marketplace or by regional institutions largely because state and federal incentives for many alternative fuels are still in the early stages of development and implementation. As California accelerates efforts to meet

LCFS goals by 2020, it is essential that local and regional entities be prepared to engage with infrastructure development and incentive initiatives appropriate for their region.

1.2 Goals and Objectives

The goal of this project was to create a coordinated effort throughout the Northwest California region that supports the successful introduction of alternative fuel vehicles, wise and effective deployment of alternative fuel infrastructure, and the development of a robust market for alternative fuels.

Key objectives of this effort were to:

- Produce a strategic plan for the development of alternative fuel markets in the Northwest California region based on an assessment of regional potential for and barriers to AF infrastructure deployment and representing engagement with and the input of key stakeholders.
- Develop materials and strategies for mobilizing regional actors to take coordinated action toward robust alternative fuel markets and engaging key stakeholders to implement the strategies and take part in outreach.
- Build an on-going network of regional decision-makers for promoting alternative fuels.
- Conduct targeted outreach to key entities throughout the region, including fleet operators, planners, first responders, and other decision-makers.

1.3 Project Metrics

The metrics used to measure the success in achieving each key objective are listed below:

Objective	Measurable Outcome		
Produce a strategic plan for the development of alternative fuel markets in the Northwest California region based on an assessment of regional potential for and barriers to AF infrastructure deployment.	 Strategic plan will demonstrate the ability to meet the region's portion of California's low carbon fuel goal 		
	 Engage at least 30 key stakeholders in the development of the strategic plan 		
Develop materials and strategies for mobilizing regional actors to take coordinated action toward robust alternative fuel markets.	 Develop and/or compile at least 10 strategies and/or materials for mobilizing regional stakeholders 		
	 Engage at least 10 key stakeholders to take part in outreach activities 		

Table 1: Project Metrics and Outcome

Objective	Measurable Outcome		
Build an on-going network of regional decision-makers for promoting alternative fuels.	 Assemble a group of at least 8 key stakeholders who are willing to engage in on-going efforts to promote alternative fuels in the region 		
Conduct targeted outreach to key entities throughout the region, including fleet operators, planners, first responders, and other decision-makers.	 Conduct at least 5 outreach events to key entities throughout the region 		
	 Engage with at least 25 key stakeholders via these targeted outreach events 		

Source: Schatz Energy Research Center.

1.4 Project Team

The project team included the Redwood Coast Energy Authority, the Schatz Energy Research Center at Humboldt State University, the North Coast Unified Air Quality Management District, the Mendocino Council of Governments, and the Siskiyou County Economic Development Council.

The Redwood Coast Energy Authority was formed in 2003 to develop and implement sustainable energy initiatives that reduce energy demand, increase energy efficiency, and advance the use of clean, efficient, and renewable resources available in the region. The Redwood Coast Energy Authority is a local government Joint Powers Authority representing all incorporated cities in Humboldt County, the County of Humboldt, and the Humboldt Bay Municipal Water District. The Redwood Coast Energy Authority administered the funding award for this project on behalf of the five-county Northwest region.

The Schatz Energy Research Center served as the technical lead on this project. The Schatz Energy Research Center was founded in 1989 with a mission to promote the use of clean and renewable energy resources. The Schatz Energy Research Center's work has included energy and sustainable transportation planning for the local region, including: the design, permitting, installation, and operation of hydrogen fueling stations; emergency first responder trainings for hydrogen vehicles and fueling stations; outreach and education efforts targeted to both key decision makers and the general public in support of the development and installation of hydrogen fueling infrastructure; and, in coordination with the Redwood Coast Energy Authority and the Siskiyou County Economic Development Council, two regional readiness studies for plug-in electric vehicles (funded by California Energy Commission grant PON-10-602).

North Coast Unified Air Quality Management District is a regional environmental regulatory agency with jurisdiction over Humboldt, Del Norte, and Trinity counties. The District's primary responsibility is controlling air pollution from stationary sources, though their efforts also address mobile sources and vehicles. They are committed to achieving and maintaining healthful air quality throughout their tri-county jurisdiction. The District is one of thirty-five local air districts in California and enforces local, state, and federal air quality regulations.

Mendocino Council of Governments is the regional transportation planning agency for the County of Mendocino and the four incorporated cities. The Mendocino Council of Governments formed as a joint powers agency in 1972 as mandated by state law to disburse state and federal funds for transportation, to provide regional planning, and to serve as a regional forum. The Mendocino Council of Governments supports transportation-related projects through local assistance and interregional partnerships.

The Siskiyou County Economic Development Council is a non-profit 501(c) 4 corporation designed to promote economic vitality in Northern California. Since its inception in 1985, the Siskiyou County Economic Development Council has been the lead organization in economic development in the area by functioning as a business consulting service and program advisor. The Siskiyou County Economic Development Council develops strategies for constructive and balanced economic growth in Siskiyou County and the greater Northern California region.

CHAPTER 2: Project Approach

The key goal of the Alternative Fuels Readiness Project was to create a coordinated effort throughout the Northwest region that supports the effective deployment of alternative fuel infrastructure and the development of a robust market for alternative fuels. To accomplish this, project objectives included producing a strategic plan based on an assessment of opportunities and barriers to AF infrastructure deployment and that represents input of key stakeholders, developing educational materials, conducting targeted outreach to entities throughout the region, and engaging stakeholders to implement the identified strategies.

Below is a list of project tasks that were completed in order to meet these objectives:

- Task 2.1 Develop AF Infrastructure and Deployment Assessment
- Task 2.2 Analyze AF Incentives
- Task 2.3 Develop Strategic Plan for AF Market Development
- Task 2.4 Assess and Develop AF excluding electricity Training Materials
- Task 2.5 Communicate AF Benefits
- Task 2.6 Alternative Fuels Readiness Plan

This chapter describes the project approach by detailing the activities of Tasks 2.1 through 2.6.

2.1 Develop AF Infrastructure and Deployment Assessment

The main analytical component of this project was an assessment of the alternative fuels' infrastructure and deployment needs in the Northwest region to inform the strategic planning effort. The assessment included three parts: 1) characterization of the current status of alternative fuels in the region, 2) analysis of potential alternative fuel portfolios that can help the region meet the State's 2020 LCFS goals, and 3) identification of challenges and best practices for planning, permitting, deployment, maintenance, and inspection of AF infrastructure in the study region.

This task builds upon ongoing work among the project collaborators who have been actively planning for the imminent emergence of plug-in electric vehicles in the region. The Redwood Coast Energy Authority is the prime partner and the Schatz Energy Research Center is the technical lead on the North Coast Plug-in Electric Vehicle Readiness Project, while the Siskiyou County Economic Development Council is the prime partner and the Schatz Energy Research Center is the technical lead on the Upstate Plug-in Electric Vehicle Readiness Project (both funded by PON-10-602). In addition, Mendocino Council of Governments, in partnership with the Mendocino County Air Quality District, funded its own study to plan for zero emission vehicle regional readiness¹ and the Siskiyou County Economic Development Council is planning to participate in the West Coast Green Highway initiative. These projects are engaged in

¹ <u>Mendocino Council of Governments website</u>. (http://www.mendocinocog.org/reports_projects.html).

assessing the need for electric vehicle supply equipment and reducing technical and regulatory barriers to installing infrastructure that will support widespread adoption of plug-in electric vehicles. Because so much work has already been accomplished in the plug-in electric vehicle arena, the project team focused the bulk of their analysis and outreach activities on the other alternative fuels under consideration. Work associated with plug-in electric vehicles predominantly involved assessing their strategic role in a regional alternative fuel portfolio as compared to the other alternative fuels being considered. To make it clear what activities included electricity, two different phrases are used to refer to the fuels under consideration: "alternative fuels" which includes electricity as a fuel and "alternative fuels excluding electricity" which excludes electricity.

2.1.1 Spatially Explicit Alternative Fuels Database

To characterize the current status of alternative fuels in the region, the project team set out to create a database of existing conventional and alternative fuels consumed in the Northwest region. In an attempt to quantify the amount of conventional transportation fuel currently consumed in each county, and the existing AF infrastructure in each county, the project team contacted several state and local agencies in pursuit of fuel consumption data, including the North Coast Air Quality Management District (a partner in this project), Mendocino Air Quality Management District, and the Siskiyou Air Quality Management District. Many different datasets were crosschecked, including the United States Department of Energy's Alternative Fuels Data Center and reliable electric vehicle infrastructure databases, to determine existing AF infrastructure.

For Humboldt County, the North Coast Air Quality Management District was able to deliver gasoline fuel quantities from each of the permitted retail gasoline dispensing facilities in the three county jurisdictions, but this did not include fuels usage in non-retail and government fleets. For Mendocino County, the Mendocino Air Quality Management District delivered fuel usage data that was more complete including all retail, non-retail, government agency, and private fleet usage within Mendocino County. Both Mendocino Air Quality Management District and North Coast Air Quality Management District do not require reporting of diesel quantities for storage or dispensing. The South Coast Air Quality Management District does not require fueling stations to report fuel sale quantities on a yearly basis.² The most recent and comprehensive fuel use data South Coast Air Quality Management District could offer was from a partial sample of county gasoline dispensing facilities in 2009. The Siskiyou County Department of Transportation does not possess data on fuel usage due to a lack of authority to require reporting. The California Board of Equalization does report fueling station sales, but these data reflect all sales from a permitted station (including diesel and concessions) and a reliable basis for disaggregation could not be identified.³

Given that each jurisdiction had different requirements on what throughput they collected, it was not possible to acquire consistent estimates of fuel usage throughout the region. Therefore, regional estimates of fuel consumption were based on outputs of the California Air

² Eric Olson, Siskiyou County Air Quality Management District. Personal communication: Aug 28, 2014.

³ Dave Armstrong, California Board of Equalization. Personal communication: Aug 4, 2014.

Resources Board's Emissions Factor 2011 model's database.⁴ The model estimates emissions from on-road vehicles using total vehicle population and vehicle miles traveled based on surveys sent out by the California Department of Transportation. Yearly consumptions values for 2013 and projected values for 2020 were available for gas and diesel.

It is worth noting again that the Emissions Factor's values are model results rather than empirical reported data. As such, these values differ from the best-reported fuel use values (Figure 1). The exception to this was Mendocino County, which was the only jurisdiction collecting comprehensive fuel throughput data from its GFDs. In that case, the model values matched the reported values quite closely – further reinforcing the choice to use the Emissions Factor model results as a reasonable proxy for actual fuel use. While it is not ideal to use modeled values for ongoing work, they represent the most accurate county-level data available at the time of study.



Figure 1: California Reformulated Gasoline Throughput Values Compared with Emissions Factor Model 2013 Values

Source: Schatz Energy Research Center, 2015.

2.1.2 Alternative Fuels Portfolio Analysis

The second goal of the AF infrastructure and deployment assessment was to determine the potential AF pathways that would best help the region meet the state's 2020 LCFS goals. Recognizing greenhouse gas (GHG) emission reduction as a driving force behind efforts to increase AF deployment, the LCFS served as a specific target for GHG mitigation that informed

⁴ California Air Resources Board. 2014. "<u>Emissions Factors 2011 model's Emissions Database."</u> (http://www.arb.ca.gov/emfac/). Accessed: Sep 22, 2014.

the analysis and strategic planning process. The LCFS provides an appropriate framework for the analysis by setting a goal of 10 percent reduction in average fuel carbon intensity while not specifying the role of each fuel in achieving that goal.

The various AF pathways each carry their own set of opportunities and challenges, costs, market penetration constraints, and emissions abatement potential. In order to better understand the portfolio of fuel technologies and policies that would most cost-effectively reduce transportation sector GHG emissions in the Northwest region, the project team developed a model that would quantify the GHG abatement potential along with cost for each AF pathway under consideration as compared to the fossil fuel baseline. The model, the Stochastic Marginal Abatement Cost Curve, draws on cost data for fuels, vehicles, and distribution infrastructure, as well as analysis of regional transportation trends, fuel-specific market penetration constraints, and fuel life cycle GHG emissions associated with each fuel pathway in each of several market segments. The model then calculates the marginal abatement cost associated with each pathway / market segment combination. The marginal abatement cost represents the cost above or below the business as usual case to indicate any additional cost to society. The marginal abatement cost curves were then used as a tool for prioritizing and analyzing the portfolio of pathways. These curves are built in merit order, assuming that the lower cost abatement is preferred overall and therefore preferentially adopted first. Total abatement for each market segment is determined based on the GHG savings associated with the respective fuel and the total conventional fuel energy it can supplant in that segment. The AF pathways are then deployed until the total abatement meets the LCFS target.

The Stochastic Marginal Abatement Cost Curve approach allows the simulation of AF pathways individually as well as for a suite of technologies. It also enables evaluation of the impacts of changing fuel and vehicle prices, electric grid carbon intensities, and other factors on the cost of GHG abatement through AF deployment. A further description of the Stochastic Marginal Abatement Cost Curve model assumptions and input follows below.

2.1.2.1 The Stochastic Marginal Abatement Cost Curve Model Description

As mentioned in Section 2.1.1, the regional estimates of fuel consumption were based on the 2020 estimates from the California Air Resources Board Emissions Factor 2011 model's database. Because different AF pathways have varying applicability in different segments of the vehicle fuel market, the Northwest region was divided into 48 different market segments based on the Emissions Factors model's categories. Each was a unique combination of the following:

- Region Del Norte, Humboldt, Mendocino, Trinity, Siskiyou, or I5. Note that I5 is a subset of the fuel usage for Siskiyou representing our estimate of the amount of transportation in Siskiyou associated with inter-regional travel. We divided Siskiyou fuel use between regional travel and the I5 corridor by assuming that the Siskiyou populace has comparable per-capita transport demand characteristics as the other counties in our study region, leaving excess fuel that can be attributed to the I5 corridor.
- **Vehicle Type** Light-duty vehicle or heavy-duty vehicles. Light-duty vehicle is composed of the light duty auto class from the California Air Resources Board Emissions Factors 2011 model, while heavy-duty vehicles is composed of all other Emissions Factors model classes combined. Our rationale for this aggregation is that medium and

heavy-duty alternative vehicles such as plug-in electric vehicles, hydrogen fuel cell electric vehicles, and flex fuel vehicles are unlikely to make more than a nominal penetration into their respective markets over the next 5 years. In the near term, alternative fuels for these vehicles will need to be focused on drop-in fuels, so we combined them into a single heavy-duty class.

- Vehicle Status New (2015-2020) or existing (earlier).
- Fuel Type Gasoline-fueled or diesel-fueled vehicles.

For example, one market segment is Del Norte County -> LDA -> Existing -> Gasoline. The annual fuel energy demand from each market segment is presented in Figure 2.



Figure 2: Annual Fuel Energy Demand for All Market Segments Used in the Analysis

Source: Schatz Energy Research Center, 2015.

The alternative fuels considered in this analysis are those major fuels built into the LCFS system as default (Method 1) pathways. These include various biofuels, electricity, and hydrogen. Natural gas was excluded from this analysis because of the current uncertainty surrounding its life cycle carbon intensity due to methane leakage from infrastructure.

2.1.2.2 Market Penetration Limits

The AF pathways considered are constrained to particular market segments and some have practical limits to the amount of uptake within those segments. Assumptions for these limits are summarized in Table 2.

Alternative Fuel Pathway	Segment Limitations	Penetration Limit	Rationale Summary	
BEV	New vehicles only (light-duty vehicle)	70%	Primarily based on the fraction of new vehicles purchased by households with more than one vehicle.	
PHEV	New vehicles only (light-duty vehicle)	100%	Dual fuel, extended range nature of plug-in hybrid electric vehicle makes them a suitable replacement for any new vehicle.	
H2	New vehicles only (light-duty vehicle / heavy-duty vehicle)	10-93%	Limit varies by region and is based on the ratio of population near urban centers to reflect the need for access to fueling infrastructure.	
Flex Vehicles	New gasoline vehicles only (light-duty vehicle)	10-93%	Limit follows the same rationale as hydrogen. Limited fueling infrastructure will be available by 2020 and only in the urban centers.	
Ethanol at E-15	Gasoline vehicles only (light-duty vehicle / heavy- duty vehicle)	100%	Drop-in fuels have unlimited potential to penetrate the market.	
Biodiesel at B-20 from Soy and Canola feedstocks	Diesel vehicles only (light-duty vehicle / heavy- duty vehicle)	100%	Drop-in fuels have unlimited potential to penetrate the market.	
Biodiesel at B-20 from Used Cooking Oil	Diesel vehicles only (light-duty vehicle / heavy- duty vehicle)	0.08-0.9%	Used cooking oil is a waste product from other industries and will be supply limited.	
Renewable Diesel from Soy and tallow	Diesel vehicles only (light-duty vehicle / heavy- duty vehicle)	100%	Drop-in fuels have unlimited potential to penetrate the market. Tallow is a waste product from another industry and will be supply limited.	

Table 2: Market Penetration Constraints Assumed in the Stochastic MarginalAbatement Cost Curve Model

Source: Schatz Energy Research Center, 2015.

2.1.2.3 The Marginal Abatement Cost Curve Approach

As previously noted, the marginal cost of GHG abatement was used as the metric for ranking AF pathways within each market segment and across segments. After a marginal abatement cost is calculated for each segment alternative, the Stochastic Marginal Abatement Cost Curve model resolves the penetration of each AF alternative within each segment. For example, if BEVs have the lowest marginal abatement cost in a particular market segment, then we assume they will penetrate that segment up to their penetration limit. In the case of BEVs, this limit is 70 percent. So, this leaves 30 percent of the market segment available for the AF alternative with the second lowest marginal abatement cost. This process continues until all of the market segments are fully allocated by the lowest cost AF alternatives.

Frequently, adopting the least cost marginal cost curve for each market segment as described above results in a final portfolio which falls short of the LCFS 2020 target for GHG abatement. Usually this occurs when biofuels like sugarcane ethanol (used as E-15) end up as the cheapest AF alternative in most of the new vehicle segments. Because ethanol can penetrate 100 percent of applicable market segments it dominates the marginal abatement cost curve. However, E-15 has a relatively poor ability to abate GHGs, so the total portfolio abatement potential is limited.

For these situations, a modified algorithm was developed for building the marginal abatement cost curve that systematically substitutes different AFs within market segments in order to yield the least cost portfolio that also satisfies the LCFS target. The result of applying this approach means that under certain circumstances, the AF alternatives that end up in the final portfolio are not strictly the lowest marginal abatement cost alternatives but rather a balanced portfolio of low-cost, high-abatement alternatives that allow the region to meet the LCFS target.

2.1.3 Planning, Permitting, and Deployment Recommendations

The final component of the infrastructure and deployment assessment was focused on identifying best practices pertaining to the planning, permitting, and deployment of AF infrastructure. As a key element in the development of a market for alternative fuel vehicles, availability of fueling infrastructure is critical. The purpose of the assessment was to understand the challenges experienced by the first wave of AF infrastructure developers and illuminate recommendations for streamlined permitting. The project team conducted a literature review and developed a set of survey questions for entities currently involved in, or anticipated to be involved in, AF infrastructure development. The team then conducted phone interviews with regional permitting and planning department officials, low-carbon fuels providers, as well as members of the United States Department of Energy Clean Cities Coalition program.

The Clean Cities Coalition program consists of a national network of local coalitions that work to establish low-carbon fuels infrastructure and employ policies to cut petroleum use in their communities. These coalitions provided a valuable resource of information on guidance and best practices generated from low-carbon fuels deployment efforts across the country.

2.2 Analyze AF Incentives

The goal of Task 2.2 was to analyze the existing and potential incentives for increased usage of alternative fuels in the region. The large-scale deployment of AF vehicles will need to

overcome technical, social, infrastructure, and market barriers, and will require a concerted and coordinated effort over a long period of time. Consequently, incentives will, and should, play a key role in the near-term. These incentives, applied at various points in alternative fuel and vehicle markets, will aid in achieving LCFS targets while also helping to develop nascent industries, enabling them to become cost competitive in the future.

While many alternative fuel technologies currently exist and could play key roles in a lowcarbon transportation future for the Northwest California region, they generally cost more than the fossil fuels they replace. Moreover, despite its importance as a driver of climate change, transportation is a very difficult sector in which to reduce emissions because it is structurally dependent on petroleum. The National Research Council has estimated that the value to society generated by the large-scale deployment of AF vehicles would exceed its cost by roughly an order of magnitude.⁵ Therefore, targeted incentives are needed to address potentially high abatement costs to reap the full benefits of large-scale AF deployment.

Even as incentives have become increasingly common, little is known about how to optimize incentive structures for AF uptake. Alternative fuel deployment incentives are an area of policy experimentation at present, and opinion remains divided on whether and how well they're working as well as what could make them perform better. Recent studies offer insights that could be useful in deploying incentive resources effectively going forward. In some cases, these incentives can be applied locally or regionally. However, even where the incentives are by necessity state or federal in scale, it is useful for local stakeholders to understand this landscape in order to both advocate at the state level for beneficial incentive models, and to educate stakeholders in the region on how to access the incentives.

Incentives need to be structured appropriately to generate the intended effect. For example, electric vehicles are only slightly more expensive than conventional vehicles in terms of life cycle cost of ownership. However, the upfront cost of buying these vehicles can pose a significant barrier to their uptake, even if lower fuel costs will offset much of this initial cost over the vehicle's lifetime. For this reason, actions to reduce the cost of electricity for charging may not be as effective in increasing their uptake as would comparably price actions to reduce their upfront cost. Understanding such dynamics is integral to creating effective incentives.

This task aimed to provide insights to regional and state entities in determining where to direct limited resources and human capital when creating incentive programs. Analysis was based on industry literature, conversations with key stakeholders in the region, and other research.

2.3 Develop Strategic Plan for AF Market Development

The culmination of efforts taken on as part of tasks 2.1 and 2.2 was the development of a strategic plan that outlines the results. The plan is divided into three sections: 1) the current status of AF and AF infrastructure in the region, 2) identified strategies for meeting the LCFS goal, and 3) next steps to implement the plan. The infrastructure and deployment assessment

⁵ The National Academies of Sciences, Engineering, and Medicine. <u>*Transitions to Alternative Vehicles and Fuels.*</u> (http://www.nap.edu/catalog/18264/transitions-to-alternative-vehicles-and-fuels).

work, alternative fuels portfolio analysis, incentives analysis, as well as extensive stakeholder input were all used to inform a comprehensive and effective plan.

Regional stakeholders were central to successfully accomplishing the objectives of this project. Early on in the project period, the project team reached out to individuals throughout the Northwest California region to form a stakeholder advisory group. The group participated in periodic meetings and had the opportunity to provide input and feedback on the strategic plan. The following is a list of stakeholder categories that were part of the stakeholder advisory group:

- California Department of Transportation
- Humboldt Bay Harbor District
- Waste Management Authorities
- Air Quality Management Districts
- Fuel marketers/distributors
- Vehicle vendors
- California Local Energy Assurance Planning
- Local governments
- Fleet operators
- Emergency responders
- Code / permitting officials
- Fuel producers
- Heavy equipment users (logging, gravel extraction, construction, etc.)

Goals for the Strategic Plan Working Group included:

- 1. Engaging with relevant government agencies to obtain input regarding a regional strategic plan;
- 2. Identifying ways to attract alternative fuels into the region, such as the development of policies, regulations, and/or incentives;
- 3. Identifying opportunities and challenges;
- 4. Identifying a mission statement for the readiness plan;
- 5. Discussing the structure of the readiness plan that would be of most use to stakeholders in the project region.

2.4 Assess and Develop AF Excluding Electricity Training Materials

The scope of task 2.4 included evaluating existing training materials produced and/or used by relevant stakeholders in order to identify gaps in available materials. The focus of this effort was on the availability of both safety and non-safety training materials for stakeholders such as first responders, fleet managers, emergency planning offices, fuel distributors, dealerships, and vehicle maintenance shops, who are engaged with fuel and vehicle handling or related planning efforts. The assessment began with a review of existing training materials and resources with an emphasis on freely available resources, and interviews with local stakeholders. The work was completed in two different phases. The first phase conducted a

broad stakeholder outreach over the phone and in person to assess how different stakeholder groups receive training for their profession. The second phase put together a working group to inform recommendations regarding the development of training materials to meet regional training needs.

2.4.1 Training Materials Task Force

The project team attempted to recruit members to the Training Materials Task Force with the goal of attaining broad geographic and industry representation. Training was broadly segregated into two different groups, as described above: safety and first responder training and non-safety training. Ultimately, stakeholder availability was the key driver that led to the formation of the workgroup.

The following is a list of stakeholder categories that were part of the Training Materials Task Force:

- Highway Patrol
- County Office of Emergency Services
- Auto Repair Services
- County Department of Transportation
- Fire Districts
- Sheriff Offices
- Community College Automotive Technology Programs

The goal of this working group was to inform recommendations in the strategic plan by:

- 1. Assessing and reviewing available training materials, curricula, and services,
- 2. Identifying training needs for the project region, and
- 3. Brainstorming possible approaches to addressing training needs.

2.4.2 Non-Safety Training Materials and Programs

Non-safety AF-related training programs were those that involve the many automotive support services. Sectors and activities that may need non-safety training were identified for the Northwest California region, and available services and resources were found and compiled to address non-safety training needs. Materials were compiled through discussions with local stakeholders and training service providers, as well as institutional mapping and literature review.

2.4.3 First Responder and Safety Training Materials and Programs

The safety AF-related materials and training programs were approached in a similar way, by identifying agencies that would respond to a vehicle/fuel emergency, and surveying and compiling existing training materials. Stakeholders were interviewed throughout the five-county region and were targeted based on the likelihood of exposure to AF in emergency situations. The team attempted to survey at least two entities from each relevant stakeholder category in each county. All participants were asked the following questions:

1. To clarify how this strategic plan pertains to you, how do you handle fuels during routine and emergency situations?

- 2. What kinds of trainings do you receive? Who provides or facilitates training for your organization: employer, government office, professional training service or school?
- 3. What kinds of training materials are used (e.g. online, video, in person, exercises)? Where do they come from?
- 4. What, if any, are the certification or attendance requirements associated with these trainings? If so:
 - a. What organization provides the certification?
 - b. How long is the certification valid?
- 5. How is training funded?
- 6. What gaps can you identify in existing material, delivery options, or funding for alternative transportation fuels?
- 7. What training or facilitation does your organization provide?

2.5 Communicate AF Benefits

Task 2.5 broadly encompasses all the outreach efforts that were part of successfully engaging stakeholders in order to accomplish all of the project objectives. Outreach, training, and marketing materials were compiled and/or developed for AF to reach key stakeholder groups, and then a significant amount of outreach to relevant stakeholders took place. The project partners were able to use their prominent positions in the community and their strong regional alliances to engage key stakeholders in helping to develop effective local strategies. Stakeholders can be broadly grouped into the following:

- Local government
- Fuel distributors
- Fleet managers
- Safety and first responders
- Private sector
- General public

Local government was engaged regarding baseline consumption of transportation fuels and locations of currently available fuel stations in the project region for task 2.1. All groups except the general public were engaged through multiple interviews with various stakeholders to elicit feedback on potential incentives for task 2.2. Since local government was the intended primary audience for the strategic plan, they were the group primarily engaged regarding form and scope of the strategic plan (task 2.3). During the project it became clear that training related to AF is needed for all stakeholder groups, including the general public. Therefore, all stakeholder groups were engaged in multiple phases during the project period, with the exception of the general public whom the project team was unable to assess how to best engage them regarding training. Because input from all the stakeholder groups was used to develop the strategic plan and readiness plan, an opportunity to review the plan was provided to all stakeholder contacts obtained during the project.

The Alternative Fuels Distributors Working group was established for the purpose of developing and implementing strategies to assist wholesalers, retailers, and others in the AF product chain in the Northwest California region. The project team shared the results of the AF infrastructure and deployment assessment and solicited input regarding the development of the regional AF strategic plan.

The target participants for this group were the local fuel distributors in the project region. There was consideration of reaching out to bulk fuel providers outside the region, but this was not pursued. The goal of this working group was to gain insight into the opportunities and challenges associated with bringing alternative fuels to market in the Northwest California region. This was accomplished by:

- 1. Discussing the key role and business activities of local fuel distributors in realizing the long-term goals of the project
- 2. Addressing the "chicken-or-egg" issue regarding market supply and demand
- 3. Listening to fuel distributors regarding the opportunities and challenges they see with accomplishing project goals

Given the breadth of scope and number of potential stakeholders in the transportation sector, a spreadsheet was developed for the project team to track stakeholder outreach and engagement. This spreadsheet collected basic stakeholder information and tracked whether contact was made, what type of information was provided, relevance to the different project tasks, fleet information if applicable, and miscellaneous notes. This spreadsheet is retained by the grant recipient and will continue to be a resource for future work in this field.

2.5.1 General Outreach

Engagement with the different groups was guided by the goals of the different objectives and tasks of this project. The effort was motivated by two goals: 1) to obtain a general sense of how different stakeholder groups are affected by the AF policy and planning efforts in the state and local region, and 2) to obtain a general sense of how different stakeholder groups received training in their respective sectors. Statistics on the communication efforts made over the project period are detailed in Table 3.

Stakeholder Group		# of Attempted Contacts	# of Successful Contacts	# of Active Planning Participants
Local Government Agencies	Planning, Permitting, Regulation	25	20	16
	Safety	60	27	3
	Community Colleges	4	3	2
Fleets	Public Fleets	52	46	26
	Private Fleets	28	16	10

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Stakeholder Group		# of Attempted Contacts	# of Successful Contacts	# of Active Planning Participants
Fuel Distributors	Private Fuel Distribution	16	11	3
Other Private	Dealerships, Towing, Salvage, and Auto Repair Businesses	52	24	5

Source: Schatz Energy Research Center & JPB Consulting, 2015.

2.5.2 Working Groups

Three working groups were formed during the project. The goal of the groups was to provide detailed feedback regarding different topics related to the development of the strategic plan. The groups, the Strategic Plan Working Group, the Fuel Distributor Working Group, and the Training Materials Working Group are described further within their relevant sections.

The following process was used by the project team to determine the stakeholders that would be invited to participate in each working group:

- 1. All project partners compiled a list of possible, applicable, and/or interested stakeholders from the region.
- 2. All project partners rated each listed stakeholder using the following scheme:
 - a. Key stakeholder with significant project influence
 - b. Primary stakeholder that is likely directly affected by this project
 - c. Secondary stakeholder that is indirectly affected by this project
- 3. A short list was created of all stakeholders that the project team was in majority agreement regarding whether they are key stakeholders
- 4. The Redwood Coast Energy Authority then fleshed out the list to obtain coverage across the geographic project region and stakeholder type.
- 5. The project team reached consensus on the final list of stakeholders to invite. The activity of reaching out to and inviting the stakeholders in the final list was assigned to project partners based on whether the stakeholder resided in the partner's geographic jurisdiction.

2.5.3 Presentations, Events and Targeted Outreach

An effective way to engage with different stakeholder groups and broadly communicate the benefits of AF was through presentations, a symposium event, and targeted outreach to fleets. The goals of the outreach efforts were to:

- Bring local stakeholders up to speed on State and local efforts to accelerate the adoption of low carbon transportation fuels and vehicles,
- Develop educational materials for the general public delivered via public outreach events and online and local news media,

• Explain the Federal Clean Cities program, outline the potential benefits of this program for the region, and pursue stakeholder interest,

The project team had the privilege of engaging with different stakeholder groups and presenting information and results of the project. A presentation and two targeted toolkits were developed for this purpose.

2.6 Alternative Fuels Readiness Plan

The goal of this task was to create a complete, comprehensive, and detailed final plan based on the results of activities completed for tasks 2.1 through 2.5. The Northwest California Alternative Fuels Readiness Plan is aimed at helping to prepare public entities for the introduction of AF infrastructure, educate and engage relevant stakeholders, and guide and accelerate the commercialization of AF in the region.

CHAPTER 3: Project Results

This chapter summarizes the results of tasks 2.1 through 2.6 for the Northwest California Alternative Fuels Readiness Project.

3.1 Develop AF Infrastructure and Deployment Assessment

The AF infrastructure and deployment assessment is presented below and includes the results of the three components: 1) characterization of the current status of AF in the region through the creation of a database, 2) assessment of the various AF pathways that would help the region meet 2020 LCFS goals, and 3) identification of challenges and best practices for planning, permitting, deployment, maintenance, and inspection of AF infrastructure in the Northwest region.

3.1.1 Spatially Explicit Alternative Fuels Database

Below is a summary of the results of the activities completed to characterize the current status of AF in the region.

The compiled list of existing AF infrastructure was used to create a station map (Figure 3). Additional data, including the number of vehicles fueled and the amount of fuel dispensed was requested from each infrastructure site as well. As indicated on the map, no public compressed natural gas transportation fueling sites exist in the region. One hydrogen station is in service within the region, located at Humboldt State University. Fueling capacity of this station is limited as it only produces 2.5 kilogram of hydrogen per day and can store up to 12 kilograms in stationary tanks, which can serve up to four vehicles with typical personal driving patterns.⁶ Three biodiesel dispensing stations are in service in Mendocino County. Several propane stations exist in the region; however, propane is a petroleum derivative and is not an approved California's Greenhouse Gases, Regulated Emissions, and Energy Use in Transportation model pathway by the California Air Resources Board, so propane's candidacy as a potential alternative fuel solution was discarded.

Public plug-in electric vehicle chargers, also known as electric vehicle service equipment (EVSE), dominate the current AF infrastructure portfolio with 48 sites counted at the time of the study. Only Level 2 (240V) and direct current fast charging stations were considered and catalogued for the AF infrastructure database. Usage data was not available for all sites, as many have adapted a National Electrical Manufacturer Association 240-volt outlet with a J1772 adapter (instead of installing networked equipment) and allowed customers to charge their vehicles as a courtesy. And in certain remote areas of the region, ChargePoint networked chargers cannot transmit usage data back to the central ChargePoint data center.

⁶ Schatz Energy Research Center. 2012. "<u>Humboldt State University Hydrogen Fueling Station and Hydrogen</u> <u>Vehicles Frequently Asked Questions</u>." (http://www.schatzlab.org/docs/FAQs_Brochure_web_updated_2012.pdf). Accessed September 14, 2014.



Figure 3: Existing Alternative Fueling Stations in the Northwest California Region

The red place markers with black dots represent L2 Public EV chargers. The red place marker with the number "1" is the Tesla supercharger. Green place markers with black dots represent biodiesel fueling stations. The blue place marker a hydrogen fueling station.

Source: Adapted from Google Maps by Schatz Energy Research Center, 2016.

3.1.1.1 Database User's Guide

The database is available upon request as a Microsoft Office Excel Worksheet file (xlsx.). The following guidelines were developed for using the database.

• The database contains two worksheets, one reporting total conventional fuel use in each of the five counties in the Northwest region, and the other providing details on AF infrastructure.

- The conventional fuels database contains values for 2013 and projected values for 2020 for gasoline and diesel use from the Emissions Factors 2011 model.
- Season, vehicle class, vehicle speed, and model year were aggregated to deliver the daily usage figures. Values are reported as thousands of gallons per day, therefore, to obtain yearly values the following conversion was used:

(Emissions Factors 2011 model output*1000) *344.25= annual gasoline or diesel value for vehicle type.

- The locations of all known public AF infrastructure are reported, as well as key details about those sites. The amount of fuel dispensed by each of these stations was investigated, but in most cases this information was not known or shared. EVSE owners did not typically track the amount of electricity they have dispensed for EVs, nor are they currently required by utilities to separately meter EVSE.
- Additional notes in the AF infrastructure database include contact information, whether the facility is networked, cost, and the displayed hours, if applicable.

3.1.2 Alternative Fuels Portfolio Analysis

The second step in the AF infrastructure and deployment assessment was to conduct an AF portfolio analysis. The results of the analysis informed a recommended mix of AF technologies that represent the least cost path toward achieving the State's 2020 LCFS goal. In addition, a number of sensitivity analyses were conducted that provide some insight into the extent to which unforeseen market outcomes could influence the preferred portfolio.

3.1.2.1 Alternative Fuel Pathway Costs

Estimates of the average lifecycle cost of the various AF pathways are presented in Figure 4. The costs are broken down by the vehicle, station, and fuel. All costs are presented as incremental, meaning that a cost of zero represents the cost of driving a conventional vehicle using gasoline or diesel. The costs are calculated on an efficiency-weighted per unit of energy basis, which is effectively the same as per unit of travel. This is done using the standard LCFS multipliers (called "energy economy ratios") that account for the relative energy efficiency of different fuel pathways. Costs are presented in units of gallons of gasoline equivalent (GGE).

Figure 4: Amortized Incremental Cost of Alternative Fuel Pathways Over Conventional Fuels



The amortized incremental cost of BEVs and plug-in hybrid electric vehicles.

Source: Schatz Energy Research Center, 2015.

For the plug-in electric vehicle pathways, the cost of fuel is less than the cost of gasoline, so the fuel cost bars in Figure 4 are dodged instead of stacked and the arrow points downward to indicate that the fuel costs are negative and represent savings. Because drop-in fuels have no vehicle costs and negligible station costs, they are the cheapest alternatives per GGE. Of the alternatives that require investment in a vehicle, BEVs are the cheapest alternative due to the considerable fuel savings associated with driving a BEV.

Figure 5 presents the results of dividing the cost of each alternative by the abatement potential of that pathway, also known as the average marginal abatement cost of each pathway in units of dollars per metric tonne of abated carbon dioxide equivalent. When this abatement potential is accounted for, the ranking of each technology changes substantially. BEVs are the lowest cost alternative followed by biodiesel from used cooking oil and renewable diesel from beef tallow. Note that corn ethanol is excluded from Figure 5 because the carbon intensity of corn ethanol is higher than the 2014 LCFS target fuel intensity. So, the most common pathways for corn ethanol cannot play a role in reducing fleet-wide carbon intensity. Note also that the values in Figure 4 are weighted by the applicable vehicle fuel efficiency.



Figure 5: Average Marginal Abatement Cost of Alternative Fuel Pathways

Source: Schatz Energy Research Center, 2015.

3.1.2.2 Results from the Stochastic Marginal Abatement Cost Curve Model

Base Scenario Average Marginal Abatement Cost Curve

While Figure 5 presents average abatement cost values, the marginal abatement cost curve approach adds the critical dimension of abatement potential to the comparison. In Figure 6, the y-axis still represents the marginal cost of abatement, but the x-axis now represents the total abatement potential of each AF pathway in its respective market segment. The curve in Figure 6 is produced by the Stochastic Marginal Abatement Cost Curve model based on a Monte Carlo simulation with 500 trials to develop a family of marginal abatement cost curves for the base scenario. The average cost and abatement potential for each segment alternative are used to build the average curve presented in the figure. The corresponding number of vehicles that would be necessary to achieve the LCFS target for each market segment is shown in Figure 7. The market penetrations are relatively small for most segments (less than 10 percent) with the exception of BEVs which achieve penetrations as high as 70 percent on average.

The portfolio average abatement cost to achieve the LCFS target is \$180 / tons of carbon dioxide equivalent. The portfolio average abatement cost is calculated as the total incremental cost of achieving the target (\$43 million) divided by the total reduction in emissions (240 kilotons). The cost for the region of continuing with conventional gasoline and diesel vehicles is \$1160 million per year, so the incremental cost of achieving the target is less than a 4 percent increase over business as usual.

Figure 6: Average Marginal Abatement Cost Curve Across 500 Trials for the Base Scenario



Source: Schatz Energy Research Center, 2015.

The portfolio is notably dominated by BEVs, which represent the lowest cost alternative across almost all segments for which BEVS are able to penetrate. The differences in cost visible within BEV as an alternative are a product of regional differences in electricity cost, emissions factors, and the difference between displacing light duty gasoline versus light duty diesel vehicles. Used cooking oil biodiesel and tallow renewable diesel are present in the portfolio but at such small penetrations as to be practically negligible. Sorghum and sugarcane ethanol both play a role in the portfolio. This is primarily due to the fact that sorghum is a cheaper alternative but doesn't have as much abatement potential as sugarcane and therefore is replaced by sugarcane across some of the trials. PHEVs and Flex vehicles with sugarcane also play a role in the portfolio, but their role is limited by the fact that other less costly alternatives usually take most or all of their applicable market segments. Finally, canola biodiesel plays a significant role as the least cost drop-in alternative for diesel that is not supply constrained. While expensive, canola biodiesel will likely be important to achieving the LCFS target because it is the only practical way to reduce the carbon intensity of medium and heavy-duty vehicle activity, assuming supply constraint assumptions on cheaper alternatives are reasonable.



Figure 7: Number of Vehicles Needed to Adopt Each Alternative Vehicle Technology by Market Segment

Source: Schatz Energy Research Center, 2015.

Cost Uncertainty and Robustness of Results

In Figure 8, the same average marginal abatement cost curve for the base scenario is plotted but with vertical error bars indicating the degree of uncertainty in the costs based on the distributions specified for the inputs that compose each marginal abatement cost. The error bars represent one standard deviation. It is clear from this figure that there is considerable uncertainty in the cost estimates and a large degree of overlap in the intervals of adjacent alternatives. This result does not, however, invalidate the utility of the results of this analysis as explained below.



Figure 7: Average Marginal Abatement Cost Curve

The error bars on the individual marginal abatement cost of each segment alternative represent +/1 standard deviation from the mean.

Source: Schatz Energy Research Center, 2015.

The costs of the alternatives are not statistically independent, but rather are correlated with each other. The biofuels in particular have a high degree of correlation, with correlation coefficients ranging from 0.44 to 0.99 with an average of 0.84. So, despite the high degree of variation in the costs, they tend to vary in the same direction, keeping the ranking of the alternatives relatively intact.

This phenomenon is illustrated in Figure 9, which depicts nine marginal abatement cost curves representing the average marginal abatement cost curve of each ranked group from the 500 trials if the marginal abatement cost curves are ordered by their portfolio average abatement cost. In other words, for each of the 500 trials a marginal abatement cost curve is constructed, and the portfolio average abatement cost is calculated, then the 500 marginal abatement cost curves are sorted by their portfolio average abatement cost and then divided into nine equal groups or "noniles". The average marginal abatement cost curve for each group is calculated and plotted in Figure 9.

Figure 9 allows the conclusion that despite the variability in costs, the overall portfolio of AF pathways is quite stable. In the 1st nonile there is a slightly greater role played by Flex fuel

vehicles on sugarcane ethanol and hydrogen. In the 8th and 9th noniles, there is a flip between sorghum and sugarcane ethanol. But overall, the ordering of the alternatives and the degree to which they contribute to the LCFS target is largely invariant. The actual cost to achieve these emissions reductions is quite uncertain (the portfolio average abatement cost ranges from \$33 / ton to \$318 / ton between the 1st and 9th nonile), but the technological pathway to get there is much less of an unknown.



Figure 8: Marginal Abatement Cost Curve of Each Nonile

The graphs show nine Marginal Abatement Cost Curves representing the average Marginal Abatement Cost Curve from each nonile of the 500 trials when ordered by their Portfolio Average Abatement Cost.

Source: Schatz Energy Research Center, 2015.

Challenges with the Traditional Marginal Abatement Cost Curve Approach

Figure 10and Figure 11 illustrate a problem with the traditional marginal abatement cost curve approach in the context of the analysis, and the solution employed to address it. Usually, a marginal abatement cost curve quantifies the abatement potential of a menu of independent measures. Implementing one technology or program does not preclude acting on any of the others. But in the context of alternative fuels, choosing to adopt one AF pathway necessarily precludes other pathways from being realized. Because the Stochastic Marginal Abatement Cost Curve model faithfully resolves these market limitations, unanticipated results can occur.

The marginal abatement cost curve in Figure 10 is the result of selecting the lowest cost alternative in every market segment for a particular trial of the Stochastic Marginal Abatement Cost Curve model. The problem with the portfolio can be blamed on sorghum ethanol, which penetrates completely into almost all of the gasoline market segments but does not abate nearly enough emissions to achieve the LCFS goal. The presented solution to this problem is

illustrated in Figure 11, where sorghum ethanol is re-ranked as the second or third place alternative within successively more expensive market segments until a portfolio is found that reaches the goal.



Figure 9: Marginal Abatement Cost Curve Model Unable to Reach LCFS Target

Source: Schatz Energy Research Center, 2015.

Figure 10: Marginal Abatement Cost Curve Model Able to Reach LCFS Target with Amended Approach



Source: Schatz Energy Research Center, 2015.

3.1.3 Planning, Permitting, and Deployment Recommendations

Local permitting and planning agencies play a key role in the development of low carbon fueling infrastructure due to their authority over zoning, code enforcement, permitting, and facility inspection. As low carbon fueling stations and electric vehicle charging stations are new to the market, there is a lack of existing language pertaining specifically to these fuels in the current zoning codes and building standards. However, the 2013 California Building Code and the 2010 Americans with Disabilities Act Standards for Accessible Design do contain standards specific to fuel dispensers and accessibility at public amenities. Use of these codes will most likely be adequate for most AF infrastructure installations, however each unique fuel will likely have distinct design requirements for safe storage and handling. In the case of EV charging infrastructure that is being added to a variety of different public spaces, new draft guidelines are under development in California to distinguish "parking" from "charging" services in order to clarify how accessibility requirements will be applied to accommodate disabled EV drivers.

At the regional level, a growing number of local jurisdictions⁷ now have experience administering permit applications for EV charging stations and to a lesser degree, biodiesel, and compressed natural gas fueling infrastructure. Currently, no low-carbon fuel-specific permitting processes are codified in the regional jurisdictions, and only some of the jurisdictions have general plans that contain language supporting the development of alternative fuels infrastructure. All jurisdictions vary in terms of general permitting requirements.

Figure 12 shows the general permitting process for EVSE, specifically. The permitting process for other low-carbon fuels is similar to the process shown below but will not require contact with the local utility and will likely include additional permitting steps related to regulatory oversight over air and water quality, and fire / hazardous materials safety.

⁷ These jurisdictions include Arcata (biodiesel production / dispensing, electric vehicle charging, compressed natural gas), Mendocino County (EV charging), Humboldt County (electric vehicle charging), and Eureka (electric vehicle charging, compressed natural gas).



Figure 11: Electric Vehicle Charging Infrastructure Permitting Process

3.1.3.1 Challenges Associated with Low-carbon Fuels Permitting

The key permitting challenges for low-carbon fuels infrastructure development are related to the novel nature of low-carbon fuels. On a local level, permitting agencies are often unfamiliar with existing codes and standards applicable to each fuel type. Further compounding this problem is the inconsistency of permitting requirements across jurisdictions (e.g., regional cities and counties). These challenges can increase project lead times and development costs, thereby suppressing the growth of a local low-carbon fuels market.

The challenges experienced by the cities and states at the forefront of low-carbon fuels development have unveiled valuable lessons for communities now planning for an efficient transition to low-carbon fuels deployment and use. Challenges identified during the permitting research and interviews include:

Source: GHD, 2014.8

⁸ Carter, David, Colin Sheppard, James Zoellick, Niki Brown, Logan Smith. (GHD, Schatz Energy Research Center, Siskiyou County Economic Development Council). 2014. *Upstate Plug-in Electric Vehicle Readiness Project.* California Energy Commission. Publication Number: CEC-ARV-12-007.

- Inconsistent permit requirements; permitting varies city-by-city, and county-by-county; this creates a lot of additional work for developers to understand and navigate unique permitting processes for each new facility.
- Inconsistency in design requirements for low-carbon fuel infrastructure increases design costs and inhibits efficiencies that can otherwise be gained through standardization. Further, inconsistent facility design requirements make it difficult for developers to know what schedule and/or budget contingencies to include in project development analyses thereby increasing overall project costs.
- Codes and standards in most local communities do not have low-carbon fuels-specific requirements.
- Permitting lead times can be long; the time between permit request and issuance can be 6 9 months or longer.
- For ethanol and possibly other liquid fuels, there is a lack of equipment certified to meet the California Air Resources Board Phase II Vapor recovery requirements. This has caused an increase in facility development time and cost to install new E-85 (85 percent Ethanol) infrastructure. Currently, ethanol fuel infrastructure developers have to get a Memorandum of Understanding from the California Air Resources Board exempting E-85 fueling stations from having certified Phase II vapor recovery equipment as a "research and development test site"; this Memorandum of Understanding has to be recertified every two years adding unnecessary steps and uncertainty to ethanol fueling station development.
- Local zoning rules do not contain specific language for low carbon fueling infrastructure siting.
 - Some communities lack sufficient land zoned to allow for the manufacture of alternative fuels.
- For electric vehicle charging stations, there is a need for zoning flexibility to allow for increased prevalence of smaller charging stations in residential areas.
- Unfamiliar and/or non-uniform inspection procedures for AF stations can cause unnecessary delays.
 - Inspectors and local officials are often unfamiliar with codes and standards specific to low-carbon fuels, which can cause delay as officials determine appropriate inspection requirements and techniques.
- Some cities have permitting requirements that trigger other code upgrade requirements increasing the costs of the original project. This can be very challenging for early adopter installers.
- Current California draft disabled access requirements for both parking as well as EV charging services has been a significant issue for developing the first wave of integrated EV charging infrastructure. The issue involves the requirement for Americans with Disabilities Act accessibility for one out of every 10 EV charging spaces. For smaller sites with only one charging station, meeting the additional accessibility requirements

presents an additional cost associated with locating a charging space that is available to all EV drivers, is located near electrical service panels, and does not impede accessibility from the existing disabled parking spaces or result in the loss of an additional parking space.

3.1.3.2 Recommendations to Streamline Permitting Process

Amending zoning codes and streamlining the local permitting process presents an opportunity to proactively support and accelerate the deployment and use of low-carbon fuels. An ideal streamlined permitting approach would involve codifying a specific process for all types of low-carbon fuels and all known low-carbon fuel use applications (e.g., both on-road and off-road), and would be revisited periodically to include new technologies as they become available.

3.2 Analyze AF Incentives

The Northwest California region, due to its geography and economics, lags behind the rest of the state in AF uptake. In some ways, the region could be an ideal market for AF technologies as this is a region with a population that is concerned about environmental issues, local economic development and has some of the highest gasoline prices in the nation. However, the Northwest California region is also economically depressed compared to the rest of the state with median family incomes in *all five* of the counties in the focus area in the bottom quartile of California counties. As a result, incentives will play a key role in any large-scale deployment of alternative fuels in the region and would support Governor Brown's stated goal of increasing "access to zero emission vehicles for disadvantaged, low-income, and moderate-income communities."

3.2.1 Current Incentives Landscape

A variety of incentives have been applied to alternative fuel markets in hopes of overcoming some of the known barriers and driving further AF uptake. The federal government has supported AF development through biofuel blend mandates and tax credits to biofuel producers, tax credits for purchase of plug in electric vehicles and installation of charging infrastructure, grants and loans for research and development, and a requirement that federal agencies add alternative fuel vehicles to their fleets. States have also been active in creating incentives for AF development. California has been particularly aggressive in this regard, having issued more than \$220 million in rebates for the purchase of over 100,000 alternate fuel vehicles since the program began in 2010, and the California Air Resources Board has indicated that these incentives will continue at current levels for the foreseeable future.¹⁰

Electric vehicle incentives have been successful in helping establish the electric vehicle market. Figure 13 below shows the growing demand for plug-in hybrid electric vehicle and BEV vehicle rebates in California.

⁹ Governor's Interagency Working Group on Zero-Emission Vehicles. 2015. <u>2015 Zero-Emission Vehicle Action</u> <u>Plan, California Governor's Office</u>. (http://gov.ca.gov/docs/DRAFT_2015_ZEV_Action_Plan_042415.pdf).

¹⁰ The California Air Resources Board. 2015. <u>Discussion Document of the Third Public Workshop on the</u> <u>Development of the Fiscal Year 2015-16 Funding Plan for the Air Quality Improvement Program and Low Carbon</u> <u>Transportation Investments.</u> (http://www.arb.ca.gov/msprog/aqip/meetings/032615_discussion_doc.pdf).



Figure 12: Monthly California Rebate Demand (January 2012 – January 2015)

Source: California Air Resources Board, 2015.10

Another key incentive type for purchase of AF vehicles relates to the cost of the fuels. Biofuels have long been subsidized by the federal government in the form of crop assistance programs, volumetric mandates under the Renewable Fuel Standard, and various production and blending tax credits. For electric vehicles, attractive EV rate schedules can be an effective tool for increasing uptake of alternative fuel. It is worth noting that properly designed EV tariff structures can also provide financial and operational benefits to utilities. Time of use pricing offers customers an incentive to charge their vehicles during off-peak hours and lowers fuel costs to EV drivers while also providing valuable load leveling for the utility, thus lowering grid operations costs and potentially increasing the penetration of renewable electricity sources.

The Northwest California study region contains areas served by five different electric utilities: Pacific Gas & Electric, Pacific Power, Shelter Cove, Trinity Public Utilities District, and Ukiah. Of these, only Pacific Gas and Electric offers any rate incentives for customers with plug in electric vehicles in California. Pacific Gas and Electric offers non-tiered time of use rates both wrapped into the whole-house electricity usage of customers (EV-A) as well as through a separate meter and dedicated EV charging circuit (EV-B). They are also piloting a sub metering program on a limited basis, using third-party meters to enable billing of EV charging separately, and on a different rate schedule, than the rest of the bill without installation of a dedicated circuit. Such a system can deliver the benefits of time of use pricing without the additional charging infrastructure cost and is being piloted at the behest of the California Public Utilities Commission.

3.2.2 Deploying Effective Incentives

Many recent studies have found financial incentives for the purchase of AFVs to be an effective tool for promoting their uptake. One study found that for 82 percent of their research subjects, the availability of financial incentives for AFV purchase would impact vehicle

choices.¹¹ Similarly, another study investigated the effectiveness of hybrid vehicle tax credits included in the Energy Policy Act of 2005, finding that a \$1000 rebate would lead, on average, to a 4.5 percentage point increase in hybrid vehicle sales.¹² This aligns very well with a third finding, that a \$5000 increase in vehicle subsidy in the United States would increase uptake of PHEVs from 10.4 percent to 31.1 percent and that of BEVs from 3.6 percent to 10.7 percent.¹³ Figure 14 shows the Congressional Budget Office estimate of tax credit levels necessary for electric vehicles to be cost-competitive with conventional vehicles.



Figure 13: Tax Credits Necessary for Electric Vehicles to be Cost-Competitive with Conventional Vehicles at 2020 Vehicle Prices

Results are based on an assumed discount rate of 10 percent and assumed prices (in 2010 dollars) of 3.90 per gallon for gasoline and 0.12 per kWh for electricity. PHEV-4 = plug-in

¹¹ Krause, Rachel M., Sanya R. Carley, Bradley W. Lane, and John D. Graham. 2013. *Perception and reality: Public knowledge of plug-in electric vehicles in 21 United States cities*. Energy Policy 63:433-440.

¹² Jenn, Alan, Ines L. Azevedo, and Pedro Ferreira. 2013. *The impact of federal incentives on the adoption of hybrid electric vehicles in the United States.* Energy Economics 40: 936-942.

¹³ Tanaka, Makato, Takanori Ida, et al. 2014. *Consumers' willingness to pay for alternative fuel vehicles: A comparative discrete choice analysis between the United States and Japan*. Transportation Research Part A. 70:194–209.

¹⁴ Congressional Budget Office. 2012. *Effects of federal tax credits for the purchase of electric vehicles*. (https://www.cbo.gov/publication/43576).

hybrid electric vehicle with a 4-kilowatt-hour battery; AEV-24 = all-electric vehicle with a 24-kilowatt-hour battery.

A slightly different view of the AF incentives landscape emerges from the work of Hackbarth and Madlener, who evaluated willingness to pay for various AFV amenities among several categories of German AFV buyers.¹⁵ Looking at fuel cost, driving range, refueling infrastructure, carbon dioxide emissions, and non-monetary government incentives the researchers found that the importance of different characteristics varies largely by consumer category. Somewhat counter-intuitively, the research indicates that purchase price and fuel cost are relatively unimportant in driving AFV uptake. The authors' explanation for this finding is that the AFV consumer base tends more towards the technophile, environmentalist, and higher-income portions of the populace. These individuals purchase AFVs for characteristics unrelated to price. The authors conclude that among these consumers, the most valued AFV characteristics are amenities such as free parking, high occupancy vehicle lane access, and availability of fast-charging infrastructure. This finding is useful, as these are amenities that can be provided in a cost-effective manner through local/regional action.

Some researchers also question whether the types of financial incentives typically offered are an effective means of reducing petroleum consumption and GHG emissions. A Congressional Budget Office study on the impact of federal tax incentives on EV uptake estimates that these incentives cost between \$3 and \$7 per gallon of gasoline saved, and between \$230 and \$4,400 per metric ton of carbon dioxide equivalent emissions avoided.¹⁷ These costs indicate that the federal tax incentive is a comparatively costly mechanism for emission abatement. By way of comparison, the median price of emission allowances paid in the May 2015 auction under California's cap-and-trade system was \$12.63 / ton.¹⁶ Moreover, if the goal is a decrease in GHG emissions, a more efficient approach might be to increase the excise tax applied to gasoline, which would impact AF uptake as well as vehicle fuel efficiency and driving/planning decisions through a single mechanism.

There is also some uncertainty as to whether emission reductions from incentive driven AFV uptake are illusory, as automakers are ultimately constrained by Corporate Average Fuel Economy standards. Since the Corporate Average Fuel Economy standard sets the average fuel economy across an automaker's entire fleet – a limit that the manufacturers are unlikely to exceed – incentive-driven increases in sales of fuel-efficient AFVs will be offset by the increased sale of fuel-inefficient vehicles elsewhere in the market.**Error! Bookmark not defined.** According to the Congressional Budget Office's study, the only mechanism through which these incentives will ultimately impact overall transport emissions is through causing an unanticipated increase in uptake of fuel-efficient vehicles, thereby allowing future revisions of Corporate Average Fuel Economy standards to be more aggressive in their fuel efficiency targets than they would otherwise have been.

¹⁵ Hackbarth, A., & Madlener, R. 2013. Willingness-to-Pay for Alternative Fuel Vehicle Characteristics: A Stated Choice Study for Germany. E. ON Energy Research Center. FCN Working Paper No. 20/2013.

¹⁶ The California Air Resources Board. <u>*California Cap-and-Trade Program and Quebec Cap-and-Trade System May</u></u> <u>2015 Joint Auction #3</u>. (http://www.arb.ca.gov/cc/capandtrade/auction/may-2015/summary_results_report.pdf).</u>*

While investigations into the efficacy of various incentive structures differ in their view of current instruments, there is some consensus as to design characteristics that could make these incentives more efficient. Income tax credits require a tax appetite greater than the amount of the credit, which gives them a potentially regressive effect. In 2011, the Congressional Budget Offices estimated that only 20 percent of potential tax filers owed federal income taxes of at least \$7,500, or the maximum zero emission vehicle rebate at the time. Error! Bookmark not defined.

Many analysts suggest that a point of sale incentive would be more effective than current mechanisms in stimulating demand for AFVs. Unlike an income tax credit, a point of sale rebate benefits all purchasers regardless of tax bracket, is simple to understand, certain, and immediate. Gallagher and Muehlegger found that a sales tax waiver of \$1,000 would lead to a 45 percent increase in sales of hybrid vehicles, compared to a 3 percent increase resulting from an income tax credit.¹⁷ To increase efficacy, the California Air Resources Board is considering a shift to a point of sale rebate model for California rather than the current system of post-purchase rebate claim. Regardless of approach, consideration should be given to ensure that the incentive doesn't increase consumer tax obligation, and to address potential erosion of the sales tax base for state and local government.

Approximately 30 percent of consumers who purchase zero emission vehicles in California never apply for a rebate.10 While some of this is due to lack of outreach regarding the availability of the incentive, much of it is probably also related to the economic circumstances of many early plug-in electric vehicle adopters. This fraction of zero emission vehicle consumers clearly is not driven by the rebate and a shift to a point of sale model would mean providing a rebate for these sales as well. To avoid this unnecessary expenditure, the California Air Resources Board's staff has recommended the creation of an income eligibility limit for the zero-emission vehicle purchase rebate. DeShazo (2014) examined the California plug-in electric vehicle rebate program and found that rebate structures that place eligibility caps on income, vehicle price caps and/or provide higher rebates for lower income consumers will tend to result in comparable or greater numbers of vehicles sold with greater program cost effectiveness and greater allocative equity across income levels.¹⁸ If the recommendation is approved, individuals with annual incomes of more than \$250,000, and joint filers with annual income of more than \$500,000 would be ineligible for the rebate. The California Air Resources Board staff have also considered increasing the size of the rebate for low- and moderateincome consumers whose purchase decisions may be more likely to be swaved by these funds and who have to date been under-represented among the purchasers of zero emission vehicles. These developments would benefit the northwestern California region, as they would further increase the reach of AF incentives and uptake of AFVs into the lower and moderateincome communities that make up this region.

¹⁷ Gallagher, Kelly Sims and Erich Muehlegger. 2011. *Giving green to get green? Incentives and consumer adoption of hybrid electric technology*. Journal of Environmental Economics and Management 61: 1-15.

¹⁸ <u>University of Michigan Energy Institute website</u>. (https://energy.umich.edu/).

3.2.3 Barriers and Solutions to the Increased Penetration of Alternative Fuels and Alternative Fuel Vehicles

Incentives are intended to help overcome barriers to the increased penetration of alternative fuels and alternative fuel vehicles. In order to evaluate existing and potential incentives, key barriers were first identified for the Northwest California region. The focus within this task was primarily on actions that regional stakeholders can take, and also included federal and state actions that would affect AF uptake.

3.3 Develop Strategic Plan for AF Market Development

Addressing the goal of increasing adoption of AF, the barriers and opportunities related to market development were assessed. Extensive stakeholder outreach was conducted in order to include multiple perspectives and identify key challenges specific to the Northwest California region. Multiple stakeholder working groups provided feedback on the recommended actions.

3.3.1 Potential Barriers to Uptake of AF

Identifying existing and potential barriers was critical to identifying next steps. Some barriers were found to be common across several alternative fuel vehicle types (e.g., higher initial costs), while others are specific to only one vehicle or fuel type (e.g., limited range and charge time for BEVs).

The following is a summary of identified barriers and the types of AFVs to which each applies are identified in parenthesis (i.e., BEV, PHEV, hydrogen fuel cell electric vehicle, flex-fuel/biofuel). Note that where the term plug-in electric vehicle is used, this applies to both BEVs and PHEVs.

- 1. Higher capital cost (plug-in electric vehicle, hydrogen fuel cell electric vehicle, flex-fuel): Most alternative fuel vehicles command a higher up-front cost than a comparable conventional internal combustion engine vehicle.
- **2. Limited range (BEV):** Limited driving range can be a real or perceived barrier for potential BEV drivers, as most BEVs cannot be driven long distances without recharging.
- **3. Limited product offerings (plug-in electric vehicle, hydrogen fuel cell electric vehicle, biofuel):** The variety of alternative fuel vehicles available on the market today is relatively limited, covering only a small subset of the wide range of end-use activities that vehicles serve.
- **4. Long charging times (plug-in electric vehicle):** The time required to charge electric vehicle batteries is long in comparison to the time required to refuel vehicles that utilize liquid or gaseous fuels (e.g., conventional gasoline and diesel, biofuel, natural gas, propane, and hydrogen powered vehicles).
- **5.** Risk aversion, market inertia, and lack of awareness (plug-in electric vehicle, hydrogen fuel cell electric vehicle, biofuel): Social factors can inhibit the deployment of a new technology, such as alternative fuel vehicles, into an existing market. These include potential customers being unfamiliar with the technology, uncertain about its costs and benefits, unaware of its market status and availability, unaware of available incentives, averse to risk, and thwarted by personal and/or market inertia.

- 6. Information gap at the primary point of sale (plug-in electric vehicle, hydrogen fuel cell electric vehicle, biofuel): Barriers can also occur at various points in the supply chain, such as with sales personnel. For example, some auto dealers have been reluctant to aggressively market plug-in electric vehicles, citing a greater time commitment required selling them and lower profit margins compared to conventional vehicles with internal combustion engines.¹⁹ A survey of over 2,000 plug-in electric vehicle buyers in California in December 2013 showed the vast majority was "dissatisfied" with their purchase experience.²⁰
- **7. Road usage charges (plug-in electric vehicle):** Currently the funding to develop and maintain roads and highways relies heavily on gasoline and diesel taxes. Individuals who drive more fuel-efficient vehicles tend to pay less in gasoline taxes, and electric vehicle drivers don't pay any. This is currently a de-facto subsidy to plug-in electric vehicle drivers, although a very indirect one that is generally not readily obvious to the vehicle owners.
- 8. Lack of public fueling infrastructure (plug-in electric vehicle, hydrogen fuel cell electric vehicle, biofuel): This barrier is in part due to the classic "chicken-or-the-egg" conundrum. Fuel providers will not deploy fueling infrastructure if there are not enough vehicles to utilize it, and consumers will not buy alternative fuel vehicles if they can't refuel them.
- **9. Barriers to residential charging infrastructure (plug-in electric vehicle):** The main barriers to widespread adoption of single-family residential charging for plug-in electric vehicles appears to be the cost and effort of installing wiring and equipment, including upgrades to electric service panels in some cases. Permitting requirements can be an additional hurdle. Residential charging can also be problematic for rental properties and for the multi-family residential sector where the benefits of EV charging are often not realized by the same entity that bears the cost of installing the charging infrastructure.
- **10.** Zoning/permitting barriers for alternative fuel stations (plug-in electric vehicle, hydrogen fuel cell electric vehicle, biofuel): Biofuel dispensing facilities will typically be added to existing gasoline stations and uses the same or similar equipment. Therefore, zoning and permitting for biofuels should not be much different than for existing gasoline stations. Hydrogen fuel poses additional zoning and permitting challenges, as it has unique physical characteristics (it is a gas, is dispensed at up to 10,000 pounds per square inch gauge and has different flammability characteristics) and is less well understood by the general public. Permitting for EV charging stations is still relatively new but has not proven to be a significant barrier in the region. EV charging stations are usually considered to be an auxiliary use and do not require special zoning approval. However, for larger EV charging station installations (i.e., numerous chargers), it is possible that a conditional use permit may be required.

¹⁹ <u>Electrification Coalition website</u>. (https://www.electrificationcoalition.org/).

²⁰ EV Owner Demographics & Diffusion Survey. 2014: Center for Sustainable Energy.

- **11.** Lack of standardization in public charging infrastructure (plug-in electric vehicle): A lack of standardization of plug-in electric vehicle charging infrastructure can present difficulties for plug-in electric vehicle drivers.
- **12.** Lack of fuel production and distribution infrastructure (hydrogen fuel cell electric vehicle, biofuel): In addition to a lack of alternative fuel retail providers in the Northwest California region, there is also a lack of local alternative fuel producers.
- **13. Blend wall (biofuel):** A blend wall is a maximum percentage of ethanol that can be blended into gasoline per Environmental Protection Agency regulation. This limit to ethanol content of fuels results from a political debate hinging on the design characteristics of vehicles as well as the interests of both biofuel and petroleum industries.
- **14. Feedstock price volatility (biofuel):** Supply risk of biofuels can be significant and can adversely affect both producer and consumer welfare.²¹ The yield and price volatilities of biofuel feedstocks affect the availability of raw materials for biofuels production, which in turn impacts biofuel supply and cost. Adding biofuels to the current petroleum-based energy sector may initially lower supply risk by diversifying the fuel mix. However, in a scaled-up scenario, biofuels could increase overall transportation energy supply risk as these agricultural supply variations are compounded with the existing volatility in oil prices driven by geopolitical and economic fluctuations
- **15. Public perception (biofuel):** First generation biofuels are made from sugar crops (sugarcane, sugar beet), starch crops (corn), oilseed crops (soybean, rapeseed, palm oil), and animal fats. While it was originally thought that there would be significant environmental gains by using these fuels made from domestic biomaterials, careful analysis has shown that some first generation biofuels may not offer much in the way of environmental benefits, as they can compete with food crops, harming food security and indirectly causing GHG emissions through land use change. Because of this, biofuels in general have acquired somewhat of a tarnished name. However, some first-generation biofuels, as well as second-generation cellulosic biofuels, can offer substantial environmental benefits. In order for these biofuels to achieve substantial market share they may need to overcome some of these market-spoiling issues associated with first generation fuels.
- **16. Miles per gallon reduction (biofuel):** Ethanol contains approximately 30 percent less energy than gasoline per unit volume, so vehicle fuel economy of E-85 can be reduced by about 25 percent, depending on gasoline formulation and vehicle characteristics. Biodiesel contains 8 percent less energy per gallon than typical No. 2 diesel in the United States. The lower energy content per gallon in liquid biofuels will result in reduced vehicle range and increased fuel consumption.

²¹ Ghoddusi, Hamed, Mandira Roy, and Jessika E. Trancik. 2014. *Biofuels Supply Risk and Price Volatility*. (http://ssrn.com/abstract=2540274).

- **17. Pure and blended biofuel property issues (biofuel):** There are numerous fuelrelated issues associated with some biofuels, all of which become more problematic for higher proportion biofuel blends.
- **18.** Lack of carbon intensity accountability (plug-in electric vehicle, hydrogen fuel cell electric vehicle, biofuel): Petroleum-based fuels have a long history of externalized societal costs, which sustains an artificially low price point for this incumbent fuel. Emerging vehicle technologies also present challenges for legislation that relies on petroleum-based fees, such as the Highway Trust Fund. The switch to low carbon fuels presents an opportunity to create a universal costing system for transpiration fuels.
- **19.** Lack of vehicle maintenance support (plug-in electric vehicle, hydrogen fuel cell electric vehicle, biofuel): A lack of trained mechanics can be a barrier to the uptake of alternative fuel vehicles.
- **20.** Lack of safety and first responder training (plug-in electric vehicle, hydrogen fuel cell electric vehicle, biofuel): Fire, police, ambulance, and other first responders need to receive regular training regarding safety issues related to alternative fuel vehicles they are likely to encounter.
- **21.** Lack of towing and salvage training (plug-in electric vehicle, hydrogen fuel cell electric vehicle, biofuel): towing and salvage companies are a critical part of the automotive support industry. However, these companies are often overlooked when considering safety and vehicle requirements. Towing companies assisting stranded alternative fuel vehicles will need to know where the local fueling stations are, which dealerships and mechanics service the vehicles, specific details of how electric and hydrogen vehicles behave when they run low on our out of fuel, and any unique safety considerations when towing or hauling these vehicles.
- 22. Lack of standardization of proprietary vehicle software (plug-in electric vehicle, hydrogen fuel cell electric vehicle, biofuel): Computers have become increasingly important in vehicles and require software to operate them. A lack in standardization of software development has resulted in numerous challenges.

3.3.2 Summary of Key Strategies to Increase the Availability and Demand for Alternative Fuels in the Region

The following are proposed recommendations to promote deployment of alternative fuels in the Northwest California region. The proposed strategies fall into the categories of:

- Market Development Actions, Funding Mechanisms and Incentive Programs
- Permitting and Zoning
- Safety, First Responder and Auto Support Industry Training
- Outreach and Promotion

The project team identified the opportunity to leverage the framework and resources of the United States Department of Energy's Clean Cities Program to move forward with implementing these strategies in the region.

Agencies with authority to execute the recommended activities are noted in parenthesis following each posited solution. The following notation is used to identify the agencies and parties who can adjust procedures or amend codes to streamline the permitting process for alternative fuel infrastructure:

S = State of California departments and agencies,

L = Local government, such as planning and permitting departments, City Councils and Boards of Supervisors,

C = Coalition of local agencies, AF developers, and non-profit entities supporting the efficient development of alternative fuels in the region.

3.3.2.1 Market Development Actions, Funding Mechanisms and Incentive Programs Funding mechanisms and incentives are emphasized, with a focus on actions that regional stakeholders can take. These actions and incentives include those aimed at increasing purchases of alternative fuel vehicles, increasing installation of alternative fueling infrastructure, and increasing availability of the alternative fuels themselves.

- R1. Work with local and State financing entities to create, or to increase access to AF vehicle financing incentives such as loan guarantees or preferential rates for AFV loans (S, L, C).
- R2. Provide financial assistance to overcome the incremental cost increase in replacing fleet vehicles with AFV technologies. Ensure that assistance is available to all regions and fleet sizes throughout the state that will be required to comply with new low-carbon emissions standards (S, L, C).
- R3. Create incentives for used vehicle dealers to source used AFVs from the SF Bay Area where economic and demographic circumstances have led to a larger pool of such vehicles on the market (S, L, C).
- R4. Provide perquisites such as free or convenient parking for AFVs in publicly owned lots and/or metered spots. Provide access to high occupancy vehicle lanes where appropriate for AFVs. Also, collaborate with other jurisdictions to enable reciprocity in those perks (S, L).
- R5. Consider subsidizing alternative fuel costs. For example, jurisdictions could provide free public electric vehicle charging. Subsidies for other fuels could be provided at comparable subsidy levels to encourage a range of alternative fuels (S, L).
- R6. Work actively to transition publicly owned fleets to AFVs as defined in Executive Order B-16-2012. State agencies have been active in this regard, targeting a 25 percent zero emission vehicle share of light duty vehicle purchases by 2020. Local agencies should follow suit; this will stimulate the local market for the vehicles and their fuels as well as increasing their visibility and familiarity in local communities. State funds, many of which are earmarked for economically disadvantaged communities, should be leveraged to bring down the cost associated with these purchases (S, L, C).
- R7. Initiate AFV phase-in for heavy-duty vehicles (e.g., >14,00lbs. GVWR) in the large and public fleets first to prove efficacy of alternative fuels in different applications and

across fleet vehicle types. Then, performance data, reduced fuel costs, and emissions control compliance advantages can be communicated to smaller fleet operators (S, L).

- R8. Vehicle purchase incentives are currently after purchase rebates and tax breaks. Pointof-sale incentives have been found to be more effective and are recommended. In addition, income eligibility guidelines that can help improve the cost effectiveness of incentive programs are also recommended (S, L).
- R9. Advocate for manufactures to offer a greater variety of vehicle types. One potential approach could be to collaboratively work with local governments, businesses, and fleets to identify needs, and voice a possible commitment of purchase should the vehicles become available (S, L, C).
- R10. Replace "least first-cost" procurement policies in public fleets with language that allows price flexibility, price preferences, life cycle costing, or other approach that considers benefits beyond initial price (S, L).
- R11. Implement a "buy local" requirement for public fleets to encourage local dealerships to increase the availability of AFVs and relevant maintenance services (S, L).
- R12. Engage auto manufacturers in an effort to improve on existing on-board diagnostic code standards and begin discussion around ways to address challenges associated with proprietary on-board software and the increased automation of vehicles (S).
- R13. Advocate for government funding for AF fueling infrastructure in Northwest California. Given the low population density and economic circumstances in the region, private markets may not provide for this infrastructure. However, its presence in the region would provide a public good, both to local residents and to others who may want to travel to Northwest California, warranting government investment (L, C).
- R14. Collaborate with local electric utilities, local EV charging station installers, and private companies to standardize the end-use customer interaction with EV charging stations installed for public use, focusing on consistent payment methods and charger access (S, L, C).
- R15. To ensure adequate geographic coverage, subsidize critically located but underutilized fueling stations (S, L).
- R16. Remove barriers to creation of AF infrastructure through fast-tracked permitting, consistent codes and standards, and waiver of key fees. Collaborate regionally on development of model permitting and zoning process to ease deployment of AF infrastructure. Seek support from state agencies, notably the Governor's office. See Section R32 or more permitting and zoning actions (S, L).
- R17. Promote installation of EV charging infrastructure at targeted, high-impact locations where drivers spend significant time parked away from home (examples include workplaces and public transportation hubs) and in multi-family settings (L, C).
- R18. Create incentives for businesses to install AF infrastructure, and lead by example by installing such equipment at public agency offices. For example, provide recognition as

a "green business" for businesses incorporating alternative transportation fuels into their operations (S, L, C).

- R19. Mandate that EV charging station be installed at any significant new parking lot development, requiring at least one charger per set number of new parking stalls. Provide technical and/or procurement support to enable this. Mandating EV charging station be available at multi-unit dwellings greatly expands the potential market for EVs. See Section R32 for more permitting and zoning actions (S, L).
- R20. Collaborate intra- and inter-regionally on the installation of AF fueling infrastructure along major highway corridors, facilitating both intra- and inter-regional travel (L, C).
- R21. Incentivize local public and private fleets to host fueling infrastructure that is accessible by the public (S, L, C).
- R22. Encourage plug-in electric vehicle dealerships to offer package deals to single-family homeowners that include the installation of a residential plug-in electric vehicle charger (S, L, C).
- R23. Offer incentives that help offset the cost of new AF equipment or the conversion of existing equipment to support AFs (S, L, C).
- R24. Mandate that any AF infrastructure built with public funds to be accessible to the public and be built to be compatible with as many vehicle types as possible. In the case of EV charging station, require that it be built on the Open Charge Point Protocol 2.0 standard. Encourage the same level of accessibility for privately funded AF infrastructure through incentives such as fast-tracked permitting and fee waivers. See Section R32 for more permitting and zoning actions (S, L).
- R25. Develop highly visible AF infrastructure markings and signage. An example is the Washington State requirement that EV charging station spaces be identified with green pavement markings. Ensure that the presence of AF supply infrastructure is clearly marked along nearby traffic corridors. This involves collaboration among entities from local agencies to California Department of Transportation and the Federal Highway Administration on development of consistent symbols and signage protocols to ensure driver awareness. Similar protocols would help make this infrastructure visible to the general public (S, L).
- R26. Where utilities are operated by local government entities, offer time of use pricing or other attractive EV rate schedules (L).
- R27. Explore the possibility of localized production and distribution of alternative fuels and encourage feasible options through incentives, subsidies, or other mechanisms (S, L, C).
- R28. Establish a service that assists fuel sellers in claiming emissions credits from alternative fuel sales. This may incentivize an increase in AF availability as this additional funding stream could alleviate the potential additional costs or risks associated with providing alternative fuels. Consider also leveraging tools that assist fuel sellers and buyers in assessing additional social and environmental impacts of fuel feedstock sources. (S, L, C).

- R29. Encourage biofuel policies that can mitigate feedstock supply risks (S, L).
- R30. Encourage the use of renewable diesel fuels that have no blend wall limit thereby eliminating fuel compatibility issues with exiting diesel vehicles, equipment, and infrastructure (S, L, C).
- R31. Remove the unintended incentive for alternative fuel drivers associated with road usage fees that are not collected from fuels used to fuel AFVs. For example, work towards replacing the existing gas tax with a carbon tax, such as The Gas Tax Replacement Act of 2015 (H.R. 309), that can help bring all fuels, including petroleum-based fuels, onto a level pricing playing field by internalizing environmental impacts (S, L).
- R32. Actively support State and Federal efforts that address blend wall issues (S, L, C).

3.3.2.2 Permitting and Zoning

Amending zoning codes and streamlining the local permitting process presents an opportunity to proactively support and accelerate the deployment and use of alternative fuels. Permitting approaches should include all alternative fuels, all known alternative fuel use applications (e.g., both on-road and off-road), and be revisited periodically to include new technologies as they come online.

- R33. Document, centralize, and make publicly accessible the details about the permitting procedures for alternative fueling infrastructure for all jurisdictions in the region (C).
 - a. Address all agency questions so that they are comfortable with the technology before they even see an application (C).
 - b. Go to CalFire and ask what concerns they have well in advance (C)
 - c. Provide on-line and in-office resources explaining the process for permitting each type of alternative fuel dispensing or charging infrastructure at each individual city or county branch office (L).
 - d. Train planning and permitting department staff about the permitting process so they can explain it clearly for any entity seeking a permit (L).
- R34. Form a Uniform Code Committee where members of nearby cities and counties develop permitting and inspection guidelines intended to enhance regional consistency in application and enforcement of existing codes (L, C).
 - a. Encourage planning and permitting staff to contact their peers in neighboring cities with AF stations to see how they handled permitting (L).
 - b. Include input from transit agencies, fleet operators, utilities, planning departments and fuels providers (C).
 - c. Adopt clear local ordinances, permits, and procedures to minimize administrative burdens (L).
 - d. Standardize permitting and inspection fees for AF infrastructure (L).
 - e. Provide clearinghouse of permit process information and where to go to get more information (C).

- R35. Create template for local governments on existing codes and standards for permitting and inspection of AF infrastructure (S, C).
 - a. Provide standard forms that request all pieces of information that will be required by the different agencies with permitting oversight (S, L).
 - b. Establish reasonable permitting fees; the cost of the permit should cover the time necessary to issue the permit (including necessary plan checks), as well as the time to inspect the installation (L).
- R36. Leverage existing codes when drafting codes specific to alternative fuel stations (S, L, C).
 - a. All alternative fuel regulations, codes, and jurisdictions with enforcement authority in the state of California are listed in the "California / Environmental Protection Agency Fuels Guidance Document, Version 1.0" (2011). This document contains information specific to every type of alternative fuel, contacts for each agency with oversight, and provides standards and requirements for fuel use, labeling, dispensing, vapor recovery, and other aspects of AF use.
 - b. The most commonly used codes pertaining to AF infrastructure are:
 - i. The California Building Standards Code, Title 24, California Code of Regulations,
 - ii. Title 24, California Code of Regulations, California Fire Code Chapter 43,
 - iii. The National Fire Protection Association 52 Vehicular Gaseous Fuel Systems Code,
 - iv. The National Fire Protection Association 70 National Electrical Code,
 - v. The National Fire Protection Association 30A code for Motor Fuel Dispensing Facilities and Repair Garages,
 - vi. The National Fire Protection Association 57, 59A codes for Liquefied Natural Gas Vehicular Fuel Systems,
 - vii. The National Fire Protection Association 50A, 50B codes for Hydrogen Fuel,
 - viii. The International Fire Code, and
 - ix. Health and Safety codes.
- R37. Make online and over-the-counter permitting available for basic AF installations and upgrades (L).
 - a. Establish a unique permit for installing each type of alternative fuel infrastructure; this will allow AF providers and fueling station developers to know exactly what is required to complete the permit process (L).
- R38. Consider the following recommendations for streamlining the permitting process of EV charging stations:

- a. List EV charging as a permitted use across a broad range of zoning classifications. If a zoning review is triggered, consider EV charging infrastructure as an "accessory" to another permitted use whenever possible.
- b. Allow for new EV charging infrastructure to be added to existing building permit / viewed as an additional "common utility" to existing permitted building (L).
- c. Avoid requiring an electrician to be present during an EV charging infrastructure inspection (L).
- **d.** Allow electricians to self-certify their installations using a standard checklist for inspecting EV charging installations (L).
- e. Create an "EV charging station permit" even if it is the same permit needed to install a washing machine in garage and put this permit application on the city or agency website (L).
- f. Consider "bulk sticker" permitting for EV charging infrastructure with random inspection process (L).
- R39. Allow for on-line or over-the-counter permits where applicable. This approach allows contractors to purchase permits online and follow the same inspection procedures as a regular permit.
- R40. Consider passing policy to wave requirements for other improvements for AF infrastructure upgrades at existing fueling facilities (L).
- R41. Develop fueling facility design standards (such as compressor noise abatement requirements) for gaseous fuels (S, L).
- R42. Develop and/or amend codes that provide specific requirements for all types of alternative fueling stations (L).
 - a. Start with the most common AF fueling / charging applications (L).
 - b. Allow for flexibility in the zoning code; eliminate the need for new building permits for straightforward AF infrastructure (e.g., re-purposing an underground fuel tank to E-85 or Biodiesel) (L).
 - c. Allow flexibility in parking space requirements when the facility owner installs AF fueling / charging infrastructure (e.g., decrease the number of parking spaces required for a facility or increase the amount of retail space allowable per parking space) (L).
- R43. Require new construction permits to have EV charging conduit and/or pre-wiring installed in all structures, meeting or exceeding California building code. Even if EV charging station isn't being installed at the outset, ensuring that necessary wiring, conduit and panel capacity are in place from the outset removes a barrier to later installation of chargers (S, L).
- R44. Make sure there is sufficient land zoned to allow for new alternative fuel supply stations to be developed (L). For example, amend zoning codes to explicitly

- a. Allow alternative fueling infrastructure at existing gas stations, truck stops and corporation yards as these sites are already designed for large fuel truck ingress, egress, and turn-around, and already have ADA compliant features (L).
- b. Encourage alternative fuel dispensing / charging equipment at existing gas station locations within one mile of any major transportation corridors (L).
- c. Allow alternative fueling infrastructure in certain commercial and/or industrial zoned properties (L).
- d. Allow compressed natural gas fueling stations where there is a viable gas supply line running along the property; permitting at these sites is more straightforward as natural gas is already there (L).

3.3.2.3 Safety, First Responder and Auto Support Industry Training

- R45. Actively engage with first responder training material development organizations to encourage the creation and mandating of time-scalable alternative vehicle and fuel courses that can be implemented in a range of scenarios (for example from a one hour "awareness" course to a full 16 hour "train-a-trainer" course) (S).
 - a. Material development organizations include California Specialized Training Institute, Peace Officer Standards and Training, California Training Officers Association, California State Fire Training, and National Fire Academy. Mandates through these organizations will increase level of local training.
- R46. Explore the potential for incorporating alternative fuel training material into existing mandated first responder courses by creating focus tracts where different personnel can take the same course but with a different focus depending on an agency, department, or first responder's needs (S).
- R47. Identify an agency, State or local, that is capable of centralizing training material resources across all safety and first responder stakeholder groups (S, L).
- R48. Work with local OES chapters to coordinate and channel funding for training across safety and first responder stakeholder groups (S, L).
- R49. Treat alternative fuels trainings as "Perishable Skills" training in the near term since safety and first responder teams will likely not use many of the skills in the field in the near future. Encourage or require refresher courses when appropriate or needed (S, L).
- R50. Develop mechanism for first responders to easily identify different types of AF vehicles (L, C). For example, require a sticker or other identifying feature on alternative fuel vehicles.
- R51. Educate building officials and Fire Marshalls about the changes that are required for maintenance facilities that work on low-carbon fueled fleets especially compressed gas vehicle maintenance. For example, address venting, doors, safety and sensor requirements (L, C).
- R52. Communicate with all regulatory and safety agencies early in the permitting process of alternative fuel stations to address concerns and questions. Address all agency

questions and concerns with supporting documentation and examples from other projects (L, C).

- R53. Train fire personnel to do inspections on alternative fuel storage and dispensing equipment; invite fire inspectors from a jurisdiction that already has the relevant infrastructure to participate in training and answer questions.
- R54. Train safety and first responder stakeholder groups on safe fueling procedures for different types of low-carbon fuels.
- R55. Earmark and/or search for funding that provides training to dealership sales staff that addresses information gaps at the point of sale (S, L, C).
- R56. Promote trainings for contractors for AF station installations. Work with State and local officials to earmark funding to support these trainings (S, L, C).
- R57. Promote alternative fuel vehicle trainings for independent mechanics, towing companies, and salvage companies, perhaps through local community colleges, local auto parts suppliers, or private training companies or vocational centers (S, L, C).
- R58. Bolster the training alternative fuel training capacity of local Community College Automotive Technology programs by funding the following:
 - a. Certification of instructors in existing automotive technology departments that results in their ability to offer certified courses on alternative fuel vehicles (S).
 - i. Ensure that certification meets any accreditation requirements of the College. For example, Automotive Service Excellence is a common certification pathway and is required for a program to be accredited by the National Automotive Technicians Education Foundation.
 - b. Integration of alternative fuel vehicle information into existing courses (S).
 - c. Development of separate courses devoted to alternative fuels when the level of demand is appropriate (S).
- R59. Work with training and employment programs, such as the California Employment Development Department or the Siskiyou Training and Employment Program, to fill the gaps in local training needs (S, L, C).
- R60. Explore ways to encourage auto manufacturers to offer trainings on their alternative fuel vehicles in the local region as trainings straight from the manufacturer are preferred by many industry groups (S, C).
- R61. Explore ways to create a local lending library of tools and technical manuals needed by mechanics. Cost is often the primary barrier to obtaining the necessary equipment and information for newer vehicles. This service could be useful to dealerships, independent auto mechanics, roadside assistance, and community colleges (S, C).

3.3.2.4 Outreach and Promotion

The following recommendations relate to marketing, education, and outreach efforts targeted and key stakeholders as well as the general public.

- R62. Promote the availability and marketing of AFVs regionally through outreach to and collaboration with dealerships. Collaborate with dealers in conducting outreach to the community through environmental and automotive events (S, L, C).
- R63. Conduct and coordinate extensive AFV outreach and education campaigns in local communities throughout the region (S, L, C).
- R64. Highlight dealerships that have taken innovative action or have had unusual success in promoting AFVs. Recognize them locally through local media or events and nominate them for statewide recognition. A contest for AFV sales over a season or a year might stimulate participation of dealers as well as media interest (S, L, C).
- R65. Reach out to fleet owners/managers to encourage their uptake of AFVs through training, incentive programs, support, and recognition. Encourage collaboration between dealers, fleet operators, and fueling infrastructure providers (S, L, C).
- R66. Develop a biofuel education and outreach campaign that distinguishes the differences between first second generation biofuels and promotes the benefits of second-generation biofuels. Consider the encouraging uptake of a biofuel certification program that distinguishes and promotes environmentally and socially responsible biofuels (S, L, C).
- R67. Facilitate biofuel trainings for fuel providers, fleet operators, and others using or providing biofuels that clearly addresses the proper storage, dispensing and use of biofuels (S, L, C).
- R68. Develop a sustained education campaign that informs all sectors of the AF market about blend wall issues, and the dos and don'ts with flex-fuel vehicles and high percentage ethanol blends (S, L, C).
- R69. Employ the "Ladder of Engagement" at all city / county planning departments (L).
 - a. The basic level of engagement is awareness of existing AFs brochures and permitting information fact sheets; make sure all counter staff informed about alternative fuels information available (L, C).
 - b. The second level of engagement is to increase AF friendly-ness; create a dedicated permit form and a dedicated person(s) on staff that can answer questions (L).
 - c. The third level of engagement is to dedicate city staff time to go after prime installation sites and partners. The goal of this effort it so identifies and market to owners of sites that are in AF-appropriate zones or already have appropriate use permits for AF infrastructure installations (e.g., gas stations, truck tops, corporation yards etc.) (L, C).
 - d. The fourth level of engagement is to partner on pilot programs, grant applications, and promotion activities to accelerate the deployment and use of alternative fuels (L, C).

3.4 Assess and Develop AF Excluding Electricity Training Materials

The first part of the scope of task 2.4 of the project was to evaluate existing training materials available on AFs for stakeholders such as first responders, fleet managers, vehicle maintenance shops, and fuel distributors, who are engaged with fuel and vehicle handling or related planning efforts.

3.4.1 Non-Safety Training Materials and Programs

Non-safety AF-related training programs involve the many automotive support services and jobs and were compiled through discussions with local stakeholders and training service providers as well as institutional mapping and literature review. Results are compiled into a list of available resources with descriptions and applicable sectors.

3.4.1.1 Sectors and Activities That May Need Non-Safety Training

The following list details sectors and activities applicable to the project region that support the automotive industry and will likely need training, such as basic introduction to AFVs, potential barriers to adoption in local government planning and land use guidelines, technical service skills, guidelines for successful fleet management, etc. Sectors such as manufacturing, engineering, drafting, etc. are not included since there is not a strong presence of these business types with an automotive focus in the project region.

- Mechanics: maintenance services and fuel handling
- **Dealerships:** sale of AF vehicles, informing new owners of unique characteristics of ownership, maintenance services, fuel handling
- Towing / Wrecking: roadside assistance, handling wrecked and discarded vehicles
- Drivers: both professional and public, fuel handling
- **Fuel stations and distributors:** station attendees, fuel handling, fueling equipment ownership and maintenance
- **Banks and Financing Institutions:** specifics needed to satisfy risk assessments on auto loans
- Fleet managers: knowledge of unique characteristics of AFVs, fuel handling
- Auto parts sales: knowledge of vehicles and part sources
- Government agencies: fuel supply permitting / zoning / regulation
- Fuel station compliance inspectors: compliance guidelines, fuel handling

3.4.1.2 Available Non-Safety Training Resources and Services

Available services and resources were found that could be utilized to address non-safety training needs. Although not exhaustive, those found or referred are listed below.

- **1. California Employment Training Program:** this is a state program that provides performance-based reimbursement funds to single entities specifically for job training courses.
- 2. College automotive programs: most of the local community colleges have established automotive programs that could be utilized to develop and offer AF and AFV related technical, certificate, and degree courses. Collaboration with existing programs offered through other colleges is encouraged. Rio Hondo College, in Southern California, offers a well-funded and established set of AFs and AFV certificate and degree programs

that are Employment Training Program certified. Furthermore, John Frala, the head of this program, conducts in-person trainings across the United States and can be contacted to establish local training courses that are Employment Training Program certified.

- **3. Bulk fuel blend sellers:** name brand fuel sellers such as Chevron or Shell often provide training to branded fueling stations. These companies set training requirements and conduct "train the trainer" courses.
- **4. Vehicle Manufacturers:** vehicle manufacturers typically provide training to dealerships. Dealerships are often required to utilize the vehicle manufacturer's training services.
- **5. California Tow Truck Association:** conducts trainings for tow truck companies across the State.
- 6. California Department of Food and Agriculture Division of Measurement Standards: sets standards for fuel quality, dispensing accuracy, and advertising, including for AFs. The California Department of Food and Agriculture also provides training modules for weights and measures officials.
- 7. Center for Advanced Automotive Technology: has been and continues to be funded by federal grants to develop advanced vehicle and fuel training materials that are all made freely available. The intended audiences range from educators to the general public. Materials range from high-level introductory presentations to complete course kits that include lesson plans, quizzes, tests, and lab worksheets.
- **8. Department of Energy, Office of Energy Efficiency and Renewable Energy:** in addition to safety training materials, Department of Energy / Office of Energy Efficiency and Renewable Energy offers training materials for elementary through college-level students, code and permitting officials, local government decision makers, and researchers. Information for different fuels is provided through their Vehicle, Bioenergy, and Hydrogen Technology Offices.
- **9. National Alternative Fuels Training Consortium:** develops and implements training courses and workshops, develops training materials, and manages numerous federal alternative fuel programs.

3.4.1.3 Gaps in Available Non-Safety Training Materials and Services

Non-safety training materials and courses were found from the Center for Advanced Automotive Technology and from numerous community college automotive technology programs outside the project region. These resources were primarily targeted to the academic sector or the mechanic and manufacturing sectors. Additional materials were found from the Department of Energy but varied in breadth of target sectors depending on the fuel with the widest range of materials available for hydrogen. Training materials made available privately through vehicle manufacturers and fueling station manufacturers were not found or requested. Furthermore, while the Division of Measurement Standards does offer training modules, none were found for non-petroleum fuels, and standards for hydrogen fueling stations are still in the process of being developed. Overall the sectors that do not appear to have targeted training materials or resources are towing and wrecking services, general public drivers, auto parts services, and financing institutions. Auto parts services or financing institutions are likely not a high priority. However, it is not clear how basic training for public drivers will be accomplished, particularly for gaseous fuels. Furthermore, training and guidance for towing and wrecking yards should be made a priority. Required materials for these services are likely identical to safety materials already available. However, there do not seem to be targeted training programs for these services.

3.4.2 First Responder and Safety Training Materials and Program

There are many training materials and resources available either related generally to safety or specifically to AF and AFV safety. The following sections list the available training resources, broken up by provider type into government agency resources, free online resources, and private/for-profit resources.

3.4.2.1 State and National Safety Training Agencies

State and regulatory training agencies are listed below. These resources are useful for obtaining information and insight into State efforts to provide AF and AFV related training. Furthermore, coordination between state and local agencies can help the region address training needs.

- **California Air Resources Board:** provides resources for first responders related to hydrogen and electric vehicles and fueling infrastructure as well as to local government planning and permitting officials.
- **California Specialized Training Institute:** part of the California Office of Emergency Services, California Specialized Training Institute provides emergency and safety training certificate programs. They also provide HazMat and codes and regulations training.
- National Alternative Fuels Training Consortium: develops and implements training courses and workshops, develops training materials, and manages numerous federal alternative fuel programs.
- **National Fire Protection Association:** offers a substantial amount of training resources, many free and many for a cost. The California Air Resources Board recommends the Hydrogen Technologies Code for hydrogen fueling infrastructure for first responders, fire marshals, and code enforcement agencies.

3.4.2.2 Freely Available Online Training Resources

Free available online training e-sources for each fuel type are extensive. Rather than attempt to cover all available materials, a subjective attempt was made to identify a small number of the high-quality materials.

3.4.2.3 Private Safety Training Resources

There are number of training companies that were referenced by stakeholders during interviews. These companies are listed here since they comprise a resource base that local stakeholders have drawn on, and that may be relevant to others. Their inclusion (or the exclusion of others) should not be construed as a recommendation or other evaluation of their relative merits.

• Action Training Systems: provides firefighter, EMS, and industrial response training.
- **California Ambulance Association:** a membership organization that numerous ambulance companies in the local region belong to.
- Northern California Training Consortium: Located in Humboldt County and owned by Arcata-Mad River Ambulance Inc., involved in safety training for the trucking and transportation industry.
- **Private Specialists:** There are a number of training specialists in the project region that provide trainings on proper response to vehicle incidents. Many do provide training on AFVs. AFV training, however, is not a top priority for first responders, and therefore availability of in-person instructor-led training on AFs and AFVs is usually quite limited. Two instructors that work for companies providing safety trainings were contacted and interviewed. Both of the trainers interviewed stated that there is a great deal of misinformation surrounding AFV incident response, particularly with respect to EVs.

3.4.3 Summary of Local AF Safety Training Exposure

Table 5 summarizes the feedback received from stakeholders on the amount of exposure to AF safety training across the five-county region. A scale of 1 to 5 was used to gauge how much exposure training staff received on AF and AFV safety training. This scale is defined in Table 4.

Rating	Significance
1	Agency has not received any safety training
2	Agency has considered but not begun training
3	Agency has received relevant training that informs response towards AF handling and response but is not geared specifically for it
4	Agency staff has all completed training at some point on AFs
5	Agency receives continual periodic training to stay up to date on AF response

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Source: Redwood Coast Energy Authority, 2015.

Table 5: Summarized Results from Stakeholder Outreach on Alternative Fuels Safety Training

Stakeholder Group	Has the stakeholder received AF or AFV specific training?	Current process used by stakeholder to obtain training materials
Firefighters	4	Private training services, online, literature, videos, magazines, personal trainers
Law Enforcement	2	Minimal exposure through hazmat training
Ambulance Services	2	N/A

Stakeholder Group	Has the stakeholder received AF or AFV specific training?	Current process used by stakeholder to obtain training materials
Roadside Assistance/ Towing Companies	3	Independent sources, community wide training, and
County Emergency Disaster Response	1	N/A
Franchise Station Owners	3	Emergency shut off protocols. Safety training provided to employees by safety strategist
Fleet Owners	3	Fleet managers who have AFVs in their fleet need technical training to work on vehicles, which includes safety elements
Wholesale Fuel Distributors	3	Emergency shut off protocols
Auto-repair shops	4	Technical training on repair
Dealerships	5	Technical training received through the manufacturer

Source: Redwood Coast Energy Authority, 2016.

A summary description of engagement with each stakeholder group follows:

- **Firefighters:** Firefighters from across the five counties were typically aware, interested, and had previously received some sort of training on AFs and AFVs. Most of the trainings already received related to AFVs were focused on extrication of victims from electric and hybrid vehicles. Sourcing of training materials is not centralized, nor is coordination required. Each department independently finds materials, conducts trainings, or hires private trainers. The types and sources of materials vary greatly from symposiums, online videos and resources, private companies, and state fire agencies. Other sources mentioned by firefighters include federal guides such as Hazmat: Emergency Response Guide from the Department of Transportation and the National Incident Management System from Federal Emergency Management Agency.
- Law Enforcement: Law enforcement agencies receive many of their trainings from a centralized source: The Commission on Police Officers Standards and Training. There are no current Police Offices Standards and Training trainings regarding AF or AFV emergency response. Most accidents in the area are dealt with by California Highway Patrol rather than local sheriffs or police departments. California Highway Patrol has received some exposure and training around electric vehicles and hybrids.
- **Ambulance Services:** Ambulance service employees have not generally received any training on vehicle accidents or safety in general, including with regard to AFs or AFVs.

Most often in the case of an accident, the fire department handles any extrication so emergency medical technicians could avoid hazards.

- **Roadside Assistance/ Towing Services:** Several towing service employees have received training by coordinating with local fire departments and dealerships. Primarily, however, they rely on the California Tow Truck Association and independent research.
- **County Emergency Disaster Response:** The emergency disaster response teams are planned and coordinated by the Office of Emergency Services in each of the five counties. They leave AF and AFV response to the local fire department.
- **Fueling Station Owners:** When employees are hired at fueling stations, they receive training on emergency situations, including how to shut off pumps and who to contact in case of emergency. This training is usually conducted internally by the owner or a hired staff member. Occasionally, propane distributors provide training on use of their equipment if there is a third-party propane service on site, however this training is sporadic.
- Fleet Owners: In some cases, onsite supervisors are responsible for finding and providing safety training related to internal operations and servicing vehicles. Trainings come in several forms, including video, in person exercises, presentations, websites, and printed materials. Certain HazMat trainings are required by each county, depending on which types of materials are stored on site. "Right to Know Protocol" requires information sharing with the county on hazardous materials stored on site, which would include any stored fuels.
- Wholesale Fuel Distributors: Wholesale fuel distributor employees who directly handle fuels receive training on safety protocols for dealing with the fuels. However, those trainings tend to be limited to the fuel currently being used. Since no distributors in the region are distributing AFs, they are not receiving training on them. Current training comes from trade associations and insurance companies. These trainings are provided so as to comply with local and state mandates
- **Auto-repair shops:** Trainings on AFs vary between auto shops. Most employee trainings cover servicing and maintaining vehicles. These trainings include some safety components as well. A few employees received training through ASE or private trainings from equipment salesman.
- **Dealerships:** Technicians at dealerships receive extensive training if they are selling AFVs on their lot. The manufacturer hosts specialized trainings that certify technicians to work on each of their vehicles, around 20 percent of time devoted to training involves some information on safety.

3.4.4 Identified Gaps

Identified gaps are categorized by:

- Existing alternative fuels safety training material, and
- Diffusion of trainings to relevant stakeholders.

Training materials on AFs are abundant in many formats for free. However, these trainings are a low priority for the stakeholders interviewed in the five-county region, and since AF and AFV trainings are not mandated they tend to be infrequent or nonexistent.

3.4.4.1 Gaps in Materials

No gaps in existing safety training materials for AF were identified after an extensive survey of existing safety training materials on AFVs was completed. The existing materials listed in the full report cover all of the fuels studied for this project for both vehicles and fuels, although it is important to note that the trainings found in this study may become obsolete as technologies change.

It is also worth noting that there is no clear method of ensuring material quality. Furthermore, trainings on AFs have not been integrated into standard extrication, hazardous materials traffic, or other mandated safety trainings, making AF and AFV training less likely to occur.

3.4.4.2 Gaps in Diffusion of Trainings

Significant gaps were found in the diffusion of the trainings to the relevant stakeholders. While training materials are available, they are not actively or uniformly disseminated in the fivecounty region. The personnel who are not responsible for handling vehicles (such as police and ambulance) have not generally received any training related to AFs and AFVs. Firefighters, on the other hand, most often have received training on some AFs and AFVs, most commonly electric vehicles and hybrid electric vehicles. Even so, AF- and AFV-related safety trainings are still a low priority, resulting in significant variation in training exposure across agencies. It has also been noted by firefighter trainers that there is a great deal of misinformation on AFV response and that it is critical that this issue be corrected. Also, there is no centralized source ensuring accuracy and quality of these trainings.

3.4.5 Pilot Stakeholder Trainings

The team piloted the *Alternative Fuels 101 Presentation* to a number of stakeholders, including those involved with non-safety and safety related auto services. This outreach is detailed further in Section 3.5.

3.5 Communicate AF Benefits

As mentioned in Chapter 2, the project involved a significant amount of outreach to relevant stakeholders, including local government, fuel distributors, fleet managers, safety and first responders, private sector, and the general public. Engagement with different stakeholder groups was typically guided by the goals of the different tasks, and various materials were developed and utilized to communicate the benefits of AF in each situation. A summary of the materials and outreach efforts follows.

3.5.1 Education, Outreach, and Promotional Materials

This project developed general and targeted outreach and education materials for different stakeholder groups. General outreach materials included a project flyer handout that provided a basic overview of the project and a webpage. The project flyer is a single page front and back color flyer that details the goals, intended audience and stakeholders, tasks, and timeline of the project.

Targeted materials included the *Alternative Fuels 101 Presentation*, a PowerPoint presentation slide deck, which included a high-level introduction to AF. Two targeted presentations were developed from the presentation slide deck: a local government "basic" presentation and a local government "technical" presentation. The presentations also included a field-tested script for engaging groups during standard 3-minute public comment periods. A set of four 15-20-

minute video modules of recorded information were also provided that included a majority of the information included in the master presentation slide deck.

Two outreach toolkits were also developed: a local government toolkit and a fleet manager toolkit. The local government toolkit includes an engagement script and guide, and a handout providing a brief overview of the strategic plan and local resources. The fleet manager toolkit includes an engagement script and guide, a summary handout of AF benefits, a list of available incentives and funding sources, a list of useful tools to help assess potential costs of different AF, and a light-duty and heavy-duty vehicle buyers guide.

3.5.2 Key Stakeholders and Working Groups

A list of key stakeholders was compiled into a workbook format that is available in a digital format upon request. Three working groups were formed during the project to provide detailed feedback regarding the different project tasks at hand.

- 1. **The Strategic Plan Working Group:** A total of 84 different local government agencies and departments were identified as potential members of the working group, with a subset total of 13 key stakeholders, in addition to project partners who are also key stakeholders, were invited to participate. Of these, 11 invited stakeholders attended. This working group met once during the project period. They were also engaged to provide feedback on a final draft version of the Readiness Plan.
- 2. **Fuel Distributor Working Group:** The project group identified a total of 34 unique, potential stakeholders. A subset of 10 were selected and invited to participate in the working group. Of these, 3 invited stakeholders attended. This working group met once during the project period. They were also engaged to provide feedback on a final draft version of the Readiness Plan.
- 3. **Training Materials Working Group:** A total of 40 different stakeholders were identified as possible working group participants. A subset of 15 were selected and invited to participate. Of these, 9 invited stakeholders participated.

3.5.3 Presentations, Events, and Targeted Outreach

The following sections detail specific outreach and engagement efforts conducted by the project team.

3.5.3.1 Broad Stakeholder Outreach on Training Needs and Materials

The work done to determine training needs for the region was done in two different phases. The first phase conducted a broad stakeholder outreach over the phone and in person to assess how different stakeholder groups receive training for their profession. The second phase put together the Training Materials Working Group. Nearly 60 different agencies and companies were contacted by phone and interview regarding the methods and sources of training they use.

In addition to this outreach effort, representatives of the project presented to the Humboldt Fire Chiefs Association Meeting on January 28th, 2015. Information about the project, and the state policies motivating it, were conveyed. A brief series of questions were asked during the meeting to gain insight into how first responder training occurs in the region, and how coordinated training events are across first responder and safety groups.

Representatives of safety and first responder groups met face-to-face in a meeting held on November 5th, 2015. The remaining stakeholders were interviewed via phone or individually in person during the month of November 2015.

North State California Clean Cities Symposium

One of the main results of the project readiness planning effort is the recognition for the need of a central entity to coordinate and continue the myriad planning and implementation efforts in the local alternative transportation fuel space. In an effort to gauge potential interest by stakeholders in the Northwest California region in forming a central coordinating entity, a symposium was held on February 25th, 2016. The event was held in three different locations simultaneously to facilitate attendance across the project region. Attendees were able to observe the presentations in real time and participate directly in coordinated discussion and dialogue at all three locations. The main event and teleconference broadcast were in Eureka at the Humboldt Office of Education. Two simulcast events were held, one in Redding at the California Department of Transportation District 2 office and one in Ukiah at the Mendocino Council of Governments office.

A list of agencies represented by event attendees is included is shown in Table 6.

Table 6: List of Represented Agencies and Groups at the Clean Cities Symposium

Eureka Location: Humboldt Office of Education Sequoia Center - 901 Myrtle Avenue

Humboldt County Association of Governments

Mendocino County Air Quality Management District

North Coast Unified Air Quality Management District

Office of Congressman Jared Huffman

Office of Assemblyman Jim Wood

Redwood Coast Energy Authority

Schatz Energy Research Center

University of California, Berkeley Transportation Sustainability Research Center

Redding Location: California Department of Transportation WestVenture Office – 1030 Butte Street

California Department of Transportation District 2

City of Redding

Office of Assemblyman Brian Dahle

Redding Electric Utility

Schatz Energy Research Center

Shasta Regional Transportation Authority

Siskiyou County Economic Development Council

Tehama County Air Pollution Control District

Ukiah Location: Mendocino Council of Governments Office - 367 N State Street, Suite 208

Brooktrails Township Community Services District

County of Mendocino

Mendocino Alcohol Fuel Group

Mendocino Council of Governments

Mendocino County Department of Transportation

Willits Area Cyclists

JPB Consulting

Source: Redwood Coast Energy Authority, 2016.

In addition, at each location a vehicle demonstration was coordinated at the end of the event. The groups that donated time and vehicles for these demonstrations are shown in Table 7.

Table 7: Donations for the Vehicle Demo Events at the End of the Clean CitiesSymposium

Agency / Group	Vehicle(s)
Eureka Location	
Ruo Lako Panchoria	Nissan Leaf
	Transit Bus running B20
California Department of Transportation District	Two Chevy Volts
Redding Location	
California Department of Transportation District 2	Nissan Leaf
	Chevy Volt
	EV Charging Station
Ukiah Location	
Mendocino County Air Quality Management	Ford F150 compressed natural gas
District	Chevy Silverado Hybrid Electric Conversion
Event attendee nersonal vehicles	Chevy Spark
	Chevy Volt

Agency / Group	Vehicle(s)
Mendocino Alcohol Fuel Group	90's Chevy Durango converted to run E- 85
	Motorized 2-stroke bicycle running E-100

Source: Redwood Coast Energy Authority, 2016.

3.5.3.2 Alternative Fuels 101 Presentations

Near the end of the project the Schatz Energy Research Center and JPB Consulting gave numerous presentations to local government stakeholder groups. These presentations provided summary highlights of the Readiness Plan, a high-level overview of federal and state alternative fuels policy drivers, and a high-level overview of alternative transportation fuels and advanced vehicle technologies. These presentations also discussed the local benefits of alternative fuels use and the potential for forming a Clean Cities Coalition to help accelerate the diversification of fuels in the region. Outreach materials were provided to supervisors, council members, commissioners, city managers and staff; these materials included the light-, medium-, and heavy-duty Clean Vehicle Buyer's guides and a list of regionally available state and federal incentives. Table 8 summarizes the presentations given.

Stakeholder Group / Event	Date of Presentation
Del Norte County Board of Supervisors Meeting	3/8/2016
Trinity County Board of Supervisors Meeting	3/15/2016
Willits City Council Meeting	3/21/2016
City of Arcata Energy Committee Meeting	3/21/2016
Ukiah Planning Commission Meeting	3/23/2016
Fort Bragg City Council Meeting	3/28/2016

Source: Redwood Coast Energy Authority, 2016.

3.5.3.3 Electric Vehicle Outreach Events

This project took advantage of EV-specific promotion efforts in the region to promote the project to the general public. The project was promoted via handouts and manned tables at five different events from June 2014 through October 2015.

Joint Meeting of the North State Super Region and the California Rural Counties Task Force

This event took place on September 17th, 2015 in Redding, California. The Redwood Coast Energy Authority was invited to speak specifically regarding regional planning efforts for hydrogen fuel cell vehicles. However, information regarding the Alternative Transportation Planning Project was provided, and printed handouts with contact information were provided. The audience consisted of representatives from transportation planning agencies and transit fleet operators across a broad geographic region.

3.5.3.5 Humboldt Transit Agency Board Meeting

The Redwood Coast Energy Authority spoke to the Humboldt Transit Agency board of directors on June 17th, 2015 in Eureka, California. The topic was specifically about renewable diesel, and the current activity in the state regarding this fuel. General information about the project as a whole was also provided. General questions regarding renewable diesel were answered.

3.5.3.6 Energy Policy Research Conference

The Schatz Energy Research Center presented at the Energy Policy Research Conference on September 10th, 2015 in Denver, Colorado. This conference is organized by the Energy Policy Institute and focuses on academic and industry discussions regarding policy in the broad energy sector. A talk was given specifically on the modeling effort developed and employed for this project, and the lessons learned.

3.5.3.7 Humboldt State University Transportation Working Group

The Humboldt State University maintains an active transportation working group that involves campus stakeholders as well as the City of Arcata. The Schatz Energy Research Center gave a presentation on November 18th, 2015 in Arcata, California. The topic was specifically about renewable diesel, and the current activity in the state regarding this fuel. General information about the project as a whole was also provided.

3.5.3.8 Mendocino Farm Hack Event

This event was on the weekend of December 6th, 2014 in Willits, California. The topic of this event was "Fuel Farming for the 21st Century" with a focus on the logistics of small-scale ethanol production from farm waste. The Redwood Coast Energy Authority gave a presentation regarding alternative transportation policy and action by the state, and the potential role of biofuels, particularly in the off-road sector. The audience consisted of local farmers, activists, inventors, and other groups interested in the intersection between farming and climate change policy and action.

3.5.4 Fleet Analysis

As an additional way to engage with fleet managers specifically, as well as to pilot test the Fleet Outreach Toolkit (see section 3.5.1), the project team completed fleet assessments for Humboldt State University and various public and privates' fleets within Mendocino County.

3.5.4.1 Humboldt State University

The purpose of the fleet analysis for Humboldt State University was to determine the opportunity to introduce renewable diesel into their existing diesel vehicle fleet and EVs through a 5-year on-road light duty vehicle replacement program. The analysis coincided well with Humboldt State University's current climate action planning efforts where they are actively compiling briefs on potential actions that can address the climate goals of the campus. The following entities and groups were engaged regarding this fleet analysis:

- Humboldt State University Climate Action Plan Transportation Working Group,
- Humboldt State University Parking and Transportation Committee,
- Campus Sustainability Coalition,
- Campus facilities management,
- Campus business services

3.5.4.2 County of Mendocino

JPB Consulting engaged with fleets in Mendocino County to pilot test the toolkit and gather feedback. In order to assess the relative magnitude and achievability of the targets set by the least-cost scenario, an analysis was completed that looked at potential impacts of converting a portion of fleet vehicles in Mendocino County to a low-carbon fuels mix. Interviews were conducted with public and private fleet operators to assess their fleet characteristics and interest in alternative fuels use. Table 9 shows the fleets that were provided with handout materials developed in the toolkit.

Fleet	Engagement Date
County of Mendocino General Services; Facilities and Fleets Division	4/25/2016
County of Mendocino; Environmental Health Division	4/25/2016
City of Ukiah Electric Utility Department	4/25/2016
Mendocino Transit Authority (Mendocino County public transportation)	4/25/2016
Mendocino Solid Waste Management (C&S Waste Solutions)	4/25/2016
Thompson & Harvey Transportation	4/25/2016
Nick Barbieri Trucking	4/25/2016
Waste Management Ft. Bragg	4/28/2016
Solid Waste of Willits	4/29/2016
Shuster's Transportation. Inc.	4/29/2016
Brooktrails Township Community Services District	4/29/2016
City of Point Arena	4/31/2016
Bray Trucking	4/31/2016
Goselin Transportation	4/31/2016
Orsi Transport Inc.	4/31/2016
Vi Do De Trucking	4/31/2016
Cold Creek Compost	4/31/2016

Table 9: Fleets Engaged in Mendocino County During Targeted Outreach Effort

Fleet operations were provided a copy of the Fleet Outreach Toolkit.

Source: JPB Consulting, 2015.

Results of the analysis indicate that fleet conversions can have a high impact on regional emissions reduction targets. For example, that model showed that converting just 41 percent of the Mendocino fleet vehicles to run off of alternative fuels over the next five years would meet 25 percent of the alternative fuel readiness planning 2020 regional greenhouse gas emissions targets. The model also showed that local fleet use of alternative fuels could help to establish a solid threshold of demand for renewable diesel, biodiesel, and ethanol (E-85) fuels in the region. Fueling Mendocino police car fleets with E-85 would alone provide nearly 1/3 of the demand needed to meet the alternative fuel readiness planning E-85 2020 fuel demand target, and the potential demand for renewable diesel fuels easily exceed the alternative fuel readiness planning target. Conversion of light-duty fleet vehicles to electric or plug-in hybrid electric vehicle technologies resulted in the largest net reductions in both greenhouse gas and criteria air pollutants representing a tremendous opportunity for local government fleets given the established and growing electric vehicle and plug-in hybrid electric vehicle market.

It should be noted that although fleet vehicle conversion to low-carbon fuels could accelerate the proliferation and use of alternative fuels regionally, the operational issues experienced by private heavy-duty fleet operators during the implementation of the 2008 Statewide Bus and Truck Rule has resulted in a residual resistance to state-mandated early adoption of new vehicle technologies. Fortunately, use of drop-in biofuels provides the region and fleet operators with a low-carbon fuel solution that will not require a new vehicle purchase or modifications.

3.6 Alternative Fuels Readiness Plan

In addressing the mission of taking the most efficient approach to reducing greenhouse gas emissions from the transportation sector, the strategic plan, as well as results from all the efforts completed for the Northwest California Alternative Fuels Readiness Project, were compiled into a user-friendly Readiness Plan that focuses on fostering a local vehicle and fuel market that meets the LCFS goal of reducing the carbon intensity of the total fuel mix by 10 percent by 2020. The least-cost path is only one of many possible benchmarks the region can use to accomplish the mission proposed here and should be used as a tool to help provide regional stakeholders gain a sense of the potential impact of changes to the transportation sector.

CHAPTER 4: Conclusions and Recommendations

4.1 Assessment of Project Success

The Northwest California Alternative Fuels Readiness Project culminated in a strong suite of recommendations for building and expanding the AF market, including the deployment of AF infrastructure and promotion of AF within the region. The anticipated outcome of the project was met with the establishment of an engaged network of stakeholders throughout the region that are fostering the implementation of the strategic plan to align with the overall goal of wise and effective deployment of AF infrastructure and development of a robust market for AF.

4.1.1 AF Infrastructure and Deployment Assessment

The main goal of this task was to assess the existing status and key issues of AF infrastructure and AF vehicles. The assessment of AF infrastructure and deployment needs in the region included characterization of the current status of alternative fuels in the region, analysis of potential AF portfolios to meet LCFS 2020 goals, and identification of challenges and best practices for planning, permitting, deployment, maintenance, and inspection of AF infrastructure. Results of this effort include a spatially explicit database of current and projected conventional fuel throughput and existing AF infrastructure that was then used to inform the AF portfolio analysis. Additionally, this task included a description of the currently available fuels and vehicles and current legislation and AF-related planning documents.

In pursuit of fuel consumption data for all five counties within the region, the team realized that each jurisdiction had varying requirements for what throughput they collected. This resulted in defaulting to basing regional estimates of fuel consumption on outputs from and existing database (California Air Resources Board's Emissions Factors 2011 model). These values are model results rather than empirical reported data however the reported values from Mendocino County, which was the only jurisdiction collecting comprehensive fuel throughput data, matched the Emissions Factors 2011 model values quite closely. This substantiated the belief that the model values were an appropriate substitute for actual fuel use for this project. While not ideal, it is considered the most accurate county-level data at present.

The AF portfolio analysis resulted in a recommended fuel mix for the region over the next five year. It is expected that technology and costs will change significantly over the next five years and the model may need to be updated and re-run to reflect changes, but for the purposes of this project, the analysis concluded with a set of targets including the estimated number of vehicles needed, the quantity of each type of low-carbon fuel needed, and AF infrastructure needed, broken down for each county, based on the lowest societal cost of each scenario to achieve the LCFS 2020 targets. The analysis does not account for all of the potential barriers to adoption or the diversity of interests and priorities of local stakeholders. But the findings are valuable to inform discussions with local stakeholders and the overall strategic planning process as one component of a larger, more deliberative community process.

For the third part of this assessment, a substantial effort went into determining how to enable the numerous industries that support the transportation sector in supporting the deployment of AF. The project was successful in identifying the many pathways for a community to streamline permitting processes to encourage AF infrastructure deployment without reducing protections for environmental health and safety. It was also determined that fairly straightforward exercises such as education and collaboration can lead to increased awareness and understanding of existing codes and regulations for AF. Modernized codes and AF-specific requirements can help accelerate the development of a market as well. The success of this task is largely due to an extensive amount of outreach and engagement with a broad network of stakeholders. Interviews with 20 individuals representing AF infrastructure developers, regional planning agencies, and Clean Cities Coalition programs were conducted in addition to a literature review. This engagement resulted in a suite of specific recommendations categorized into state, local, and coalition action items for permitting process improvements, land use and zoning, and education and training.

4.1.2 Analyze AF Incentives

The evaluating incentives task involved describing the current AF incentives landscape, understanding the efficacy of current incentives, and determining and evaluating potential incentives. By identifying key barriers to the increased adoption of AF, the team was able to determine how well the current incentives work to address these barriers and determine potential solutions that could then guide the further use or development of incentives. The result of this task is an easily navigated list of barriers categorized into those that apply to vehicles, AF infrastructure, or AF, and a corresponding list of recommended actions to overcome those barriers. This evaluation was a crucial component of a complete strategic plan and can be used as a starting point to address community needs, and a guide to structure programs so that they are tied to success metrics and phased out over time.

4.1.3 Strategic Plan for AF Market Development

The approach to the strategic plan was similar to that for the incentives evaluation and resulted in a suite of key findings and proposed recommendations to increase the availability of and demand for AF in the region. The recommendations were categorized into those that promoted market development, such as funding mechanisms and incentive programs; permitting and zoning recommendations; training recommendations; and outreach and promotion strategies. A stakeholder advisory group, the Strategic Plan Working Group, was the main tool used to inform the development of the plan, and ensure it was addressing region-specific challenges, key customer segments, and strategic partnerships. The Working Group included 11 stakeholders that met once during the project period and were engaged to provide feedback on the Readiness Plan. This task not only resulted in a plan developed with input and buy-in from committed actors within the AF sector, it also served to educate and engage those stakeholders with less direct involvement with the project.

4.1.4 Assess and Develop AF Excluding Electricity Training Materials

The goal of this task was to develop an AF excluding electricity training class and training materials for fleet operators, planners, first responders, and decision-makers. The proposed components of this task included assembling a training methods and materials task force, obtaining existing relevant materials, identifying challenges to AF vehicle operations for various fleets, conducting at least one pilot training on AF infrastructure development aimed towards

fleet operators, planners, and first responders using the materials developed for this task, conducting a pilot consultation for at least one AF fleet operator to assess increased adoption, and assessing the need for full regional workforce development training on AF and AF infrastructure. The team performed a literature review and surveyed stakeholders about AF and AF infrastructure training. The results were compiled into a list of existing training materials and services, with particular emphasis on freely available resources, and examined to identify any gaps based on the feedback from stakeholders. The Training Materials Working Group met once and consisted of representatives from emergency responder groups, auto repair shops, training/educational institutions, and fleets. Although the Training Materials Working Group was intended to be the focus group that provides insight and guidance regarding training needs and material availability, significantly more interviews were conducted with stakeholders who were not originally selected to be members of the working group; the results of which added to the findings in this assessment. Overall this was a valuable exercise as numerous materials were found to be readily available, but trainings are a low priority for stakeholders and tend to be infrequent or nonexistent. Insufficient funding and a lack of dissemination of information were found to be the main barriers to implementing training. A summary of high-level needs included identifying challenges categorized by stakeholder group (first responders, auto industry service, and local government/public) and suggested actions to address the challenges.

4.1.5 Communicate AF Benefits

The goal of this task was to develop materials and strategies that communicate the benefits of AF to targeted groups and to assist alternative fuel wholesalers/retailers and/or others in the product chain, with the intent of increasing the availability of and demand for alternative fuels. This was an ambitious and all-encompassing goal that involved several components. The first accomplishment was developing a high-priority list of decision-makers and fleet operators that directly impact AF market development. This list is in a workbook form, and also served as a tracking tool for communication with key stakeholders.

The team was able to engage with stakeholders through a variety of avenues, which provided opportunity for a wide level of community participation. Outreach to fuel distributors occurred in parallel with establishing the Fuel Distributor Working Group. The Working Group was able to meet once during the project period to discuss their role in realizing long term project goals and provide input on the opportunities and challenges they see with accomplishing those goals. Targeted presentations made to stakeholder groups and regional fleet operators were meant to both determine materials and strategies that would work best to communicate the benefits of AF to them, as well as secure purchase agreements to demonstrate AF demand.

On the demand side, two high-level fleet operators were targeted and receptive to hearing about incorporating AF into their fleet operations. An analysis was completed for Humboldt State University to provide an overview of the economic, environmental, and social impacts of replacing their petroleum diesel use with a renewable diesel alternative. A presentation was made to the Humboldt Transit Authority as well, proposing renewable diesel for their bus fleet.

Although the project team was not able to catalyze supply or demand agreements between fuel suppliers and distributors, beginning those conversations was an important first step in considering how to approach stated concerns. Distributors generally feel there is not enough AF demand, and too much risk associated with taking on new fuel distribution technologies. They would prefer to serve an existing market rather than take on the risk of kickstarting the market. Suggestions included engaging government fleets to be the "guinea pigs" rather than for-profit businesses. Distributors are also concerned about investing in infrastructure that will become obsolete as state regulations and standards change. In essence, the feedback was extremely valuable in identifying concerns on the supply side beyond just market demand.

The stated goals of the regional AF symposium were to bring together stakeholders to bring them up to speed on state and local efforts related to low-carbon transportation fuels and vehicles, explain the Clean Cities program and outline potential benefits of the program for the region, and develop key decision points to be discussed at a follow-up working meeting of interested stakeholders. The event drew representatives from 22 agencies throughout the region. It was held at three different locations simultaneously to allow as many people from the large five-county Northwest California region to attend. All three locations observed the presentations in real time, participated in coordinated discussion and dialogue, and were able to experience various AF vehicles at the end of the event at each location. Electric light-duty vehicles, transit buses using B-20 biodiesel, a light-duty pickup truck running compressed natural gas, and a sport utility vehicle converted to run E-85 were among the vehicles on display. The symposium was an important culmination to the Readiness Project as participants from working groups, local government, and other key stakeholders were able to come back together to decide on the trajectory and momentum of continued efforts around low-carbon transportation in the region. It was a success in drawing participation and identifying a potential region-wide vehicle to foster implementation of the strategic plan within the Clean Cities Program template.

Alternative Fuels Readiness Plan

The Northwest California Alternative Fuels Readiness Plan includes results of efforts completed for tasks 2.1 through 2.5, as well as an outline of next steps to becoming a Clean Cities Coalition. The Readiness Plan is designed to be a visually inviting document that appeals to a wide audience. In addition to making the subject of low-carbon fuels accessible to industry stakeholders and the public, the Readiness Plan highlights all the efforts currently being made in the community and the overall commitment to meeting our share of greenhouse gas emissions reduction goals. The success of the Readiness Plan is yet to be determined but will serve as a complete and comprehensive plan for the introduction of AF vehicles, wise and effective deployment of AF infrastructure, and the development of a robust market for AF.

4.2 Other Notes, Limitations, and Conclusions

In addition to the above findings, the following are useful to consider in light of our portfolio analysis:

The Northwest California region is not obligated to proactively achieve the LCFS standard. But there is a cost associated with not acting which will be reflected in rising gasoline and diesel prices as the LCFS standard ratchets down over the next five years. Taking action now could position the region to take advantage of the inherent subsidy that cleaner fuel pathways will receive from the higher carbon alternatives. Under the LCFS, conventional vehicles burning fossil fuels will no longer be the cheapest way to travel and so there is an economic opportunity to the adoption of low carbon alternatives.

- Our analysis assumed that the composition of E-10 reformulated gasoline won't change over the next 5 years and was therefore not an option for reducing the carbon intensity of our fuel. But in fact, the ethanol currently blended into reformulated gasoline could be replaced by lower carbon ethanol alternatives and therefore could play an important role in achieving the LCFS target.
- The LCFS is specifically designed to address the carbon intensity of fuels and not the energy efficiency of the vehicles that consume the fuel. Because we approached the analysis through the lens of LCFS, we did not consider fuel efficiency measures as potential options for reducing GHG emissions in the region. A more comprehensive analysis would include hybrid electric vehicles as a potential pathway for reducing our carbon intensity, even though they wouldn't qualify for credits tradable in the LCFS carbon market. In addition, sticking with the LCFS framework causes the GHG savings from plug-in hybrid vehicles to be underestimated. Even while using gasoline, these vehicles are more efficient than a typical conventional vehicle, but these savings are not considered because the fuel itself is the same as that found in a conventional gasoline vehicle.
- Our methodology for estimating the incremental cost of AF vehicles makes a somewhat skewed comparison between, for example, the available plug-in electric vehicles on the market today and the mix of conventional vehicles that people in the region purchase. The disconnect occurs because plug-in electric vehicles are being initially built for the upper tiers of the vehicle market, with the luxury Tesla Model S being the most conspicuous example. This problem also occurs with flex fuel vehicles because most of the available flex vehicles on the market are small trucks, which cost more than cars. The true apples-to-apples incremental cost of the AF vehicles is likely less than what we've assumed. Our rationale for our approach is that these higher-end vehicles are what are available now for drivers to purchase. The market is changing rapidly, but over the next five years we expect that on average, AF vehicle adoption will require that consumers incur both a premium for the AF technology as well as a premium for purchasing a higher end vehicle.
- The marginal abatement costs emerging from this analysis represent the aggregate cost to society of each fuel pathway. These costs are shared between the public sector, private sector, and individuals. Our model does not address the distribution of these costs between the actors; instead we assume that a lower aggregate societal cost is preferable.
- Finally, as in the above example, the analysis presented here does not account for all of the potential barriers to adoption or the diversity of interests and priorities of local stakeholders. Therefore, the findings are meant only to *inform* discussions with local stakeholders and the strategic planning process. They should not be taken as a plan for the Northwest California region, but rather as one component of a larger, more deliberative process.

4.3 Future Work

The analysis detailed in this report raised several interesting questions that merit further study and adaptation:

- The Marginal Abatement Cost Curve approach taken here identifies low-cost options for GHG abatement in the AF space for the region but does not evaluate the actions that would be necessary to meet the deployment targets in the resulting portfolios. A key next step is the evaluation of AF deployment incentives at a variety of levels, the extent to which they are being utilized, how they are structured, and how they might be better designed to optimize AF deployment for GHG mitigation. These questions and others will drive task 2.2 of this project, fleshing out the picture presented by this analysis for the strategic planning process.
- In this iteration of the AF portfolio analysis, the type of ethanol currently present as E-10 in the reformulated gasoline blend is taken as a baseline and is exogenous to the model. In the further investigation of alternative fuel deployment options for the Northwest region, we will consider including a more sophisticated treatment of existing E-10 blends to enable displacement of some existing ethanol fuels by lower-carbon alternatives. This would enable some role for ethanol fuels in lowering alternative fuel carbon intensity even without the blend wall being raised.
- As discussed above, we did not consider natural gas in this analysis because of concerns with fugitive methane driving its carbon intensity above that of gasoline. In the time since we built the model structure, however, the California Air Resources Board has conducted draft carbon intensity calculations for natural gas inclusive of fugitive methane, and their findings indicate a moderate abatement potential. If these findings stand up to the current scrutiny, and are published as an adapted default fuel pathway, we will include this pathway in our analysis.
- Many of the alternative fuels being sold into the LCFS market are under Method 2
 pathways rather than the defaults. We have assumed the default carbon intensities to
 ensure conservative findings and because there is limited data availability surrounding
 the costs of these proprietary processes. However, future investigation could include
 evaluating the potential cost-competitiveness of demonstration-scale fuel pathways
 approved by the California Air Resources Board under method 2. The Stochastic Marginal
 Abatement Cost Curve model will enable consideration of the price point at which these
 fuels would begin to displace other alternative fuel pathways based on their respective
 marginal abatement costs.

4.4 Conclusions and Lessons Learned

Conventional vehicles can be difficult to unseat; consumers know their attributes and are accustomed to buying, driving, and fueling these vehicles. Additionally, petroleum-based fuels have a long history of externalized societal costs, which sustains an artificially low price point for this incumbent fuel. AF vehicles, on the other hand, have many different operational characteristics, but also have new benefits with which drivers and other stakeholders must become familiar. It is expected that technology and costs will change significantly over the next five years, opening doors for some fuels and closing them for others. Regardless of the ultimate fuels mix, the switch to low-carbon fuels presents an opportunity to create a universal costing system for transportation fuels that includes all lifecycle costs and levels the playing field for clean fuels to take hold in our local energy economy.

The barriers to increasing the diversity of low-carbon fuels are mainly related to the relative newness of alternative fuels and are not tied to the efficacy of the fuels and technologies

themselves. Many of these barriers can be surmounted through outreach, education, thoughtful policy, and coordinated regional efforts to establish a low-carbon fuels network.

AF Infrastructure and Deployment

The results of the AF infrastructure and deployment assessment have important implications for both local government entities as well as state regulatory agencies. It is clear that there is no "silver bullet" to achieving the 2020 LCFS target in the Northwest California region, and that a mix of alternative fuel technologies will need to be deployed. It is also clear that battery electric vehicles (BEVs) will play a critical role, as they offer the lowest cost abatement in almost all plausible scenarios for future technology and fuel system development. But BEVs alone will not be sufficient to reach the target because they can only penetrate into the new vehicle market, leaving the existing vehicle stock unaltered. Therefore, a mix of low carbon biofuels (in the form of sugarcane and sorghum derived ethanol and canola derived biodiesel) will be critical to achieving the LCFS target in the next 5 years.

Hydrogen, on the other hand, appears to be too expensive at present to play a significant role in achieving the 2020 target, but with sufficient cost reductions, it has the potential to play a key role in the future due to its relatively low carbon intensity, breadth of applications, vehicle range, and refueling speed. The role of biofuels depends in large part upon lifting the blend wall of ethanol and the extent to which fuel blenders outside the region alter their current ethanol blends to incorporate lower carbon ethanol in their E-10. Without one or both of these developments, it is very possible that the 2020 LCFS target can't be achieved in the region.

The average abatement costs of the technology portfolios suggested by the portfolio model results are typically well over \$100 per tonne of GHG emissions abated, implying that carbon credit prices are likely to rise well above current levels. It is entirely possible that the California Air Resources Board will act to contain these costs in the future, effectively loosening the 2020 carbon intensity target.

4.4.1 Permitting

While alternative fuel vehicles and fuel supply are the primary components needed to forge a low-carbon transportation market, it is just as important to enable the numerous industries that support the auto industry.

Key findings from this research are:

- Current permitting challenges and delays are primarily due to the novel nature of lowcarbon fuels, and local agency unfamiliarity with existing codes pertaining to alternative fuels.
- There are many proven approaches to streamline the permit approval process for lowcarbon fuels infrastructure. Use and adaptation of current building codes as well as collaboration across regional city / county planning and building departments can lead to consistent permitting requirements that will reduce uncertainty, permit approval time, and project development costs.
- Modernized land use codes and low-carbon fuels-specific permitting requirements can provide fleet operators and fuels distributors with opportunities to help accelerate the development of a thriving low-carbon fuels market.

Many of the recommended approaches for overcoming the permitting barriers to developing low-carbon fueling infrastructure can be undertaken by a local coalition comprising public agency representatives, low-carbon fueling station developers, and other community groups supporting a transition to alternative fuels. Other actions such as procedural and code changes will need to be executed by agencies with broader authority such as City Councils, Boards of Supervisors and local permitting and planning departments. Some actions, if undertaken at the state level could eliminate the need for developing new local permitting policies.

4.4.2 Incentives

The marginal abatement costs emerging from this analysis represent the aggregate cost to society of each fuel pathway. It is important to recognize that these costs are shared between the public sector, private sector entities, and individuals. The Stochastic Marginal Abatement Cost Curve model, as is common in marginal abatement cost curve analyses, does not consider the distribution between these actors, and assumes that a lower aggregate societal cost is better. However, in pathways such as BEVs, without significant public-sector subsidies, up-front vehicle costs may reduce uptake by individuals, constraining penetration of that fuel.

Incentives are intended to help overcome barriers, such as the one detailed in the above example. Barriers and proposed solutions related to the uptake of AF vehicles, support services, and fuels were identified throughout the project to inform the strategic plan. The incentives analysis focused on identifying complementary actions to the proposed recommendations.

Currently, financial incentives in the form of rebates and tax credits are the primary incentives for purchasing an AF vehicle. Although rebates and tax credits have been effective in addressing the issue of higher up-front AF vehicle costs, there is some consensus as to design characteristics that could make incentives more effective. Additional financial incentives could be helpful in addressing costs associated with the installation of EV charging equipment, including any necessary electrical upgrades. Monetary awards and local publicity may work hand-in-hand to incentivize dealerships to create a better AF vehicle buying experience.

Financial incentives may also play a part in encouraging the local production of transportation fuels within the region. Reducing the added cost of separate labeling, storage and handling of higher biofuel blends, and targeting vehicle manufacturers to encourage design of conventional vehicles to allow higher biofuel blends, would help overcome the "blend wall" barriers.

Incentives that may be effective in addressing social and technical barriers include providing an extensive network of AF infrastructure and working to improve technologies. Local governments can really only significantly influence the first approach but can lobby state and federal agencies to continue and/or increase funding for research and development. Incentives to encourage private installation of EV chargers, such as a green building attribute, economic zoning incentives, subsidizing soft costs, and minimizing risks could contribute to providing an extensive AF infrastructure network.

4.4.3 AF Excluding Electricity Training Materials

Sufficient materials and resources were found for training technicians and manufacturing workers, as well educate key decision makers such as code and permitting officials and the general public regarding AF and AFVs. However, there is a need for non-safety training to be

implemented, particularly for automotive mechanics in the region. Collaboration between city and county planning and permitting staff, public safety agencies, and fuels providers can lead to increased awareness of existing codes and regulations for AF.

Many quality free safety training materials on AF are also available, including an official 16hour course through the National Fire Academy that is recognized by the state and local fire departments. Firefighters are the most likely to encounter alternative fuels and vehicles in an emergency situation, and some have had AF training in the past, in particular with electric vehicles, but considerably more training is needed. All other first responder and safety stakeholder groups have received little-to-no training on AFs. Mandated training or other avenues towards implementing necessary training will be a key component in implementing the Readiness Plan.

4.4.4 Communicate AF Benefits

Communicating the benefits of AF is an ongoing multifaceted effort. A significant amount of targeted outreach to stakeholders was completed with an equal amount of feedback gained in return. An abundant amount of education and training materials were found to be readily available for AF, and new materials were developed to address targeted needs. Overall, a coordinated strategy worked to engage stakeholders, pilot tools, and further define barriers to increased AF adoption. The Clean Cities Symposium provided a culmination to the outreach efforts and provided a venue for a region-wide initial discussion of how to maintain momentum around the topic of meeting state low-carbon fuel standard goals. Northwest California is well equipped to become a Clean Cities Coalition with a comprehensive strategic plan for moving forward but will need to continue to secure additional stakeholder buy-in over the coming years to fully implement the recommended actions.

4.5 Recommendations

Reducing emissions from the transportation sector is integral to achieving ambitious GHG emissions reductions targets and reduced health impacts from air pollution. With the magnitude of this opportunity in mind, state and local government agencies and all key regional stakeholders must commit to implementing the recommended actions in the Readiness Plan in the immediate near term to pave the way for alternative fuels.

The mix of jurisdictions and goals in the fuels space in California has led to a situation wherein critical data on regional fuel use is not being collected or disseminated. Different agencies are operating in their own remits and no one seems to be tasked with gathering and reporting comprehensive fuel use data. The California Air Resources Board is presumably collecting detailed data on sales at a corporate level as part of LCFS reporting and compliance, but as far as we know these data are not being disaggregated spatially, nor are they being made public except in aggregated form. Regional air quality management districts, tasked with managing air quality, are concerned with gasoline dispensing facilities' emissions compliance rather than total fuel throughput, and only collect the latter data on an ad hoc basis. The Board of Equalization is charged with tax and financial administration and so is concerned with fuel throughput only indirectly. This fragmentation of responsibility in fuels has led to a lack of

comprehensive, spatially disaggregated data on fuel use.²² These data are important for analysis and policy work, and it is our recommendation that they be collected and made available to the public going forward.

There is a chicken-or-egg phenomenon going with alternative fuels: people are not willing to buy low-carbon fuel vehicles until there is fuel available, yet the AF infrastructure is slow to develop absent a market. Agencies need to be doing everything in their power to stimulate this ecosystem if they hope to foster AF deployment. There are many pathways for a community to streamline the permitting process in order to encourage the adoption of lowcarbon fuels without reducing protections for environmental health and safety. High priority actions include:

- Develop statewide permitting standards and/or model regulations to be applied at the local level.
- In absence of statewide permitting standards, form a Uniform Code Committee where members of nearby cities and counties develop permitting and inspection guidelines intended to enhance regional consistency in application and enforcement of existing codes pertaining to low-carbon fuels.
 - Provide standard forms that request all pieces of information that will be required by the different agencies with permitting oversight.
 - Provide on-line and in-office resources explaining the process for permitting each type of low-carbon fuel dispensing or charging infrastructure at each individual city or county branch office.
- Modernize land use codes to include low-carbon fuels-specific permitting requirements.

Streamlined permitting for AF infrastructure can be achieved through early collaboration between city/county planning and permitting staff, public-safety agencies, fuels providers and community stakeholders. This action will lead to increased awareness and understanding of existing codes and regulations for low-carbon fuels, and will allow for a simplified permitting process, which will in turn provide fleet operators and fuels distributors with opportunities to accelerate the development of a thriving low-carbon fuels market in the Northwest California region.

In regard to current incentives, income tax credits require a tax liability greater than the amount of the credit; it's estimated that only 20 percent of potential tax filers owe federal income taxes of at least \$7,500, or the maximum zero emission vehicle rebate at the time.²⁰ Analyses suggest that a point of sale incentive would be more effective than current mechanisms in stimulating demand for AFVs. Unlike an income tax credit, a point of sale rebate benefits all purchasers regardless of tax bracket, is simple to understand, certain, and immediate. To increase efficacy, the California Air Resources Board is considering a shift to a point of sale rebate model for California rather than the current system of post-purchase rebate claim. Regardless of approach, consideration should be given to ensure that the

²² It is possible that these data are in fact being collected, but that we were unable to secure them. If so, we would be eager to gain access to them and would recommend that they be made more publicly available.

incentive doesn't increase consumer tax obligation, and to address potential erosion of the sales tax base for state and local government.

Major biofuels firms should be encouraged to use several risk management strategies, including more resilient production technologies, feedstock crop diversification, feedstock geographical diversification, storage technologies, and financial contracts. Public policy can play a role in a producer's risk management strategies by funding research and development to develop higher yield and more resilient feedstock crops, as well as by incentivizing crop and geographical diversification of feedstock, and by facilitating risk sharing with the fossil fuel sector. Public policy can also reduce the impact of fuel supply volatility by enabling consumers to shift their purchasing patterns between biofuels and fossil fuels. This may require supporting the development and deployment of flex-fuel vehicles, increasing biofuel blend walls, or requiring adjustments to the formulation of targets for the share of biofuels in the total fuel portfolio.²³

Petroleum-based fuels have a long history of externalized societal costs, which sustains an artificially low price point for this incumbent fuel. Emerging vehicle technologies also present challenges for legislation that relies on petroleum-based fees, such as the Highway Trust Fund. This presents an opportunity to create a more universal costing system for transportation fuels.

4.5.1 Regional Commitment to Action: A Clean Cities Coalition

The project team has identified an opportunity to leverage the framework and resources of the United States Department of Energy's Clean Cities Program in order to move forward with alternative fuels readiness efforts in the region. Clean Cities Coalitions provide a framework for businesses and governments to work together as a Coalition to enhance markets, coordinate activities, identify mutual interests, develop regional economic opportunities, and improve air quality. The tools and support available through the Clean Cities program will enhance the impact and effectiveness to regional efforts to accelerate the use of alternative fuels.

The Department of Energy indicates that receiving official designation as a Clean Cities Coalition is a multi-year process that requires a clear organizational structure, funding for the Coordinator position, and an active stakeholder group that meets regularly and has defined roles. The Clean City Coalition structure includes a Steering Committee, Working Groups, and a Coordinator.

Proposed goals for a Northwest California Clean Cities Coalition might include increasing the number of AFVs and hybrid-electric vehicles on the road each year and increasing the number and diversity of fueling stations in the region. Funding the Coordinator position and Coalition activities for the first three to five years (and beyond) could come from several avenues. Currently, the project leads, the Redwood Coast Energy Authority and the Schatz Energy Research Center, have multiple active contracts that align well with Clean Cities Program goals and can be leveraged to provide initial funding to launch a coalition.

²³ United States Department of Energy. <u>*Handbook for Handling, Storing, and Dispensing E85 and Other Ethanol-Gasoline Blends.* (http://www.afdc.energy.gov/uploads/publication/ethanol_handbook.pdf).</u>

GLOSSARY

ALTERNATIVE FUEL (AF)— An alternative fuel is defined as biofuel, ethanol, methanol, hydrogen, coal-derived liquid fuels, electricity, natural gas, propane gas, or a synthetic transportation fuel.²⁴

ALTERNATIVE-FUEL VEHICLE (AFV)—A vehicle designed to operate on an alternative fuel (e.g., compressed natural gas, methane blend, electricity). The vehicle could be either a dedicated vehicle designed to operate exclusively on alternative fuel or a nondedicated vehicle designed to operate on alternative fuel and/or a traditional fuel.

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

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

- 1. Forecasting future statewide energy needs.
- 2. Licensing power plants sufficient to meet those needs.
- 3. Promoting energy conservation and efficiency measures.
- 4. Developing renewable and alternative energy resources, including providing assistance to develop clean transportation fuels.
- 5. Planning for and directing state response to energy emergencies.

Funding for the CEC's activities comes from the Energy Resources Program Account, Federal Petroleum Violation Escrow Account, and other sources.

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

GREENHOUSE GAS (GHG)—Any gas that absorbs infrared radiation in the atmosphere. Greenhouse gases include water vapor, carbon dioxide (CO2), methane (CH4), nitrous oxide (NOx), halogenated fluorocarbons (HCFCs), ozone (O3), perfluorinated carbons (PFCs), and hydrofluorocarbons (HFCs).

LOW CARBON FUEL STANDARD (LCFS)—A set of standards designed to encourage the use of cleaner low-carbon fuels in California, encourage the production of those fuels, and therefore reduce greenhouse gas emissions. The LCFS standards are expressed in terms of the carbon intensity of gasoline and diesel fuel and their respective substitutes. The LCFS is

²⁴ United States Department of Energy. <u>*Alternative Fuel Definition and Specifications.*</u> (https://afdc.energy.gov/laws/9218).

a key part of a comprehensive set of programs in California that aim cut greenhouse gas emissions and other smog-forming and toxic air pollutants by improving vehicle technology, reducing fuel consumption, and increasing transportation mobility options.