CALIFORNIA ENERGY COMMISSION

CALIFORNIA NATURAL RESOURCES AGENCY

California Energy Commission

Clean Transportation Program

FINAL PROJECT REPORT

Tri-Counties Hydrogen Readiness Plan

Encompassing the Counties of Ventura, Santa Barbara and San Luis Obispo

Prepared for: California Energy Commission

Santa Barbara County Air Pollution Control District

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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-14-603 to provide funding opportunities under the Clean Transportation Program to produce a regional Hydrogen Readiness Plan. In response to PON-14-603, the recipient submitted an application which was proposed for funding in the CEC's notice of proposed awards January 16, 2015 and the agreement was executed as ARV-14-038 on July 9, 2015.

ABSTRACT

This report is a hydrogen readiness plan prepared for the Tri-Counties region of Santa Barbara, Ventura and San Luis Obispo. The plan takes advantage of work already performed at the state level and in other areas to prepare communities for the safe use of hydrogen as a clean alternative fuel for transportation. The plan addresses the placement of infrastructure for vehicle refueling by prioritizing favorable locations and identifying potential sites, establishing key public and private stakeholders, and implementing community outreach efforts. The plan also includes selected resources that can be used by planners, permitting staff and first responders to safely and effectively prepare for the use of hydrogen and Fuel Cell Electric Vehicles in the Tri-Counties region. The plan addresses the use of fuel cell electric vehicles with retail and municipal fleet users. This planning work was collaborated and coordinated with the existing hierarchy of regional planning documents that are now adopted or in development to foster the use of Alternative Fuels and Alternative Fuel Vehicles in the Tri-Counties Region.

The plan identified three key priorities for ongoing hydrogen readiness planning efforts in the Tri-Counties. These are: (1) to secure funding to support hydrogen infrastructure build-out, vehicle incentives and outreach efforts (for example from public-private partnerships, California Environmental Quality Act mitigation, settlements, enforcement actions, and grants, etc.); (2) to develop a strategy for creating commercial opportunities locally for the production and delivery of low-carbon hydrogen; and (3) increasing public awareness of hydrogen and FCEVs to facilitate early adoption and create a foundation for broader consumer acceptance in the future.

Keywords: Hydrogen Readiness Plan, Central Coast, Ventura County, Santa Barbara County, San Luis Obispo County, Fuel Cell Electric Vehicles, Hydrogen Refueling Infrastructure, First Responders

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EXECUTIVE SUMMARY

California has long promoted the used of hydrogen as well as fuel cell electric vehicles. Together, with the California Fuel Cell Partnership, the State has developed a "roadmap" for becoming a world leader in the use of hydrogen as a transportation fuel. Other parties have contributed to the significant progress made to date including Energy Independence Now, and several leading automobile manufacturers.

While there has been considerable effort to promote and deploy hydrogen and fuel cell electric vehicles in the major cities, there has been less emphasis on developing hydrogen infrastructure in regional communities. However, the Central Coast Tri-Counties were recently funded to develop a hydrogen readiness plan for the Tri-Counties region (Santa Barbara, Ventura and San Luis Obispo).

The objectives of this project were to:

- Develop a Tri-Counties Hydrogen Refueling Infrastructure Plan that includes analysis of hydrogen siting options, a prioritized list of potential sites for hydrogen refueling stations, and assessment of site readiness.
- Develop a list of key public and private stakeholders specific for each municipality and county in the region that need to be included in the hydrogen infrastructure discussion. Many of the key stakeholders have already been identified in the Plug-in Central Coast EV Readiness Plan and the Central Coast Alternative Fuel Vehicles Readiness Plan.
- Assess potential barriers to the efficient and timely permitting and construction of hydrogen stations and provide recommendations for avoiding or mitigating these barriers.
- Compile a "Tri-Counties Hydrogen Station Permitting Manual" which includes resources to help streamline the Permitting Process for Hydrogen Refueling Stations, including checklists for permitting and safety assessments for hydrogen stations. In addition, city and county planning issues including zoning and California Environmental Quality Act will also be reviewed.
- Summarize the potential for use of fuel cell electric vehicles in local municipal fleets, assess safety concerns at potential refueling sites, and make presentations for the orientation of civic leaders.
- Develop a range of hydrogen refueling technology options that would be candidates for local agencies or private companies to select from, including renewable hydrogen, onsite reforming, and offsite hydrogen transport.
- Compile presentation materials that can be used to train local first responders and technicians at vehicle repair facilities and with emergency towing companies.
- Develop outreach strategies targeted to potential fuel cell electric vehicle owners and fleets to promote the use of fuel cell electric vehicle vehicles and the benefits of using hydrogen as a fuel.
- Prepare a plan for rolling out the hydrogen fuel infrastructure plan to local communities.
- Develop and track performance metrics for each task included in this preparedness plan to ensure that resources are applied and used effectively.

This planning work was collaborated and coordinated with the existing hierarchy of regional planning documents that are now adopted or in development to foster the use of Alternative Fuels and Alternative Fuel Vehicles in the Tri-Counties Region.

Key accomplishments of the project were as follows:

- Development of a Tri-Counties Infrastructure Plan that outlines how the region will facilitate the installation of hydrogen refueling stations over time and determine where those stations will be most effectively sited. This plan was developed through application of UC Irvine's Spatially and Temporally Resolved Energy and Environment Tool model at the regional and municipal level, together with extensive work locally to review siting options.
- Analysis of hydrogen production and delivery options, with assessment of cost implications and potential for reducing emissions.
- Development of a Hydrogen Station Permitting Manual for our local municipalities and government agencies to use as a reference document when permitting a range of new hydrogen refueling station types in this region. It is expected that the manual will also be a useful resource for infrastructure providers.
- Compilation of resources that address hydrogen safety issues and provide guidance and training resources for First Responders.
- Establishing a suite of materials for the promotion of fuel cell electric vehicles and the potential for hydrogen as a transportation fuel.
- Assembling an improved database of fleet information for municipal and commercial fleets in the Tri-Counties, and assessment of fleet operator interest in hydrogen as an alternative fuel.

Based on the analyses and information presented in this report, the following recommendations are suggested for ongoing hydrogen readiness activities in the Tri-Counties. Recommendations are sorted into two groups: "Local and Regional Recommendations" and "Suggested Actions for the State".

Local and Regional Recommendations

- Ensure ongoing local support for hydrogen planning and infrastructure build-out.
- Set local targets for infrastructure. The immediate target would be for the installation of another station in close proximity to the existing station to entice local dealers to offer vehicles for sale in the region.
- Support ongoing research and adoption of renewable hydrogen.
- Keep the plan a living document. One way to do this would be to support an ombudsman for the region.
- The planning focus going forward should be on making sure permitting and response agencies know where available resources are and helping them make contact with peers in jurisdictions where hydrogen stations have already been permitted.
- For first responders, provide access to training resources and support for local trainers. There is a need to recognize the time constraints on first responders' time constraints given the extensive amount of training they need to take.
- Conduct ongoing outreach to expand awareness of hydrogen and fuel cell electric vehicles, with a focus on highlighting benefits. fuel cell electric vehicle test-drives, and vehicle loaner programs should be used when possible since research shows

that firsthand experience with new vehicle technologies is effective at increasing acceptance.

- Obtain testimony on hydrogen safety from an expert authority that is widely trusted, such as local fire official and emergency response personnel. This testimony can be incorporated into broader outreach and education campaigns in communities where hydrogen refueling stations are in operation or planned. Public notifications, community workshops, and information resources should be provided during the planning and permitting process for new hydrogen stations to help ensure that safety concerns are addressed.

Moving forward it is evident that there are three key priorities for ongoing hydrogen readiness planning efforts in the Tri-Counties. These are: (1) to secure funding to support hydrogen infrastructure build-out, vehicle incentives and outreach efforts (for example from public-private partnerships, California Environmental Quality Act mitigation, settlements, enforcement actions, and grants, etc.); (2) to develop a strategy for creating commercial opportunities locally for the production and delivery of low-carbon hydrogen; and (3) increasing public awareness of hydrogen and fuel cell electric vehicles to facilitate early adoption and create a foundation for broader consumer acceptance in the future.

If these three priorities are successfully addressed in the near term, there will be a much greater chance that the Tri-Counties region will become a vibrant new "hub" for clean hydrogen transportation. This, in turn, would have significant secondary benefits for lowering carbon intensity of the local energy infrastructure, also resulting in many environmental co-benefits. This is an audacious goal, but the opportunity is real if the intention is sincere.

Chapter 1: Introduction

Hydrogen has long been regarded as a clean alternative fuel for transportation. To this end, California has been promoting hydrogen and Fuel Cell Electric Vehicles (FCEVs), with the consistent support and leadership from the CEC, the California Air Resources Board (CARB). Also, together with the California Fuel Cell Partnership, the State has developed a "roadmap" for becoming a world leader in the use of hydrogen as a transportation fuel. Other parties have contributed to the significant progress made to date including Energy Independence Now, and several leading automobile manufacturers.

While there has been considerable effort to promote and deploy hydrogen and FCEVs in the major cities, there has been less emphasis on developing hydrogen infrastructure in regional communities. However, the Central Coast Tri-Counties were recently funded to develop a hydrogen readiness plan for the Tri-Counties region (Santa Barbara, Ventura and San Luis Obispo). Through a well-designed and coordinated planning effort, there is a potential to accelerate the introduction and use of hydrogen in the Tri-Counties region, and one with great potential for the adoption of Hydrogen FCEVs based on past experience with other forms of advanced vehicle technologies.

The goal of this Final Report is to assess the project's success in achieving the Agreement's goals and objectives and providing energy-related and other benefits to California. The objectives are to describe the project's purpose, approach, activities performed, and results; to present an objective assessment of the success of the project; to make insightful observations based on results obtained; to draw conclusions; and to make recommendations for further projects and improvements to the Energy Commission's funding process for planning projects.

Project Goals and Objectives

The goal for this grant was to prepare a hydrogen infrastructure readiness plan for the Tri-Counties, which is supported by strong proactive leadership throughout the region. By accomplishing this goal, the intent was to position this region for moving efficiently down a well-planned and synchronized path for introducing hydrogen-fueled transportation.

The challenge to be addressed in the project is how to best extend the network of hydrogen refueling infrastructure out from the major urban clusters to a more regional level. The CEC recognizes the need for hydrogen infrastructure readiness planning in regional communities, as well as the major urban areas. The counties of Ventura, Santa Barbara and San Luis Obispo represent a critical corridor for travel between the Bay Area and Southern California, and the region is a proven location for "early adoption" of alternative fuel technologies.

Existing barriers to successful implementation include market limitations – specifically, the availability of FCEVs and hydrogen infrastructure – and also financial barriers, including vehicle cost and the significant investment needed for reliable refueling stations. To allow FCEVs to be operational in a community, the infrastructure needs to be available at the same time as the vehicles are offered for sale.

The hydrogen readiness work outlined in this plan is a critical first step in this process. In addition to sound technical analyses, the planning effort includes promotional activities in local communities, which will highlight the many environmental benefits of using hydrogen as a fuel compared with traditional fuels. To date, local communities have very little

experience with hydrogen, so awareness building, highlighting advantages, and managing concerns will be essential for gaining public acceptance. Training permitting staff and first responders provides another critical need to help communities to become better prepared for this new fuel. Given that hydrogen refueling stations are costly, a readiness plan will provide a regional foundation for the strategic introduction of FCEVs together with the necessary refueling infrastructure.

This plan draws extensively from the existing body of information now available from statewide planning and installation efforts to date (including the annual CARB progress reports on FCEV deployment and hydrogen station development), and also from multiple local sources. This experience-based information will form the foundation for addressing the unique challenges that are anticipated in successfully achieving both an incipient and long-term hydrogen refueling network for the Tri-Counties region. We see this effort as a critical step for expanding the reach of hydrogen infrastructure beyond the main urban centers of California.

The objectives of this project were to:

- Develop a Tri-Counties Hydrogen Refueling Infrastructure Plan that includes analysis of hydrogen siting options, a prioritized list of potential sites for hydrogen refueling stations, and assessment of site readiness.
- Develop a list of key public and private stakeholders specific for each municipality and county in the region that need to be included in the hydrogen infrastructure discussion. Many of the key stakeholders have already been identified in the Plug-in Central Coast EV Readiness Plan and the Central Coast Alternative Fuel Vehicles Readiness Plan.
- Assess potential barriers to the efficient and timely permitting and construction of hydrogen stations and provide recommendations for avoiding or mitigating these barriers.
- Compile a "Tri-Counties Hydrogen Station Permitting Manual" which includes resources to help streamline the Permitting Process for Hydrogen Refueling Stations, including checklists for permitting and safety assessments for hydrogen stations. In addition, city and county planning issues including zoning and California Environmental Quality Act will also be reviewed.
- Summarize the potential for use of FCEVs in local municipal fleets, assess safety concerns at potential fueling sites, and make presentations for the orientation of civic leaders.
- Develop a range of hydrogen refueling technology options that would be candidates for local agencies or private companies to select from, including renewable hydrogen, onsite reforming, and offsite hydrogen transport.
- Compile presentation materials that can be used to train local first responders and technicians at vehicle repair facilities and with emergency towing companies.
- Develop outreach strategies targeted to potential FCEV owners and fleets to promote the use of FCEV vehicles and the benefits of using hydrogen as a fuel.
- Prepare a plan for rolling out the hydrogen fuel infrastructure plan to local communities.

Develop and track performance metrics for each task included in this preparedness plan to ensure that resources are applied and used effectively.

Project Tasks

The project work tasks were in alignment with the CEC's Program Opportunity Notice which was the basis of funding for this work (PON-14-603), as follows:

- Regional Hydrogen Refueling Infrastructure Plan
- Streamlining the Permitting Process for Hydrogen Refueling Stations
- Promotion of FCEV Use
- Training
- Safety Assessments
- Incorporation of FCEVs in Municipal Fleets

A Work Plan was developed with sections that cover project objectives, project management, detailed work activities, and a section on the schedule and deliverables. The Work Plan addressed each of the tasks listed above with a description of the task, the objective of the task, how the task was to be conducted, who the task lead was, and which parties had a role in performing the task. The Work Plan served as a key reference for monitoring and measuring progress with the project.

This planning work was collaborated and coordinated with the existing hierarchy of regional planning documents that are now adopted or in development to foster the use of Alternative Fuels and Alternative Fuel Vehicles in the Tri-Counties Region. Existing plans are in place in the form of County and City General Plans and Climate Action Plans. A summary of applicable planning documents is provided in Appendix A. The work did not duplicate any activities in the Tri-Counties that have been previously funded by CEC. On the contrary, this work was complementary to and supportive of other plans and projects developed in the Tri-Counties/Central Coast region, including:

- Tri-Counties Alternative Fuels Readiness Plan
- Tri-Counties Plug-in Electric Vehicle Readiness Planning

Energy Commission funding for the first hydrogen refueling station constructed in Santa Barbara which opened in May 2016

Chapter 2:
Hydrogen Refueling Infrastructure Plan

Statewide Context

To assess the future potential of hydrogen vehicles in the Tri-Counties region, and the actions that regional and local stakeholders can take to support FCEV readiness, it is helpful to provide some context of the statewide policy and planning efforts for hydrogen fuel to date[1]. As such, this chapter gives an overview of the following issues:

- Development of FCEV technology and the California Zero Emission Vehicle (ZEV) mandate
- Overview of California's Hydrogen Infrastructure Strategy
- Statewide hydrogen refueling infrastructure

Development of FCEV Technology and the California ZEV Mandate

Fuel cells have been under development for many years, and over the last twenty years, a vast amount of work has been devoted to making fuel cells commercially viable and cost-effective in vehicles. The California ZEV mandate has played a key role in driving this development, and auto manufacturers have collaborated closely with government agencies in California through the California Fuel Cell Partnership.

While manufacturers have been developing the vehicle technologies, the state has begun a diligent program to establish a hydrogen refueling infrastructure across the state, with the initial priority of supporting FCEV clusters in the two primary urban areas – the Bay Area to the north, and the Los Angeles basin to the south. This investment program is discussed in more detail in the next section.

Overview of California's Hydrogen Infrastructure Strategy

The California Hydrogen Highway Network was initiated in April of 2004 by Executive Order S-07-04 under then Governor Arnold Schwarzenegger. The intent of the Order and associated investments in FCEV technology by the California Energy Commission has been to ensure that hydrogen refueling stations will be in place to meet the needs of future FCEV drivers, and to facilitate the advancement of hydrogen vehicles as projected under the ZEV mandate[2]. Over the medium-term (5-10 years), hydrogen technologies also have potential to be deployed in medium and heavy-duty vehicle segments, as well as the light-duty sector.

To provide an overall strategic framework for FCEV deployments across all vehicle types, California Fuel Cell Partnership published A California Road Map: The Commercialization of Hydrogen Fuel Cell Electric Vehicle in 2012.3 This Road Map and subsequent updates have

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1 Note. More detail of the background and context for hydrogen fuel development in California is included in the Central Coast Alternative Fuels Plan.

2 ZEVs are vehicles with zero tailpipe emissions

3 A California Road Map: The Commercialization of Hydrogen Fuel Cell Vehicles, June 2012, available at http://cafcp.org/sites/files/A%20California%20Road%20Map%20June%202012%20%28CaFCP%20technical%20version%29_1.pdf

articulated the core policy and program framework for FCEV market development, including the all-important development of a new hydrogen refueling infrastructure.

The Road Map in turn served as a basis for Governor Jerry Brown's March 2012 Executive Order that directed California state agencies to support the accelerated deployment of the full range of ZEVs, including FCEVs.[4] The passage of Assembly Bill 8 (Perea, 2013) was another pivotal step in FCEV development, extending through 2023 the Air Resources Board's Air Quality Incentive Program and the Energy Commission's Alternative and Renewable Fuel & Vehicle Technology Program. The state's comprehensive ZEV Action Plan has provided further guidance on bringing FCEVs to market.[5]

AB 8 included a crucially important provision to fund at least 100 hydrogen stations with up to $20 million a year. Since the passage of AB 8, three automakers (Honda, Toyota, and Hyundai) have moved ahead and introduced FCEVs to the California market, and other automakers are expected to enter the market in the 2017-2022 timeframe. FCEVs have been embraced by key state policy makers because -- once an appropriate refueling infrastructure is in place -- they will combine the convenience and utility of conventional Internal Combustion Engine vehicles with the quiet and clean attributes of electric vehicles.

The majority of the hydrogen fuel produced in California is currently derived from natural gas, though current state law mandates that 33 percent of the hydrogen supplied for FCEVs must be from renewable sources (SB 1505[6]). With the potential to develop a supply chain for renewable and low-carbon hydrogen fuel, the state has produced another key policy document known as the Vision for Clean Air -- developed by several leading air quality management agencies -- to highlight strategies to accelerate the introduction of FCEVs as well as EVs in the context of air quality policy and goals.

While policies for FCEV promotion are developed primarily at the state level, local and regional stakeholders can work together with hydrogen fuel suppliers and the California Fuel Cell Partnership to support and accelerate existing plans for hydrogen refueling station deployment.

Statewide Hydrogen Refueling Infrastructure

The Road Map and ZEV Action Plan together prescribe a minimum network of hydrogen stations to establish the foundation for robust, commercial-scale FCEV adoption. Focused on "early adopter" areas in Southern California and the San Francisco Bay Area, the FCEV station network includes "connector" and "destination" stations intended to anchor the evolving statewide network and enable north-south travel.

In 2015, the CEC announced funding for 28 new stations, which – when constructed – will result in 51 total stations. Additional stations will be funded by the CEC until there are at least 100 stations across the state by 2020. Current information on the status of stations is provided by the California Fuel Cell Partnership and the Governor's Office for Business.

The Hydrogen Progress, Priorities and Opportunities Report was recently published by the California Fuel Cell Partnership and its Original Equipment Manufacturers Advisory Group – including Honda, General Motors, Hyundai, Mercedes-Benz, Nissan, Toyota and

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4 Executive Order B-16-2012, March 23, 2012, available at http://gov.ca.gov/news.php?id=17472

5 ZEV Action Plan: A roadmap toward 1.5 million zero-emission vehicles on California roadways by 2025, February 2013, and updated in 2016, available at https://www.gov.ca.gov/docs/2016_ZEV_Action_Plan.pdf

6 SB 1505 Environmental Performance Standards for Hydrogen Fuel

Volkswagen. The report included a consensus list of recommended priority locations for the next 19 hydrogen stations to be built in the state. While these are simply recommendations, it is of relevance to the Tri-Counties in that the city of Thousand Oaks was recommended as a Primary Priority, and the cities of Ventura or Oxnard was recommended as Secondary Priority locations.

The first hydrogen system to be installed in the Tri-Counties is located in Santa Barbara at the Conserv Fuels station at 150 South La Cumbre Road. The system was developed by First Element Fuels with funds awarded by the California Energy Commission in 2014. The station construction was managed by Black and Veatch and began operating in May 2016.

In its first two years of operation, it is expected that fuel for the station will be sourced by Air Products and Chemicals. As is the case for most early hydrogen refueling stations, the California Energy Commission will also be providing Operations and Maintenance funding for at least the first three years of operation, with the expectation that the station will become commercially sustainable in later years as demand for hydrogen grows.

The Santa Barbara station is a starting point for the development of a regional hydrogen network for the region, to be developed in the years to come. It also provides a starting point for north-south connectivity along HWY 101.

Tri-Counties Regional Demand Analysis

As a basis for developing the infrastructure plan for the Tri-Counties region, it is necessary to assess the potential need for hydrogen fuel in the years to come. In turn, for transportation, this is dependent on the FCEVs sales projections for the region, and the anticipated need for hydrogen fuel by vehicles traveling to the region or in-transit through the region. To make this assessment, the ZEV mandate projections for the state were used as a starting point, and pro-rated for the region. Projected sales by the Original Equipment Manufacturers were also factored into this initial assessment.

California Fuel Cell Electric Vehicle Sales Projections

For many years, the California ZEV mandate has played a key role in setting targets for ZEV sales in California. However, the ability to meet those targets has been limited by the challenges of manufacturing vehicles that attain the ZEV standards and, at the same time, meet customer expectations. FCEVs are still in the early stages of commercialization, and there are many barriers to implementation that can impede the speed at which a new technology can be deployed. For this reason, the ZEV mandate targets should be considered targets or goals, rather than projections of actual sales.

An estimate of projected sales numbers can be obtained from the CARB Midterm Review of Advanced Clean Cars Program released in January 2017 which projects at least one million ZEVs by 2025[7]. Specific FCEV projections can also be derived from the Original Equipment Manufacturer survey conducted by CARB in 2014 and discussed in detail in the July 2015 Annual Evaluation of FCEV Deployment and Hydrogen Fuel Station Network Development report (CARB Hydrogen Report 2015). Mandatory surveys were distributed to 16 auto manufacturers requesting information on planned deployment of FCEVs. Data reported back to CARB from the Original Equipment Manufacturers forecast an acceleration in the number of vehicles made available for sale in California from present to 2021 (the last year included in the survey). CARB has recently projected, from the results of this survey, that

7 CARB News Release, available at https://www.arb.ca.gov.newsrel/newsrelease.php?id=890

the state's fleet of FCEVs is expected to grow to nearly 35,000 vehicles by 2021. (Refer to Table 1.)

The same report stated that a minimum of 51 stations would be needed to service an expected demand of 13,500 vehicles, so the assumption is made here that a single station could serve about 265 vehicles on a consistent basis. Table 1 includes a separate analysis to show that this number is corroborated by a simple projection of station use based on hydrogen consumption data now available for vehicles coming to market.

Analysis of Hydrogen Fuel Demand from Personal Vehicles in Tri-Counties Region

Projections of vehicle numbers, hydrogen fuel demand and refueling infrastructure requirements were made for the Tri-Counties region based upon "best estimates" for the statewide data presented above. Using the CARB survey data, the prorated sales projections would be approximately 1,000 vehicles by 2020 and 3,000 vehicles by 2025. Table 2 provides a summary of these projections. Table 2 also shows that the Tri-Counties would need about four stations (minimum) to meet the projected retail demand in 2020, and about eleven stations by 2025, which assumes that vehicle owners work or live near station sites.

While the projections appear to be very precise, it is simply due to the prorating process that was used to develop the estimates. In reality, it would be prudent to use a range in the projections for planning purposes, with lower and higher estimates of the number of stations needed for planning refueling infrastructure needs.

Of course, these demand projections assume that the auto manufacturers promote sales in this region, consistent with other target sales locations. On the contrary, vehicle sales in a region are dependent on the availability of infrastructure, so it could substantially impede sales potential if the infrastructure is not planned and installed.

This emphasizes the need to have redundant and reliable infrastructure in the region so that local dealers are in a position to offer FCEVs for sale. FCEV sales are also likely to be impeded locally if owners have to travel out of the region (100+ miles) for dealer service.

Other Demand for Hydrogen

Other potential demand for hydrogen could arise from fleet operations using FCEVs, heavy duty vehicles (including buses, freight transportation and drayage vehicles), and with turnkey forklift operations using hydrogen. As and when additional demand occurs for these potential needs, then the fueling equipment and infrastructure would likely be different from that used for FCEV refueling especially for heavy duty vehicles. When the equipment is similar, it may or may not be available to the general public.

The possibility of siting hydrogen stations at auto dealerships that sell FCEVs may be another way to provide hydrogen if and when primary stations go offline. This would provide additional resiliency and redundancy for the local hydrogen refueling network.

Base Case Planning Scenario[8]

This section presents a summary of the FCEV retail sales projections for the Tri-Counties and the infrastructure that will be needed to meet projected demand. Based primarily on the CARB 2015 report and the Original Equipment Manufacturer survey data, it is assumed that there will be a minimum need for an additional three or four hydrogen refueling stations by 2020 to service approximately 500 to 1,000 FCEVs that could be operating in the region by that time. It is anticipated that at least two or three stations will be needed in Ventura County, and one additional station in Santa Barbara County.

Beyond 2020, it is assumed that the number of FCEVs in the Tri-Counties will grow further, and that additional build-out of the refueling infrastructure will be needed. Based on the data available during the planning process, it is reasonable to assume that the number of FCEV sales would increase to about 2,500 or 3,000 by 2025 consistent with a base case (or "business as usual") projection. Overall this would require at least ten to twelve stations in the region by that time.

While there is clearly some uncertainty with this analysis, the projections provide a rationale for local decision-makers to promote this new vehicle technology, and to support the goals of the state for deployment of FCEVs.

8 Projections based on original equipment manufacturer survey data reported by ARB. Approach is consistent with analysis by Ogden et al in Joan Ogden, Christopher Yang, Michael Nicholas, Lew Fulton , NextSTEPS White Paper: The Hydrogen Transition, Institute of Transportation Studies University of California, Davis, July 29, 2014, p. 15, available at http://steps.ucdavis.edu/files/08-13-2014-08-13-2014-NextSTEPS-White-Paper-Hydrogen-Transition-7.29.2014.pdf

Table 1: California Air Resources Board 2015 Annual Projection of FCEV Deployment and Hydrogen Fuel Station Network Development

Projected Number of FCEVs in California Fleet		
Year End	Vehicles	Source/Derivation
2018	10,500	CARB Hydrogen (AB8) Report 2015, 2nd bullet, page 3
2019	18,433	interpolated
2020	26,367	interpolated
2021	34,300	CARB Hydrogen Report 2015, 2nd bullet, page 3
2022	42,800	extrapolated, assuming additional 8,500 new vehicles per year
2023	51,300	extrapolated, assuming additional 8,500 new vehicles per year
2024	59,800	extrapolated, assuming additional 8,500 new vehicles per year
2025	68,300	extrapolated, assuming additional 8,500 new vehicles per year
Hydrogen Stations Operational by Year-End 2016		
51	stations	CARB Hydrogen (AB8) Report 2015, 3rd bullet, page 3
9,400	kg per day	CARB Hydrogen (AB8) Report 2015, 3rd bullet, page 3
13,500	vehicles	CARB Hydrogen (AB8) Report 2015, 3rd bullet, page 3
254	kg/vehicle/yr.	derived from information provided
265	vehicles per station	derived from information provided
184	kg/station/day	derived from information provided
Vehicle-Station Projection Check		
15000		Vehicle miles per year
300	Mile	Range (Toyota Mirai)
50		Fuel stops per year (once per week)
20	Min	Time to refuel (conservative estimate, more likely to be 5-10 min)
3	vehicle/hr.	Single station capacity
12	Hr.	Time actively used each day
36		Vehicles filled per day
252		Vehicles per week (Vehicles per Station)
Compares well with CARB report which indicates an average of 265 vehicles per station		

Footnote – California Fleet Projection numbers are based on CARB Hydrogen (AB8) Report 2015 issued in July 2015. Numbers changed only slightly in the next annual report issued in July 2016 but would not change these projections in a material way.
Source: CARB

Table 2: Tri-Counties Regional Projections (Minimum Requirements)

Population Data for Pro-rating				
	Population (2015)			
California	38,000,000		100%	(1)
Santa Barbara County	450,000		1.2%	
Ventura County	840,000		2.2%	
San Luis Obispo County	280,000		0.7%	
Tri-Counties	1,570,000		4.1%	
FCEV Numbers Pro-rated based on Population				
	2020		2025	
California	26,367		68,300	(2)
Santa Barbara County	312		809	
Ventura County	583		1,510	
San Luis Obispo County	194		503	
Tri-Counties	1,089		2,822	
Pro-rated Number of Stations				
	2020		2025	
California	100		258	(2)
Santa Barbara County	1		3	
Ventura County	2		6	
San Luis Obispo County	1		2	
Tri-Counties	4		11	
Annual Fuel Use (kg)				
	2020		2025	
California	6,701,040		17,358,319	(2), (3), (4)
Santa Barbara County	79,354		205,559	
Ventura County	148,128		383,710	
San Luis Obispo County	49,376		127,903	
Tri-Counties	276,859		717,173	

Notes: 1. Population estimates based on Census data 2010, projected to 2015 2. Estimate from CARB FCEV Annual Evaluation Report, July 2015 3. Consistent with FCEV driven 15,000 miles per year, 5kg tank, 300-mile range 4. Each vehicle filled about once per week, on average.
Source: CARB

Accelerated FCEV Adoption Scenario

With increased promotion locally and support from the auto manufacturers, an option available to local decision makers in the Tri-Counties could be to implement actions that will accelerate the FCEV adoption rate. If the planned adoption rate increased by a factor of three times, the opportunity for further growth in the near term would be stimulated, along with the many environmental benefits of ZEVs. In this case, there could be about 2,500 vehicles in the region by 2020 (needing about 10 stations), and 7,500 or more by 2025 (needing about 30 stations). To accomplish this would require an investment of about $20 million by 2020 and about $60 million by 2025, split among the three counties (prorated by population).

Assuming a conventional car driven 12,000 miles per year would emit about 5 tons of carbon dioxide, replacing 1,000 vehicles with hydrogen would reduce tailpipe emissions by 5,000 tons per year, or about 60,000 tons over the life of the vehicle (12 years). With an accelerated adoption scenario and a total of 7,500 FCEVs (by 2025), the yearly carbon dioxide emissions reduction would be 38,000 tons, or about 450,000 tons over 12 years. Further benefits would accrue as hydrogen becomes commercially viable and attractive to private sector investment.

Studies indicate that an alternative fuel like hydrogen would need to be available at about 5-10 percent of the existing gasoline stations to alleviate driver concerns about fuel availability. With about 540 gasoline stations in the Tri-Counties, this suggests that about 25-50 stations would need to have hydrogen to achieve this.[9] [10] Other research indicates that take 15 percent or more for successful penetration.[11] With this latter basis, the number of stations with hydrogen in the Tri-Counties would likely have to increase to 70 or more to support a mature hydrogen fuel transportation system.

While these are rather speculative projections, they do present a starting point for decision makers to determine how many stations are likely to be needed to follow in line with the state growth projections for FCEVs over the next five to ten years, and also an idea of the additional investment needed to accelerate the adoption rate if desired.

Tri-Counties Siting Analysis

Introduction

Section 2 includes a summary of the statewide strategy for FCEV deployment with the initial effort focused on vehicle sales and infrastructure development in the two primary urban areas of the state – the Bay Area in the north, and the Los Angeles basin in the south. In the initial "roadmap analysis", Santa Barbara was identified as a "destination station", primarily for FCEVs traveling north or south between Los Angeles and the Bay Area.

With this initial station now in operation in Santa Barbara, there is potential to build out a local infrastructure to support additional FCEV deployment in the Tri-Counties region. The

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9 M. Nicholas, S. Handy, and D. Sperling, "Using Geographic Information Systems to Evaluate Siting and Networks of Hydrogen Stations," Transp. Res. Rec. J. Transp. Res. Board, vol. 1880, pp. 126–134, Jan. 2004.

10 M. W. Melaina, "Initiating hydrogen infrastructures: preliminary analysis of a sufficient number of initial hydrogen stations in the US," Int. J. Hydrogen Energy, vol. 28, no. 7, pp. 743–755, 2003.

11 Hydrogen Infrastructure Analysis is available at https://www.researchgate.net/publication/222697006_Initiating_hydrogen_infrastructures_Preliminary_analysis_of_a_sufficient_number_of_initial_hydrogen_stations_in_the_US

strategy for local infrastructure development is principally driven by the availability and demand for passenger vehicles, but also to increase the reliability of supply in the local area for destination travelers, and also for establishing north-south connectivity along the Highway 101 corridor. At this time, the station in Santa Barbara theoretically allows for hydrogen vehicles to travel north to San Jose – the next nearest station to the north along the 101 – but the distance is about 280 miles, which is close to the maximum range for most early FCEVs.

For these reasons, the refueling station siting analysis for the Tri-Counties region has accounted for three main factors when considering spatial distribution of sites:

- To serve the projected growth of retail sales (discussed in Section 2);
- To increase the appeal of the region as a destination for FCEV drivers (mainly from the Los Angeles area initially); and
- To provide reliable connectivity between Los Angeles and the Bay Area along the 101 corridor[12].

Market Demand for FCEVs and Hydrogen Refueling Infrastructure

As part of the planning effort, a detailed analysis was conducted of the current situation in the Tri-Counties region relative to population and economic demographics, and sales potential for FCEVs in the region. This analysis was used to develop hydrogen infrastructure "build-out" scenarios for the next five to ten years. The approach used is described below.

Projecting market demand for FCEVs is essential for assessing the need for refueling stations in the region over the near term. To assess this, staff at the University of California Irvine Advanced Power and Energy Program were asked to adapt their Spatially and Temporally Resolved Energy and Environment Tool model to the Tri-Counties region. The Spatially and Temporally Resolved Energy and Environment Tool model was developed by University of California Irvine Advanced Power and Energy Program to provide insight and information to help decision-makers plan for infrastructure investments related to alternative fuels transportation. The primary objective for applying the Spatially and Temporally Resolved Energy and Environment Tool model was to develop a strategic approach to the siting of hydrogen refueling stations across the Tri-Counties using FCEV market proxy data.

The Spatially and Temporally Resolved Energy and Environment Tool model was used to identify 20 "high priority" gasoline stations in the Tri-County area. The analysis was based on several different sets of Alternative Fuel Vehicle (AFV) sales registration data that serve as proxies for FCEVs. Connectivity between northern California and southern California was also analyzed. The Spatially and Temporally Resolved Energy and Environment Tool results were then compared to the Station Coverage Value given by the California Hydrogen Infrastructure Tool. The California Hydrogen Infrastructure Tool Station Coverage Value is the ability of the proposed station to fill an identified gap in refueling coverage.

Three different sets of AFV sales registration data were used: (1) battery electric vehicles (BEVs), (2) plug-in hybrid electric vehicles (PHEVs) combined with hybrid electric vehicles (HEVs), and (3) BEVs combined with PHEVs and HEVs. The AFV sales registration data, obtained from Information Handling Services Automotive, show the number of a type of vehicle registered in a zip code tabulation area. The spatial resolution of this data set is rather coarse, so it was combined with high resolution population data (1km x 1km) to

12 To fully utilize a station takes about 250 fueling events per week, so this would require 125 round trips per week by FCEVs with no additional local demand (assuming they fill at this location both ways).

evaluate potential station locations. In essence, this approach allows for counting potential vehicle sales (demand points) in each grid cell. Existing gasoline refueling stations were used as candidate locations for siting future hydrogen refueling stations. Station addresses were obtained from the APCDs in the three counties.

The final "demand weight" for each cell is the product of the cell population weight and the number of registrations in the zip code tabulation area, as shown in Figure 1.

Figure 1: Demand Weight Formula

$$Demand\ Weight = ZCTA\ AFVs * Cell\ Weight = ZCTA\ AFVs * \frac{Cell\ Population}{ZCTA\ Population}$$

Source: Santa Barbara County Air Pollution Control District

The "demand point" for each cell is represented by the point location of its centroid. Potential hydrogen refueling stations are then identified using a Maximize Market Share algorithm in the GIS system. This algorithm seeks to place a given number of stations (set at 20) to maximize the demand (i.e., FCEV proxy) on the stations within a given service coverage area. This is the area that is served by a station and can be defined by drive time or distance. In these analyses, drive time was used, and based on previous studies, this was chosen to be six minutes. It appears to be a good compromise between parity with the convenience of gasoline service, and minimization of infrastructure investment.

Once the station locations are allocated using the Maximize Market Share algorithm, they are ranked according to the total demand points (FCEV proxy) covered by a six-minute drive time from the gasoline station.

A detailed report of the Spatially and Temporally Resolved Energy and Environment Tool modeling analysis is included in Appendix B, and this includes results for the three different sets of AFV registration data. In general, there was not much difference between the results using the different data sets (HEV+PHEV) and (HEV+PHEV+BEV) data sets, since the number of HEVs and PHEVs is larger than the number of BEVs. However, using BEV sales alone, as the proxy shows slightly different results than for the other two data sets, with more demand indicated for San Luis Obispo County. The results – expressed as the number of stations by county – are summarized in Table 3.

Table 3: Number of Stations by County

	Ventura	Santa Barbara	San Luis Obispo
HEV + PHEV	13	5	3
HEV + PHEV + BEV	13	5	3
BEV	11	5	5

Source: Santa Barbara County Air Pollution Control District

With 21 stations (20 additional stations plus the existing La Cumbre station) these would cover 80 percent of total sales within the 6-minute radius (i.e., 7,386 out of 9,223 in the Tri-Counties). These are shown in Appendix B. The California Hydrogen Infrastructure Tool Station Coverage Values are also shown for each suggested station in Appendix B. This is the California Hydrogen Infrastructure Tool coverage gap score. The California Hydrogen Infrastructure Tool Station Coverage Value is the ability of the proposed station to fill an identified gap in refueling coverage.

The spatial distribution of proxy demand and possible station locations are shown for the Tri-Counties in Figure 3. (Note that these results are based on modelling analysis of potential FCEV sales based on proxy data, and not guaranteed to reflect actual sales that may occur.)

Further Assessment of Candidate Stations

Given that the Spatially and Temporally Resolved Energy and Environment Tool model projects the best locations for hydrogen refueling infrastructure using a theoretical analysis and mathematical algorithms, it does not account for physical characteristics of the existing stations, such as space availability (for the hydrogen refueling system), access and curb-appeal. For this reason, the project team used the modelling results presented in Figure 2 to develop a more realistic assessment of station alternatives.

The intent of this assessment was to reconcile the "preferred" station locations from the model with real-world options, thus giving options to decision makers for identifying stations, while staying consistent with the projections of market demand from the Spatially and Temporally Resolved Energy and Environment Tool analysis. For example, the Spatially and Temporally Resolved Energy and Environment Tool model may have selected a specific station on a given street based on the allocation algorithm, yet there may be an alternative station in close proximity with more space, better access and with less permitting constraints. This alternative would satisfy the intent to site a hydrogen station within that general location, and at the same time offer a more suitable site alternative.

To accomplish this, the team looked at station alternatives in the high market potential areas and conducted a screening analysis to assess site characteristics. The local Air Districts provided addresses of the active-permit gasoline fueling stations in the three counties – Ventura (259), Santa Barbara (154), and San Luis Obispo (127) – with a total of 540 stations in the Tri-Counties. Non-commercial fueling stations (e.g. golf course fueling stations, city fleets, water districts, Cal-trans, fire stations etc., about 130 facilities) were disregarded (for retail sales potential), and remaining retail fueling station locations were retained.

Stations within the high market potential areas and in close proximity to the primary freeways (Hwy 101 and Hwy 118) were visited. University of California, Irvine data showed high FCEV sales potential around Thousand Oaks, Simi Valley, Camarillo, Ventura and Oxnard (in Ventura County), and along the south coast of Santa Barbara County. In San Luis Obispo, the higher sales potential areas are along Highway 101 from Arroyo Grande through the City of San Luis Obispo and on to Atascadero. As such, stations in these areas were carefully reviewed, and multiple high-scoring stations were identified for these areas. In total, 183 stations were visited, 92 in Ventura, 60 in Santa Barbara and 31 in San Luis Obispo.

These stations were numerically rated, using five qualitative criteria as follows:

- Space available on the forecourt (maximum of 6)
- Appearance (6)
- Neighborhood (3)
- Ease of Access (3)
- Proximity to Freeway (3)

With this approach, space and appearance carried twice the weight of other criteria. Stations that ranked low in these two primary criteria were not closely investigated.

Stations north of Atascadero were not visited at this time, but they are nonetheless areas where connectivity could be relevant in the final analysis. Stations identified in the

University of California, Irvine report in these areas were reviewed via satellite imagery for size and freeway accessibility. Nipomo stations were not considered due to the town's small size, and proximity to larger population centers in Santa Maria and Arroyo Grande, both communities with high-ranking viable station options.

Stations that had a total rating score of 17 or higher were identified as good potential alternatives to those identified by University of California, Irvine. The results are summarized in Tables 4 through 7 for Ventura, Santa Barbara and San Luis Obispo counties, respectively. Complete results of the field assessment are included in Appendix B.

It should be emphasized that the station prioritization shown in Tables 4 through 7 is not meant to imply that the highest ranked stations would necessarily be the first for hydrogen refueling placement, nor does it imply that only the stations shown would be considered. The qualitative assessment and prioritization does, however, indicate that there are good options for siting hydrogen refueling systems at existing gasoline stations in all three counties.

Reliability and Redundancy

The initial experience with FCEV refueling in California has raised concerns about the reliability of the refueling infrastructure while it is still in its embryonic stages. This fragility is a concern for potential vehicle owners if there is complete dependency on a single station in a given area. Even with optimal reliability, there are going to be times when stations are out of service for one reason or another.

This draws attention to the need for incorporating a "reliability strategy" into the analysis. While this can be most simply established by offering redundant stations in reasonable proximity, this, by itself, can be uneconomic when funding for new stations is limited. That said, the placement of initial stations in growth areas should be clustered if feasible to account for this as well as supporting expansion of the market.

Some of the other factors considered in this plan as possible ways for dealing with the reliability issue are as follows:

- Support the efforts of station manufacturers and installers in technology improvement to further enhance the dispensing technology to increase station reliability.
- Incorporate a limited number of lower pressure stations – at lower cost – when there are other reasons for pursuing this. For example, at dealerships or fleet locations where there could be other fuel cell vehicle types with additional demand.
- Consider supporting pilot projects for emerging technologies for hydrogen production where it makes sense to design for lower demand.

Continue to support online applications and communication systems that provide FCEV owners current and very specific information about station status. This would allow them to plan carefully for their refueling needs when there are system limitations. For example, this could include an interactive capability that could be implemented when an owner expresses intent to use a station during an extended trip, so that if the station does go down there is clear information available about the repair plan, or if the stations are networked provide real time availability information via smartphone apps.

Figure 2: Results of University of California Irvine Advanced Power and Energy Program Spatial Modeling (grouped by cluster)[13]

Group	Rank	Street Address	City	County	Zip Code	AFVs Covered	Total AFVs Covered	CHIT Coverage Gap Score [x100]	Total CHIT Score
1	2	45 N. REINO RD	Thousand Oaks	Ventura	91320	607	2308	1.78	7.00
1	4	1152 E AVENIDA DE LOS ARBOLES	Thousand Oaks	Ventura	91360	571		1.90	
1	3	293 S MOORPARK RD	Thousand Oaks	Ventura	91361	596		1.45	
1	*5*	*4500 E THOUSAND OAKS BLVD*	*Thousand Oaks*	Ventura	*91362*	*534*		*1.87*	
2	17	507 E THOMPSON BLVD	Ventura	Ventura	93001	173	1403	0.39	6.15
2	15	7700 TELEGRAPH RD	Ventura	Ventura	93004	266		1.56	
2	13	522 N LAS POSAS RD	Camarillo	Ventura	93010	303		0.97	
2	8	4870 SANTA ROSA RD	Camarillo	Ventura	93012	419		0.84	
2	20	246 W EL ROBLAR DR	Meiners Oaks, Ojai	Ventura	93023	106		0.27	
2	18	655 S VENTURA RD	Oxnard	Ventura	93030	136		2.13	
3	11	50 W NEW LOS ANGELES AVE	Moorpark	Ventura	93021	339	1363	0.35	2.36
3	10	2627 YOSEMITE AVE	Simi Valley	Ventura	93063	346		0.84	
3	1	1196 E LOS ANGELES AVE	Simi Valley	Ventura	93065	678		1.17	
4	21	4401 VIA REAL	Carpinteria	Santa Barbara	93013	102	1706	0.54	2.73
4	6	101 W CARRILLO ST	Santa Barbara	Santa Barbara	93101	505		1.24	
4	*7*	*150 S LA CUMBRE RD*	*Santa Barbara*	*Santa Barbara*	*93105*	*434*		*0.26*	
4	9	1476 E VALLEY RD	Montecito	Santa Barbara	93108	350		0.54	
4	12	5960 CALLE REAL	Goleta	Santa Barbara	93117	315		0.15	
5	16	296 SANTA ROSA RD	San Luis Obispo	San Luis Obispo	93401	213	606	0.78	1.18
5	14	100 BARNETT ST	Arroyo Grande	San Luis Obispo	93420	275		0.22	
5	19	2000 EL CAMINO REAL	Atascadero	San Luis Obispo	93422	118		0.18	

13 It should be emphasized that the station prioritization shown in Tables 4-7 does not mean to imply that the highest ranked stations would be the first for hydrogen refueling placement, nor does it imply that only the sites shown would be considered and supported.

Figure 3: Tri-Counties Network of Potential Hydrogen Refueling Stations Based on Spatially and Temporally Resolved Energy and Environment Tool Modeling

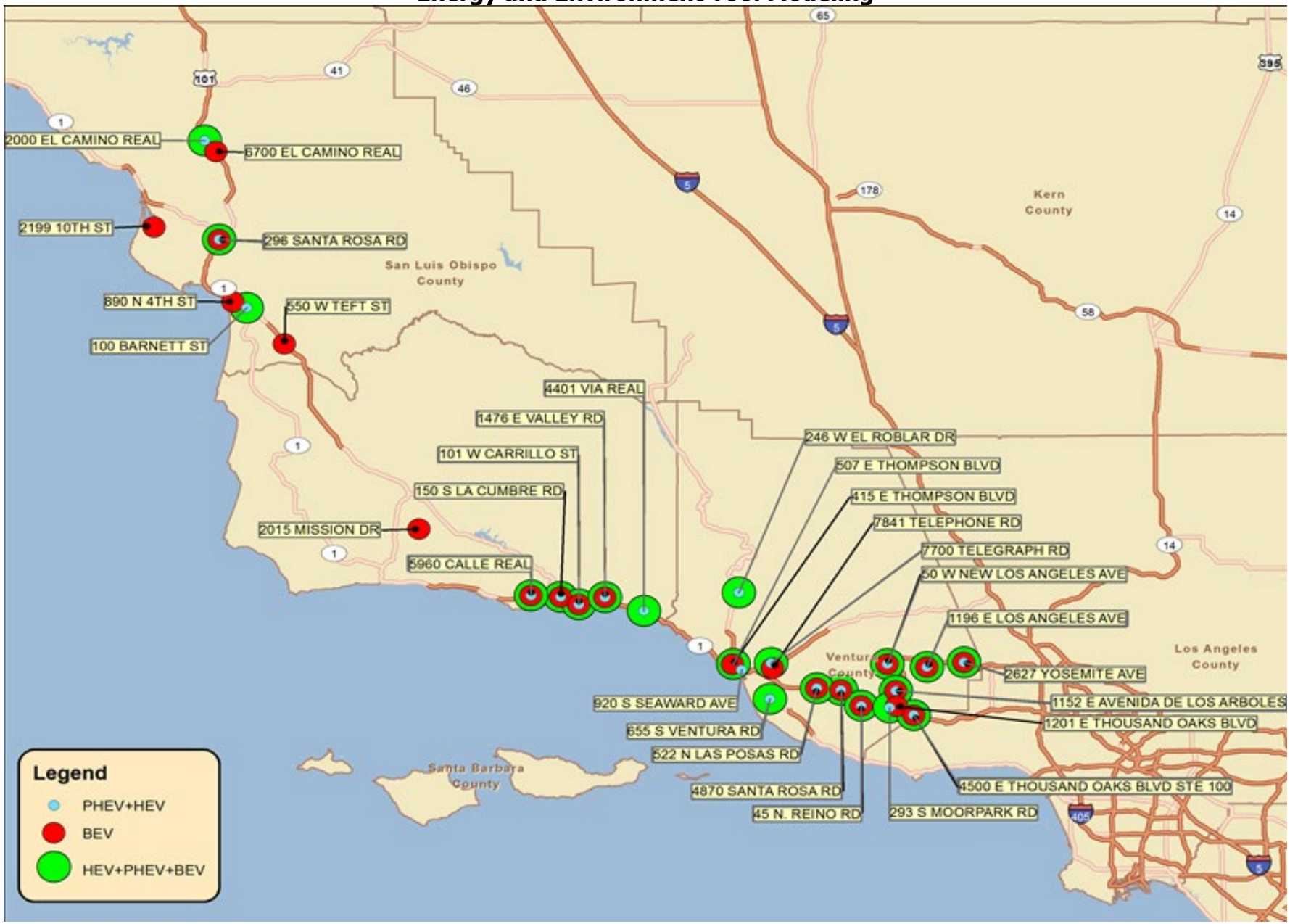


Table 4: Existing Gas Stations with High Suitability Ratings for Adding Hydrogen (East Ventura County)

Name	Address	City	Zip	SCORE
Hampshire Road Shell	395 Hampshire Road	Thousand Oaks	91360	18
7-Eleven #33162	609 Rancho Conejo Blvd.	Thousand Oaks	91320	18
Jenda, Inc.	3995 Thousand Oaks Blvd.	Thousand Oaks	91362	17
Rolling Oaks 76	293 S. Moorpark Rd.	Thousand Oaks	91361	17
Oaks Shell	56 E. Thousand Oaks Blvd.	Thousand Oaks	91360	17
Westlake Chevron	225 Hampshire Rd.	Westlake Village	91361	17
Borchard Arco AM/PM	2305 Borchard Rd.	Newbury Park	91320	21
GSE 76 Ventu Park	575 N. Ventu Park Rd.	Newbury Park	91320	20
Newbury 76	848 Wendy Dr.	Newbury Park	91320	18
USA Gasoline #68174	518 Rancho Conejo Blvd.	Newbury Park	91320	18
S & G Energy, Inc.	445 North Ventu Park Rd	Newbury Park	91320	18
Wendy Drive Chevron	2870 Camino Dos Rios	Newbury Park	91320	17
Borchard Chevron	2290 W. Borchard Rd.	Newbury Park	91320	17
Campus Plaza Shell	6599 Collins Dr.	Moorpark	93021	20
Moorpark Chevron	502 Los Angeles Ave.	Moorpark	93021	18
Union 76	550 W. Los Angeles Av	Moorpark	93021	17
Yosemite Shell	2627 Yosemite Ave.	Simi Valley	93063	21
Circle K #2211185	5195 East Cochran	Simi Valley	93063	20
Swank's Chevron	2449 Stearns Street	Simi Valley	93063	20
Chevron #9-1024	2568 Sycamore Drive	Simi Valley	93065	19
Apro LLC dba United Oil #10	108 Cochran Street	Simi Valley	93065	19
RJR Enter. dba Simi Valley Arco	25 Tierra Rejada Rd.	Simi Valley	93065	17
Kam's Canyon Mobil Service Ctr	2500 Tapo Canyon Rd	Simi Valley	93063	17

Source: Santa Barbara County Air Pollution Control District

Table 5: Existing Gas Stations with Higher Suitability Ratings for Adding Hydrogen (West Ventura County)

Name	Address	City	Zip	SCORE
Arneill Chevron	255 Arneill Rd.	Camarillo	93010	20
Proud Auto	4676 Adolfo Rd.	Camarillo	93012	18
Las Posas Mobil, Inc.	501 Las Posas Road	Camarillo	93010	18
Chevron #200209	4870 Santa Rosa Road	Camarillo	93010	18
Tesoro Shell #68511	107 W. Ventura Blvd.	Camarillo	93010	18
Hilu Chevron	522 N. Las Posas Rd.	Camarillo	93010	17
Circle K #2709460	2200 N. Rose Ave.	Oxnard	93030	20
Chevron SS #20-8020	1900 N. Rose Ave.	Oxnard	93030	20
Circle K #2709483	490 S. Victoria Ave.	Oxnard	93030	19
7-Eleven Facility #33399	2201 E. Gonzales Rd.	Oxnard	93036	18
S & S Chevron	2901 Saviers Road	Oxnard	93033	18
Vineyard Mobil	2851 E. Vineyard Ave.	Oxnard	93036	17
Oxnard Vineyard Chevron	2251 N. Oxnard Blvd.	Oxnard	93036	17
Rose Shell	1901 N. Rose Ave.	Oxnard	93030	17
Chevron #9-0576	920 S Seaward Ave	Ventura	93003	21
California Chevron	507 E Thompson Blvd.	Ventura	93001	20
Johnson Drive Carwash & Gas	2757 Johnson Dr.	Ventura	93003	19
Seaward Oil, Inc.	779 South Seaward Ave.	Ventura	93001	19
Johnson Oil Corp. Fac. 309330	6762 North Bank Dr.	Ventura	93003	18
Zaitoon Inc.	605 S. Mills Rd.	Ventura	93003	17
Arco AM/PM	5669 Valentine Rd.	Ventura	93003	17
Tesoro Arco #42054	2124 East Harbor Blvd	Ventura	93001	17

Source: Santa Barbara County Air Pollution Control District

Table 6: Existing Gas Stations with Higher Suitability Ratings for Adding Hydrogen (Santa Barbara County)

Name	Address	City	Zip	SCORE
Circle K Stores, Inc.	402 W. Mission Street	Santa Barbara	93101	19
Circle K Stores, Inc.	4801 Hollister Avenue	Santa Barbara	93111	18
Turnpike Fuel Partners, LP	250 N. Turnpike Road	Santa Barbara	93111	18
Janda Partners, L.P.	1085 Coast Village Road	Santa Barbara	93108	18
Tesoro Refining & Marketing Company LLC	340 W. Carrillo Street	Santa Barbara	93101	18
Chevron USA Products Company	115 S. La Cumbre Road	Santa Barbara	93105	17
World Oil Marketing Company	1800 State Street	Santa Barbara	93101	17
World Oil Marketing Company	5960 Calle Real	Goleta	93117	18
Circle K Stores, Inc.	49 N. Glen Annie Road	Goleta	93117	17
76 (Next to old Carrows)	4401 Via Real	Carpinteria	93013	19
Chevron	4290 Via Real	Carpinteria	93013	19
seven eleven	4410 Via Real	Carpinteria	93013	18
Moller Retail, Inc.	89 E. Highway 246	Buellton	93427	19
USA Gas	197 E Highway 246	Buellton	93427	19
Pacific Fuel Group	206 E. Hwy 246	Buellton	93427	19
Aljnar, Inc.	188 E. Highway 246	Buellton	93427	19
Tom's Gas	230 E Highway 246	Buellton	93427	17
ERN Oil, Inc.	605 Bell Street	Los Alamos	93440	17
Moller Retail, Inc.	910 E. Betteravia Rd.	Santa Maria	93454	20
Valley Pacific Petroleum Services, Inc.	1155 E. Betteravia Rd	Santa Maria	93455	19
Circle K Stores, Inc.	1220 E. Betteravia Rd	Santa Maria	93454	18
Main Street Shell Service	1204 E. Main St	Santa Maria	93454	17
Main Street Petroleum	1038 E. Main St	Santa Maria	93454	17

Source: Santa Barbara County Air Pollution Control District

Table 7: Existing Gas Stations with Higher Suitability Ratings for Adding Hydrogen (San Luis Obispo County)

Name	Address	City	Zip	County	SCORE
Mission Station, Inc.	328 Marsh Street	San Luis Obispo	93401	SLO	19
Tesoro Station No. 68613	296 Santa Rosa Street	San Luis Obispo	93405	SLO	17
Chevron # 98169 (Trett's)	3180 S. Broad Street	San Luis Obispo	93401	SLO	17
Refuel	2211 Broad Street	San Luis Obispo	93401	SLO	17
ARCO - Arroyo Grande AM/PM	100 Barnett Street	Arroyo Grande	93420	SLO	19
Mobil (Petro Grande)	525 Traffic Way	Arroyo Grande	93420	SLO	17
Chevron - Kautz	1284 Grand Avenue	Grover Beach	93433	SLO	20
Grover Beach Flyers	684 West Grand Avenue	Grover Beach	93433	SLO	17
Five Cities Chevron	340 Five Cities Drive	Pismo Beach	93449	SLO	19
Spyglass Shell (AU Energy)	2699 Shell Beach Road	Pismo Beach	93449	SLO	17
Atascadero 76	6305 Morro Road	Atascadero	93422	SLO	19

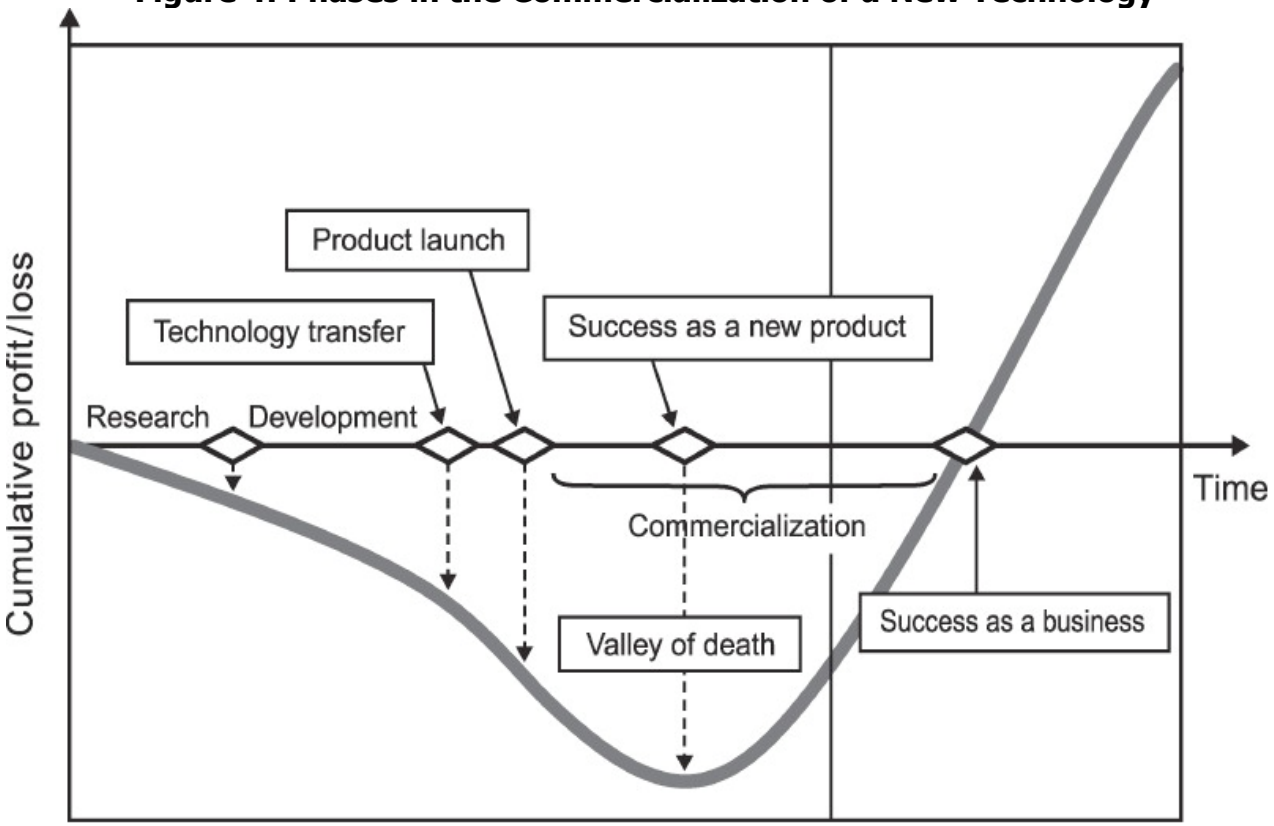
Source: Santa Barbara County Air Pollution Control District

Avoiding Stranded Assets

Clearly, there is a vital need for stations to be built concurrently with the growing number of FCEVs in the region, but it would not make financial sense to build "too many" refueling stations if FCEVs were not available for sale, or if they were not in demand by potential customers in this region.

The data included in Tables 4 through 7 can be used to project the pace of build-out necessary to support the growing demand for FCEVs. However, projections are notoriously unreliable for newly deployed vehicle types, and for any new technology there is a proving and acceptance period through which the technology has to go before it does (or does not) become mainstream, as shown in Figure 4.

Figure 4: Phases in the Commercialization of a New Technology



Source: Santa Barbara County Air Pollution Control District

The sales projections which the Original Equipment Manufacturers have collectively shared with the state are probably the best indication of sales potential at this stage, so the numbers given above have been used as the basis for planning infrastructure needs in the Tri-Counties from present out to 2025.

This further emphasizes the need for close coordination in the planning and implementation process between the local communities, the vehicle manufacturers, and the government agencies that provide funding support for station construction and operation.

Hydrogen Station Priorities

The market proxy data indicate that there are likely to be strong markets in several cluster areas of the Tri-Counties, with highest demand projected in the eastern end of Ventura County, both in the Westlake/Thousand Oaks/Newbury Park area (1,927) and also Simi Valley/Moorpark (1,275). Third and fourth highest rankings using the proxy metric are the Santa Barbara County South Coast (1,242) and Camarillo/Ventura/ Oxnard (1,226) in western Ventura County. Stations in these four areas cover 90 percent of the initial FCEV demand projected for the Tri-Counties.

Thus, based on market demand potential alone, the initial station priorities for the Tri-Counties should be:

1. Thousand Oaks/Newbury Park/ Westlake (eastern Ventura County)
2. Simi Valley/Moorpark (eastern Ventura County)
3. Santa Barbara County South Coast (now in place and operational)
4. Camarillo/Ventura (western Ventura County)
5. San Luis Obispo County

Since the first station is already operational in Santa Barbara, the initial priorities to maximize potential are in Ventura County. With stations in these first four general locations, there would be sufficient coverage to provide a reasonable level of redundancy since the stations in Ventura County would be within about 20 to 30 miles of each other, and for vehicle owners in Santa Barbara, there could be an alternative station reasonably close by as soon as one is in place in the Camarillo/Ventura area.

Since each County is likely to set its own priorities for establishing hydrogen infrastructure, there is potential for Santa Barbara to address the redundancy issue more immediately by pursuing options for a second station somewhere between Goleta and Carpentaria.

After this initial round, the subsequent priorities would be to install additional stations to meet growing demand or to focus on a connector station in San Luis Obispo County to provide access to the Bay area along the 101 corridor. This would serve all vehicle owners to the south in this respect as well as serving local demand. The proxy data suggest that subsequent build out to meet demand is likely to be most needed in the following areas:

1. Thousand Oaks/Newbury Park/ Westlake – second station
2. Simi Valley/Moorpark – second station
3. Santa Barbara – second station
4. Camarillo/Ventura/Oxnard – second station

The main conclusions from this are that the Thousand Oaks area is clearly a top priority, and the second priority could be Simi Valley/Moorpark based on demand alone, or Camarillo/Ventura to meet demand and provide broader redundancy in the early years. Subsequently, the need for additional stations to meet demand in Ventura will be considered as well as the needs for a connector station in San Luis Obispo and a second station for local redundancy in Santa Barbara. Both of these latter locations would also serve growing local demand.

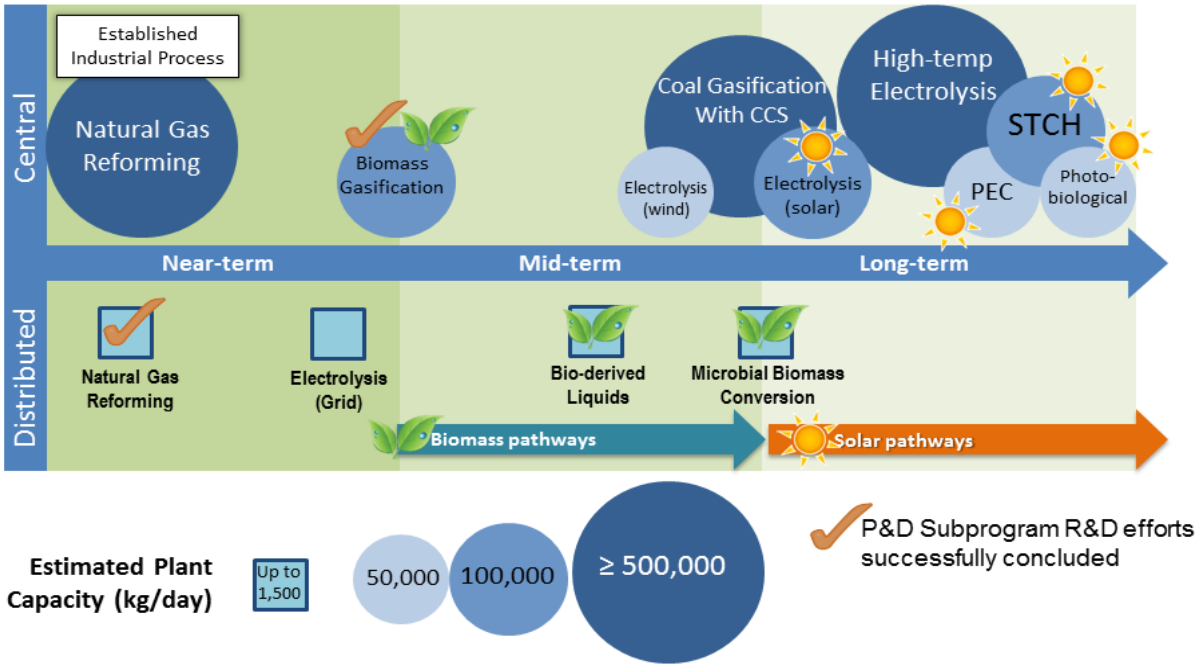
The field work done locally has shown that there are favorable gas stations having the necessary attributes for siting hydrogen dispensers in each of the priority areas.

Hydrogen Production and Distribution

The U.S. Department of Energy maintains a website that provides a comprehensive summary of the available hydrogen production methods that could be developed in the near-term, mid-term and long-term, shown in Figure 5.[14]

14 Hydrogen Production Pathways, available at http://energy.gov/eere/fuelcells/hydrogen-production-pathways

Figure 5: Hydrogen Production Pathways



Source: Department of Energy Office of Energy Efficiency and Renewable Energy

While there are many potential options in the longer term, the figure shows that there are only two basic approaches that are viable in the near-term, and these are natural gas reforming and electrolysis. Factors that will influence the near-term pathway(s) chosen are likely to be the cost for hydrogen at the pump, and the carbon intensity of the life cycle process (well-to pump). Production and distribution both have an effect on carbon intensity.

The following considerations are relevant in this respect:

- There is a California mandate that requires 33 percent of all hydrogen produced for use in FCEVs will have to come from renewable sources – once the total quantity of hydrogen delivered in the state exceeds a defined level. Over time, this percentage is likely to increase as the state moves to achieve its goal of 80 percent reduction in greenhouse gas emissions by 2050.[15]
- Each hydrogen production pathway has its pros and cons. For example, most of the hydrogen produced and delivered for FCEVs in California at this time comes from centralized production of hydrogen using Steam Methane Reforming. This is probably the least-cost option presently, but it has a relatively high carbon intensity because it uses natural gas as a source and the hydrogen must be distributed via trucked deliveries. In contrast, on-site electrolysis can have a low carbon intensity (dependent on the source of electricity used), but is currently more costly, and more difficult to produce at volume.
- In due course, there is a real possibility that distributed hydrogen production will become an option, for example through "compact onsite reformation". The implication of this is that there would be a reduced need for transporting hydrogen from central production facilities.

15 SB 1505 Environmental Performance Standards for Hydrogen Fuel

- As the above figure suggests, hydrogen production and delivery methods are likely to change and improve over time, so it would be prudent not to move too fast in one direction at this early stage. For example, by investing in too many stations dependent on centralized hydrogen Steam Methane Reforming production. Stranded assets and investments need to be avoided. As such, it may be advantageous to keep options open with respect to production and delivery methods during the early years.

Steam Methane Reforming of Natural Gas

Today, Steam Methane Reforming accounts for about 95 percent of domestic hydrogen production. In this process, natural gas is mixed with high-temperature steam in the presence of a catalyst to separate the hydrogen. Carbon dioxide is emitted as an effluent gas with this process. Most of the hydrogen produced in this way is used for industrial processes and in the refining of crude oil.

A recent report by the Institute for Transportation Studies at UC Davis concludes that natural gas will continue to be the least expensive and most energy-efficient resource from which to produce hydrogen through the 2020s.[16]

Use of Renewable Natural Gas for Hydrogen Production

The steam reforming process can be used to produce renewable hydrogen when the natural gas feedstock is replaced with biogas or landfill gas. A biogas or landfill gas feedstock can be used to produce hydrogen with a lower carbon intensity than natural gas Steam Methane Reforming, but the actual value will depend on the fuel used for steam production and the need for distribution. Experience has shown that the biogas conditioning system needs to be effective and reliable to avoid having contaminant gases foul the fuel cell membranes (particularly in stationary applications). For transportation fuels, there are specified conditions for the hydrogen gas quality, so this should not be an issue for FCEVs. In the Tri-Counties, it is unclear how much biogas or landfill gas would be available for the production of hydrogen, but the revised Low Carbon Fuel Standard proposed by CARB does allow for the use of out-of-state biogas or landfill gas to be purchased and used to offset the natural gas emissions. This latter approach is being used by hydrogen producers currently to meet or exceed the State 33 percent renewable hydrogen requirement.

Onsite Production of Hydrogen Using Electrolysis

Through this process, an electric current splits water into hydrogen and oxygen. With electrolysis, traditional methods use purified water and power from the grid. If the electricity is from a renewable source, then the hydrogen is also said to be renewable. Electrolysis of water is a less common method of producing hydrogen for FCEV use currently, but several production projects are being developed, including some that plan to use wind or solar power. Some experts maintain that onsite electrolysis is up to twice as expensive as hydrogen produced by steam reformation of natural gas.[17]

Emerging Technologies for Hydrogen Production

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16 Joan Ogden, Christopher Yang, Michael Nicholas, Lew Fulton , NextSTEPS White Paper: The Hydrogen Transition, Institute of Transportation Studies University of California, Davis, July 29, 2014, p. 15, available at http://steps.ucdavis.edu/files/08-13-2014-08-13-2014-NextSTEPS-White-Paper-Hydrogen-Transition-7.29.2014.pdf

17 Julia Pyper, "Is electrolysis the pathway to reach totally carbon-free hydrogen fuel?," Climatewire, November 20, 2014, available at http://www.eenews.net/stories/1060009250

The development of clean, sustainable, and cost-competitive hydrogen production processes is essential to the success of hydrogen powered transportation. Research and development of alternative ways to produce hydrogen have been ongoing for several years and continue to this day. In 2009, the Freedom Car and Fuel Partnership issued a paper called "Hydrogen Production – Overview of Technology Options" which included a summary of seven key production technologies in three broad categories (listed below).[18] Some of these approaches are approaching commercialization, but further research is ongoing at the national laboratories, universities and in the commercial sector.

Thermal Process

- Distributed natural gas reforming
- Bio-derived liquids reforming
- Coal and biomass gasification
- Thermochemical production

Electrolytic and Photolytic Processes

- Water electrolysis
- Photo electrochemical hydrogen production19
- Biological hydrogen production

Another potential technology development that could be relevant in the near term is Carbon Capture and Sequestration. The first commercial scale carbon capture and sequestration projects are now operational, and Steam Methane Reforming is one process where carbon capture can be accomplished at a reasonable cost, especially when there is a price on carbon emissions. One example is the Shell Quest project in Alberta, Canada. New technologies are also emerging in which a CO_2 stream is converted directly to carbon, avoiding the need to inject and store underground. One example is the LytEn carbon sequestration system which has been proposed with several hydrogen production pathways approved by CARB[20]. (Refer to Section 2.4.8, below for further details.)

Based on dialogue with community stakeholders through the planning period, it is evident that there is concern about building a hydrogen infrastructure that is dependent on hydrogen production from fossil fuels, including natural gas. This emphasizes the importance of continued progress in developing and implementing sources of cost-effective renewable hydrogen.

Water and Natural Gas Requirements

An important consideration in the development of new production pathways is the resources that are needed to produce the hydrogen. In particular, the transition from petroleum to hydrogen is less beneficial if the hydrogen is derived from natural gas – another fossil fuel – and electrolysis may be less appealing if the demand for water competes with existing needs for potable water.

Figure 6 compares the resource requirements for hydrogen produced from steam reforming (natural gas and water) with the water needed for hydrogen produced by electrolysis. In

18 Freedom Car & Fuel Partnership, "Hydrogen Production – Overview of Technology Options", 2009.

19 The photoelectrochemical production pathway is being pursued by several R&D groups including one local start-up in Santa Barbara called HyperSolar (hypersolar.com)

20 LytEn Low Carbon Fuel Standard Pathway for the Production of Hydrogen from Natural Gas and Renewable Natural Gas, available at https://www.arb.ca.gov/fuels/lcfs/2a2b/apps/lyt-H2-rpt-121715.pdf

general, it is apparent that the water requirements for either pathway are not substantial when compared with other existing water uses. This concern is further mitigated if non-potable sources of water can be used to produce the hydrogen in due course.

Hydrogen Distribution

Once hydrogen is produced, there are several ways to deliver it to vehicles. When produced centrally in larger production units, it is usually stored as a compressed gas or as a cryogenic liquid (at -253˚C), and then distributed by truck (or gas pipeline in some cases) to the hydrogen refueling station. When hydrogen is produced on-site at or near the refueling station, then the need for distribution is eliminated.

In the near term, most hydrogen delivered to the Tri-Counties would likely come by truck from sources in the Los Angeles area that currently produce hydrogen for other users. Relatively small amounts of gaseous hydrogen can be transported short distances by high-pressure tube trailers (at 250 bar or 3,600 pounds per square inch). A modern high-pressure tube trailer is capable of transporting approximately 600 kilograms (kg) of hydrogen (in contrast to gasoline tank trucks, which can transport nearly 14 times the equivalent energy). Tube trailers are currently limited by Department of Transportation regulations to pressures of less than 250 bar, but further development and testing of Types II, III, or IV higher-pressure composite vessels for hydrogen, along with the development of appropriate codes and standards, will eventually allow the use of higher-pressure hydrogen tube trailers that also comply with federal truck weight limitations.

Figure 6: Fuel Production Resource Projections

(a) Steam Reforming							
	Use 2(H2O) + CH4 = CO2 + 4(H2)						
		MW					
Ideal	H - 8 atoms	8	1	kg	Production of 1kg of hydrogen		
	C - 1 atom	12	1.5	kg			
	O - 2 atoms	28	3.5	kg			
	CH4	16	2	kg	Needs 2kg of Natural Gas (CH4)		
	2 (H2O)	32	4	kg	Needs 4kg of Water (H20)	1.1	gallon
	CO2	40	5	kg	Generates 5kg of CO2		
Add process heat - assume this doubles the quantity of methane needed (actual data); assume 50% steam overfeed							
	CH4		4	kg	Needs 4kg of Natural Gas (CH4)		
	2 (H2O)		6	kg	Needs 6kg of Water (H20)	1.6	gallon
	CO2		10	kg	Generates 10kg of CO2		
(b) Electrolysis							
	Use 2(H2O) = O2 + 2(H2)						
		MW					
	H - 4 atoms	4	1	kg	Production of 1kg of hydrogen		
	O - 2 atoms	28	7	kg	Generates 7kg of oxygen; no CO2		
	2 (H2O)	32	8	kg	Needs 8kg of water	2.1	gallon
Assume electrolysis is 70% conversion rate from water to hydrogen/oxygen							
	2 (H2O)		11.4	kg	Needs 8kg of water	3.0	gallon
(c) Resource Needs (minimum) assuming 100% efficiency of hydrogen conversion process							
	Number of FCEVs	1	1000		Estimate for Tri-Counties, 2020		
	Hydrogen per year	254	254,148	kg	CARB 2015 Report		
	Steam Reforming:	1,017	1,016,593	kg NG			
		517	516,904	therm NG			
		1,525	1,524,889	kg water			
		404	404,187	gall water			
	Electrolysis	2,905	2,904,550	kg water			
		770	769,881	gallons, total			
Unit Conversion factors							
	Density of water	8.3	lb/gall	3.77	kg/gall		
	Natural Gas	1,017	kg NG	per vehicle per year			
		0.712	kg/m3				
		1,428	m3 NG				
		50,430	ft3 NG				
		1025	btu/scft				
		52	MMBtu	per vehicle per year			
		517	therms	per vehicle per year			
For Comparison							
	Typical Household in SB	500	therms per year (NG)				
		60,000	gallons water per year				

Source: Santa Barbara County Air Pollution Control District

The cryogenic liquid delivery option is more economical than gaseous trucking for high market demands (greater than 300 kg/day) because a liquid tanker truck with a capacity of approximately 4,000 kg can transport more than 10 times the capacity of a typical tube trailer. The energy cost for converting gaseous hydrogen to liquid is high because hydrogen has an extremely low condensing point (-423.2°F at atmospheric pressure). The theoretical thermodynamic energy needed for hydrogen liquefaction represents approximately 10 percent of the energy in the hydrogen (lower heating value). An estimate for current liquefaction is that the energy required amounts to about 35 percent of the energy content of the hydrogen.

Current analysis shows that pipeline delivery, where feasible, provides the lowest cost option for large refueling station demand (greater than about 600 kg/day). Compressed gas tube-trailers are well-suited for hydrogen delivery for smaller end-use demand and short distance deliveries due to their low payload (~300 kg).

The contribution of refueling station capital investment contributes approximately half of the total delivery cost. The capital investment at the refueling station is dominated by cost of compression and storage. The investment risk and the underutilization of the refueling station capital investment during the pre-commercialization and the transition to large scale deployment of fuel cell electric vehicles represent the major market barriers to the full commercialization of fuel cell electric vehicles.

Mobile Refuelers

The potential use of mobile hydrogen refueling trucks to service initial (lower) demand for fuel has been discussed. This could be an approach used by the Tri-Counties to provide temporary fueling capability in new market areas, and also as a way to fuel vehicles if primary stations are inoperable. Such units would be required to meet the National Fire Protection Association 2: Hydrogen Technologies Code and local codes.

Mobile refuelers have been used for early market hydrogen delivery in Japan. They combine hydrogen storage with a dispenser in a portable unit that can fuel vehicles directly, or to transfer hydrogen to a storage tank at a refueling station. Mobile refuelers have a typical capacity of 110 kg at 350 bar (5,000 psi) using steel tubes. Liquid hydrogen supply mobile refuelers combine a liquid cryogenic pump and heat exchanger/vaporizer to produce high-pressure gaseous hydrogen for fueling. The mobile refueler is transported using a separate traction vehicle.

Mobile refuelers are considered a short-term bridge technology, which would no longer be needed once a viable network of stations in operating.

Hydrogen Dispensing

FCEVs are designed to accept hydrogen in gaseous form pressurized at two levels, either 350 bar (5,000 psi) -- known as H35 -- or 700 bar (10,000 psi) – known as H70. Currently, 700 bar (Hydrogen 70) gaseous on-board storage has been chosen for the first generation of commercial vehicles, while 350 bar (Hydrogen 35) is typically used for buses, forklifts, and other lift trucks. A full tank of hydrogen on a light duty FCEV (usually about 4 to 6 kilograms) provides range of approximately 300 miles, which is almost comparable to a conventional vehicle.

Hydrogen refueling stations can be co-located with regular gasoline stations or they can be operated in stand-alone locations. Hydrogen dispensing equipment is similar in appearance to gasoline dispensers, although hydrogen fuel is delivered to vehicles in a gaseous state. Stations are designed for unattended operation.

Hydrogen dispensers being installed today usually have one hose and nozzle for each of the two standard delivery pressures. Users cannot attach the high-pressure nozzle to a lower pressure receptacle, so there is no chance of fueling at the wrong pressure level. When a driver activates the dispenser, hydrogen flows from the storage tanks and through the nozzle into the vehicle's on-board storage tanks. If filling with Hydrogen 70 (light-duty vehicle standard), the hydrogen passes through a booster compressor and chiller before entering the dispenser.

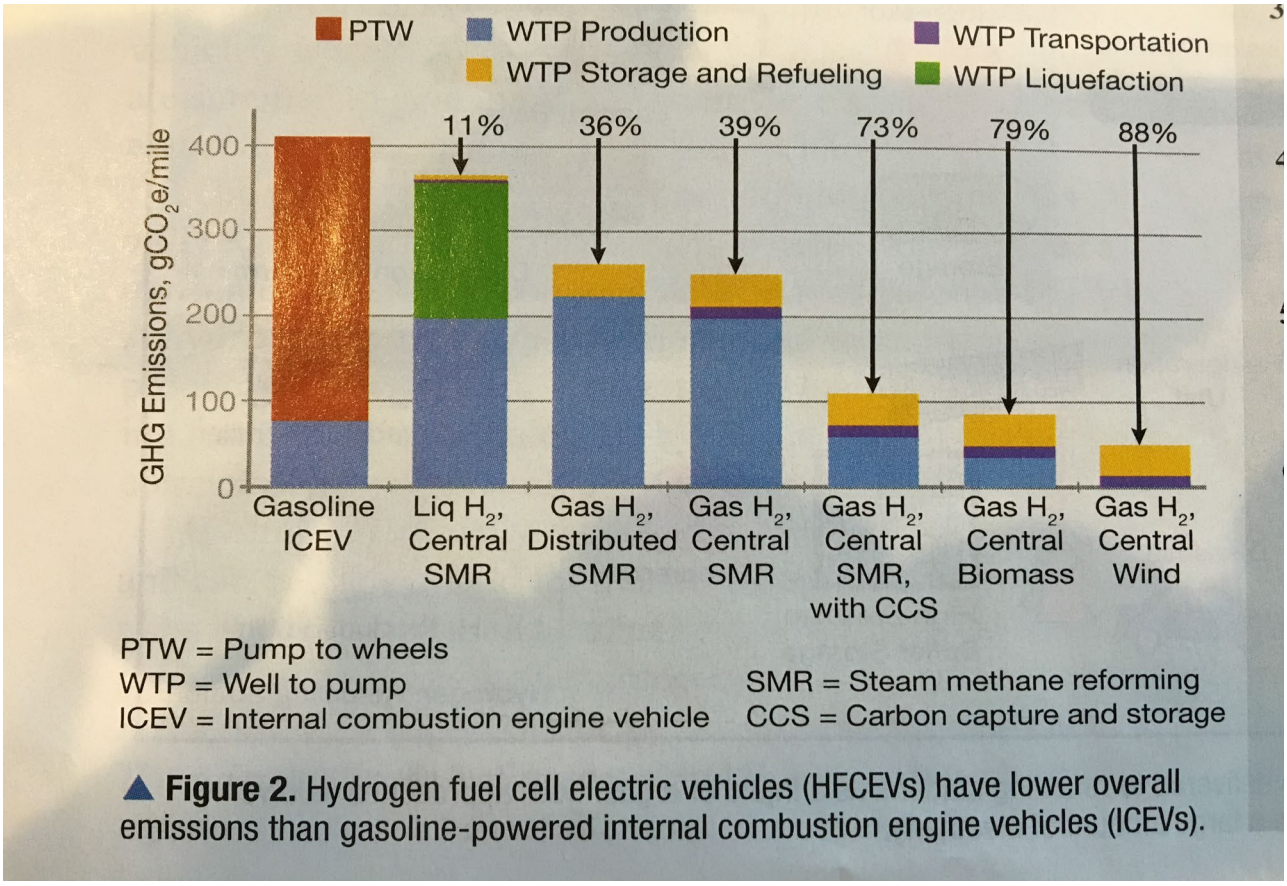
The dispensers are designed to accept credit cards and display sales information conforming to state weights and measures requirements. Volume is displayed in kg. Fueling time is approximately 5 minutes per tank for a typical light duty vehicle. The State has made significant progress developing a reliable method for assuring the accurate measurement of fuel delivery to an FCEV.

Hydrogen leak detection, in the absence of odorizers, is a challenge. Currently, commercially available leak detection equipment is handheld. Ideally, an online leak detector (direct or indirect measurement) would be a desirable addition to a tube trailer.

Summary of Production and Distribution Pathways

Figure 7 presents a summary of the greenhouse gas emissions for the various hydrogen production options, including distribution (Well to Pump). As part of the revision process for the Low Carbon Fuel Standard regulation, CARB has recently issued an updated set of approved hydrogen pathways Figure 8 shows the production alternatives currently under consideration in California, and for providing hydrogen to the Tri-Counties region in the near term.

Figure 7: Comparison of Greenhouse Gas Emissions for Various Production and Distribution Combinations



Source: Reddi, Krishna; Amgad Elgowainy and Michael Wang, Argonne National Laboratory; Chemical Engineering Progress, AIChE, July 2016, page 51.

Of the 15 hydrogen pathways listed in Figure 8, there are four variation of natural gas Steam Methane Reforming (three central and one onsite); one Steam Methane Reforming onsite using renewable feedstocks; four that use renewable biogas (two with 33 percent and two with 100 percent) – all with carbon capture; four with Landfill Gas with carbon capture; one using electrolysis with solar electricity; and one that is a "Tri-generation" process using a fuel cell and biogas. The figure shows that, with the use of carbon capture, some of the pathways using non-fossil feedstocks can result in negative carbon intensity values.

Figure 8: Summary of Low Carbon Fuel Standard Hydrogen Pathways

App #	Class	Applicant & Pathway Discription	Feedstock	Fuel Type	Current FPC	Current CI	Certification Date
	Lookup Table	CARBOB - based on the average crude oil supplied to California refineries and average California refinery efficiencies	Crude Oil	CARBOB	CBOB001	99.78	NA
	Lookup Table	California grid electricity	CA Grid Electricity	Electricity	ELC002	105.16	NA
	Lookup Table	Compressed H2 from central reforming of NG (includes liquefaction and re-gasification steps)	North American NG	Hydrogen	HYGN001	151.01	NA
	Lookup Table	Liquid H2 from central reforming of NG	North American NG	Hydrogen	HYGN002	143.51	NA
	Lookup Table	Compressed H2 from central reforming of NG (no liquefaction and re-gasification steps)	North American NG	Hydrogen	HYGN003	105.65	NA
	Lookup Table	Compressed H2 from on-site reforming of NG	North American NG	Hydrogen	HYGN004	105.13	NA
	Lookup Table	Compressed H2 from on-site reforming with renewable feedstocks	North American NG	Hydrogen	HYGN005	88.33	NA
	M2A/2B	LytOil (DBA LytEn): 33.3% Renewable Biogas, On- Site Hydrogen (Prospective)	Landfill Gas	Hydrogen	HYGN007	15.29	12/30/15
	M2A/2B	LytOil (DBA LytEn): 100% Renewable Biogas, On- Site Hydrogen (Prospective)	Landfill Gas	Hydrogen	HYGN008	-46.91	12/30/15
	M2A/2B	LytOil (DBA LytEn): 33.3% Renewable Biogas, Tube Trailer (Prospective)	Landfill Gas	Hydrogen	HYGN009	29.84	12/30/15
	M2A/2B	LytOil (DBA LytEn): 100% Renewable Biogas, Tube Trailer (Prospective)	Landfill Gas	Hydrogen	HYGN010	-32.36	12/30/15
	M2A/2B	FuelCell Energy, Inc.: Hydrogen produced in a fuel cell using biogas derived from the mesophilic anaerobic digestion of wastewater sludge, with electricity co-product credit.	Biogas from Wastewater Sludge	Hydrogen	HYGN011	-0.82	02/02/16
T2R-1080	Legacy	Fuel Producer: Alameda-Contra Costa Transit District (A149) Facility Name: Division 2 (F1600). Hydrogen production via electrolysis using solar electricity	Solar Elericity via Electrolysis	Hydrogen	HYGE200L	0.00	09/30/16
T2R-1033	Legacy	Fuel Producer: LytEn (L700) Facility Name: LytEn (K4933). Landfill gas to hydrogen production via cracking of methane and transport by tube trailer	Landfill Gas	Hydrogen	HYGLF200L	-5.28	09/30/16
T2R-1034	Legacy	Fuel Producer: LytEn (L700) Facility Name: LytEn (K4933). North American fossil NG and landfill gas to on-site hydrogen production via cracking of methane	Fossil NG & Landfill Gas	Hydrogen	HYGFLF200L	40.36	09/30/16
T2R-1035	Legacy	Fuel Producer: LytEn (L700) Facility Name: LytEn (K4933). Landfill gas to on-site hydrogen production via cracking of methane	Landfill Gas	Hydrogen	HYGLF201L	-12.65	09/30/16
T2R-1036	Legacy	Fuel Producer: LytEn (L700) Facility Name: LytEn (K4933). North American fossil NG and landfill gas to hydrogen production via cracking of methane and transport by tube trailer	Fossil NG & Landfill Gas	Hydrogen	HYGFLF201L	47.73	09/30/16

CARBOB and Electricity pathways are included to show Carbon Intensities for reference.
Source: CARB

Hydrogen Station Cost Estimates

Details of the costs for installing and operating hydrogen refueling systems is of interest to local decision makers who may be considering local support for building the regional infrastructure. The information summarized below is drawn from three main sources. These are: (1) the California Assembly Bill 8 Joint Agency Report: Assessment of Time and Cost Needed to Attain 100 Hydrogen Refueling Stations in California (mid-year 2015)[21]; (2) the California Hydrogen Business Council report titled "Financing the 101st Hydrogen Station"; September 2016[22]; and (3) The U.S. Department of Energy financial projections analysis[23].

Station Installation Cost

The Assembly Bill 8 Joint report summarizes investments made by the State over the last five years for hydrogen station installation. The report suggests that each station using delivered hydrogen costs about $2.1 million to install, of which the state has been contributing up to 85 percent of the total. This is based on awards made for the first 51 stations in California. This share is declining over time, and for the current round of funding (2016), the state contribution is expected to be 70 percent. Most of these stations have a capacity of about 18 kg/day.

Costs for stations with higher capacity – increased storage of hydrogen gas onsite, or by using liquefied hydrogen – will likely be higher than $2.1 million and could be as much as $2.8 million for a 350 kg/day station with delivered liquid hydrogen. For a 130 kg/day station using present day electrolysis, the CEC data show that station installation costs are on the order of $3.1 million. Clearly, there is a considerable premium for delivering hydrogen using this technology.

The hydrogen business community is concerned that the high cost for station installation will be an impediment to achieving the state's longer-term goals for hydrogen. This is clearly expressed in the California Hydrogen Business Council report referenced above. The report focused on the business case for commercialization of hydrogen station installation and operation, concluding that there are four primary variables that control station profitability as follows (based on assumptions for a 200 kg/day station):

- For each station there needs to be 400 vehicles clustered around the station, each using 0.5 kg/day of hydrogen
- Margin on hydrogen sales needs to be $3/kg or better
- Operations and Maintenance cost needs to be $100,000/year or less
- Capital cost of station must be $1,000,000 or less

Meeting these targets will be a substantial challenge for California. The Assembly Bill 8 Joint Agency report projects that station costs could decline by as much as 50 percent if the global development of the hydrogen infrastructure continues which suggests that the station cost target of $1 million is achievable based on work being performed at National Renewable Energy Laboratory. Experience in other regions and countries (including the East Coast States and Japan) indicates that stations can be built and installed for less than

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21 AB8 Joint Agency Report: Assessment of Time and Cost Needed to Attain 100 Hydrogen refueling Stations in California, 2015 (California Energy Commission and California Air resources Board Joint Report to California legislature (with National Renewable Energy Laboratory Technical Support). Jim McKinney lead author, ARFVT Program Manager CEC. Ref CEC-600-2015-016

22 California Hydrogen Business Council Report "Financing the 101st Station", September 2016.

23 U.S. Department of Energy National Renewable Energy Laboratory - reference

$2.1 million. However, it is unclear what station design factors will change and how quickly this will become feasible.

The AB8 report recognizes that automakers are already contributing to station development costs, but there is a clear need to stimulate further station investments through innovative partnerships between government and the private sector.

Station Operating and Maintenance Costs

Operating and Maintenance costs include equipment maintenance and onsite station operability. Given that there is low throughput for each of the stations installed to date, the State has been supporting station Operations and Maintenance with grants of up to $300,000 per station (over three years). Station throughput will need to increase substantially to deliver the margin needed to cover this together with a return on investment, but National Renewable Energy Laboratory modeling analysis shows that this would be achievable with 75 percent station utilization.

The cost for dispensed fuel is not included in the Operations and Maintenance package, as that is paid for separately at the "pump". On average, the current price for hydrogen in California is about $14/kg (Assembly Bill 8 report) which equates to $5.60 per gallon of gasoline, taking account of the fact FCEVs are about 2.5 times more efficient than Internal Combustion Engine vehicles (and 1kg of hydrogen has about the same useful energy as 1 gallon of gasoline).

The U.S. Department of Energy has projected that the future price of hydrogen could drop to $8/kg to $10/kg within a few years which would be competitive with gasoline as $3.50 per gallon. Longer range the cost could drop even further to $2-$5/kg (based on the U.S. Department of Energy forecast included in the Assembly Bill 8 report).

In summary, it is apparent that Operations and Maintenance can be covered as soon as station utilization increases, and there is potential for fuel costs to decrease such that they are competitive with gasoline. The Low Carbon Fuel Standard regulation, currently going through a revision process, will soon require all hydrogen fuel producers to participate in the Low Carbon Fuel Standard program which in many cases will provide an opportunity for revenue generation. CARB has estimated that $2 to $3 per kg may be available for hydrogen generated using pathways with low or negative Carbon Intensity values. (Assembly Bill 8 annual report, 2016)

The station financial costs for installation and Operations and Maintenance were modeled by National Renewable Energy Laboratory using the H2FIRST model[24]. This acronym stands for Hydrogen Financial Station, a model developed by The U.S. Department of Energy for cost estimation based on early work by Energy Independence Now[25].

24 H2FIRST

25 Energy Independence Now Financial Tool

Chapter 3:
Hydrogen Station Permit Streamlining

Introduction

Experience around the state has shown there can be significant delays in getting a hydrogen station installed because of unseen or unexpected issues that arise during the permitting process. Some of these delays have been two years or more, and this has created frustration and a cost burden that is an impediment to the smooth introduction of a hydrogen infrastructure.

Every time a station is proposed in a new community, there is potential for delays if hydrogen is perceived as a "new technology" and one with unreasonable safety concerns. That said, it is important that the permitting be done properly and thoroughly to provide early assurance that stations can be designed and built safely and in a way that meets applicable codes and standards. This is important if it is to operate successfully and be readily accepted in the community.

There is now a growing body of experience related to station permitting and there is a plethora of information that is available to permit agencies to help expedite the review process. The intent of this manual is to summarize that information so that there is clear guidance on resources that are available, and to summarize how each resource can be most useful. In this way the permit process may be expedited and streamlined in a way that leads to a consistent high-level of permitting across the Tri-Counties.

The guidance can help ensure that important considerations are not overlooked, and also to avoid any unnecessary time wasted in conducting studies and research on issues that have already been addressed effectively by others.

Review of Available Permitting Guidance and Resources

Table 8 (included at the end of this Chapter) presents a matrix of several key resources that are publicly available to Planning and Fire Departments for performing plan checks. The table includes an indication of the content of each resource as it relates to hydrogen station permitting.

The California Governor's Office of Business and Economic Development has issued a comprehensive "Hydrogen Station Permitting Guidebook", which is an excellent resource for guiding the permitting process. Other sources of information included in this table include the State of California ZEV Readiness Guidebook, and permit tools available from The U.S. Department of Energy H_2Tools website. These reference materials are described briefly below. Given that many of these references are likely to change and be updated, it is recommended that the links provided to electronic versions of these documents be used to access the most current versions when needed.

California Governor's Office of Business and Economic Development "Hydrogen Station Permitting Guidebook"

This reference document provides best practices for planning, permitting and commissioning for a new hydrogen refueling station. It was published by the Governor's Office of Business and Economic Development in November 2015 (First Edition). Hydrogen Station Permitting Guidebook is available at https://gobiz.app.box.com/v/hydrogenpermittingguidebook

National Renewable Energy Laboratory – Guide to Permitting Hydrogen Motor Fuel Dispensing Facilities

This is a comprehensive guide for permitting resources recently released by The U.S. Department of Energy. It includes a detailed listing of applicable codes and standards for permitting a hydrogen refueling station. (First issued in 2016). Guide to Permitting Hydrogen Motor Fuel Dispensing Facilities is available at http://www.nrel.gov/docs/fy16osti/64042.pdf

U.S. Department of Energy Permitting for Officials

This reference is called "Regulations, Codes and Standards Template for California Hydrogen Dispensing Stations". It was published by the National Renewable Energy laboratory in 2013. Authors were C. Rivkin, C. Blake, R. Burgess, W. Buttner, and M. Post. Regulations, Codes and Standards Template for California Hydrogen Dispensing Stations is available at www.nrel.gov/docs/fy13osti/56223.pdf

National Fire Protection Agency-2 Code

The National Fire Protection Agency-2 Code is available for purchase from the ANSI Publications website. Staff from National Fire Protection Agency have summarized the requirements of applicable requirements in a PowerPoint Presentation. National Fire Protection Agency-2 Hydrogen Technologies Code is available at http://catalog.nfpa.org/NFPA-2-Hydrogen-Technologies-Code-2016-Edition-P1144.aspx?icid=B484

Ongoing Support Efforts

In addition to making resources available to permit agency staff, another practice which can help to raise confidence in hydrogen as a transportation fuel is to encourage first-time permit authorities to make contact with their peers in other jurisdictions where hydrogen has been successfully permitted.

Where guidance is to be provided by local permitting authorities, it is important that the guidance be current and kept up to date through a formal review process. There may be merit in having a State agency take on that role through a centralized website to minimize the need for repeating this effort at every local agency.

Additional Resources

- California Fuel Cell Partnership: "A California Roadmap: Bringing Fuel Cell Electric Vehicles to the Golden State Air, Climate, Energy, Water and Security Well-to-Wheels Report"
- Clean Cities Coalition: "H2 Readiness: Best Practices for Hydrogen Stations in Early Adopter Communities"
- Governor's Interagency Working Group on Zero-Emission Vehicles 2013 ZEV Action Plan
- Governor's Office of Planning and Research: "Zero Emission Vehicles in California: Community Readiness Guidebook"
- H2 Readiness - Best Practices for Hydrogen Station in Early Adopter Communities. Part of the Clean Cities California ZEV Action Plan, April 2014

Table 8: Hydrogen Permitting Resource Matrix

Permit Item	California Governor's Office of Business and Economic Development Hydrogen Station Permitting Guidebook	NREL Permitting Guide for Officials in California	DOE H2Tools – National Permit Guide for Hydrogen Refueling Stations, 2016
Permitting Guidebook	✓	✓	
Permit Template	p.42	p.4, p.14	
Permitting Activities Checklist	pp.1-4	p.2	
Zoning	p.22		
Setbacks	p.34		
Codes and Standards – General	p.35	pp.17-20	✓
Codes and Standards - California	p.24	pp.17-20✓	
California Environmental Quality Act Guidance	p.23	p.22	
Permit Review Process	p.26		
Construction	p.30		
Commissioning	p.31		
Safety Review	p.32		
Signage			
Permit Fees	p.25		
California Accidental Release Prevention Program		p.24	
Other topics			

Source: Santa Barbara County Air Pollution Control District

Chapter 4:
Promotion and Awareness of Hydrogen and FCEVs

Introduction

The purpose of developing a Promotion Plan for hydrogen and FCEVs was to engage with key stakeholders in the Tri-Counties region (including local officials, civic leaders, and community groups) to build support for hydrogen as a transportation fuel and help them prepare for siting hydrogen refueling stations in their jurisdictions, safely and efficiently. The activity included individual meetings, and outreach at community events, summits, and workshops. Promotional materials and information resources were also developed.

There is currently low awareness of hydrogen as a transportation fuel in the Tri-Counties and the important role it is expected to play in state goals related to climate change, air quality, and ZEV adoption. The limited familiarity with hydrogen and FCEVs among stakeholders became clear early on in the outreach process. In many cases, local officials and members of the public did not know that FCEVs were available for purchase or lease. Many outreach contacts also had little-to-no knowledge of FCEV benefits or state activities to help build a robust hydrogen refueling network.

Strategy

Previous outreach conducted for the AFV Readiness planning effort informed outreach activities for the regional Hydrogen Readiness project. In some cases, standalone workshops and information sessions conducted for the AFV Readiness plan were not well attended despite targeted promotion efforts in communities where these activities were conducted. In general, it has been more effective to "meet people where they are at" and incorporate outreach into events and forums that already have a large audience.

For the Hydrogen Readiness promotion task, awareness activities were conducted at larger community events and forums whenever possible. For standalone promotion and awareness events, robust media outreach and information campaigns launched to notify the public, news outlets, and local officials. In some cases, outreach events were targeted to both community members and local officials. Of the 7 promotion events held, 5 were attended by a mix of community members and local officials.

All promotion activities considered during this project for promoting FCEVs and hydrogen were designed to supplement outreach efforts associated with ongoing AFV readiness planning in the Tri-Counties and provided specific emphasis on hydrogen. This was needed because of the general lack of awareness of FCEVs and hydrogen currently. The Tri-Counties Hydrogen Readiness project team also took steps to avoid duplicative promotional activities that were already being conducted in the region by other entities, including the California Fuel Cell Partnership and Original Equipment Manufacturers offering FCEVs.

Outreach and awareness activities did not place extensive focus on promoting the FCEV adoption because of the current level of market development in the region. Only one hydrogen refueling station is operating in the Tri-Counties region currently and no local dealership are offering FCEVs for sale or lease. This limited the potential for FCEV adoption in the region during the project period, so promotional activities place greater emphasis on increasing "hydrogen literacy" and FCEV acceptance.

Promotion and Awareness Activities

The Tri-Counties Hydrogen Readiness Project Team engaged with local officials and community groups in the highest priority communities. The following outreach activities were accomplished:

- Made contact with officials in the highest priority municipalities, including the cities of Thousand Oaks, Moorpark, Simi Valley, Camarillo, Oxnard, Ventura, and Santa Barbara.
- Convened workshops to present the Hydrogen Readiness Plan effort. The intent of these workshops was to provide further awareness of hydrogen with public officials, and to discuss potential refueling locations as identified. (ongoing)
- Conducted community forums and meetings to present the primary benefits of using hydrogen to "help attain the State's climate change policies" and associated co-benefits.
- Coordinated closely with automakers and Dealers to ensure consistency in the promotional activities with their marketing plans for FCEVs.
- Developed outreach and education materials, including a brochure for use locally.

Table 9 provides a detailed account of promotion and awareness activities.

Table 9: Promotion & Awareness Activities

Official Promotion Activities				
Date	Activity	Venue	County	Attendance
5/13/2016	Hydrogen Station Ribbon Cutting Ceremony*	Conserv Fuel (Santa Barbara, CA)	Santa Barbara County	15
10/27/2016	UC Santa Barbara Central Coast Sustainability Summit*	UC Santa Barbara (Santa Barbra, CA)	Santa Barbara County	35 est.
12/7/2016	Future of Transportation' Forum*	Jeanette's Edelweiss (Thousand Oaks)	Ventura County	8
1/19/2017	Central Coast Clean Cities Coalition Workshop	Cal Poly San Luis Obispo (San Luis Obispo, CA)	San Luis Obispo County	11
2/22/2017	Drive Clean - Hydrogen and FCEV Forum*	Santa Barbara Public Library (Santa Barbara, CA)	Santa Barbara County	
Community Promotion Activities				
Date	Activity	Venue	County	Attendance
4/16/2016	Santa Barbara Earth Day Festival 'One Element' Workshop	Alameda Park (Santa Barbara, CA)	Santa Barbara County	11
5/13/2016	Hydrogen Station Ribbon Cutting Ceremony*	Conserv Fuel (Santa Barbara, CA)	Santa Barbara County	65
10/27/2016	UC Santa Barbara Central Coast Sustainability Summit*	UC Santa Barbara (Santa Barbra, CA)	Santa Barbara County	60 est.
12/7/2016	Future of Transportation' Forum*	Jeanette's Eidlweiss (Thousand Oaks)	Ventura County	75
1/19/2017	Central Coast Clean Cities Coalition Workshop	Cal Poly San Luis Obispo (San Luis Obispo, CA)	San Luis Obispo County	12
2/22/2017	Drive Clean - Hydrogen and FCEV Forum*	Santa Barbara Public Library (Santa Barbara, CA)	Santa Barbara County	60

Source: Santa Barbara County Air Pollution Control District

Outreach to Civic Leaders

A comprehensive list of local officials was compiled during outreach for the Alternative Fuel Vehicles Readiness Plan in 2015. This list was updated for Hydrogen Readiness outreach and used to contact officials at high-priority municipalities, as identified in the Hydrogen Station Siting Analysis. The goal of this outreach to officials was to coordinate meetings with officials to brief them on the Tri-Counties Hydrogen Readiness planning effort.

In some cases, the lead up to elections in November 2016 delayed outreach to elected representatives and their staff. To help ensure that officials were aware of the regional Hydrogen Readiness effort, other approaches were used. These included delivering presentations and comments on the regional Hydrogen Readiness Plan at public meetings and submitting notification letters.

Public Awareness

Community events focused on increasing public awareness of hydrogen and increasing acceptance of FCEVs, with particular emphasis on the benefits of FCEVs and the important role hydrogen is expected to play in meeting the state's climate goals. Opportunities to highlight hydrogen and FCEVs were identified and events were organized to gain attention from local media and community members.

In addition, FCEVs and hydrogen were also featured prominently at the Santa Barbara Earth Day Festival's annual Green Car Show, which attracts more than 30,000 community members each year. The show included a static FCEV display featuring the Toyota Mirai and Hyundai Tucson FCEV. A second Toyota Mirai was made available for test-drives at the festival's Ride & Drive event. During the two-day event, 104 rides and 118 test-drives were provided.

Promotional Materials & Information Resources

There is a strong need to make information about hydrogen and FCEVs readily available to elevate public awareness. Promotional materials and information resources created by the Tri-Counties Hydrogen Readiness project team include webpages, print materials, and press releases. Posts to social media, newsletter notifications, and blogs were also used to raise awareness of FCEVs and hydrogen.

Print material development was coordinated with the California Fuel Cell Partnership, the Air Pollution Control Districts and other partners to avoid duplicative efforts. Since the California Fuel Cell Partnership has already made a comprehensive brochure about hydrogen and FCEVs available at Santa Barbara hydrogen refueling station, the Tri-Counties Hydrogen Readiness project team developed a smaller brochure to serve a supplementary resource. This brochure is available at the local hydrogen station in Santa Barbara and will be distributed at future outreach events. Promotional materials and a complete list of information campaigns are provided in Table 10.

Table 10: Promotional Materials & Information Campaigns

Information Resources	Purpose	Distribution	Reference
Earth Day Festival Guide	The guide promoted the Festival's Green Car Show and Ride & Drive events featuring FCEVs and provided information about "One Element" workshop on April 16, 2016.	The guide was published in the Santa Barbara Independent, which reaches 135,000 readers in Santa Barbara County each Thursday.	Item 1
Digital Hydrogen Ribbon Cutting Email Invitation	Developed to inform local officials, elected representatives, and community influencers of the Santa Barbara hydrogen refueling station's opening.	The PDF invite was distributed through a Mail Chimp email campaign.	Item 2
Hydrogen Ribbon Cutting Campaign	Two press releases were developed for the hydrogen station ribbon-cutting ceremony to notify local and regional news media. A blog post, e-news feature, and social media were also used to promote the event.	Press releases were email to local news outlets and radio stations; additional promotion was web-based.	Items 3, 4, 5, & 6
National Hydrogen & Fuel Cell Day Campaign	An information campaign was launched to increase awareness of hydrogen and FCEVs for the national celebration.	Included blog post on cecsb.org, an e-news feature, and social media posts.	Items 7 & 8
Hydrogen & FCEV Webpage	The webpage covers the fundamentals of FCEVs and hydrogen and is intended to serve a "living resource" that will be updated on a quarterly basis.	Online, with URL included in promotional materials	Item 9
Santa Barbara Hydrogen Readiness Forum Campaign	Launched to promote a special community forum on hydrogen and FCEVs. Included press release distribution to media; advertising in the Santa Barbara Independent and Santa Barbara News Press; and blog post and e-news features	Press release to media, advertisements, online blog post, story, and social media posts	Item 10, 11 & 12
Hydrogen & FCEV Handout	The handout address common questions about hydrogen and FCEVs, and supplements print materials made available locally by the California Fuel Cell Partnership	Available at the Santa Barbara Hydrogen refueling Station, and handed out during outreach events	Item 13

Source: Santa Barbara County Air Pollution Control District

Findings & Recommendations

Interactions with the public and stakeholders made it clear that there is a general lack of awareness about hydrogen and FCEVs among the public and local officials. In many cases, stakeholders were unfamiliar with the benefits and operating characteristics of FCEVs and had limited knowledge of the role hydrogen is expected to play in attaining state ZEV and climate goals. The vast majority of outreach attendees at community events had little-to-no awareness of hydrogen's use as a transportation fuel and were unaware that FCEVs were available for sale or lease. This highlights the need for ongoing promotion and awareness activities.

Continuing promotion and awareness activities will play an important role in expand acceptance of hydrogen and FCEVs, which is the first step toward accelerating market growth. In the early stages of FCEV and hydrogen market development, promotion activities should target the high-priority areas identified in the Hydrogen Station Siting Analysis. These high priority areas have a higher concentration of demographics that are most likely to be early adopters of FCEVs. Additional focus should be given to communities where hydrogen refueling infrastructure is installed to spur FCEV sales.

Our experience has shown that providing test-drives in plug-in electric vehicles has been one of the most effective approaches for increasing acceptance among consumers. Similar experiential promotion activities are recommended for elevating consumer acceptance of FCEV in areas where hydrogen refueling station are operating or planned. These activities could include FCEV Ride & Drives at community events and loaning FCEVs to local organizations and municipalities.

Over the course of promotion activities for the Tri-Counties Hydrogen Readiness Plan, it also became clear that safety is a primary public concern. Obtaining testimony on hydrogen safety from an expert authority that is widely trusted – such as local fire officials and emergency response personnel – is one of the most effective ways to address safety concerns. Incorporating this testimony from trusted authorities into broader outreach and education campaigns will help allay unwarranted safety concerns about hydrogen and FCEVs – especially in communities where hydrogen refueling stations are in operation or planned. This was corroborated through discussions with the Santa Barbara City Fire Department Fire Chief.

The planning and permitting process for new hydrogen refueling stations provide additional opportunities for increasing awareness and addressing safety concerns. Jurisdiction or fueling infrastructure installers could benefit from launching a public relations campaigns that notifies community members about the new stations and provides opportunities to learn about the station's design and safety measures. It is important for permitting jurisdictions to demonstrate transparency and take proactive steps to inform members of the public during the planning process for new hydrogen refueling stations. (Refer to Chapter 3.)

The Promotion Plan in Appendix D provides additional guidance for increasing awareness of FCEVs and hydrogen, as well as addressing public concerns about safety.

Additional Resources

California Air Resource Board

Clean Vehicle Buying Guide and Information, available at https://www.driveclean.ca.gov/

California Clean Vehicle Rebate Program

Fuel Cell Electric Vehicle Consumer Rebates, available at https://cleanvehiclerebate.org/eng

California Fuel Cell Partnership (Cafcp.org)

Hydrogen refueling Station Map, available at http://cafcp.org/stationmap

How It Works – Fuel Cell Electric Vehicles, available at http://cafcp.org/sites/default/files/HowItWorks-Fuel-Cell-Booklet.pdf

Hydrogen - Frequently Asked Questions, available at http://cafcp.org/sites/default/files/FCEV_factbooklet.pdf

Community Environmental Council

Hydrogen & FCEV Information Page, available at CECSB.org/fcev

Santa Barbara County Air Pollution Control District

Hydrogen & FCEVs, available at https://www.ourair.org/hydrogen-fuel-cells/

Chapter 5:
Hydrogen Safety, Awareness and Response

This chapter summarizes the tasks performed to assemble materials on hydrogen safety and emergency response for training and raising awareness with first responders in the region. Also included is a summary of the meetings and trainings held during the term of the planning project.

One significant learning from this effort was that Fire Departments are challenged with a heavy burden of training requirements for routine operations, and time is limited for scheduling additional (optional) training sessions. This changed the emphasis of this task in a way that focused outreach and engagement efforts on Fire Departments operating in the cities which were identified in the siting analysis as high priority based on anticipated market indicators.

Hydrogen Safety

The use of hydrogen for FCEVs introduces hazards that are applicable to the refueling stations, the vehicles, and the community. There is an abundance of material available on hydrogen safety from government agencies, industry associations and businesses involved in the production, distribution and use of hydrogen. The web-based H2Tools portal includes a number of summary sheets and fact sheets on hydrogen safety. The California Fuel Cell Partnership website is another source of information on hydrogen safety relevant to refueling stations and FCEVs.

Hydrogen is a flammable gas with a wide flammability range (4 percent to 75 percent by volume) and relatively low ignition energy. It has a very low density and therefore must be stored at high pressures (10,000–15,000 psi range) to achieve enough mass for practical use. The ease of ignition and high storage pressure of hydrogen create a large portion of the risk associated with hydrogen usage.

Hydrogen also has the ability to attack—and damage to the point of leakage—certain materials that are used for the construction of storage containers, piping, valves, and other appurtenances. This destructive capability is sometimes referred to as hydrogen embrittlement (Cramer and Covino 2003). The mechanisms of hydrogen embrittlement can be complex and vary with several physical parameters including temperature and pressure. Hydrogen's ability to escape through materials based on its destructive abilities and small molecule size also contributes to the risk associated with hydrogen usage.

The hydrogen code (National Fire Protection Agency-2) includes an array of design features and systems that are intended to address the typical range of hazards that could occur from the use of hydrogen. Because of the requirements in this code, hydrogen stations are required have multiple safety systems to protect against fire, leakage, and explosion. Retaining walls, equipment setbacks, and bollards are designed into the site plan to maximize safety. To date, there have been no known catastrophic failures of hydrogen refueling equipment for vehicles. However, there has been at least one incident in which a hydrogen tube trailer was involved in an on-road accident which resulted in a short-lived but intense fire.

As for the vehicles, automakers and federal agencies have conducted extensive safety testing at the component, system and vehicle level. FCEVs have several safety systems designed for hydrogen and electric drive to protect passengers and first responders in case of an accident. FCEVs have been in real-world accidents and crash tests, and all have

performed as designed with safety rating equivalent to Internal Combustion Engine vehicles.

Training Resources for First Responders

From an extensive literature review and discussions with Fire Department personnel and the California Fuel Cell Partnership, it became clearly evident that the training materials recently developed by the U.S. Department of Energy in partnership with National Fire Protection Agency and the California Fuel Cell Partnership were particularly well-suited for the need, so the resources assembled in this report and made available to the local Fire Departments are mostly based on this central set of resources. The resources include training curricula for (1) hydrogen awareness, and (2) hydrogen emergency response.

In addition, the Fire Departments expressed concern about responding to hazards in general associated with any new alternative fuel vehicles, citing high voltage hazards as paramount. For this reason, the training materials assembled include auto manufacturer response manuals for the FCEV models that are current available for lease or purchase in California.

Meetings and Trainings

A high priority recommendation included in this report is to ensure that competent training facilitators are available locally to deliver hydrogen awareness and response training to Fire Department personnel on an as-needed basis. Using the U.S. Department of Energy training materials, this will ensure that a consistent level of training is made available to Fire Departments in future, and it can help ensure that materials are always kept current and consistent with best practices as they develop.

Chapter 6:
Municipal Fleets

Introduction

The potential for early adoption of FCEVs among regional fleet operators was assessed as part of the regional Tri-Counties Hydrogen Readiness planning effort. Fleet operators in the region were contacted to gauge the current level of interest in FCEV adoption and to identify potential public hosts for hydrogen refueling infrastructure. Fleet operators were also asked about opportunities for siting shared public-private hydrogen refueling stations.

Information was collected from regional fleet operators through informational interviews and an online survey. Survey Monkey was used to distribute the online survey for the Tri-Counties Hydrogen Readiness project to 35 fleet operators in the Tri-Counties region. Items included in the survey were modelled after a questionnaire that the Southern California Association of Governments developed to gauge interest in hydrogen and FCEVs.

Of the 35 municipalities and public agencies contacted in the region, 26 provided information to the project team. This included 24 survey responses and 3 interviews with fleet operators that declined to complete the online questionnaire. Informational interviews were conducted with 12 fleet operators who completed the online questionnaire to obtain more detailed information about potential opportunities for FCEV adoption and hydrogen refueling station siting.

A comprehensive list of public fleet operators was compiled to conduct fleet outreach in the region and is provided in Table 11. Appendix D includes a comprehensive list of public fleet contacts, a copy of the online questionnaire, and an informational interview template.

Summary of Current Situation

No public fleets in the Tri-Counties region have incorporated FCEVs as of this report's publication. However, the County of Santa Barbara plans to lease a Toyota Mirai within the next year. Except for the County of Santa Barbara, no fleet operators who responded to the online questionnaire or participated in informational interviews are planning to purchase or lease an FCEV in 2017. However, numerous fleet operators expressed interest in purchasing or leasing an FCEV at some point in future.

No fleet operators in the region have hydrogen refueling infrastructure installed at their organization's site, and no contacts reported plans to install infrastructure in the future. Of the 25 fleet operators contacted, 7 indicated that they would be open to installing on-site hydrogen refueling infrastructure in the future if they could secure funding to reduce station costs.

The project team found that fleet operators had limited awareness of FCEVs and hydrogen. Many fleet operators were unable to explain the benefits and operating characteristics of FCEVs during informational interviews, and survey responses suggest that fleet operates may not have a good understanding of FCEV's operating characteristics and benefits. There is a need for ongoing work to expand fleet operator's understanding of FCEV and their environmental advantages, as well as the anticipated role that hydrogen is expected to play in reducing emissions of both greenhouse gases and criteria air pollutants.

Table 11: Public Fleet Outreach Contacts

Public Organization	Contact	Completed Survey?	Interviewed?
County of Santa Barbara			
City of Carpinteria	Matt Roberts	Yes	No
City of Buellton	Rose Hess	Yes	No
City of Goleta	Bob Morgenstern	Declined	Yes
City of Lompoc	Dirk Ishiwata	Yes	Yes
City of Santa Barbara	Gary Horwald	Yes	Yes
City of Santa Maria	Robert Dupuis	Declined	Yes
County of Santa Barbara	Eric Baker	Declined	Yes
Santa Barbara MTD	Steve Hahn	Yes	Yes
UC Santa Barbara	John Behlman	Yes	Yes
County of Ventura			
City of Camarillo	Kevin Jorgensborg	Yes	No
City of Moorpark	Ashraf Rostom	Yes	Declined
City of Oxnard	Joe Rodriguez	Yes	No
City of Port Hueneme	Fred Camarillo	No	No
City of Santa Paula	Jose Arreola	Yes	Yes
City of Simi Valley	John Willoughby	Yes	Declined
City of Thousand Oaks	Larry McKinney	Yes	No
City of Ventura	Mary Joyce Ivers	Yes	Yes
County of Ventura	Peter Bednar	Yes	Yes
CSUCI	Ray Porras	Declined	Declined
Gold Coast Transit	Reed Caldwell	Yes	Yes
City of Ojai	Greg Grant	Yes	Yes
Ventura Unified School District	Wendy Stevens	Yes	No
County of San Luis Obispo			
Cal Poly Transportation/Facility Services	Tim Jones	Yes	No
Cal Poly University Police	Debbie Anderson	No	No
San Luis Obispo Regional Transit Authority	David Roessler	No	No

Public Organization	Contact	Completed Survey?	Interviewed?
City of Morro Bay	Rob Livick	No	No
City of Pismo Beach Transportation	Dan Johnson	No	No
Cuesta College	Terry Reece	No	No
Lucia Mar Unified School District	Sharon Harwin	Yes	Yes
Port of San Luis Harbor District	Jay K. Elder	Declined	No
San Luis Coastal Unified School District	Annie Sharp	No	No
County of SLO	Rocky Buoy	Yes	No
City of SLO	Isaac Shuck	Yes	No
City of Arroyo Grande	Raul Juarez	Yes	No
City of Atascadero	Bob Joslin	Yes	No
City of Paso Robles	Bob Solway	Yes	No
Total Contacts		**Total Responses**	**Total Interviews**
35		**24**	**12**

Source: Santa Barbara County Air Pollution Control District

In general, fleet operators were unaware of State's effort to help fund the construction of 100 hydrogen refueling stations. Building greater awareness of the public-private partnership to create a robust hydrogen refueling network is an important step to increasing confidence in the fuel pathway among public fleet operators. Overall, these findings highlight the need for continuing outreach to local stakeholders that will elevate awareness of hydrogen and FCEVs.

Survey and Interview Analysis

Survey responses or informational interviews were held with 26 of the 35 public fleet operators contacted by the project team. The online survey had a response rate of 70 percent, with 24 of 35 survey recipients providing completed questionnaire via Survey Monkey. Data on respondent demographics and public fleet size was collected in Items 1 through 4 of the online survey.

All survey respondents self-identified as staff at local government entities or public institutions. More than half (54 percent) of all respondents indicated that they were responsible for making procurement decisions or recommend vehicles to a board. Another 40 percent of respondents recommend or suggest vehicles for procurement, but do not make final decisions. One respondent indicated that they were not responsible for procurement decisions and did not recommend vehicles for purchase to decision-makers.

Items 5 and 6 of the survey collected data on public fleet operators' current attitudes towards FCEVs and other alternative fuel vehicles. Overall, interest in FCEV deployment among fleet operators was mixed. For Item 5, twelve of the surveyed fleet operators expressed interested in incorporating FCEVs into their fleet in the future but did not have near-term plans to purchase or lease an FCEV. The project team learned that the County of Santa Barbara is planning to lease a Mirai in 2017. However, County of Santa Barbara staff did not complete the online questionnaire, so this is not reflected in survey results.

For Item 5, shown in Figure 9, a total of 7 survey respondents indicated that they were not interested in adding FCEVs to their fleet and one fleet operator indicated that they did not consider hydrogen to be an alternative fuel. Interestingly, there was no relationship between current or planned deployment of plug-in electric vehicles and interest in FCEVs.

In general, survey results for Item 6 suggest that acceptance and understanding of hydrogen and FCEVs is low among fleet operators relative to other alternative fuels. Table 12 shows the number of fleet operators who agreed with positives statements for different alternative fuels in Item 6 of the survey, and provides additional context

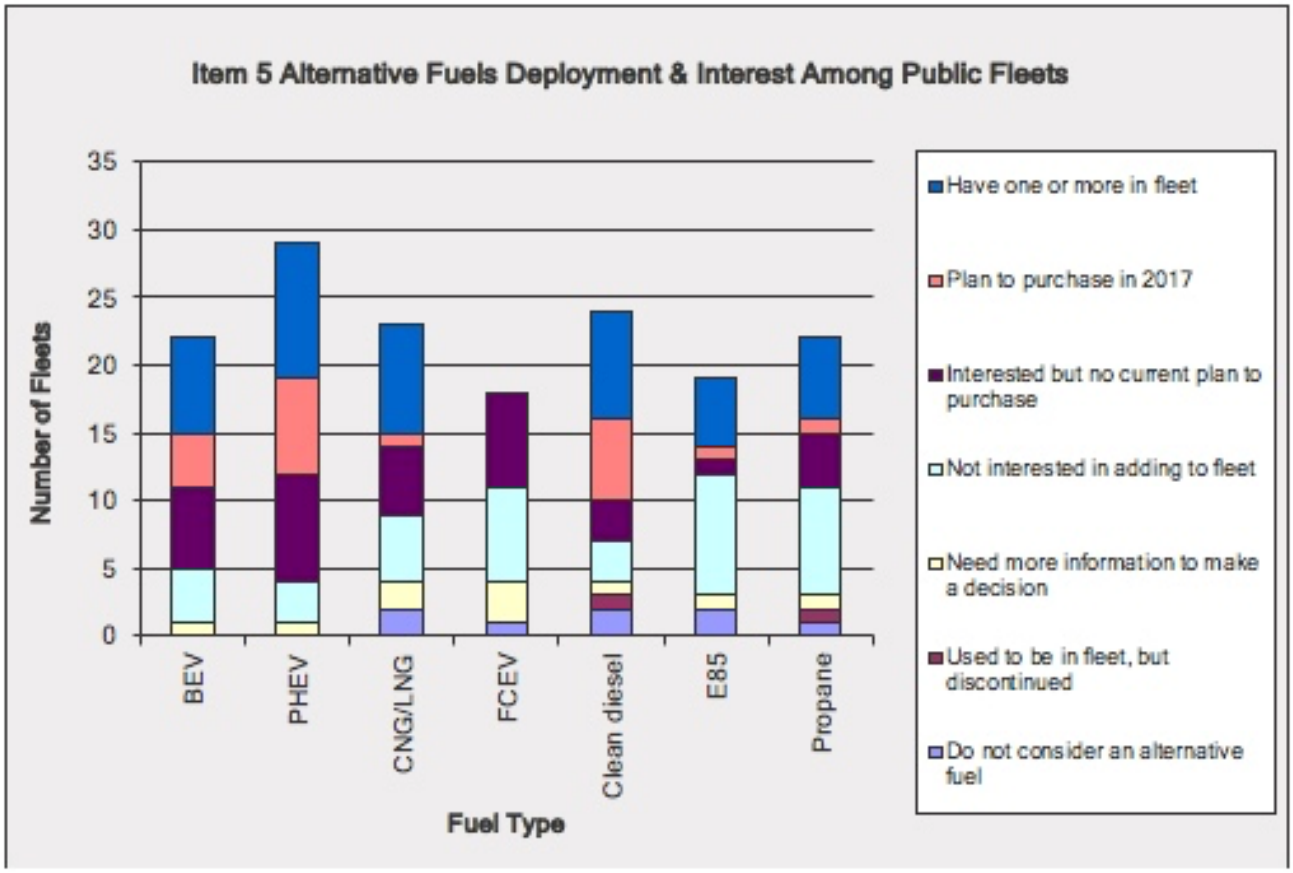
Only 2 out of 22 fleet operators indicated that the size and type of FCEVs they needed for their fleet are available. In contrast, more than 10 fleet operators felt that the size and type of vehicles they needed were available as battery electric, plug-in hybrid electric, natural gas, and clean diesel vehicles. Additionally, only 2 fleet operators (<10 percent) felt that they could justify the higher upfront cost of FCEVs. In general, more fleet operators indicated that they could justify costs associated with battery electric, plug-in hybrid, and natural gas vehicles. Few fleet operators agreed with positive statements about FCEV reliability, maintenance availability, fueling access, and performance relative to other alternative fuels.

Table 12: Public Fleet Manager Evaluations of FCEVs

Statement	BEV	PHEV	FCEV	NG	Clean Diesel	E85	Propane
Size and type of vehicles I need are available	11	13	2	12	12	7	6
Can justify the cost of vehicle, fuel, and ownership	7	10	2	13	8	4	4
Vehicles are reliable and maintenance is available	8	13	2	8	10	6	5
I have access to fueling or charging	11	12	0	7	9	1	4
Driving range or performance meets needs	8	11	3	11	8	5	4
Rebates and incentives are available	5	6	2	5	3	2	1
Federal tax credits are available for fleet operators	1	1	1	3	1	2	1
Is a public benefit (reduced GHGs, pollution, or petroleum)	11	14	6	11	5	6	5

Source: Santa Barbara County Air Pollution Control District

Figure 9: FCEV Deployment & Interest at Regional Public Fleets



Source: Santa Barbara County Air Pollution Control District

In Item 7 of the survey, fleet operators were asked to describe their challenges and concerns with adding alternative fuels to fleets in the online questionnaire. Additional information about these concerns and challenges was collected through information interviews. In general, the foremost concerns were related to the costs and affordability of alternative fuel vehicles and infrastructure. Procuring alternative fuel vehicles that are a good fit for some applications was also a commonly cited challenge. Other concerns centered around maintenance and the limited availability of alternative fuel vehicles. Informational interviews with public fleet operators made it clear that financial constraints present a major barrier to increasing the number of alternative fuel vehicles.

Item 8 asked survey respondents to evaluate sources of information or education that would help address the challenges and concerns that the respondent identified. Overall, public fleet operators felt that information about available rebates, mechanic training, and maintenance availability would be most effective for addressing their challenges and concerns. Information about total cost of ownership, government mandates and regulations, on-site fueling or charging infrastructure, and public benefits were also rated as important information sources to inform fleet management decisions. Many interviewed fleet operators indicated that grant funding from outside entities would be essential for deployment of hydrogen refueling infrastructure at their organizations.

Item 9 of the survey asked respondents to read the following paragraph about a new type of "green fuel vehicle" with the same operating characteristics, performance, and benefits as FCEVs:

> *Green fuel is a renewable, gaseous fuel used in vehicles that range from small off-road vehicles (forklifts, tugs) to passenger cars to transit buses. Green fuel is available at gas stations and the fuel's dispensers accept credit cards for payment. The vehicles fill in minutes, have range similar to their gasoline/diesel counterparts and have zero emissions. Operating the vehicles meets California's requirement for ZEVs and the vehicles are eligible for HOV stickers. Purchase price is higher than conventional vehicles but can be offset with rebates and cost of ownership is similar to other alternative fuels.*

After reading the paragraph, 14 of the 26 surveyed fleet operators said that the benefits and rebates for the green fuel vehicle could justify the higher purchase price and 15 of the 26 respondents indicated that paying for fuel with a credit card would not be a problem. Also, 14 of the 26 responds said that obtaining ZEVs was important for meeting state and local requirements.

Interestingly, most respondents felt that the attributes and operating characteristics of the green fuel vehicle described in Item 9 would justify a higher purchasing price for but only 2 respondents felt that they could justify the higher purchase price of FCEVs when answering Item 5. Since the green fuel vehicle has the same operating characteristics and benefits as an FCEV, it is possible that responses on Items 5 and 9 diverged because fleet operators lacked awareness about FCEVs or had negative perceptions of FCEVs.

Many fleet managers who participated in follow-up interviews with the project team showed greater receptiveness to FCEVs after being briefed about their benefits and learning about hydrogen's anticipated role in attaining state climate and air quality goals. None of the contacted fleet operators expressed negative views about hydrogen or FCEVs during interviews. This suggests that a lack of awareness among fleet operators skewed their evaluations of hydrogen and FCEVs in Item 5 and is likely responsible for the divergent responses for Item 9.

The final question on the survey, Item 10, asked fleet operators to the 3 most effective ways of learning about the green fuel described in Item 9. The largest number of fleet operators felt that a green fuel website would be the most effective way to learn more about the green fuel. Presentations at association meetings or workshops were identified as the second most effective way of learning, followed closely by vehicle loaner programs.

Barriers & Challenges for Public Fleets

Informational interviews were conducted to obtain addition insight into the barriers and challenges that make it difficult for public fleet managers to purchase or lease FCEVs. Vehicle and infrastructure costs were the most commonly cited barriers to incorporating FCEVs and other alternative fuel vehicles into public fleets. Financial constraints and concerns about cost are particularly relevant since FCEVs have a higher cost than other comparably-sized vehicles. Public fleets operators are not eligible for many of the incentives, tax credits, and rebates offered for alternative fuel vehicles in California and the United States. The inability to leverage incentives and rebates that reduce the final purchase price of FCEVs presents a challenge to public fleet adoption.

The lack of publicly-accessible hydrogen refueling stations presents another challenge to the purchase and lease of FCEVs by public fleets. All interviewed fleet operators said that the high cost of hydrogen stations would a major barrier to installing onsite hydrogen refueling infrastructure. Until station costs fall, most fleet operators with FCEVs will need to rely on off-site hydrogen refueling stations that are privately owned and operated unless they can secure grant awards or outside sources of funding for onsite station installations. Numerous fleet operators also expressed concerns about the risk of stranded FCEV and hydrogen assets.

Many fleet operators indicated that the availability of medium- and heavy-duty AFVs is a major challenge. The medium- and heavy-duty AFVs that are available, including larger classes of FCEVs, are generally too expensive for fleet operators to justify unless incentives or grant awards can be leveraged. Since larger vehicles are associated with higher fuel consumption, the limited availability of medium- and heavy-duty AFVs is a barrier to reducing greenhouse gas and air pollution emissions from fleet operations.

In some cases, institutional barriers also prevented fleet operators from incorporating more alternative fuel vehicles into their organization's fleet. Incorporating cleaner alternative fuel vehicles such as FCEVs was not a priority at 2 of the 25 organizations contacted. In other cases, fleet managers with an interest in deploying FCEVs and other alternative fuel vehicles did not have sufficient internal support from decision-makers or managers.

Appendix D provides a listing of fleets in the Tri-Counties based on best-available data at the time of this planning and outreach project. The goal of the survey was to measure awareness and interest in hydrogen and FCEVs. Questions are taken from the California Fuel Cell Partnership survey made available by Keith Malone.

Potential Opportunities for Public Fleet FCEV Adoption

Fleet operators at 12 public organizations were interested in deploying FCEVs. The organizations that expressed the greatest interest included UC Santa Barbara, the County of Ventura, City of Ventura, City of Thousand Oaks, City of Santa Barbara, and the Santa Barbara County APCD. The City of Oxnard, City of Lompoc, City of Carpinteria, Cal Poly San Luis Obispo, Santa Barbara Metropolitan Transit District, and Gold Coast Transit District were open to exploring opportunities for FCEV deployment. In the near term, the greatest opportunities for public fleet adoption of FCEVs will be at government entities in Santa Barbara and Thousand Oaks that are located near public hydrogen refueling stations.

Light-duty vehicles make up the largest share of vehicles in public fleets. As older light-duty vehicles are replaced and more hydrogen refueling infrastructure comes online in the region, there will be opportunities to incorporate more FCEVs into public fleets. In the near term, incentive and rebate programs for public fleet operators will be key to driving increased FCEV adoption. Providing fueling infrastructure at a nearby location will be key to increasing FCEV adoption among public fleets. Several fleet operators indicated that they would be open to refueling at a public station and were willing to drive up to 3-5 miles to refuel in most cases.

FCEVs are also well-suited to medium- and heavy-duty applications. As the availability of medium- and heavy-duty FCEVs increases and purchase prices fall, there may also be opportunities to deploy more medium- and heavy-duty FCEVs in local fleets. Providing hydrogen refueling infrastructure for these larger vehicles at or near fleet headquarters will be key to increased medium- and heavy-duty FCEV adoption by fleets. In the near term, projects supported with outside sources of funding will be the most effective way to support deployment medium- and heavy-duty FCEVs in public fleets.

Light Duty Vehicles - Municipal fleets and private sector fleets include light duty vehicle fleets, transit bus fleets and suitable heavy-duty fleets.

Buses and Heavy-Duty Vehicles - Transit buses are one of the best early transportation applications for fuel cell technology. Buses operate in congested areas where pollution is already a problem. These buses are centrally located and refueled, highly visible, and subsidized by government. By evaluating the experiences of these early adopters, the U.S. Department of Energy has determined the status of bus fuel cell systems and established lessons learned to aid other fleets in implementing the next generation of these systems.

However, there was low interest in FCEV buses and hydrogen among local transit authorities. Local transit agencies have already invested heavily in alternative fuel pathways for compressed natural gas, clean diesel, or electricity. Contacts at these transit agencies expressed concerns about adding another alternative fuel to the mix. Limited space in transit fleet yards also presented a barrier to the installation of onsite hydrogen refueling stations. At some transit agencies, union rules would present barrier to refueling at off-site. Awareness of FCEVs and hydrogen was low at local transit agencies.

Shared Private-Public Stations

Few fleet operators could identify opportunities for public-private fueling at their organizations. Overall, all but two fleet operators felt that shared public-private fueling was not viable for a station installed onsite at their organization. Public access issues, siting limitations, and liability concerns were the primary barriers identified for shared public-private refueling. However, contacts at the County of Ventura and UC Santa Barbara were open to exploring shared public-private fueling opportunities in the future if they received financial support to install a hydrogen refueling station onsite.

Fleet operators were more supportive of using nearby, publicly accessible hydrogen refueling stations to fuel FCEVs in their fleet. Fleet managers at the City of Santa Barbara, City of Ventura, County of Ventura, and UC Santa Barbara indicated that they would be willing to drive a short distance (no more than 5 miles) to refuel fleet FCEVs. In the near term, installing hydrogen refueling stations in high-priority areas at locations that are near major fleet headquarters is likely to be the best strategy for increasing fleet adoption.

Summary

Ongoing outreach and engagement activities will play an important role in increasing awareness of FCEVs among regional fleet operators and elevating receptiveness to FCEV adoption. Outreach activities made it clear that there is a general lack of awareness regarding FCEVs and hydrogen among fleet operators. There is also a need to build greater institutional support for FCEVs, as well as other alternative fuels. Outreach to local officials and elected representatives will help to build this internal support for hydrogen and FCEVs.

Moving forward, it will be important to provide fleet managers and officials with more information about the benefits, economic performance, and operating characteristics of available FCEVs, as well as the role that hydrogen is expected to play in reducing emissions of both greenhouse gases and criteria air pollutants. Surveyed fleet operator also indicated that information about total cost of ownership, government mandates and regulations, on-site fueling infrastructure, and public benefits would help them address challenges and concerns related to FCEV deployment.

To familiarize fleet operators with FCEVs and hydrogen, vehicle loaner programs should be coordinated between Original Equipment Manufacturers and public agencies located near hydrogen refueling stations. Research shows that hands-on experience with new vehicle technologies such as FCEVs and battery electric vehicles is one of the most effective ways to increase their acceptance among potential early adopters. Toyota recently provided a Mirai on loan to the City of Santa Barbara and UC Santa Barbara, which helped elevate interest in FCEVs at these organizations.

To provide additional education about FCEVs and hydrogen, a regional website should be developed with targeted information for fleet operators, as well as other consumers and potential fueling station site hosts. Additionally, presentations at regional fleet associations and workshops or forums connected to local symposiums or conferences could be conducted to increase fleet operators' knowledge of FCEVs.

Vehicle and infrastructure costs were also identified as major barriers to incorporating FCEVs and other alternative fuel vehicles into public fleets. Public fleet operators tend to focus on the costs of vehicles and infrastructure when making decisions about vehicle procurement. The project team recommends developing more state and local programs that reduce the final cost of FCEVs with incentives or financing options that will reduce the total cost of ownership for public fleets. Grant funding opportunities for FCEV pilot project and hydrogen refueling stations should also be tracked and shared with eligible entities.

Providing fleet operators with information about mechanic training resources and maintenance availability for FCEVs will also help increase uptake as more hydrogen refueling stations come online in the region. To address this need, resources and Original Equipment Manufacturer contacts for mechanic trainings could be compiled and shared with fleet operators. Providing local mechanic trainings through local fleet associations could also help more mechanics and technicians prepare for work on FCEVs.

Many of the public organizations contacted by the project team have adopted Climate Action Plans. However, few public entities in the region have implemented specific policies or targets for reducing fleet greenhouse gas emissions. Policies that specifically address fleet greenhouse gas emissions but provide enough flexibility to accommodate operational needs could help to accelerate the adoption of FCEVs and other alternative fuels among fleet operators. These policies could be included in new Climate Action Plans or incorporated into existing Climate Action Plans when they are updated.

Implementation of additional recommendations in the Central Coast Alternative Fuel Vehicles Readiness Plan will also support adoption of FCEVs among local fleets as more hydrogen refueling infrastructure comes online. These recommendations include:

- Developing goals and policies for public fleets to incorporate alternative fuels delivering the greatest suite of benefits, considering greenhouse gas and air quality impacts, economy of operation on a life-cycle basis, and operational requirements.
- Creating Green Fleet Spreadsheets that identify the actions, AFV investments, fuel and operating cost savings available through accelerated deployment of Alternative Fuel Vehicles.
- Revising and updating green fleet plans on an annual basis to assess the economic and environmental benefits of AFV fleet procurement.
- Collecting fleet baseline data and analyzing specific opportunities for optimization related to vehicle specifications, route characteristics, and other important parameters.

Chapter 7:
Findings, Recommendations and Next Steps

During the course of implementing the Tri-Counties Hydrogen Readiness Planning project work plan, a great deal was learned about the current state of readiness in the region, and the most important needs for successful deployment of FCEVs in the near term. All work tasks proposed in the Program Opportunity Notice grant agreement have been completed, and a number of key findings have come up from this work, and these are summarized in this section. Details of the analyses and observations that lead to these findings are presented throughout the body of this report.

Also included are a series of recommendations which are intended to provide guidance and direction to community leaders for continuing with the FCEV deployment effort in the region, and to provide feedback for state agencies and other regions that may learn from our experience with this project.

At the end of this section, key priorities for the region to consider are summarized as Next Steps. These priorities apply to the development of the hydrogen refueling network and deployment of FCEVs in the tri-Counties region.

Findings and Recommendations

Local and Regional

1. Finding: The recommendations included in this report will need community leaders to continue efforts to support and encourage ongoing efforts to build out the hydrogen infrastructure in the Tri-Counties.
   Recommendation: Ensure ongoing local support for hydrogen planning and infrastructure build-out.
2. Finding: The statewide target of 100 stations is being used to guide statewide infrastructure efforts. Regional targets can similarly help guide regional infrastructure development. Without a basic network of hydrogen stations, automakers are reluctant to designate dealerships to sell FCEVs locally, and most potential buyers in the Tri-Counties are unwilling to travel 100 miles plus to purchase and service their vehicles. Eventually, hydrogen would need to be available at 5-10 percent of the stations in the region to alleviate driver concerns about fuel availability.
   Recommendation: Set a local target for infrastructure. The immediate target would be for the installation of another station in close proximity to the existing station, to entice local dealers to offer vehicles for sale in the region.
3. Finding: Many community stakeholders are in favor of hydrogen as a fuel, but only if it is generated through renewable processes.
   Recommendation: Support ongoing research and adoption of renewable hydrogen.
4. Finding: Hydrogen planning efforts are not expected to be static. New information and new guidance regularly becomes available from national, state and industry sources.
   Recommendation: Keep the plan a living document. One way to do this would be to support an ombudsman for the region.
5. Finding: Many cities have now gone through the hydrogen station permitting process, and there is a growing body of experienced people who are willing to offer help and

support to those going through this for the first time.
Recommendation: The planning focus going forward should be on making sure agencies know where available resources are and helping them get in touch with peers who have already handled station applications.

6. Finding: First responders are faced with extensive demands for required training and the available time for additional training such as hydrogen awareness training is limited. Comprehensive training materials are available through a collaboration of experts coordinated by the U.S. Department of Energy National Laboratories. However, to date there are only a small number of competent trainers who have experience delivering this training (for example, staff with at the California Fuel Cell Partnership).
   Recommendation: For first responders the focus should be on providing access to training resources and support for local trainers. There is need to recognize the time constraints on first responders given the extensive amount of training they need to take.
7. Finding: There is a significant lack of awareness about hydrogen and FCEVs among the public, local officials, and municipal fleet managers. In many cases, stakeholders were unfamiliar with the benefits and operating characteristics of FCEVs and had limited knowledge of the role hydrogen is expected to play in attaining state ZEV and climate goals.
   Recommendation: Conduct ongoing outreach to expand awareness of hydrogen and fuel cell electric vehicles, with a focus on highlighting benefits. FCEV test-drives and vehicle loaner programs should be used when possible since research shows that firsthand experience with new vehicle technologies is effective at increasing acceptance.
8. Finding: Community outreach made it clear that safety is a primary public concern. These safety concerns are largely connected to the general lack of familiarity with hydrogen and FCEVs. However, specific strategies will help overcome this barrier to broader acceptance of FCEVs and hydrogen.
   Recommendation: Obtain testimony on hydrogen safety from an expert authority that is widely trusted, such as local fire official and emergency response personnel. This testimony can be incorporated into broader outreach and education campaigns in communities where hydrogen refueling stations are in operation or planned. Public notifications, community workshops, and information resources should be provided during the planning and permitting process for new hydrogen stations to help ensure that safety concerns are addressed.

Next Steps

Going forward it is evident that there are three key priorities for ongoing hydrogen readiness planning efforts in the Tri-Counties. These are:

1. Secure funding to support hydrogen infrastructure build-out, vehicle incentives and outreach efforts (for example from public-private partnerships, California Environmental Quality Act mitigation, settlements, and grants, etc.);
2. Develop a strategy for creating commercial opportunities locally for the production and delivery of low-carbon hydrogen; and
3. Increase public awareness of hydrogen and FCEVs to facilitate early adoption and create a foundation for broader consumer acceptance in the future.

Much of this effort would need to be done locally given the intense competition that now exists for limited state funds. Local agencies, particularly the three APCDs in the Tri-Counties region, will need to recognize this as a key challenge if there is real intent to accelerate the adoption rate for hydrogen vehicles.

If these three priorities are successfully addressed in the near term, there will be a much greater chance that the Tri-Counties region will become a vibrant new "hub" for clean hydrogen transportation. This, in turn, would have significant secondary benefits for lowering carbon intensity of the local energy infrastructure, also resulting in many environmental co-benefits. This is an audacious goal, but the opportunity is real if the intention is sincere.

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GLOSSARY

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 AIR RESOURCES BOARD (CARB)—The "clean air agency" in the government of California whose main goals include attaining and maintaining healthy air quality, protecting the public from exposure to toxic air contaminants, and providing innovative approaches for complying with air pollution rules and regulations.

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.

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

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

KILOGRAM (kg)—The base unit of mass in the International System of Units that is equal to the mass of a prototype agreed upon by international convention and that is nearly equal to the mass of 1,000 cubic centimeters of water at the temperature of its maximum density.

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

ZERO EMISSION VEHICLE (ZEV)—Vehicles that produce no emissions from the on-board source of power (e.g., an electric vehicle).

Appendix A:
Summary of Adopted County Plans

Table 13 presents a complete summary of all the adopted plans of the tri-counties area and their respective cities.

Table 13: Summary of Adopted County Plans

City/ County	Plan	Date Adopted	Details
SLO County	EnergyWise Plan (Their version of a Climate Action Plan)	Nov 2011	5.16: Encourage the installation of alternative fueling stations and sites that are available for use by public and private vehicles, including waste fleets. 5.25: Continue to expand the use and availability of alternative and low carbon fuels for vehicles and equipment. Supporting Actions: Participate in countywide efforts to establish an alternative fuel infrastructure network. Support and facilitate the development of alternative fuel technologies such as the installation of new or retrofit of electric vehicle charging stations and alternative fueling stations. Ensure that alternative fuel stations and support facilities are allowed uses in land use designations that currently allow gas and service stations. 6.17: Explore the use of alternative fuels in County vehicles and support the development of alternative fueling stations in the county through participation in the Central Coast Clean Cities Coalition.
City of SLO	Climate Action Plan	July 2012	3.3.2- TLU 2: Alternative Vehicles Promote clean air vehicles and expand the network of electric car charging stations and car-sharing parking spaces.
City of Arroyo Grande	Climate Action Plan	Nov 2013	3.3.2- TLU 6: Electric Vehicle Network and Alternative Fueling Stations [Continue to develop and implement the electric vehicle readiness plan through expanding the use of alternative fuel vehicles and fueling stations in the community (e.g., through identifying and zoning locations for fueling stations, offering incentives for alternative fuel vehicles, etc.).] *All SLO City Climate Action Plans have similar statements—focus does appear to be on electric vehicles, but framework is suggested for clean air vehicles and alternative fuel vehicles (e.g. hydrogen fuel cell)*

City/ County	Plan	Date Adopted	Details
City of Atascadero	Climate Action Plan	Jan 2014	3.3.2- TLU 7: Electric Vehicle Network and Alternative Fueling Stations
City of Grover Beach	Climate Action Plan	Sept 2014	3.3.2- TL 7: Electric Vehicle Network and Alternative Fueling Stations
City of Morro Bay	Climate Action Plan	Jan 2014	3.3.2- TL 5: Electric Vehicle Network and Alternative Fueling Stations
City of Paso Robles	Climate Action Plan	Nov 2013	3.3.2- TL 7: Electric Vehicle Network and Alternative Fueling Stations
City of Pismo Beach	Draft Climate Action Plan	Not Yet Adopted?	3.3.2- TL 8: Electric Vehicle Network and Alternative Fueling Stations
SB County	Energy and Climate Action Plan	May 19, 2015	IV. Greenhouse Gas Reduction Strategy 4-7. T 3: Alternative-Fuel Vehicles and Incentives -Increase the use of alternative-fuel vehicles, and plan for the development of alternative-fuel infrastructure. GO 3: Fuel-Efficient and Alternative Fuel Vehicle Fleet, available at http://longrange.sbcountyplanning.org/programs/climateactionstrategy/climateaction.php
	General Plan	Adopted 1994 Republish July 2014	Energy Element Goal 5: Alternative Energy POLICY 5.6: ALTERNATIVE FUEL REDUCTION CREDITS - Provide regulatory flexibility for use of mobile source Emission Reduction Credits in meeting County clean air goals.

City/ County	Plan	Date Adopted	Details
			POLICY 5.10: ALTERNATIVELY FUELED VEHICLES - The County shall encourage the use of alternatively fueled vehicles by individuals. Public Service 5.10.1: The County should gather data that quantifies the cost of operating alternatively fueled vehicles. The County should request that this information be distributed by the Department of Motor Vehicles, California Energy Commission, and other organizations. Regulatory Incentive 5.10.1: The County shall request the Santa Barbara County Association of Governments to amend the Transportation Demand Management (TDM) Ordinance to provide credit to business-supporting clean-fuel vehicle efforts.
City of SB	Climate Action Plan	Sept 2012	2.3.2 Renewable Energy Measures 9. Alternative/advanced fuels (City program; GP policy ER6.2; target 2020) Support and implement the California Energy Commission and State Air Resources Board goal for alternative/advanced fuels set forth in AB 1007, for non-petroleum fuel use of 20 percent by 2020 and 30 percent by 2030. 10. Incentives for alternative fuel infrastructure (City program; GP policy ER6.3; target 2015) Give priority through expedited processing to projects providing infrastructure for alternative/advanced fuels. *Also suggests future Climate Plan guidelines Measure 12- Incentives for alternative fuel infrastructure
City of SB	General Plan	2011	Environmental Resources Element: Air Quality Policies ER8: Low-Emission Vehicles and Equipment.

City/ County	Plan	Date Adopted	Details
			Expand infrastructure and establish incentives for use of lower emission vehicles and equipment…
City of Goleta	Climate Action Plan	July 2014	-nothing about alt transportation here
Ventura County	Annual Climate Protection Plan	April 2012	#13: The Climate Protection Plan team recommended a change to the wording of this commitment, from "Integrate a suite of green vehicles policies to promote efficiency, alternative fuels, and the infrastructure required for alternative travel modes" to the one shown above.
City of Oxnard	Energy Action Plan (Component of Climate Action and Adaptation Plan)	June 2013	5. Energy Action Plan Community Programs C-7: Support Electric Vehicle Infrastructure Working with the community, especially the service station operators, to identify locations for alternative fuel and electric vehicle fueling stations that encourage local public and commercial use of alternative fuel vehicles.
City of Oxnard	General Plan	2011	ICS-6.6 Alternative Transportation Options Utilize, where feasible, environmentally clean transit vehicles such as a liquefied natural gas and hybrids.
City of Simi Valley	Climate Action Plan	June 2012	R2-T8/MT-T8: Expand Renewable Fuel/Low-Emission Vehicle Use Collaboration between local and regional governments and business to foster the increased use of renewable fuels through the siting of new alternative fueling/recharging locations; Collaboration with energy providers to ensure the availability of necessary facilities and infrastructure to encourage the use of privately owned zero emission vehicles. This can be accomplished by having conveniently located charging and fueling stations for these vehicles;

Source: Santa Barbara County Air Pollution Control District

Appendix B:
Modeling and Field Assessment Results

Application of Spatially and Temporally Resolved Energy and Environment Tool for Tri-Counties Hydrogen Readiness Plan

The Spatially and Temporally Resolved Energy and Environment Tool was used to identify the top 20 gasoline stations in the Tri-County area based on several different sets of alternative vehicle sales registration data (Information Handling Services Automotive) that serve as proxy for FCEVs. Connectivity between northern California and southern California was also analyzed. Finally, these Spatially and Temporally Resolved Energy and Environment Tool results were compared to the Station Coverage Value given by the California Hydrogen Infrastructure Tool. The California Hydrogen Infrastructure Tool Station Coverage Value is the ability of the proposed station to fill an identified gap in refueling coverage.

Methodology

Three different sets of alternative vehicle sales registration data were used. BEVs, PHEVs combined with HEVs, and BEVs combined with PHEVs and HEVs. These different sets of alternative vehicle sales registration data allow comparison of different FCEV market proxies. The alternative vehicle sales registration data shows the number of a type of vehicle registered in a zip code tabulation area. This spatial resolution is too coarse, so another data set is combined with the alternative vehicle sales registration data, i.e., high resolution population data (1km x 1km). The population data used are LandScan Population density from Oak Ridge National Laboratory [1], [2]. Using the combined alternative vehicle registration data and population data, a high enough spatial resolution exists to evaluate gasoline stations based on this high-resolution combined data set, i.e., counting vehicles (demand points) in proximity.

The basic methodology for station siting based on demand points (vehicle proxy) is broken into three steps. First the Network Model is built including the roadways, the existing infrastructure, and the spatially distributed demand (demand points or FCEV proxy). Next, Location-Allocation algorithms are applied to the network model producing locations for stations based on the scenario parameters.

Network Model

Four datasets compose the Network Model: (1) the roadway network; (2) the existing refueling infrastructure which includes existing hydrogen refueling stations (in this case, only the station in Santa Barbara), and the existing gasoline stations which serve as candidate locations for expanding the network; and (3) the demand points that represent the FCEVs.

Roadway Network

The roadway network used comes from ESRI's database of streets in North America [3]. This network dataset includes speed limits of individual streets as well as classifications of what types of turns can be made at intersections throughout the network. This provides for usage of ESRI's Network Analyst toolset that provides implementation of the travel time algorithms leveraged for the analysis [4].

Existing Infrastructure (Existing Infrastructure and Candidate Sites)

Existing hydrogen refueling structure is modeled based on information from CARB's Assembly Bill 8 Report as well as from the Governor's Office of Business and Economic Development (GOBIZ) [5], [6]. Existing gasoline refueling stations are chosen as the candidate locations for sites of future hydrogen fueling stations and were obtained from the Tri-Counties. Figure 13 shows a map of the locations of existing infrastructure.

Demand Points (Proxy FCEVs)

The demand points are derived from registrations of BEVs, HEVs and PHEVs in the Tri-Counties and LandScan Population density from Oak Ridge National Laboratory [1], [2]. The vehicle registrations are provided by Information Handling Services Automotive for Zip Code Tabulation Areas. These registrations are distributed to LandScan cells (1km x 1km cell size) based on the cell's relative contribution to the population of the zip code tabulation area using a weighted distribution methodology. This methodology assigns a weight to each LandScan cell based on its relative contribution to the population of the zip code tabulation area in which its centroid lies, shown in Figure 10.

Figure 10: Cell Weight Formula

$$Cell\ Weight = \frac{Cell\ Population}{ZCTA\ Population}$$

Source: Santa Barbara County Air Pollution Control District

The final demand weight for each cell is the product of the cell weight and the number of HEV registrations in the zip code tabulation area, shown in Figure 11.

Figure 11: Demand Weight Formula

$$Demand\ Weight = ZCTA\ HEVs * Cell\ Weight = ZCTA\ HEVs * \frac{Cell\ Population}{ZCTA\ Population}$$

Source: Santa Barbara County Air Pollution Control District

Finally, the LandScan cells are represented in the Network by the point location of their centroid in order to provide an exact location for the Network algorithms. The point locations combined with the underlying demand weights are referred to as *demand points*. Figure 14 shows the mapping of the weighted distribution methodology for the City of Santa Barbara.

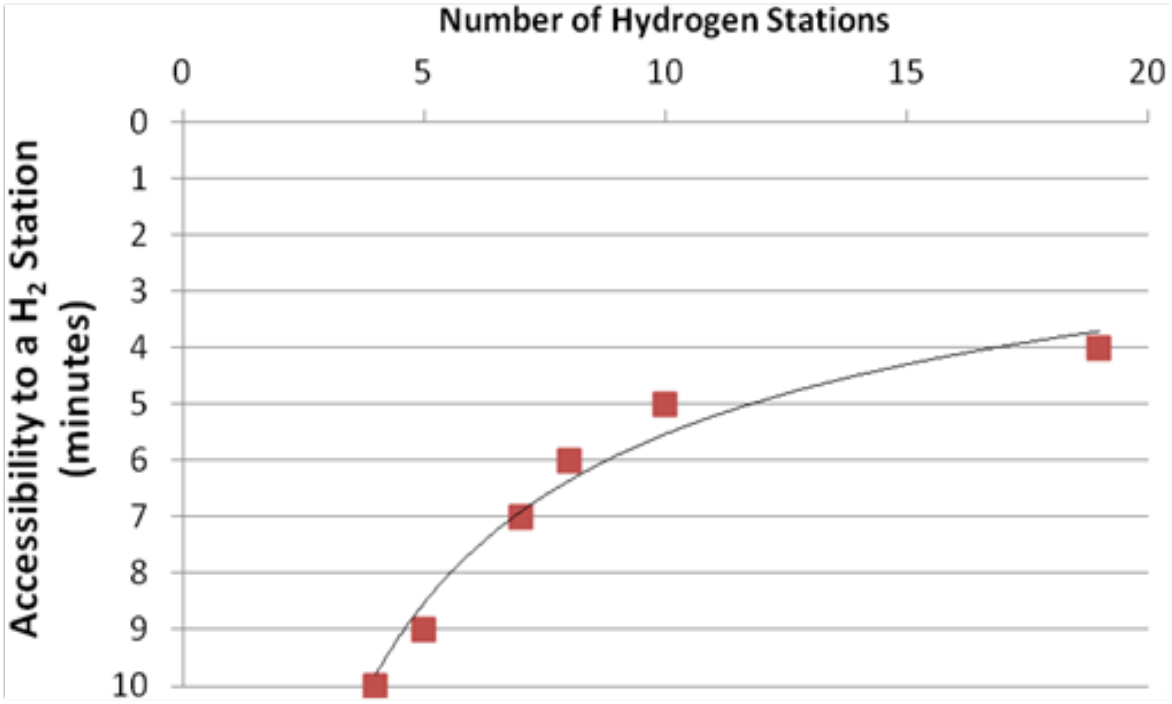
Location-Allocation Algorithm

The stations are allocated using a Maximize Market Share algorithm in ArcGIS. This algorithm seeks to place a given number of stations to maximize the demand (i.e., FCEV proxy) on the stations. A service coverage needs to be prescribed. The service coverage is the area that is served by a station and can be defined by drive time or distance. In these analyses, drive time was used. Previous analyses [7] have shown that a 6 minute service coverage represents a tipping between an inconvenient refueling experience (driving more than 10 min to get to refueling station from house) and the current convenience of gasoline refueling (2-3 min from house to refueling station).

Six Minute Drive Time

The following analysis from [7] of past existing and planned hydrogen stations in the Santa Monica region (4 total) provide a maximum travel time from anywhere in the region to a hydrogen station in 10 minutes. The addition of just one more station (5 total) can drop this travel time down to 9 minutes. Two more stations (7 total) reduces the time to 7 minutes, and an additional station (8 total) reduces the travel time to 6 minutes. Two more (10 total) can reach coverage in just 5 minutes, and a final 9 additional stations (19 total) are required to reach 4-minute travel time in parity with the 126 existing gasoline stations. This trend is shown in Figure 12.

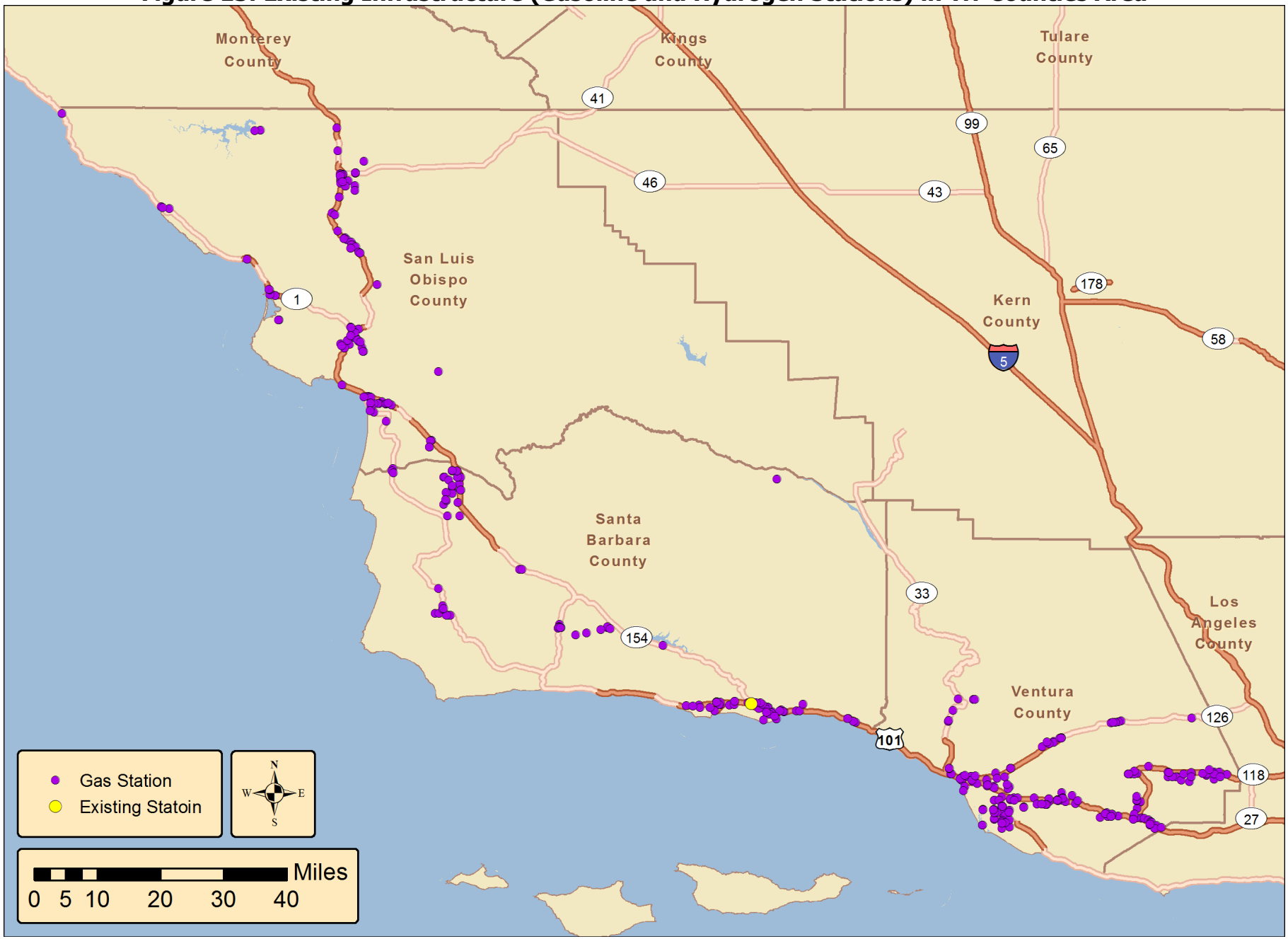
Figure 12: Decrease in Travel Time with Increase in Hydrogen Stations



Source: Santa Barbara County Air Pollution Control District

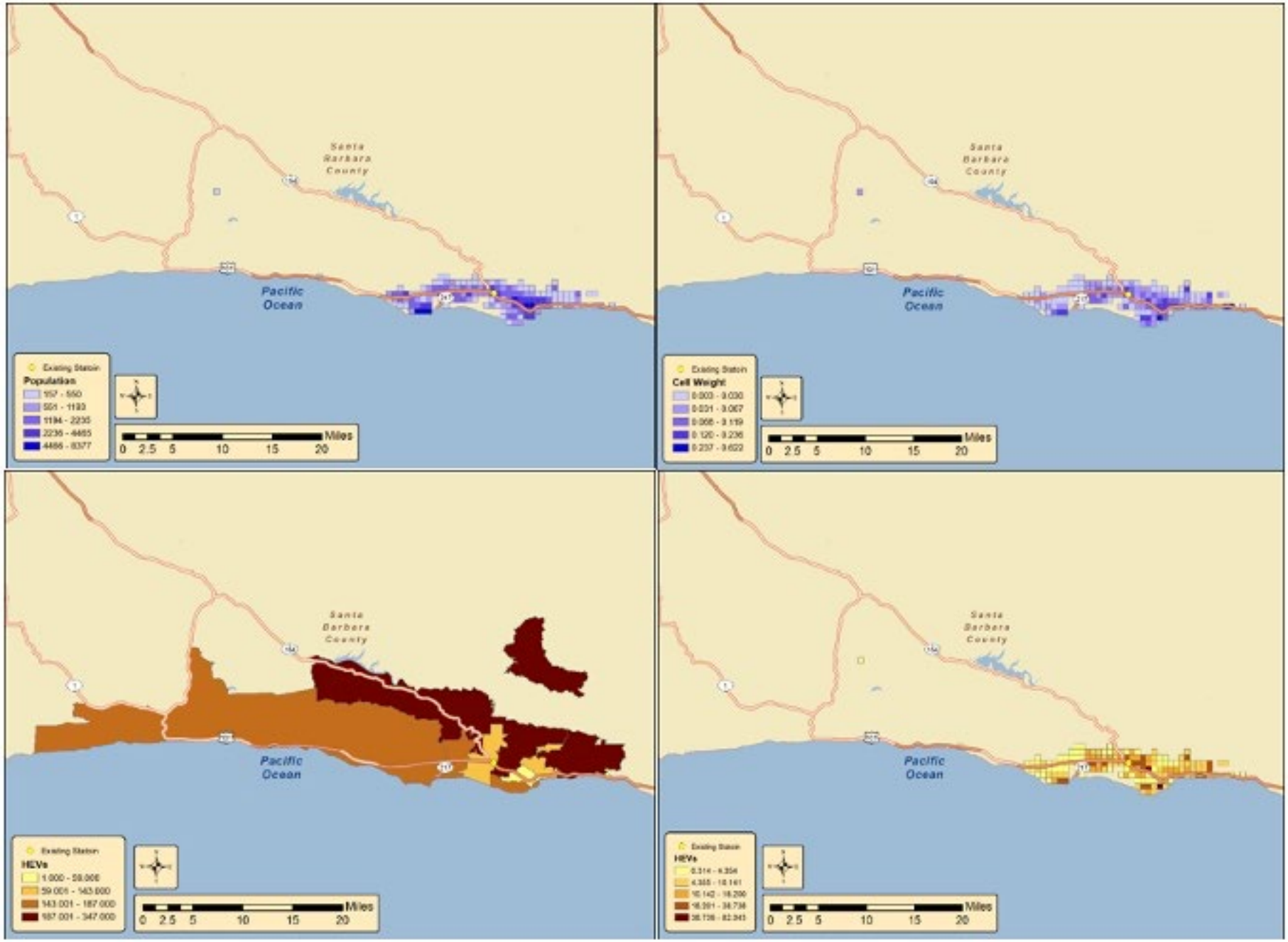
On examination of Figure 12, service coverage of 6 minutes appears to be a good compromise between parity with gasoline and minimization of infrastructure investment. With 126 existing gasoline stations in the Santa Monica region, 8 hydrogen stations represents just 6.3 percent of the total. This result matches well with previous research in the field of fueling infrastructure which indicate that 5 percent of gasoline fueling locations require alternative fuel in order to alleviate driver concerns about fuel availability [8], [9].

Figure 13: Existing Infrastructure (Gasoline and Hydrogen Stations) in Tri-Counties Area



Source: Santa Barbara County Air Pollution Control District

Figure 14: Weighted Distribution Methodology Example for Santa Barbara



Source: Santa Barbara County Air Pollution Control District

Station Ranking

Once the station locations are allocated using the Maximize Market Share algorithm, they are ranked according to the total demand points (FCEV proxy) covered by a six-minute drive time from the gasoline station. Because the Location-Allocation GIS tool applies heuristics on fringe cases, a more robust tool is used. This tool builds an Origin-Destination Cost Matrix for each station and all of the demand points in the stations' 6-minute service coverage, including all fringe cases. The tool has been custom adapted for usage by Spatially and Temporally Resolved Energy and Environment Tool in order to properly account for the covered demand points (FCEV proxy).

Results:

The results for the three different sets of alternative vehicle registration data sets used are shown in Figure 15 with the number of FCEV proxy covered and the California Hydrogen Infrastructure Tool coverage gap score shown in

Table 14 (BEV as FCEV proxy), Table 15 (PHEV+HEV as FCEV proxy), and Table 16 (HEV+PHEV+BEV as FCEV proxy). Figure 15 allows comparison between using different data sets as FCEV proxy in siting hydrogen refueling stations. In general, there is not much difference between using the HEV+PHEV and HEV+PHEV+BEV data sets as FCEV proxy since the number of HEVs and PHEVs is so much larger than the BEVs. However, the BEVs as FCEV proxy is different than the other two data sets considered with more hydrogen stations being sited in San Luis Obispo county. For both the HEV+PHEV and HEV+PHEV+BEV as FCEV proxy cases, there are 13 stations located in Ventura county, 5 (4 additional) in Santa Barbara county, and 3 in San Luis Obispo county, but for the BEV as FCEV proxy case there are 11 located in Ventura county, 5 (4 additional) in Santa Barbara county, and 5 in San Luis Obispo county. This is a result of a proportionally higher occurrence of BEVs in San Luis Obispo county. In terms of ranking stations by FCEV proxy covered, there are also differences. The HEV+PHEV and HEV+PHEV+BEV as FCEV proxy cases result in the top 5 stations in terms of FCEV proxy covered being in Ventura county. However, the BEV as FCEV proxy case results in the top 5 stations being in Ventura and Santa Barbara counties with two in Ventura county and three in Santa Barbara county.

BEVs as FCEV Proxy

20 additional stations plus the existing La Cumbre station cover 738 of Tri-Counties' 868 BEVs (85 percent). 11 are located in Ventura county, 5 (4 additional) in Santa Barbara county, and 5 in San Luis Obispo county.

Table 14 shows the FCEV proxy (as BEVs) covered within a 6-minute drive time from each station. The California Hydrogen Infrastructure Tool coverage gap score is also shown.

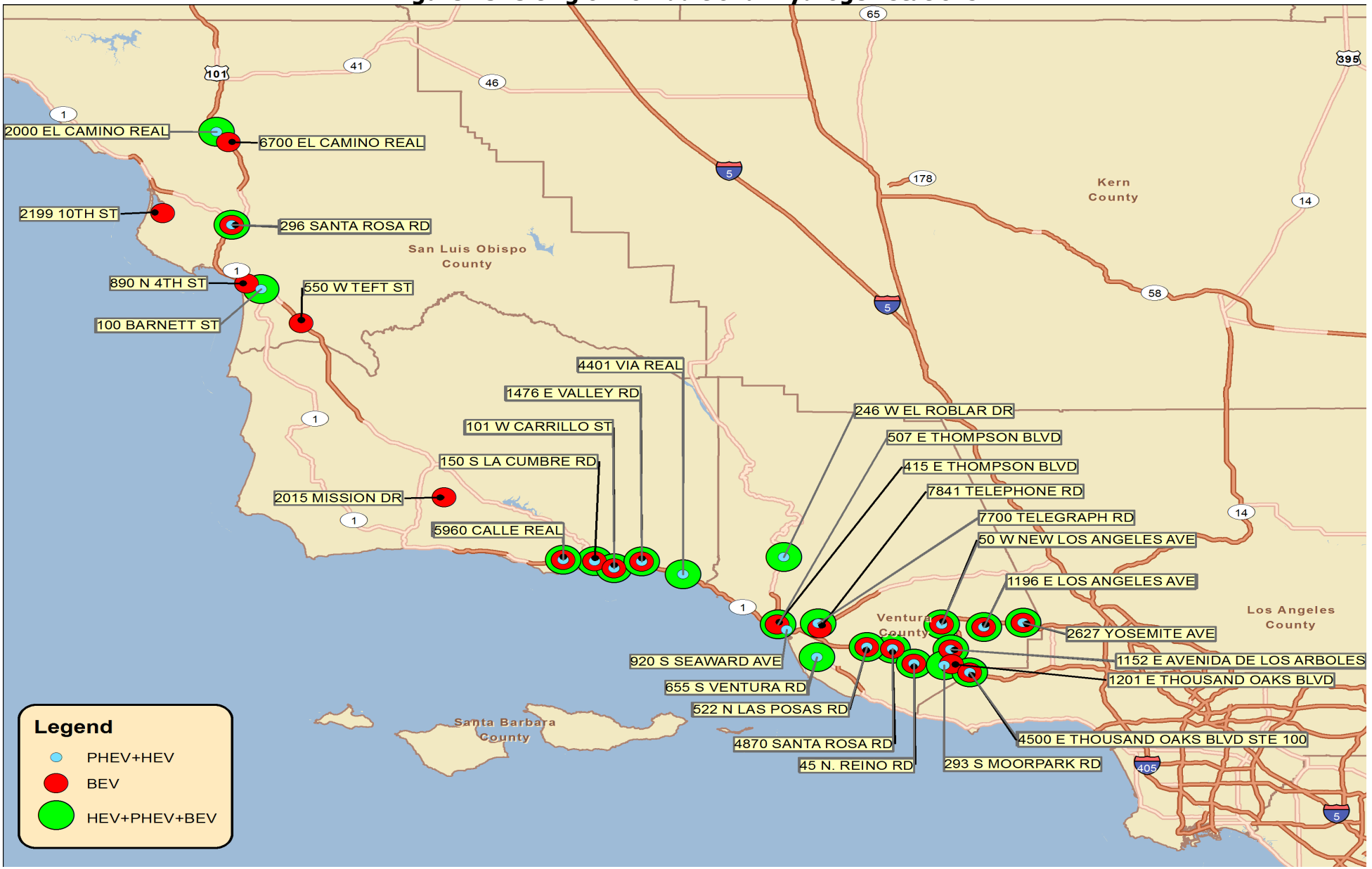
HEVs and PHEVs as FCEV Proxy

20 additional stations plus the existing La Cumbre station cover 6665 of Tri-Counties' 8355 HEVs & PHEVs (80 percent). 13 are located in Ventura county, 5 (4 additional) in Santa Barbara county, and 3 in San Luis Obispo county. Table 15 shows the FCEV proxy (as HEV+PHEVs) covered within a 6-minute drive time from each station. The California Hydrogen Infrastructure Tool coverage gap score is also shown.

BEVs, HEVs, and PHEVs as FCEV Proxy

20 additional stations plus the existing La Cumbre station cover 7386 of Tri-Counties' 9223 BEVs, HEVs, & PHEVs (80 percent). 13 are located in Ventura county, 5 (4 additional) in Santa Barbara county, and 3 in San Luis Obispo county. Table 16 shows the FCEV proxy (as HEV+PHEV+BEVs) covered within a 6-minute drive time from each station. The California Hydrogen Infrastructure Tool coverage gap score is also shown.

Figure 15: Siting of 20 Additional Hydrogen stations



Note: 21 in total including the existing La Cumbre station in Santa Barbara, to the tri-county hydrogen refueling network using three different alternative vehicle registration datasets (BEV, HEV, and HEV+BEV)

Source: Santa Barbara County Air Pollution Control District

Table 14: Tabulation of Maximized Market Share Algorithm Siting Of 20 Additional Hydrogen Stations Based On BEVS As FCEV Proxy Data Ranked In Order Of FCEV Proxy Within 6 Minute Drive Time

Street Name	City	County	Zip Code	BEVs Covered	CHIT Coverage Gap Score [x100]
1201 E THOUSAND OAKS BLVD	Thousand Oaks	Ventura County	91362	65	1.9224
1476 E VALLEY RD	Montecito	Santa Barbara County	93108	65	0.5375
45 N. REINO RD	Thousand Oaks	Ventura County	91320	60	1.7843
101 W CARRILLO ST	Santa Barbara	Santa Barbara County	93101	59	1.2389
150 S LA CUMBRE RD	Santa Barbara	Santa Barbara County	93105	57	0.2603
1152 E AVENIDA DE LOS ARBOLES	Thousand Oaks	Ventura County	91360	47	1.895
4500 E THOUSAND OAKS BLVD STE	Thousand Oaks	Ventura County	91362	45	1.8683
5960 CALLE REAL	Goleta	Santa Barbara County	93117	42	0.1546
1196 E LOS ANGELES AVE	Simi Valley	Ventura County	93065	42	1.1712
4870 SANTA ROSA RD	Camarillo	Ventura County	93012	36	0.8419
890 N 4TH ST	Pismo Beach	San Luis Obispo	93449	34	0.4227
2627 YOSEMITE AVE	Simi Valley	Ventura County	93063	29	0.8417
296 SANTA ROSA RD	San Luis Obispo	San Luis Obispo	93401	29	0.7755
50 W NEW LOS ANGELES AVE	Moorpark	Ventura County	93021	28	0.349
7841 TELEPHONE RD	San Buenaventura	Ventura County	93004	23	1.3381
522 N LAS POSAS RD	Camarillo	Ventura County	93010	20	0.9674
415 E THOMPSON BLVD	San Buenaventura	Ventura County	93001	15	0.3905
2015 MISSION DR	Solvang	Santa Barbara County	93463	13	0.1949
2199 10TH ST	Los Osos	San Luis Obispo	93402	10	0.3924
6700 EL CAMINO REAL	Atascadero	San Luis Obispo	93422	10	0.1791
550 W TEFT ST	Nipomo	San Luis Obispo	93444	8	0.1454

Source: Santa Barbara County Air Pollution Control District

Table 15: Tabulation of Maximize Market Share Algorithm Siting Of 20 Additional Hydrogen Stations Based On HEVs+PHEVs as FCEV Proxy Data Ranked In Order of FCEV Proxy Within 6 Minute Drive Time

Street Name	City	County	Zip Code	HEV+PHEVs Covered	CHIT Coverage Gap Score [x100]
1196 E LOS ANGELES AVE	Simi Valley	Ventura County	93065	636	1.1712
45 N. REINO RD	Thousand Oaks	Ventura County	91320	552	1.7843
293 S MOORPARK RD	Thousand Oaks	Ventura County	91361	540	1.451
1152 E AVENIDA DE LOS ARBOLES	Thousand Oaks	Ventura County	91360	520	1.895
4500 E THOUSAND OAKS BLVD STE	Thousand Oaks	Ventura County	91362	478	1.8683
101 W CARRILLO ST	Santa Barbara	Santa Barbara County	93101	447	1.2389
4870 SANTA ROSA RD	Camarillo	Ventura County	93012	384	0.8419
150 S LA CUMBRE RD	Santa Barbara	Santa Barbara County	93105	377	0.2603
2627 YOSEMITE AVE	Simi Valley	Ventura County	93063	317	0.8417
50 W NEW LOS ANGELES AVE	Moorpark	Ventura County	93021	311	0.349
1476 E VALLEY RD	Montecito	Santa Barbara County	93108	286	0.5375
522 N LAS POSAS RD	Camarillo	Ventura County	93010	283	0.9674
5960 CALLE REAL	Goleta	Santa Barbara County	93117	273	0.1546
100 BARNETT ST	Arroyo Grande	San Luis Obispo	93420	241	0.2215
7700 TELEGRAPH RD	San Buenaventura	Ventura County	93004	225	1.5554
296 SANTA ROSA RD	San Luis Obispo	San Luis Obispo	93401	184	0.7755
920 S SEAWARD AVE	San Buenaventura	Ventura County	93001	179	0.7797
655 S VENTURA RD	Oxnard	Ventura County	93030	128	2.1266
2000 EL CAMINO REAL	Atascadero	San Luis Obispo	93422	111	0.1791
246 W EL ROBLAR DR	Meiners Oaks	Ventura County	93023	100	0.2665
4401 VIA REAL	Carpinteria	Santa Barbara County	93013	94	0.5422

Source: Santa Barbara County Air Pollution Control District

Table 16: Tabulation of Maximize Market Share Algorithm Siting Of 20 Additional Hydrogen Stations Based On HEV+PHEV+BEVs as FCEV Proxy Data Ranked In Order of FCEV Proxy Within 6 Minute Drive Time

Street Name	City	County	Zip Code	HEV+PHEV+BEVs Covered	CHIT Coverage Gap Score [x100]
1196 E LOS ANGELES AVE	Simi Valley	Ventura County	93065	678	1.1712
45 N. REINO RD	Thousand Oaks	Ventura County	91320	607	1.7843
293 S MOORPARK RD	Thousand Oaks	Ventura County	91361	596	1.451
1152 E AVENIDA DE LOS ARBOLES	Thousand Oaks	Ventura County	91360	571	1.895
4500 E THOUSAND OAKS BLVD	Thousand Oaks	Ventura County	91362	534	1.8683
101 W CARRILLO ST	Santa Barbara	Santa Barbara	93101	505	1.2389
150 S LA CUMBRE RD	Santa Barbara	Santa Barbara	93105	434	0.2603
4870 SANTA ROSA RD	Camarillo	Ventura County	93012	419	0.8419
1476 E VALLEY RD	Montecito	Santa Barbara	93108	350	0.5375
2627 YOSEMITE AVE	Simi Valley	Ventura County	93063	346	0.8417
50 W NEW LOS ANGELES AVE	Moorpark	Ventura County	93021	339	0.349
5960 CALLE REAL	Goleta	Santa Barbara	93117	315	0.1546
522 N LAS POSAS RD	Camarillo	Ventura County	93010	303	0.9674
100 BARNETT ST	Arroyo Grande	San Luis Obispo	93420	275	0.2215
7700 TELEGRAPH RD	San Buenaventura	Ventura County	93004	266	1.5554
296 SANTA ROSA RD	San Luis Obispo	San Luis Obispo	93401	213	0.7755
507 E THOMPSON BLVD	San Buenaventura	Ventura County	93001	173	0.3905
655 S VENTURA RD	Oxnard	Ventura County	93030	136	2.1266
2000 EL CAMINO REAL	Atascadero	San Luis Obispo	93422	118	0.1791
246 W EL ROBLAR DR	Meiners Oaks	Ventura County	93023	106	0.2665
4401 VIA REAL	Carpinteria	Santa Barbara	93013	102	0.5422

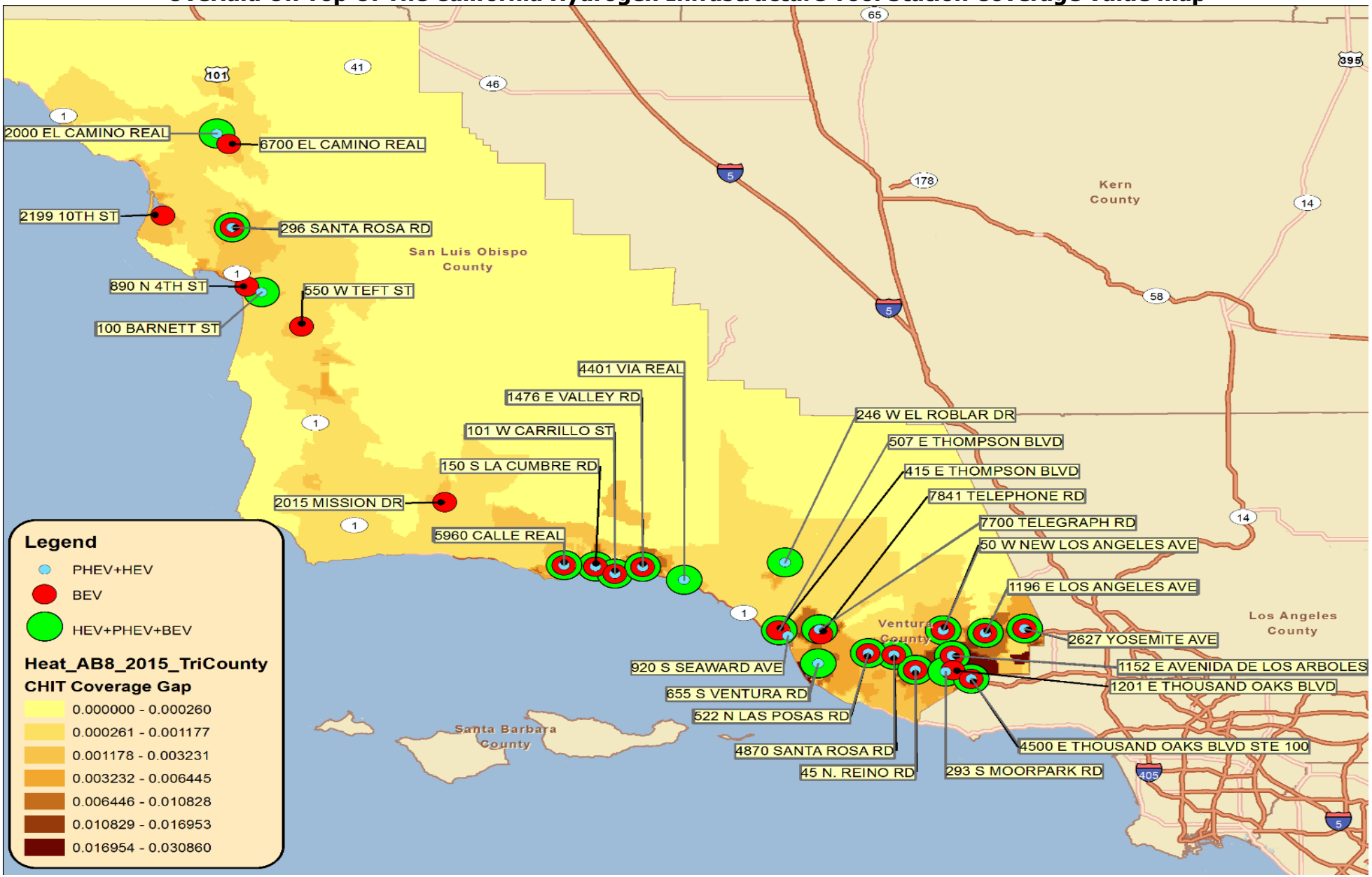
Source: Santa Barbara County Air Pollution Control District

Spatially and Temporally Resolved Energy and Environment Tool Compared to California Hydrogen Infrastructure Tool

The California Hydrogen Infrastructure Tool Station Coverage Value is the ability of the proposed station to fill an identified gap in refueling coverage. Figure 16 shows the Spatially and Temporally Resolved Energy and Environment Tool suggested hydrogen station sites on top of the California Hydrogen Infrastructure Tool Station Coverage Values, which is shown separately in Figure 17. The California Hydrogen Infrastructure Tool Station Coverage Values are also shown for each suggested Spatially and Temporally Resolved Energy and Environment Tool stations in Tables 14 through 16.

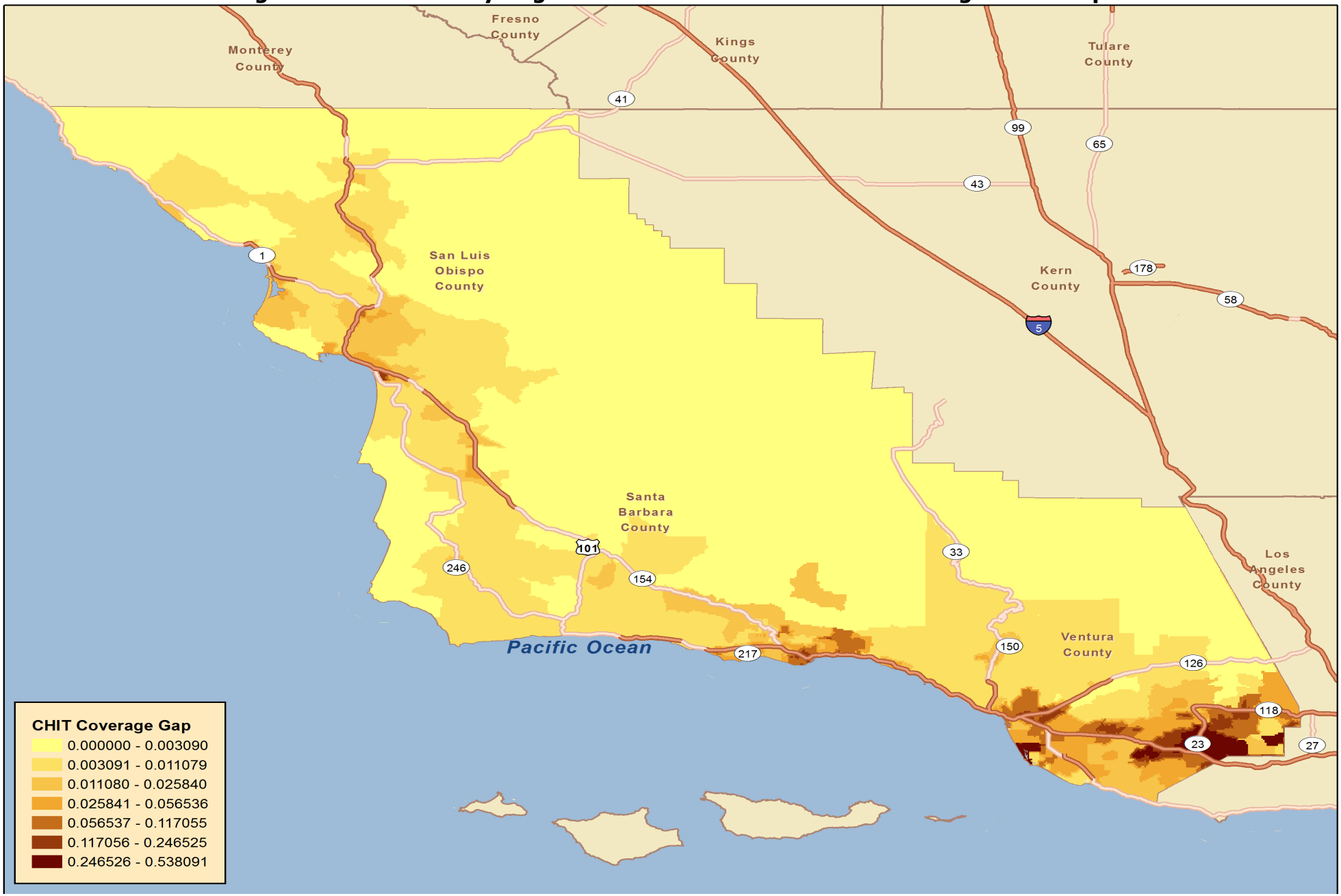
Figures 18 and 19 show the existing and potential future connectivity along Highway 101 provided by the existing Santa Barbara hydrogen station on 150 S La Cumbre Rd and the suggested Spatially and Temporally Resolved Energy and Environment Tool hydrogen stations, respectively. Figures 20, 21 and 22 show the distribution of BEVs, HEVs and PHEVs, and HEVs and PHEVs and BEVs after application of the weighted distribution method. Tables 17 through 24 show the results of the field assessment of existing retail fueling stations.

Figure 16: Suggested Spatially and Temporally Resolved Energy and Environment Tool Hydrogen Refueling Stations Overlaid On Top Of The California Hydrogen Infrastructure Tool Station Coverage Value map



Source: Santa Barbara County Air Pollution Control District

Figure 17: California Hydrogen Infrastructure Tool Station Coverage Value Map

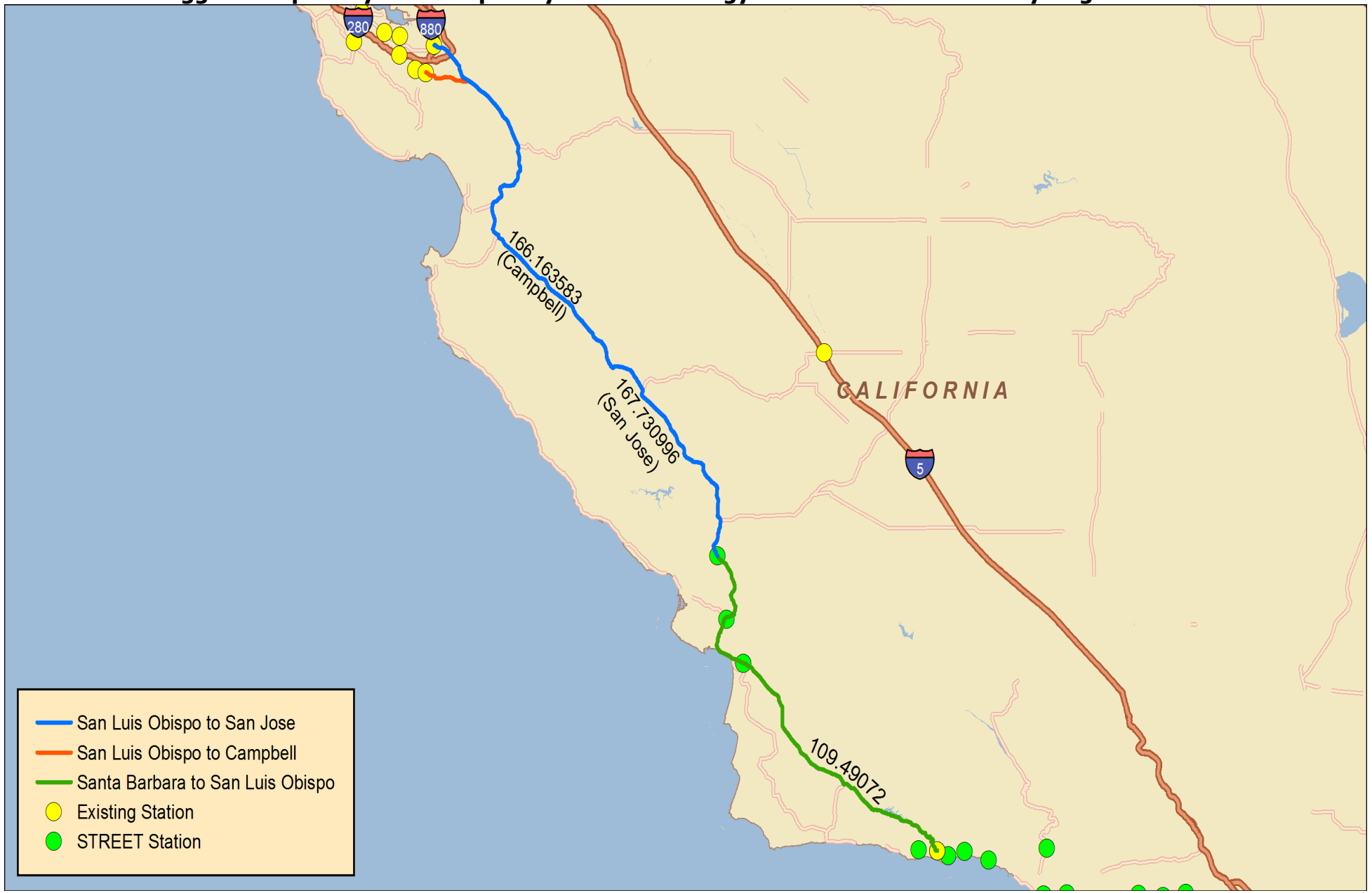


Source: Santa Barbara County Air Pollution Control District

Figure 18: Current Connectivity Between Northern And Southern California along Highway 101 Provided By The Existing Santa Barbara Hydrogen Station on 150 S La Cumbre Rd.

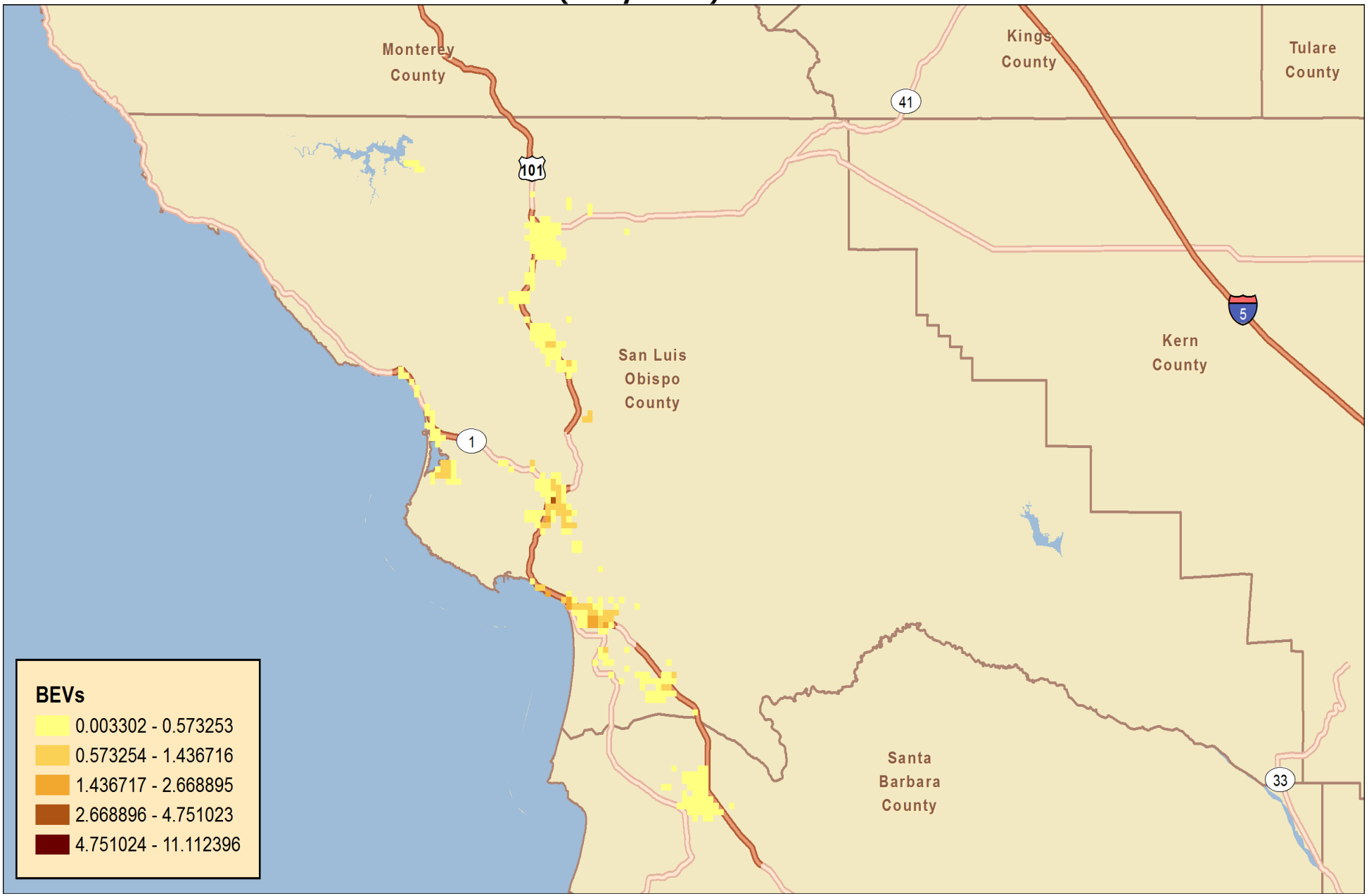
Source: Santa Barbara County Air Pollution Control District

Figure 19: Future Possible Connectivity Between Northern And Southern California along Highway 101 Provided By Suggested Spatially and Temporally Resolved Energy and Environment Tool Hydrogen Stations



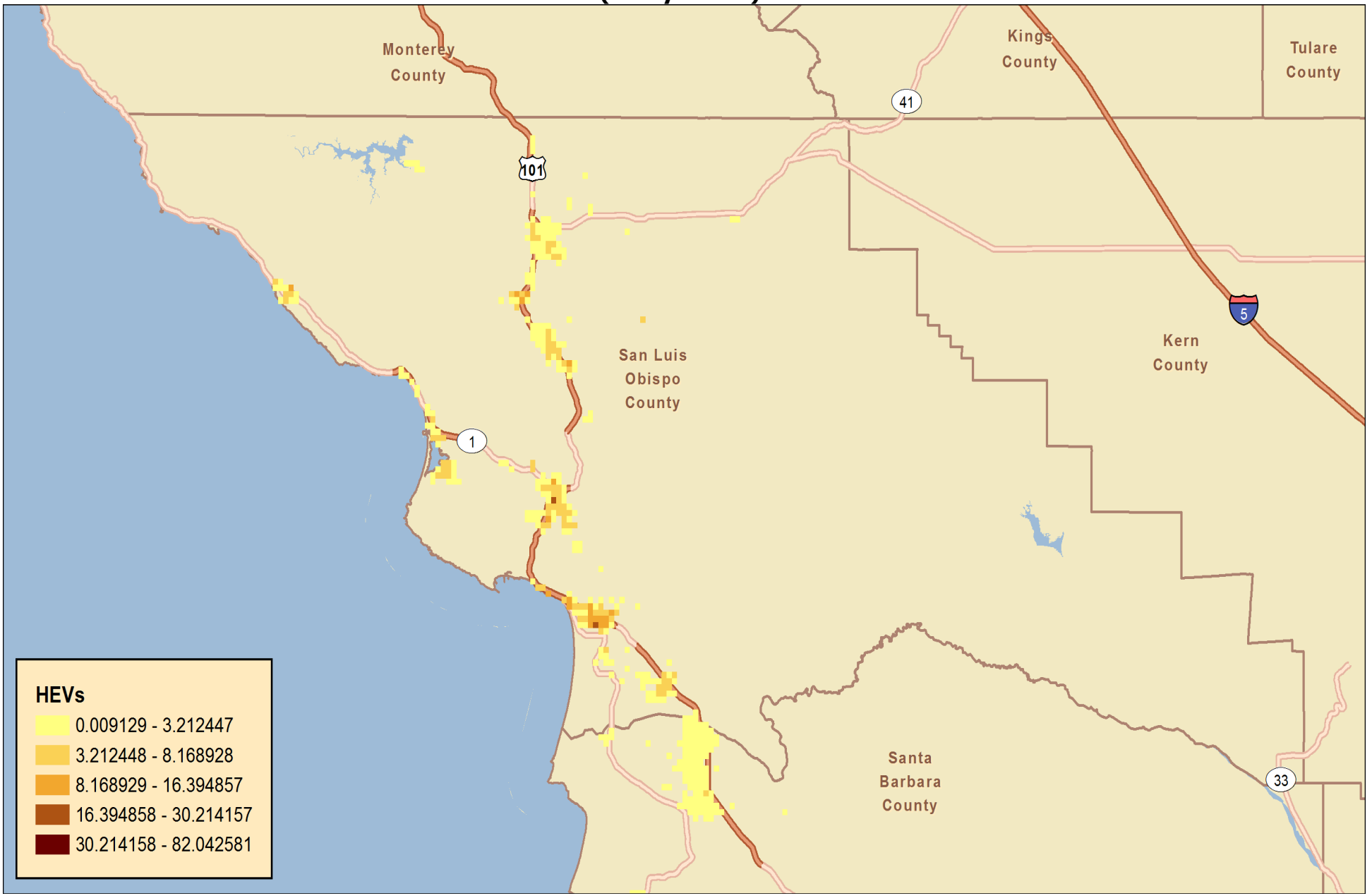
Source: Santa Barbara County Air Pollution Control District

Figure 20: Distribution of BEVs After The Application Of The Weighted Distribution Method described in Demand Points (Proxy FCEVs) Section



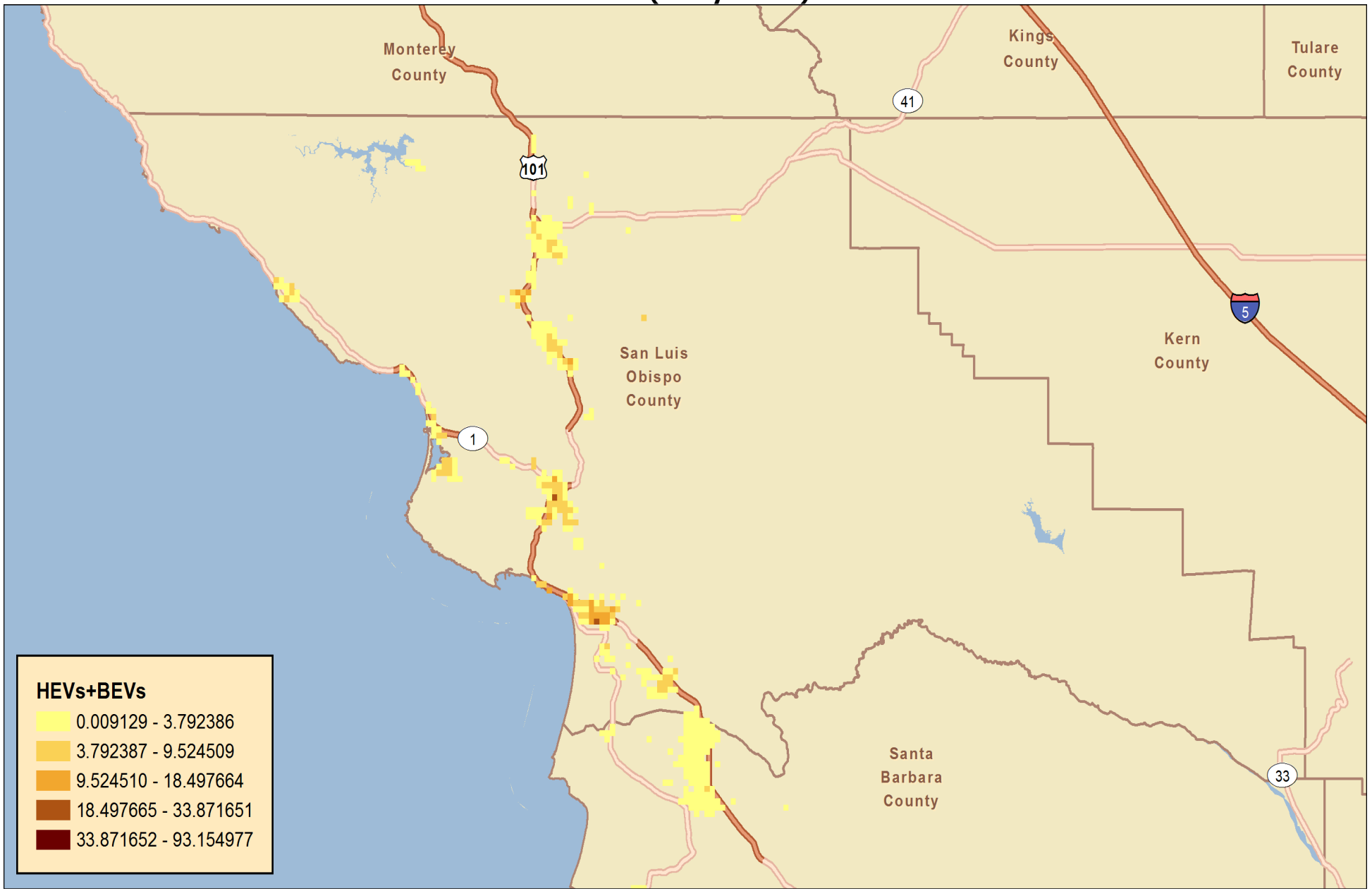
Source: Santa Barbara County Air Pollution Control District

Figure 21: Distribution of HEVs+PHEVs After The Application of the Weighted Distribution Method described in Demand Points (Proxy FCEVs) section



Source: Santa Barbara County Air Pollution Control District

Figure 22: Distribution of HEVs+PHEVs+BEVs After The Application of the Weighted Distribution Method Described in Demand Points (Proxy FCEVs) Section



Source: Santa Barbara County Air Pollution Control District

Table 17: Ventura County Stations Visited and Scored

Name	Address	City	Zip	Space	Appearance	Neighborhood	Ease of Access	Proximity to Freeway	Overall Score
Yosemite Shell	2627 Yosemite Ave.	Simi Valley	93063	6	6	3	3	3	21
Chevron #9-0576	920 S Seaward Ave	Ventura	93003	6	6	3	3	3	21
Circle K #2211185	5195 East Cochran	Simi Valley	93063	6	5	3	3	3	20
Swank's Chevron	2449 Stearns Street	Simi Valley	93063	6	5	3	3	3	20
Circle K #2709460	2200 N. Rose Ave.	Oxnard	93030	5	6	3	3	3	20
Chevron SS #20-8020	1900 N. Rose Ave.	Oxnard	93030	5	6	3	3	3	20
Campus Plaza Shell	6599 Collins Dr.	Moorpark	93021	5	6	3	3	3	20
Arneill Chevron	255 Arneill Rd.	Camarillo	93010	6	5	3	3	3	20
California Chevron	507 E Thompson Blvd.	Ventura	93001	6	6	2	3	3	20
GSE 76 Ventu Park	575 N. Ventu Park Rd.	Newbury Park	91320	5	6	3	3	3	20
Borchard Arco AM/PM	2305 Borchard Rd.	Newbury Park	91320	5	5	3	3	3	19
Chevron #9-1024	2568 Sycamore Drive	Simi Valley	93065	6	5	2	3	3	19
Apro LLC dba United Oil #10	108 Cochran Street	Simi Valley	93065	4	6	3	3	3	19
Circle K #2709483	490 S. Victoria Ave.	Oxnard	93030	6	6	3	3	1	19
Johnson Drive Carwash & Gas	2757 Johnson Dr.	Ventura	93003	5	6	2	3	3	19
Seaward Oil, Inc.	779 South Seaward Ave.	Ventura	93001	6	4	3	3	3	19
7-Eleven Facility #33399	2201 E. Gonzales Rd.	Oxnard	93036	4	6	3	3	2	18
S & S Chevron	2901 Saviers Road	Oxnard	93033	5	5	3	3	2	18
Moorpark Chevron	502 Los Angeles Ave.	Moorpark	93021	4	5	3	3	3	18
Proud Auto	4676 Adolfo Rd.	Camarillo	93012	4	5	3	3	3	18
Las Posas Mobil, Inc.	501 Las Posas Road	Camarillo	93010	4	5	3	3	3	18

Name	Address	City	Zip	Space	Appearance	Neighborhood	Ease of Access	Proximity to Freeway	Overall Score
Tesoro Shell #68511	107 W. Ventura Blvd.	Camarillo	93010	3	6	3	3	3	18
Chevron #200209	4870 Santa Rosa Road	Camarillo	93010	4	5	3	3	3	18
Johnson Oil Corp. Fac. No.	6762 North Bank Dr.	Ventura	93003	5	5	2	3	3	18
Hampshire Road Shell	395 Hampshire Road	Thousand	91360	5	5	3	3	2	18
7-Eleven #33162	609 Rancho Conejo Blvd.	Thousand	91320	4	5	3	3	3	18
Newbury 76	848 Wendy Dr.	Newbury Park	91320	5	4	3	3	3	18
S & G Energy, Inc.	445 North Ventu Park	Newbury Park	91320	4	5	3	3	3	18
USA Gasoline #68174	518 Rancho Conejo Blvd.	Newbury Park	91320	4	5	3	3	3	18
RJR Enter. dba Simi Valley Arco	25 Tierra Rejada Rd.	Simi Valley	93065	4	5	3	3	2	17
Kam's Canyon Mobil Service	2500 Tapo Canyon Road	Simi Valley	93063	5	4	2	3	3	17
Vineyard Mobil	2851 E. Vineyard Ave.	Oxnard	93036	4	5	3	3	2	17
Rose Shell	1901 N. Rose Ave.	Oxnard	93030	5	4	2	3	3	17
Union 76	550 W. Los Angeles	Moorpark	93021	5	5	3	3	1	17
Hilu Chevron	522 N. Las Posas Rd.	Camarillo	93010	3	5	3	3	3	17
Arco AM/PM	5669 Valentine Rd.	Ventura	93003	3	6	2	3	3	17
Zaitoon Inc.	605 S. Mills Rd.	Ventura	93003	4	4	3	3	3	17
Tesoro Arco #42054	2124 East Harbor Blvd	Ventura	93001	5	4	2	3	3	17
Jenda, Inc.	3995 Thousand Oaks Blvd.	Thousand	91362	4	4	3	3	3	17
Westlake Chevron	225 Hampshire Rd.	Westlake	91361	3	5	3	3	3	17
Rolling Oaks 76	293 S. Moorpark Rd.	Thousand	91361	5	3	3	3	3	17
Oaks Shell	56 E. Thousand Oaks Blvd.	Thousand	91360	4	4	3	3	3	17
Wendy Drive Chevron	2870 Camino Dos Rios	Newbury Park	91320	3	5	3	3	3	17

Name	Address	City	Zip	Space	Appearance	Neighborhood	Ease of Access	Proximity to Freeway	Overall Score
Borchard Chevron	2290 W. Borchard Rd.	Newbury Park	91320	4	4	3	3	3	17
Oxnard Vineyard Chevron	2251 N. Oxnard Blvd.	Oxnard	93036	4	5	3	2	3	17
Chevron Stations Inc. #202037	2395 Erringer Road	Simi Valley	93065	4	5	2	3	2	16
Alliance	5803 East Los Angeles	Simi Valley	93063	3	4	3	3	3	16
Stearns Petroleum, Inc.	2605 Stearns St.	Simi Valley	93063	5	3	2	3	3	16
Stearns Alliance Gas Minimart	2404 Stearns St.	Simi Valley	93063	3	4	3	3	3	16
HDOC #093	3402 Vineyard Ave	Oxnard	93030	5	4	3	3	1	16
Arco/AMPM	500 S. Victoria Ave.	Oxnard	93030	4	5	3	3	1	16
Moorpark Petroleum	50 W. New Los Angeles	Moorpark	93021	4	5	3	3	1	16
Main & Mills Mobil	3500 E Main St	Ventura	93003	3	4	3	3	3	16
Victoria Chevron	2199 S. Victoria Avenue	Ventura	93003	4	5	2	2	3	16
Market Street Carwash & Gas	4411 Market St.	Ventura	93003	4	5	3	2	2	16
Rafi's Chevron #6	1152 Avenida De Los	Thousand	91360	4	4	3	3	2	16
Circle K #2211092	855 North Wendy Dr.	Newbury Park	91320	3	4	3	3	3	16
Sycamore Shell	2405 N. Sycamore Dr.	Simi Valley	93065	4	5	2	3	1	15
Tesoro USA #63217	2211 Tapo St.	Simi Valley	93063	4	4	3	3	1	15
Shell #68621	2390 Tapo St.	Simi Valley	93063	4	5	2	3	1	15
Shell #68580	2460 E. Vineyard Ave.	Oxnard	93036	4	4	2	2	3	15
Universal Victoria Inc.	2440 S. Victoria Ave.	Ventura	93003	3	4	2	3	3	15
Seaward Inc.	2099 E. Harbor Blvd.	Ventura	93001	2	5	2	3	3	15
Harbor Valero / Subway	2121 East Harbor Blvd	Ventura	93001	5	2	2	3	3	15
Dalex Chevron	172 N. Moorpark Rd.	Thousand	91360	4	4	3	2	2	15

Name	Address	City	Zip	Space	Appearance	Neighborhood	Ease of Access	Proximity to Freeway	Overall Score
Oxnard Arco AM/PM	1132 S. Oxnard Blvd.	Oxnard	93030	3	5	3	3	1	15
Simi Shell Food Mart	1120 Los Angeles Ave.	Simi Valley	93065	4	3	3	2	3	15
Tesoro USA #63215	706 Los Angeles Ave.	Simi Valley	93063	5	4	2	2	2	15
Oxnard Service Station LLC	2850 S. Rose Ave.	Oxnard	93033	3	5	2	3	1	14
Victoria Oil Corp. #255523	1121 S. Victoria Ave.	Ventura	93003	3	4	3	2	2	14
T. O. Oil, Inc. dba T. O. Chevron	3505 N. Moorpark Road	Thousand	91360	3	5	3	2	1	14
Simi Gas	501 E. Los Angeles Ave.	Simi Valley	93065	5	3	2	2	2	14
Silvas Oil Company, Inc.	6417 Ventura Blvd.	Ventura	93002	6	2	1	2	2	13
Thousand Oaks Union 76	2861 Moorpark Rd	Thousand	91360	4	4	2	2	1	13
Simi Valley Union 76	2706 E. Los Angeles Ave.	Simi Valley	93065	4	3	2	2	2	13
Tesoro USA #68232	2661 E. Thompson Blvd.	Ventura	93003	4	3	2	2	1	12
H.D.O.C. #106	774 North Ventura Avenue	Ventura	93001	6	2	1	2	1	12
Kassra Inc.	2292 Thompson Blvd.	Ventura	93001	2	5	2	2	1	12
Anita Spirit	415 E. Thompson Blvd.	Ventura	93001	2	3	2	2	3	12
Simi Valley Circle K	510 E. Los Angeles Ave.	Simi Valley	93065	3	3	2	2	2	12
HD Fuel	2399 Tapo St.	Simi Valley	93063	2	3	2	3	1	11
Moorpark Service Inc.	13800 Princeton Ave.	Moorpark	93021	4	3	2	1	1	11
Rafi's Chevron #5	3477 Telegraph Road	Ventura	93003	4	3	2	1	1	11
Tesoro USA #68233	1717 S. Victoria Ave.	Ventura	93003	2	3	2	2	2	11
G & M Oil Co./Chevron #308293	2314 E. Thompson Blvd.	Ventura	93003	3	3	2	2	1	11
Sycamore Union 76	2383 Sycamore Drive	Simi Valley	93065	2	2	2	2	2	10
Auto Fuels, Inc.	2460 Auto Center Dr.	Oxnard	93030	2	2	2	1	2	9

Name	Address	City	Zip	Space	Appearance	Neighborhood	Ease of Access	Proximity to Freeway	Overall Score
Oxnard Arco	700 South Oxnard Blvd	Oxnard	93030	2	3	1	2	1	9
Ventura Gas & Mini Mart	2599 East Main St.	Ventura	93003	2	3	2	1	1	9
Valero	2689 N. Moorpark Rd	Thousand	91360	2	2	2	2	1	9
Oxnard EZ Gas	303 N. Oxnard Blvd.	Oxnard	93030	2	3	1	2	1	9
USA Gasoline #63036	887 N. Ventura Ave.	Ventura	93001	2	2	1	2	1	8

Source: Santa Barbara County Air Pollution Control District

Table 18: Ventura County, Other Retail Stations Not Visited

Name	Address	City	Zip	Space	Appearance	Neighborhood	Ease of Access	Proximity to Freeway	Score
Circle K #2211246	45 N. Reino Rd.	Newbury Park	91320						
Thousand Oaks / Public Works	1993 Rancho Conejo Blvd.	Thousand Oaks	91320						
Arco Smog Pros	600 Moorpark Rd	Thousand Oaks	91360						
Thousand Oaks Chevron	1201 E. Thousand Oaks	Thousand Oaks	91360						
USA Gasoline #68224	1640 N. Moorpark Rd.	Thousand Oaks	91360						
Wendy Auto Center Inc.	420 E. Thousand Oaks Blvd.	Thousand Oaks	91360						
Circle K #2211126	942 Westlake Blvd.	Westlake Village	91361						
Michael E. Ply Hampshire 76	3102 East Thousand Oaks	Thousand Oaks	91362						
ProGas, Inc dba Thousand Oaks	2473 Thousand Oaks Blvd.	Thousand Oaks	91362						
TR Oil	3050 E. Thousand Oaks	Thousand Oaks	91362						
USA Gasoline #63211	1715 East Thousand Oaks	Thousand Oaks	91362						
Silvas Oil Company, Inc.	50 Julian Street	Ventura	93001						
Silvas Oil Company, Inc.	2191 N. Ventura Ave.	Ventura	93001						
College Shell	4111 Telegraph Road	Ventura	93003						
TBA Enterprises Inc	7700 Telegraph Rd.	Ventura	93003						
Telephone Road Chevron	9460 Telephone Rd.	Ventura	93004						
Tesoro Shell #68632	7841 Telephone Rd.	Ventura	93004						
Ventura 76	11008 Citrus Drive (Wells)	Ventura	93004						
Ventura Valero	11005 Citrus Dr.	Ventura	93004						
7-Eleven Store #33567	255 N. Carmen Drive	Camarillo	93010						
Arco Facility #83345	650 N. Arneill Rd.	Camarillo	93010						

Name	Address	City	Zip	Space	Appearance	Neighborhood	Ease of Access	Proximity to Freeway	Score
Auto Tech Gas Buster Mart	2157 Las Posas Rd.	Camarillo	93010						
Carmen Auto Center	256 Carmen Dr.	Camarillo	93010						
Shell Camarillo	1604 Ventura Blvd.	Camarillo	93010						
USA Gasoline #68115	4418 E. Central Ave.	Camarillo	93010						
USA Gasoline #68116	305 Carmen Dr.	Camarillo	93010						
Dawson Carwash	2911 Petit St.	Camarillo	93012						
7-Eleven #33513	903 Ventura St.	Fillmore	93015						
Chevron #9-7983	704 W. Ventura St.	Fillmore	93015						
Fillmore Shell Inc	1107 W. Ventura St.	Fillmore	93015						
Saif's Food Mart	423 W. Ventura St.	Fillmore	93015						
Tesoro USA #68135	660 Ventura St.	Fillmore	93015						
Valero Corner Store #3751	117 E. Ventura St.	Fillmore	93015						
Moorpark #6	7150 Walnut Canyon	Moorpark	93021						
Shell #68564	301 W. New Los Angeles	Moorpark	93021						
Oak View Shell	905 Ventura Ave.	Oak View	93022						
USA Gasoline #63207	795 Ventura Ave.	Oak View	93022						
A & I Mini Mart & Gas	246 W. El Roblar Dr.	Meiners Oaks	93023						
Circle K #01045	11408 Ventura Avenue	Ojai	93023						
Ojai Chevron #9-0478	360 East Ojai Ave.	Ojai	93023						
Ojai Gas Inc.	1124 Maricopa Rd.	Ojai	93023						
Valero Corner Store #3754	616 E. Ojai Ave.	Ojai	93023						
7-Eleven #33159	1501 W. 5th Street	Oxnard	93030						

Name	Address	City	Zip	Space	Appearance	Neighborhood	Ease of Access	Proximity to Freeway	Score
Alliance Station	1861 N. Ventura Rd.	Oxnard	93030						
Chevron	877 S. Ventura Rd.	Oxnard	93030						
Costco Wholesale Corp. #420	2001 E. Ventura Blvd.	Oxnard	93030						
Del Norte Shell	200 Del Norte Boulevard	Oxnard	93030						
El Rio Vineyard Shell & Foodmart	2778 Vineyard Avenue	Oxnard	93030						
Lashkari's Service Station	105 North Oxnard Boulevard	Oxnard	93030						
Nissim Tovim, Inc.	1400 S. Oxnard Blvd.	Oxnard	93030						
Offshore Gas	1050 S. Ventura Road	Oxnard	93030						
Oxnard Ultramar Carwash	655 South Ventura Road	Oxnard	93030						
Rose & 5th Inc.	501 S. Rose Ave.	Oxnard	93030						
Tesoro USA #68182	1790 E. Pleasant Valley Rd.	Oxnard	93030						
USA Gasoline #63208	1501 W. Gonzales Rd.	Oxnard	93030						
Ventura Road Chevron #9-7423	1860 N. Ventura Road	Oxnard	93030						
Wooley Gas Faal Corporation	1060 South J Street	Oxnard	93030						
Convenience Retailers, LLC	1445 W. Channel Islands	Oxnard	93033						
Fred's Gas & Food Mart	3211 Saviers Road	Oxnard	93033						
Joe's Gas & Smog	1720 S. Oxnard Blvd.	Oxnard	93033						
Saviers 76	3650 Saviers Rd.	Oxnard	93033						
Shell #68579	1440 W. Channel Islands	Oxnard	93033						
USA Gasoline #68183	5040 Saviers Rd.	Oxnard	93033						
Ventura Co. CI Harbor Fuel Dock	3855 Pelican Way	Oxnard	93035						
Food 4 Less Fuel Center #335	190 W. Esplanade Dr.	Oxnard	93036						

Name	Address	City	Zip	Space	Appearance	Neighborhood	Ease of Access	Proximity to Freeway	Score
Arco AM/PM #06516	3907 E. Telegraph Rd.	Piru	93040						
USA Gasoline #68189	2651 N. Ventura Rd.	Port Hueneme	93041						
ADAR Chevron	983 E. Harvard Blvd.	Santa Paula	93060						
Circle K #05238	765 W. Harvard Boulevard	Santa Paula	93060						
Fastlane 76	206 E. Harvard Blvd.	Santa Paula	93060						
Golden State Petroleum	55 Hallock Dr.	Santa Paula	93060						
Peck Oil Corp.	806 W. Harvard Blvd.	Santa Paula	93060						
Santa Paula Shell	100 S. Hallock Dr.	Santa Paula	93060						
Valero of Santa Paula	145 S. 10th St.	Santa Paula	93060						
Chevron Car Wash	1196 E. Los Angeles Ave.	Simi Valley	93063						
Circle K #2211127	2340 N. Kuehner Dr.	Simi Valley	93063						
USA Gasoline #63216	1356 N. Erringer Rd.	Simi Valley	93063						
1st Noor LLC	1099 East Los Angeles	Simi Valley	93065						
7-Eleven, Inc.	1369 Erringer Road	Simi Valley	93065						
Costco Wholesale Corp. #128	2660 Park Center Dr.	Simi Valley	93065						
Plaza Food Mart	1695 Royal Ave.	Simi Valley	93065						
Valley Shell	1220 Sycamore Dr	Simi Valley	93065						

Source: Santa Barbara County Air Pollution Control District

Table 19: Santa Barbara County (South), Stations Visited and Scored

Name	Address	City	Zip	Space	Appearance	Neighborhood	Ease of Access	Proximity to Freeway	Overall Score
Circle K Stores, Inc.	402 W. Mission Street	Santa Barbara	93101	5	5	3	3	3	19
Chevron USA Products Company	4290 Via Real	Carpinteria	93013	6	5	3	3	2	19
Carpinteria Car Care	4401 N. Via Real	Carpinteria	93013	6	5	3	3	2	19
Seven-Eleven, Inc.	4410 Via Real	Carpinteria	93013	6	4	3	3	2	18
Tesoro Refining & Marketing Company	340 W. Carrillo Street	Santa Barbara	93101	6	3	3	3	3	18
Janda Partners, L.P.	1085 Coast Village	Santa Barbara	93108	5	6	3	2	2	18
Circle K Stores, Inc.	4801 Hollister Avenue	Santa Barbara	93111	4	5	3	3	3	18
Turnpike Fuel Partners, LP	250 N. Turnpike Road	Santa Barbara	93111	5	4	3	3	3	18
World Oil Marketing Company	5960 Calle Real	Goleta	93117	5	4	3	3	3	18
World Oil Marketing Company	1800 State Street	Santa Barbara	93101	5	5	3	3	1	17
Chevron USA Products Company	115 S. La Cumbre	Santa Barbara	93105	2	6	3	3	3	17
Circle K Stores, Inc.	49 N. Glen Annie Road	Goleta	93117	5	4	3	2	3	17
Conico State, LLC.	3060 State Street	Santa Barbara	93105	3	5	3	3	2	16
Sancino Oil Corporation	6895 Hollister Avenue	Goleta	93117	4	4	3	2	3	16
Convenience Retailers, LLC.	165 N. Fairview	Goleta	93117	4	4	3	2	3	16
Tesoro Refining & Marketing Company	8 S. Milpas Street	Santa Barbara	93101	5	3	2	2	3	15
Montecito Harbor Chevron	401 W. Montecito	Santa Barbara	93101	4	5	3	1	2	15
Channel Auto Services, LP.	101 W. Carrillo Street	Santa Barbara	93101	2	5	3	3	2	15
Tesoro Refining & Marketing Company	3618 State Street	Santa Barbara	93105	3	4	3	3	2	15
Olive Oil & Gas LP	1298 Coast Village	Santa Barbara	93108	4	3	3	2	3	15
Jemesa, LLC	1929 Cliff Drive	Santa Barbara	93109	3	6	3	2	1	15
Walnut Wash Partners	5097 Hollister Avenue	Santa Barbara	93111	3	5	3	2	2	15

Name	Address	City	Zip	Space	Appearance	Neighborhood	Ease of Access	Proximity to Freeway	Overall Score
North Turnpike Partners, LP	175 N. Turnpike Road	Goleta	93111	3	4	3	2	3	15
North Fairview Properties	42 N. Fairview Avenue	Goleta	93117	4	4	3	1	3	15
Icon Oil Company, Inc.	1935 State Street	Santa Barbara	93101	4	5	3	1	1	14
Four Jays, LP.	3898 State Street	Santa Barbara	93105	3	5	3	1	2	14
World Oil Marketing Company	2837 De La Vina	Santa Barbara	93105	2	5	2	3	2	14
The Village Service Station	1476 E. Valley Road	Santa Barbara	93108	3	5	3	2	1	14
Fairview Auto Care, Inc.	55 N. Fairview Avenue	Goleta	93117	3	3	3	2	3	14
Tesoro Refining & Marketing Company	636 W. Carrillo Street	Santa Barbara	93101	2	4	1	3	3	13
Merpour Enterprises, Inc.	303 W. Carrillo Street	Santa Barbara	93101	2	2	3	3	3	13
Thrifty Oil Company	231 N. Milpas Street	Santa Barbara	93103	5	3	2	2	1	13
Circle K Stores, Inc.	2299 Las Positas Road	Santa Barbara	93105	4	2	2	2	3	13
CST California Stations, Inc.	5661 Calle Real	Goleta	93117	3	3	3	2	2	13
World Oil Marketing Company	5648 Hollister Avenue	Goleta	93117	4	3	2	2	2	13
Convenience Retailers, LLC.	200 S. Milpas Street	Santa Barbara	93103	3	3	1	2	3	12
Educated Car Wash/Wasem Family	3735 State Street	Santa Barbara	93105	3	4	3	1	1	12
American Fuel	2234 De La Vina	Santa Barbara	93105	3	1	2	3	2	11
Fast Lane Arco Gas-Mart	180 N. N Fairview	Goleta	93117	3	1	3	2	2	11
Stop & Shop Gas 2	134 S. Milpas Street	Santa Barbara	93103	1	3	1	2	3	10
Goleta Properties, LLC.	5755 Hollister Avenue	Goleta	93117	3	2	1	2	2	10
El Ranchero Market	1502 San Andres	Santa Barbara	93101	2	2	1	2	1	8
Thrifty Oil Company	4069 State Street	Santa Barbara	93110	2	2	1	1	2	8

Source: Santa Barbara County Air Pollution Control District

Table 20: Santa Barbara County (South), Other Retail Stations Not Visited

Name	Address	City	Zip	Space	Appearance	Neighborhood	Ease of Access	Proximity to Freeway	Score
Carpinteria 76	5085 Carpinteria Avenue	Carpinteria	93013						
Shoreline Oil, Inc.	1116 Casitas Pass Road	Carpinteria	93013						
Summerland Gas & Liquor	2285 Lillie Avenue	Summerland	93067						
Moller Retail, Inc.	150 S. La Cumbre Road	Santa Barbara	93105						
Seven-Eleven, Inc.	7390 Calle Real	Goleta	93117						
Winchester 76 & Market	20 Winchester Canyon Road	Goleta	93117						

Source: Santa Barbara County Air Pollution Control District

Table 21: Santa Barbara County (North) Stations Visited and Scored

Address	City	Zip	Space	Appearance	Neighborhood	Ease of Access	Proximity to Freeway	Overall Score	Score
Moller Retail, Inc.	910 E. Betteravia Road	Santa Maria	93454	5	6	3	3	3	20
Valley Pacific Petroleum Services,	1155 E. Betteravia Road	Santa Maria	93455	6	4	3	3	3	19
Aljnar, Inc.	188 E. Highway 246	Buellton	93427	5	5	3	3	3	19
Thrifty Oil Company	197 E. Highway 246	Buellton	93427	5	5	3	3	3	19
Pacific Fuel Group	206 E. Hwy 246	Buellton	93427	5	5	3	3	3	19
Moller Retail, Inc.	89 E. Highway 246	Buellton	93427	5	5	3	3	3	19
Circle K Stores, Inc.	1220 E. Betteravia	Santa Maria	93454	5	4	3	3	3	18
Conico Buellton LLC	90 E. Hwy 246	Buellton	93427	4	5	3	3	3	18
Main Street Petroleum	1038 E. Main Street	Santa Maria	93454	4	4	3	3	3	17
Au Energy, LLC.	1204 E. Main Street	Santa Maria	93454	4	4	3	3	3	17
ERN Oil, Inc.	605 Bell Street	Los Alamos	93440	5	4	3	2	3	17
Tom's Gas & Market	230 E. Highway 246	Buellton	93427	4	4	3	3	3	17
Santa Maria Petroleum	2404 S. Broadway	Santa Maria	93454	4	4	3	3	2	16
Orcutt 76	100 E. Clark Avenue	Orcutt	93455	4	4	3	3	1	15
Jims Service Center	2015 Mission Drive	Solvang	93463	3	3	3	3	2	14
Circle K Stores, Inc.	1104 E. Clark Avenue	Santa Maria	93455	4	3	3	3	1	14

Source: Santa Barbara County Air Pollution Control District

Table 22: Santa Barbara County (South), Other Retail Stations Not Visited

Name	Address	City	Zip	Space	Appearance	Neighborhood	Ease of Access	Proximity to Freeway	Score
New Cuyama Gas Station	5007 Highway 166	Cuyama	93254						
Guadalupe '76	1080 Guadalupe Street	Guadalupe	93434						
Lou's Chevron Service	1100 E. Ocean Avenue	Lompoc	93436						
Seven-Eleven, Inc.	1337 N. H Street	Lompoc	93436						
Tesoro Refining & Marketing	1000 N. H Street	Lompoc	93436						
Pommerville's Automotive & Gas	1001 N. H Street	Lompoc	93436						
Circle K Stores, Inc.	1400 N. H Street	Lompoc	93436						
Vons - A Safeway Company	603 N. "H" Street	Lompoc	93436						
Stuart's Petroleum	940 N. "H" Street	Lompoc	93436						
Sunshine Market & Gas	719 W. Laurel Avenue	Lompoc	93436						
Circle K Stores, Inc.	1421 E. Ocean Avenue	Lompoc	93436						
Moller Retail, Inc.	801 East Ocean	Lompoc	93436						
Anishan Services, Inc.	3705 Constellation Road	Vandenberg Village	93437						
CST California Stations, Inc.	1216 E. Ocean Avenue	Lompoc	93438						
Collins Market	290 Bell Street	Los Alamos	93440						
Santa Maria Alliance	1519 N. Broadway	Santa Maria	93454						
Moller Retail, Inc.	1027 Stowell Road	Santa Maria	93454						
Ralphs Grocery Co./Food4Less	1493 S. Broadway	Santa Maria	93454						
Pepper Tree Chevron	1601 N. Broadway	Santa Maria	93454						
Sofijon, LLC.	1606 N. Broadway	Santa Maria	93454						
Anita's Spirit	1611 S. Broadway	Santa Maria	93454						

Name	Address	City	Zip	Space	Appearance	Neighborhood	Ease of Access	Proximity to Freeway	Score
Easy Gas	1901 S. Broadway	Santa Maria	93454						
Tesoro Refining & Marketing	2164 S. Broadway	Santa Maria	93454						
Santa Maria Car Wash	2301 S. Broadway	Santa Maria	93454						
Santa Maria Petroleum	2404 S. Broadway	Santa Maria	93454						
SLO Gas & Mart, Inc.	739 E. Donovan Road	Santa Maria	93454						
Gasco Auto Care	740 E. Donovan Road	Santa Maria	93454						
Fastrip Oil Company, L.P.	751 Guadalupe Street	Guadalupe	93454						
High Desert Oil Company Inc.	815 W. Main Street	Santa Maria	93454						
Trojan Petroleum	1665 W. Betteravia Road	Santa Maria	93455						
SLO Gas & Mart, Inc.	1101 E. Clark Avenue	Santa Maria	93455						
ChevronTexaco Products Company	3580 Santa Maria Way	Santa Maria	93455						
NAPHT LLC (ampm)	1611 S. Blosser	Santa Maria	93458						
Tesoro Refining & Marketing	1144 W. Main Street	Santa Maria	93458						
Chumash CA Gas Station, LLC.	990 Edison Street	Santa Ynez	93460						
Chumash CA Gas Station, LLC.	3101 Mission Drive	Santa Ynez	93460						
J. Winther Chevron	3595 Sagunto Street	Santa Ynez	93460						

Source: Santa Barbara County Air Pollution Control District

Table 23: San Luis Obispo County Stations Visited and Scored

Address	City	Zip	Space	Appearance	Neighborhood	Ease of Access	Proximity to	Overall Score	Score
Chevron - Kautz	1284 Grand Avenue	Grover Beach	93433	6	6	3	3	2	20
ARCO - Arroyo Grande AM/PM	100 Barnett Street	Arroyo Grande	93420	5	5	3	3	3	19
Five Cities Chevron	340 Five Cities Drive	Pismo Beach	93449	5	5	3	3	3	19
Mission Station, Inc.	328 Marsh Street	San Luis Obispo	93401	5	5	3	3	3	19
Atascadero 76	6305 Morro Road	Atascadero	93422	5	5	3	3	3	19
Chevron # 98169 (Trett's)	3180 S. Broad Street	San Luis Obispo	93401	5	5	3	3	1	17
Grover Beach Flyers	684 West Grand Avenue	Grover Beach	93433	5	5	3	3	1	17
Mobil (Petro Grande)	525 Traffic Way	Arroyo Grande	93420	4	4	3	3	3	17
Refuel	2211 Broad Street	San Luis Obispo	93401	4	5	3	3	2	17
Spyglass Shell (AU Energy)	2699 Shell Beach Road	Pismo Beach	93449	5	3	3	3	3	17
Tesoro Station No. 68613	296 Santa Rosa Street	San Luis Obispo	93405	4	5	3	3	2	17
ARCO - BNB Gas & Mart	12424 Los Osos Valley	San Luis Obispo	93405	4	3	3	3	3	16
Arroyo Grande Chevron	251 Grand Avenue	Arroyo Grande	93420	3	4	3	3	3	16
Arroyo Grande Shell	222 Grand Ave.	Arroyo Grande	93420	3	4	3	3	3	16
Chevron # 91717 (Foothill)	151 N Santa Rosa Street	San Luis Obispo	93405	3	5	3	3	2	16
Conserv Fuel	254 Santa Rosa Street	San Luis Obispo	93405	4	4	3	3	2	16
Edna Valley Shell	4021 Broad Street	San Luis Obispo	93401	4	6	3	2	1	16
Laguna Shell	11590 Los Osos Valley	San Luis Obispo	93405	3	5	3	3	2	16
Madonna Shell	204 Madonna Road	San Luis Obispo	93401	3	4	3	3	3	16
Miller's 76	542 Five Cities Drive	Pismo Beach	93449	4	4	3	3	2	16
San Luis Chevron dba Coast Investments,	2000 Monterey Street	San Luis Obispo	93401	4	4	2	3	3	16

Address	City	Zip	Space	Appearance	Neighborhood	Ease of Access	Proximity to	Overall Score	Score
Tesoro Station No. 68614	3 Santa Rosa Street	San Luis Obispo	93405	4	4	3	3	2	16
ARCO #5779 (Pismo Beach)	890 Fourth Street	Pismo Beach	93449	2	4	3	3	3	15
Katch-Go Petroleum	1294 Grand Avenue	Arroyo Grande	93420	4	3	3	3	2	15
Gill's Market	1490 E. Grand Ave.	Arroyo Grande	93420	2	4	3	3	2	14
Arroyo Grande Valero	610 Grand Avenue	Arroyo Grande	93420	3	3	2	3	2	13
Valley Convenience Stores #10	200 Five Cities Drive	Pismo Beach	93449	3	4	2	2	2	13
Broad St. 76 Express	2015 Broad Street	San Luis Obispo	93401	1	4	3	3	1	12
University Spirit Gas & Mini Mart	1756 Monterey Street	San Luis Obispo	93401	2	2	2	2	2	10
7-Eleven (Pismo Beach)	99 S Dolliver St	Pismo Beach	93449	2	2	2	2	1	9

Source: Santa Barbara County Air Pollution Control District

Table 24: San Luis Obispo County, Other Retail Stations Not Visited

Name	Address	City	Zip	Space	Appearance	Neighborhood	Ease of Access	Proximity to Freeway	Score
John's 76	157 Higuera Street	San Luis	93401						
Golden Gate Chevron (Los Osos)	995 Los Osos Valley Road	Los Osos	93402						
Valley Liquor	2199 10th Street	Los Osos	93402						
Costco Gasoline	1540 Froom Ranch Way	San Luis	93405						
Mesa View Market	610 Mesa View Drive	Arroyo Grande	93420						
7-Eleven Citgo (Atascadero)	8000 El Camino Real	Atascadero	93422						
AA Mini Mart	6700 El Camino Real	Atascadero	93422						
Atascadero Gas & Mart, Inc.	6280 Morro Road	Atascadero	93422						
Circle K # 2701197	6930 Morro Road	Atascadero	93422						
Circle K # 2701232	4381 El Camino Real	Atascadero	93422						
Golden Gate Shell (Atascadero)	2000 El Camino Real	Atascadero	93422						
Golden Rissco Inc. dba Atascadero	8955 Montecito Avenue	Atascadero	93422						
Hitching Post Shell	8000 Morro Road	Atascadero	93422						
Jaco Hill Company (Chalk Mountain	9990 El Camino Real	Atascadero	93422						
Neena Enterprises, Inc.	6100 San Anselmo Road	Atascadero	93422						
San Anselmo Chevron	6105 San Anselmo Rd.	Atascadero	93422						
Stagecoach Liquor	5145 El Camino Real	Atascadero	93422						
Tesoro Station Number 68505	9155 San Gabriel Road	Atascadero	93422						
Pacific Gas & Electric Company - Diablo	P.O. Box 65	Avila Beach	93424						
Cambria General Store	850 Main Street	Cambria	93428						
Chevron (Cambria)	2194 Main Street	Cambria	93428						

Name	Address	City	Zip	Space	Appearance	Neighborhood	Ease of Access	Proximity to Freeway	Score
Old Cambria Marketplace (Cambria Shell)	589 Main Street	Cambria	93428						
Cayucos Gas	198 North Ocean Avenue	Cayucos	93430						
ARCO (Morro Bay AM/PM)	940 Morro Bay Boulevard	Morro Bay	93442						
Lucky 7 Mini Mart & Gas	1860 Main Street	Morro Bay	93442						
Morro Bay Chevron	1798 Main Street	Morro Bay	93442						
Stuart's Petroleum Station	911 Morro Bay Boulevard	Morro Bay	93442						
Valero Corner Store #3556	900 Morro Bay Boulevard	Morro Bay	93442						
Chevron # 95867 (Ellenson's Nipomo)	460 West Tefft Street	Nipomo	93444						
Naojo, Inc. dba La Placita Market	515 Orchard Road	Nipomo	93444						
SLO Gas Mart (Nipomo)	501 West Tefft Street	Nipomo	93444						
Stop N Buy	459 West Tefft Street	Nipomo	93444						
Vons - Safeway # 4607 (GDF-Nipomo)	550 West Tefft Street	Nipomo	93444						
Oceano Market and Gas	1711 Front St.	Oceano	93445						
7-Eleven - Paso Robles	2331 Spring Street	Paso Robles	93446						
ARCO #42072	195 Niblick Road	Paso Robles	93446						
ARCO #42093	1201 Ysabel Avenue	Paso Robles	93446						
Chevron (South Paso)	1849 Ramada Drive	Paso Robles	93446						
Chevron (Woodland)	190 Niblick Road	Paso Robles	93446						
Chevron #98013 (Dorsey)	1302 24th Street	Paso Robles	93446						
Fill & Save	1493 Creston Road	Paso Robles	93446						
Golden Hill Mobil	2401 Golden Hill Road	Paso Robles	93446						
Jaco Hill Company (Appy's Liquor)	2816 Spring Street	Paso Robles	93446						

Name	Address	City	Zip	Space	Appearance	Neighborhood	Ease of Access	Proximity to Freeway	Score
Jaco Hill Company (Wayside Liquor &	703 Creston Road	Paso Robles	93446						
Mobil (Spring Street)	1339 Spring Street	Paso Robles	93446						
Oak Hill Center	2150 Heritage Loop Road	Paso Robles	93446						
One Stop Food Store	1924 Creston Road	Paso Robles	93446						
One Stop Store	703 Spring Street	Paso Robles	93446						
Paco AMPM	1900 Ramada Drive	Paso Robles	93446						
Paso Robles Jet Center	4810 Wing Way	Paso Robles	93446						
Paso Robles Public Schools	2910 Union Road	Paso Robles	93446						
Pioneer Food Mart	1145 Spring Street	Paso Robles	93446						
Spirit Gas Station	1637 Spring Street	Paso Robles	93446						
Steve's Gas	1441 Spring Street	Paso Robles	93446						
Tesoro Station No. 68584	1244 24th Street	Paso Robles	93446						
Valero Corner Store #3557	2340 Spring Street	Paso Robles	93446						
Wine Country Gateway RV Park, LLC	81 Wellsona Road	Paso Robles	93446						
Chevron (San Miguel)	998 K Street	San Miguel	93451						
Ragged Point Inn (Union 76)	19019 State Highway	San Simeon	93452						
Pintor's Tire & Fuel	22301 El Camino Real	Santa	93453						
Singh Chevron	701 Las Tablas Road	Templeton	93465						
Templeton Market & Deli	390 N Main St	Templeton	93465						

Source: Santa Barbara County Air Pollution Control District

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Appendix C:
Resources for Hydrogen Safety, Awareness, and Response

Alternative Fuels Training Materials

First Responder Alternative Fuels Training Toolkit

This tool toolkit was developed by Plug In America, available at http://www.pluginamerica.org/, in partnership with the Community Environmental Council, available at http://www.cecsb.org/, and the Central Coast Clean Cities Coalition, available at http://www.c-5.org/, as part of a California Energy Commission grant to advance the use of alternative fuels throughout the Central Coast region.

Through a brief overview, this toolkit will familiarize first responders with the various alternative fuel technologies. Additionally, this toolkit will provide resources and guidance in further available trainings and educational materials in the handling of alternative fuel vehicles.

Through the following resources and materials first responder personnel will be able to:

- Identify additional educational opportunities;
- Understand the potential hazards of each technology;
- Understand how to safely approach an incident in which an alternative fuel vehicle is involved.

Alternative Fuels Overview

Types of Alternative Fuels

- Hydrogen: Can be produced domestically from fossil fuels, nuclear power, or renewable resources, such as hydropower. Hydrogen Fuel Cell Vehicles leave nothing behind but water, so they don't emit any harmful air pollutants.
- Electricity: About 20 percent of California's electricity comes from renewable energy sources such as wind, geothermal, and solar. As a result, vehicles that are powered by electricity produces 75 percent fewer greenhouse gas emissions than a comparable gasoline-powered vehicle.
- Natural Gas: A fossil fuel that generates less air pollutants and greenhouse gases. CNG costs about 50 percent less than gasoline or diesel, emits up to 90 percent fewer emissions than gasoline and* there's an abundant supply right here in America.
- Biodiesel: Biodiesel is a domestically produced, renewable fuel that can be manufactured from vegetable oils, animal fats, or recycled restaurant grease for use in diesel vehicles. Biodiesel blends of 20 percent and below will work in any diesel engine without the need for modifications.
- Ethanol: Ethanol is a renewable, domestically produced alcohol fuel made from plant material, such as corn, sugarcane, or grasses. More than 2,300 filling stations in the U.S. sell E85.
- Propane: A domestically abundant fossil fuel that generates less harmful air pollutants and greenhouse gases. There are more than 143,000 on-road propane

vehicles in the United States. Many are used in fleet applications, such as school buses, shuttles, and police vehicles.

Electric Vehicles

BEVs (shown in Figure 23)

- Fully electric vehicles use electricity to power a battery.
- No gasoline, no oil changes, no internal combustion engine
- 70 - 200-mile range

Figure 23: Three Battery Electric Vehicles

Left: Nissan Leaf, Middle: Volkswagen e-Golf, Right: Chevrolet Spark
Source: Nissan, Volkswagen, Chevrolet

PHEVs (shown in Figure 24)

- Run on electricity but as their battery runs out of charge, a gasoline powered engine kicks in.

Figure 24: Three Plug-in Hybrid Electric Vehicles

Left: BMW X5 xDrive40e, Middle: Chevrolet Volt, Right: Volvo XC90 T8
Source: BMW, Chevrolet, Volvo

Ethanol Vehicles (shown in Figure 25)

- E85 can be used in Flexible Fuel Vehicles, designed to run on gasoline, E85 or any mixture of the 2
- MPG: Due to ethanol's lower energy content, Flexible Fuel Vehicles operating E85 get roughly 15-30 percent fewer miles per gallon
- More than 2,300 filling stations in the U.S. sell E85
- Flexible Fuel Vehicles are offered by several vehicle manufacturers

Figure 25: Four Ethanol Vehicles

Top Left: Ford Focus, Top Right: Chevrolet Equinox, Bottom Left: Mercedes Benz GLA 250, Bottom Right: Dodge Dart
Source: Ford, Chevrolet, Mercedes Benz, Dodge

Biodiesel Vehicles

- Form of diesel fuel from vegetable oils, animal fats, or recycled grease
- Can be used in pure form (B100) or blended with petroleum diesel (B20)
- Can be used in most diesel engines

Hydrogen Vehicles (shown in Figure 26)

- Used in FCEVs or internal combustion engine vehicles
- Unlike FCEVs, Internal Combustion Engines produce tailpipe emissions and are less efficient
- A fuel cell is 2-3 times more efficient than an internal combustion engine running on gasoline.

Figure 26: Two Hydrogen Vehicles

Left: Toyota Mirai, Right: Hyundai Tucson
Source: Toyota, Hyundai

Clean Natural Gas Vehicles

- Vehicles available that run on clean natural gas alone or mixed with gasoline
- Fuelled at public stations

The Need for First Responder Training

Due to the ever-growing number of publicly available AFVs it has become of the utmost importance first responders have the information they need to respond to an incident involving an AFV or fuelling equipment. First responders including fire department, paramedic, and police personnel must be properly trained to respond to the scene of an emergency involving an AVF or fuelling equipment.

Multi-Fuel Trainings

National Fire Protection Agency Alternative Fuel Vehicles Training Program

National Fire Protection Agency's self-paced online Alternative Fuel Vehicles Training Program for Emergency Responders teaches emergency responders how to safely deal with emergency situations involving alternative fuel passenger vehicles, trucks, buses, and commercial fleet vehicles. Upon completing the program, students will receive a certificate for their successful completion. National Fire Protection Agency's Alternative Fuel Vehicles Training Program, available at http://catalog.nfpa.org/Alternative-Fuel-Vehicles-Training-Program-for-Emergency-Responders-Online-Training P15552.aspx?icid=D533#sthash.epyPh4xr.GWRMHaqD.dpuf.

National Fire Protection Agency also offers a website specific to electric vehicle training to learn how to safely deal with emergency situations involving electric vehicles and hybrid vehicles, available at http://www.evsafetytraining.org/.

National Alternative Fuels Training Consortium

The National Alternative Fuels Training Consortium is the only nationwide alternative fuel vehicle and advanced technology vehicle training organization in the United States. The National Alternative Fuels Training Consortium develops curricula and disseminates training about alternative fuels, alternative fuel vehicles, and advanced technology vehicle education. National Alternative Fuels Training Consortium courses and workshops are offered in both traditional classroom and online learning formats. Participants learn by using educational discussions, videos, and assessments as well as lab and shop activities. Participants of the National Alternative Fuels Training Consortium training receive access to state-of-the art curricula, unsurpassed train-the-trainer courses and workshops, timely instructor updates, and professional development training, available at http://www.naftc.wvu.edu/

National Alternative Fuels Training Consortium Clean Cities Learning Program Toolbox

National Alternative Fuels Training Consortium is working in partnership with the U.S. Department of Energy Clean Cities Program to develop the turn-key Clean Cities Learning Program to raise awareness and foster a greater understanding of alternative fuels, alternative fuel vehicles, and advanced technology vehicles through a targeted education and outreach effort. The National Alternative Fuels Training Consortium Clean Cities Learning Program Toolbox, available at http://www.naftc.wvu.edu/cleancitieslearningprogram, is designed specifically to reduce the risks taken by first responders when responding to an incident involving alternative fuels, alternative fuel vehicles, and advanced vehicle technologies.

Fact Sheets highlighting the various alternative fuel types and safety information can be viewed at the following links:

Biofuels and Biofuel Vehicles, available at http://assets.slate.wvu.edu/resources/527/1287694991.pdf

Gaseous Fuels and Gaseous Fuel Vehicles, available at http://assets.slate.wvu.edu/resources/527/1287695094.pdf

Hydrogen and Hydrogen-Powered Vehicles, available at http://assets.slate.wvu.edu/resources/527/1287695095.pdf

Electric Drive Vehicles, available at http://assets.slate.wvu.edu/resources/527/1287695093.pdf

Office of the State Fire Marshal

CA State Fire Training certification program: Office of the State Fire Marshall certification standards with state & national certification program standards, available at http://osfm.fire.ca.gov/training/alternativefuelvehicles.php

Triangle Alternative Fuels First Responder Online Training Modules

The Triangle Alternative Fuels First Responder Training offers free, self-paced curriculum for the fire and rescue community, available at http://www.ncdoi.com/OSFM/RPD/PT/Videos_Alternative_Fuels.aspx

Fuel-Specific Training

Biodiesel

The National Hazardous Materials Fusion Center offers a Biodiesel Training Package, which includes various resources for dealing with biodiesel, including instructor guides and participant manuals, available at http://www.hazmatfc.com/Resources/Training-Packages/Biodiesel-Training-Package

E85/Flex-Fuel

The Ethanol Emergency Response Coalition has a website devoted to support the safe handling of ethanol and ethanol-blended fuels. The site offers a variety of resources and training guides for ethanol emergency response, including seven learning modules and videos. Ethanol Emergency Response Coalition is available at http://ethanolresponse.com/pages/resources

Electric Vehicles

The National Fire Protection Agency provides Electric Vehicle Safety Training and resources for electric and hybrid-electric vehicles. See more in the National Fire Protection Agency Electric Vehicle Emergency Field Guide, available at http://www.evsafetytraining.org

Hydrogen Fuel Cell First Responder Training

The California Fuel Cell Partnership and the Pacific Northwest National Laboratory collaborated to develop a national hydrogen safety training resource for emergency responders. The resource provides a single repository of credible and reliable information related to hydrogen and fuel cells that is current and accurate and eliminates duplicative efforts among various training programs. The National Hydrogen Safety Training Resource for Emergency Responders, available at https://h2tools.org/fr/nt

Emergency Response Guides for Alternative Fuel Vehicles

West Virginia University offers vehicle-specific emergency response guides. Guides are listed by manufactured and vehicle, available at http://afvsafetytraining.com/erg.html

Appendix D:
Fleets

Table 25 shows a complete list of contacts of Tri-Counties fleet managers.

Table 25: Fleet Contacts

Agency	First	Last	Email	Phone	Ext	County
City of Carpinteria	Matt	Roberts	mattr@ci.carpinteria.ca.us	(805) 755-4443		Santa Barbara
City of Buellton	Rose	Hess	roseh@cityofbuellton.com	(805) 688-5177		Santa Barbara
City of Goleta	Bob	Morgenstern	rmorgenstern@cityofgoleta.org	(805) 968-6769		Santa Barbara
City of Lompoc	Dirk	Ishiwata	d_ishiwata@ci.lompoc.ca.us	(805) 875-8048		Santa Barbara
City of Santa Barbara	Gary	Horwald	ghorwald@santabarbaraca.gov	(805) 564-5402		Santa Barbara
City of Santa Maria	Robert	Dupuis	rdupuis@cityofsantamaria.org	(805) 925-0951	2229	Santa Barbara
County of Santa Barbara	Eric	Barker	ebarker@countyofsb.org	(805) 681-5573		Santa Barbara
Santa Barbara MTD	Steve	Hahn	shahn@sbmtd.gov	(805) 705-1277		Santa Barbara
UCSB	John	Behlman	john.behlman@tps.ucsb.edu	(805) 893-5416		Santa Barbara
City of Camarillo	Kevin	Jorgensborg	kjorgensborg@ci.camarillo.ca.us	(805) 388-5377	711	Ventura
City of Moorpark	Ashraf	Rostom	arostom@moorpark.ca.gov	(805) 517-6362		Ventura
City of Oxnard	Joe	Rodriguez	joseph.rodriguez@ci.oxnard.ca.us	(805) 385-8011		Ventura
City of Port Hueneme	Fred	Camarillo	fcamarillo@cityofporthueneme.org	(805) 986-6556		Ventura
City of Santa Paula	Jose	Arreola	jarreola@spcity.org	(805) 933-4268		Ventura
City of Simi Valley	John	Willoughby	jwilloughby@simivalley.org	(805) 583-6489		Ventura
City of Thousand Oaks	Larry	McKinney	lmckinney@toaks.org	(805) 449-2499	0	Ventura
City of Ventura	Mary Joyce	Ivers	mjivers@ci.ventura.ca.us	(805) 652-4539		Ventura
County of Ventura	Peter	Bednar	peter.bednar@ventura.org	(805) 672-2040		Ventura
CSUCI	Ray	Porras	ray.porras@csuci.edu	(805) 437-8434		Ventura
Gold Coast Transit	Reed	Caldwell	rcaldwell@gctd.org	(805) 483-3959	134	Ventura

Agency	First	Last	Email	Phone	Ext	County
City of Ojai	Greg	Grant	grant@ojaicity.org	(805) 646-5581		Ventura
Ventura Unified School District	Wendy	Stevens	wendy.stevens@venturausd.org	(805) 641-5000	1320	Ventura
Cal Poly Transportation/ Facility Services	Scott	Loosley	sloosley@calpoly.edu	(805) 756-2816		San Luis Obispo
Cal Poly University Police	Debbie	Anderson	djanders@calpoly.edu	(805) 756-6680		San Luis Obispo
City of Morro Bay	Rob	Livick	rlivick@morrobayca.gov	(805) 772-6569		San Luis Obispo
City of Pismo Beach Transportation	Dan	Johnson	djohnson@pismobeach.org	(805) 773-7057		San Luis Obispo
Cuesta College	Terry	Reece	treece@cuesta.edu	(805) 546-3100	2531	San Luis Obispo
Lucia Mar Unified School District	Sharon	Harwin	sharon.harwin@lmusd.org	(805) 474-3000	5881	San Luis Obispo
Port of San Luis Harbor District	Jay K.	Elder	jaye@portsanluis.com	(805) 595-5400		San Luis Obispo
San Luis Coastal Unified School District	Annie	Sharp	asharp@slcusd.org	(805) 596-4105	4203	San Luis Obispo
County of SLO	Rocky	Buoy	rbuoy@co.slo.ca.us	(805) 781-5120		San Luis Obispo
City of SLO	Isaac	Shuck	ishuck@slocity.org	(805) 781-7046		San Luis Obispo
City of Arroyo Grande	Raul	Juarez	rjuarez@arroyogrande.org	(805) 473-5468 (805) 459-5855		San Luis Obispo
City of Atascadero	Bob	Joslin	Bjoslin@atascadero.org	(805) 461-5000		San Luis Obispo
City of Paso Robles	Bob	Solway	bsolway@prcity.com	(805) 227-7276		San Luis Obispo
San Luis Obispo Transit Authority	David	Roessler	droessler@slorta.org	(805) 781-4835		San Luis Obispo

Source: Santa Barbara County Air Pollution Control District

Fleet Operator Survey Items

Introduction

With support from the **California Energy Commission**, the Central Coast Alternative Fuel Vehicles Collaborative ("the Collaborative") is distributing this survey to gauge the level of adoption and interest in alternative fuel vehicles among municipal fleet operators.

The regional Collaborative is a partnership of the Air Pollution Control Districts for Ventura, Santa Barbara, and San Luis Obispo counties; the Community Environmental Council, and the Central Coast Clean Cities Coalition.

If you have any problems completing the online survey, please contact Cameron Gray, the Collaborative Coordinator, at **805-963-0583 x111** for assistance.

To begin the survey, please click the **'Next'** button below.

Screening Questions

- How many vehicles does your organization have in its fleet?

Light-duty	<10	10-50	>50
Medium-duty	<10	10-50	>50
Heavy duty	<10	10-50	>50
Transit bus	<10	10-50	>50
Other	<10	10-50	>50 (light towers, material handling, tugs)

- What is the zip code of your primary fleet yard? _____
- Is your organization

  Government Utility Business

- Which best describes your role?

  I decide to buy vehicles or recommend vehicles to a board

  I recommend/suggest vehicles, but do not make the decision

  I perform maintenance on vehicles, but do not make recommendations on purchasing

  I drive vehicles

Questions

This survey is to understand and measure awareness and adoption of alternative fuel vehicles in California fleets.

1. Please choose as many answers as apply for each vehicle or fuel:
    - Have one or more in fleet-Plan to purchase in 2015-Interested, but no current plan to purchase
    - Not interested in adding to fleet
    - Need more information to make a decision-Used to be in fleet, but discontinued
    - Do not consider an alternative fuel

Plug-in battery electric-------

Plug-in hybrid or range extended electric-------

Natural gas (Clean Natural Gas or Liquefied Natural Gas)-------

Methanol-------

Hydrogen fuel cell-------

Clean diesel-------

E85-------

Propane-------

For each vehicle or fuel, please select the statements that are true for your fleet in Table 26.

Table 26: Fleet Questions

	Size and types of vehicles I need are available	Can justify the cost of vehicle, fuel and ownership	Vehicles are reliable and maintenance is available	I have access to fueling or charging	Driving range or performance meets needs	Rebates and incentives are available	Is a public benefit (reduced GHG, pollution, or petroleum)
Plug-in battery electric							
Plug-in hybrid or range extended electric							
Natural gas (CNG or LNG)							
Methanol							
Hydrogen fuel cell							
Clean diesel							
E85							
Propane							

Source: Santa Barbara County Air Pollution Control District

In a few words, please describe your biggest challenge or concern about adding alternative fuels and vehicles to your fleet. (Open Ended)

Please tell us if information or education about the following would address your challenges in Table 27.

Table 27: Informational Assessment

	Not at all	Not really	A step in the right direction	Yes	Absolutely
Total cost of ownership					
Available rebates and incentives					
Government mandates and regulations					
Fleet purchasing language or policy					
Public fueling/charging availability and future growth					
Fueling/charging at fleet yard					
Public benefits					
Safety					
Maintenance or mechanic training					

Source: Santa Barbara County Air Pollution Control District

Other: _____

1. Please read the following short paragraph about a new vehicle type that is coming to market and then answer three yes/no questions:

Green fuel is a renewable, gaseous fuel used vehicles that range from small off-road vehicles (forklifts, tugs) to passenger cars to transit buses. Green fuel is available at gas stations and dispensers accept credit cards for payment. The vehicles fill in minutes, have range similar to their gasoline/diesel counterparts and have zero emissions. Operating the vehicles meets California's requirement for ZEVs and the vehicles are eligible for high-occupancy vehicle stickers. Purchase price is higher than conventional vehicles but can be offset with rebates and cost of ownership is similar to other alternative fuels.

   a. Paying for fuel with a credit card would be a problem for my fleet. YES NO
   b. It's important that we obtain ZEVs to meet state requirements. YES NO
   c. The benefits and rebate can justify the higher purchase price. YES NO

2. If you wanted to learn more about green fuel and green fuel vehicles, which THREE ways would be most effective for you? *(pick three)*
   - Radio, newspaper or magazine advertising
   - Stories in printed or online magazines
   - A Green Fuel website and social media
   - Vehicle loaner program
   - Podcasts or other digital media
   - Workshops or training events
   - Presentations at Clean Cities or association meetings
   - Other _____

Survey Submission Message

Congratulations! You've completed the Tri-Counties Alternative Fuel fleet survey.

To submit your completed survey, please click the '**Done**' button below.

Thank you!

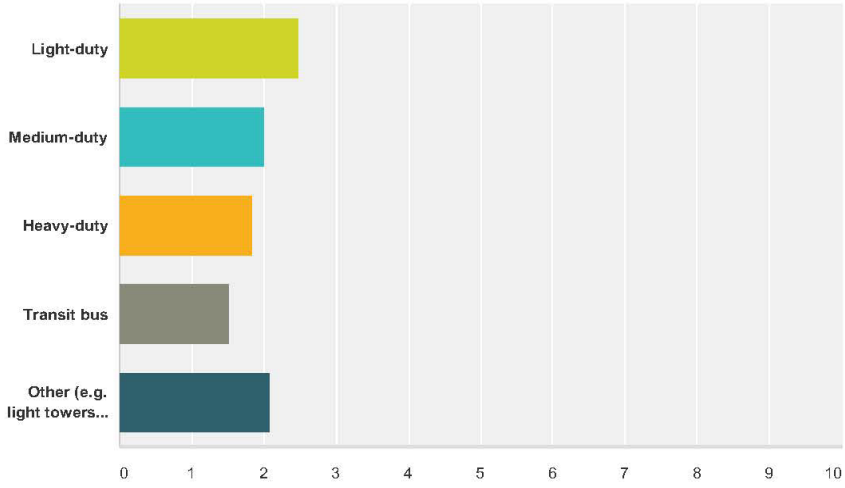
Survey Results

Figure 27 shows the questions and results from the Tri-Counties Fleet Operator Survey on Alternative Fuels.

Figure 27: Tri-Counties Fleet Operator Survey on Alternative Fuels

Q1 How many vehicles does your organization have in its fleet?

Answered: 25 Skipped: 0



	< 10 vehicles	10 - 50 vehicles	> 50 vehicles	Total	Weighted Average
Light-duty	8.70% 2	34.78% 8	56.52% 13	23	2.48
Medium-duty	30.00% 6	40.00% 8	30.00% 6	20	2.00
Heavy-duty	42.11% 8	31.58% 6	26.32% 5	19	1.84
Transit bus	57.89% 11	31.58% 6	10.53% 2	19	1.53
Other (e.g. light towers, materials handling, tugs)	38.46% 5	15.38% 2	46.15% 6	13	2.08

Figure 27: Tri-Counties Fleet Operator Survey on Alternative Fuels (cont'd)

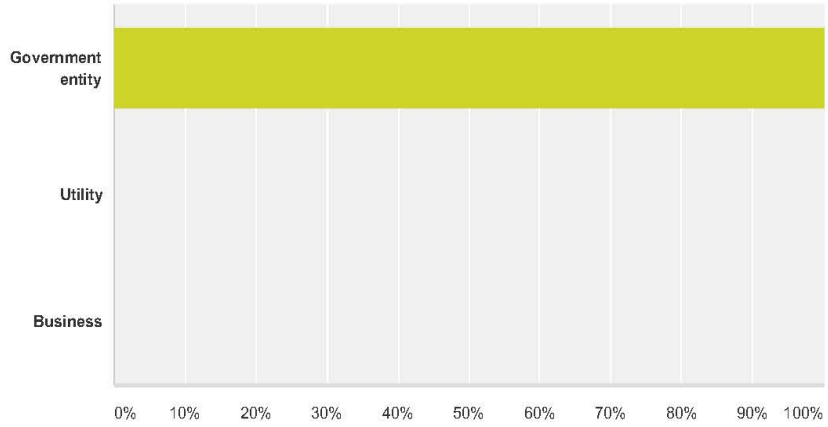
Q2 What is the zip code of your primary fleet yard?

Answered: 25 Skipped: 0

Figure 27: Tri-Counties Fleet Operator Survey on Alternative Fuels (cont'd)

Q3 Is your organization a:

Answered: 25 Skipped: 0

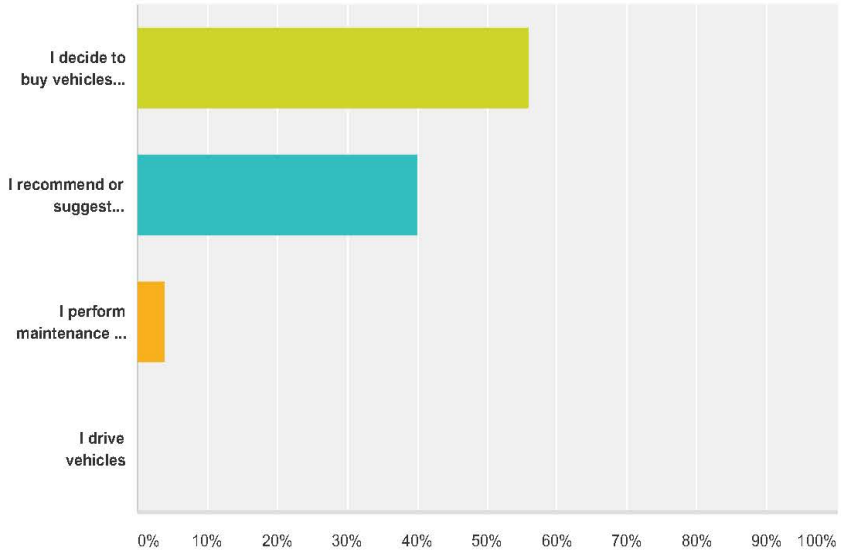


Answer Choices	Responses	
Government entity	100.00%	25
Utility	0.00%	0
Business	0.00%	0
Total		25

Figure 27: Tri-Counties Fleet Operator Survey on Alternative Fuels (cont'd)

Q4 Which best describes your role?

Answered: 25 Skipped: 0



Answer Choices	Responses	
I decide to buy vehicles or recommend vehicles to a board	56.00%	14
I recommend or suggest vehicles, but do not make the decisions	40.00%	10
I perform maintenance on vehicles, but do not make recommendations for purchasing	4.00%	1
I drive vehicles	0.00%	0
Total		25

Figure 27: Tri-Counties Fleet Operator Survey on Alternative Fuels (cont'd)

Q5 Please choose as many answers as apply for each vehicle or fuel:

Answered: 25 Skipped: 0

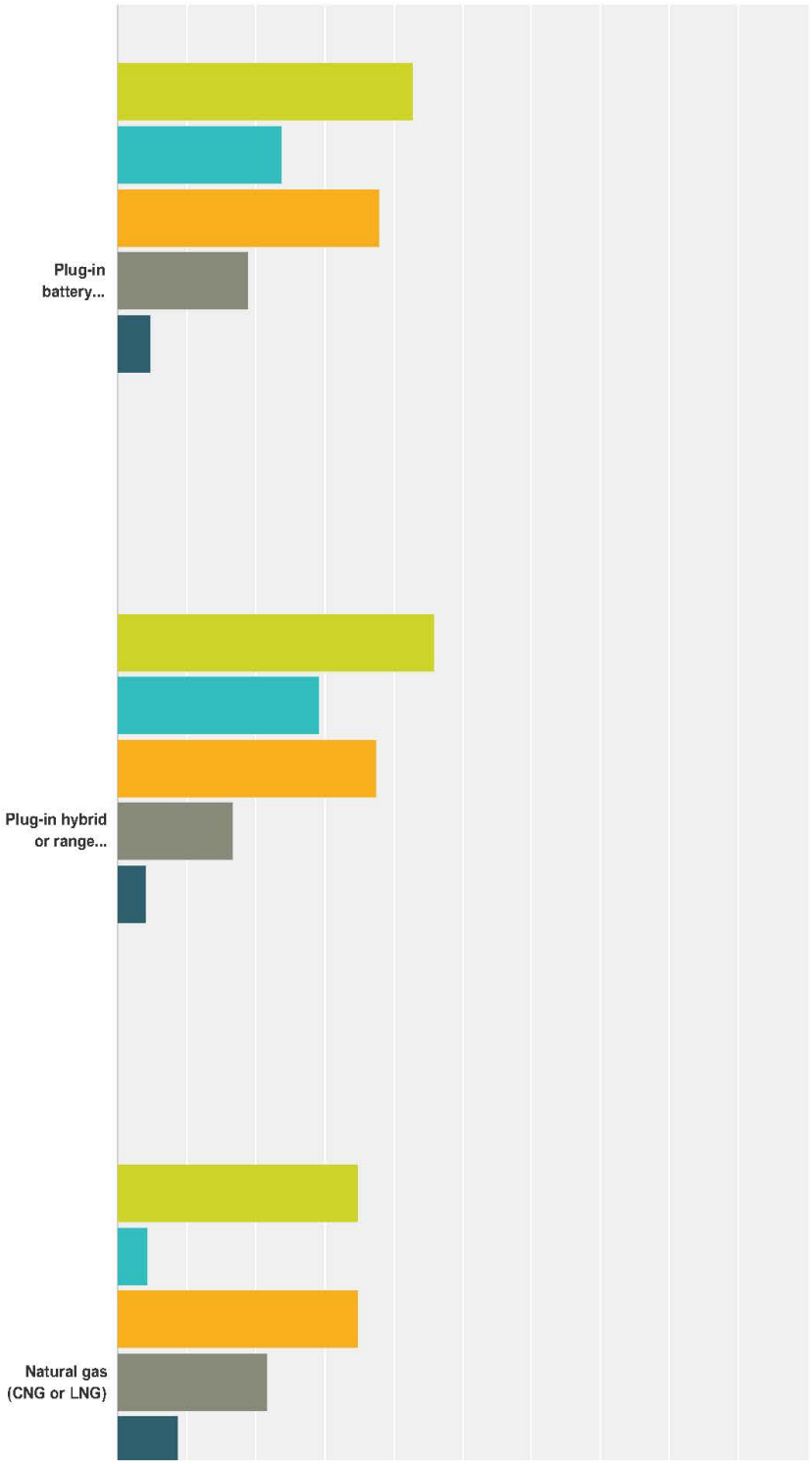


Figure 27: Tri-Counties Fleet Operator Survey on Alternative Fuels (cont'd)

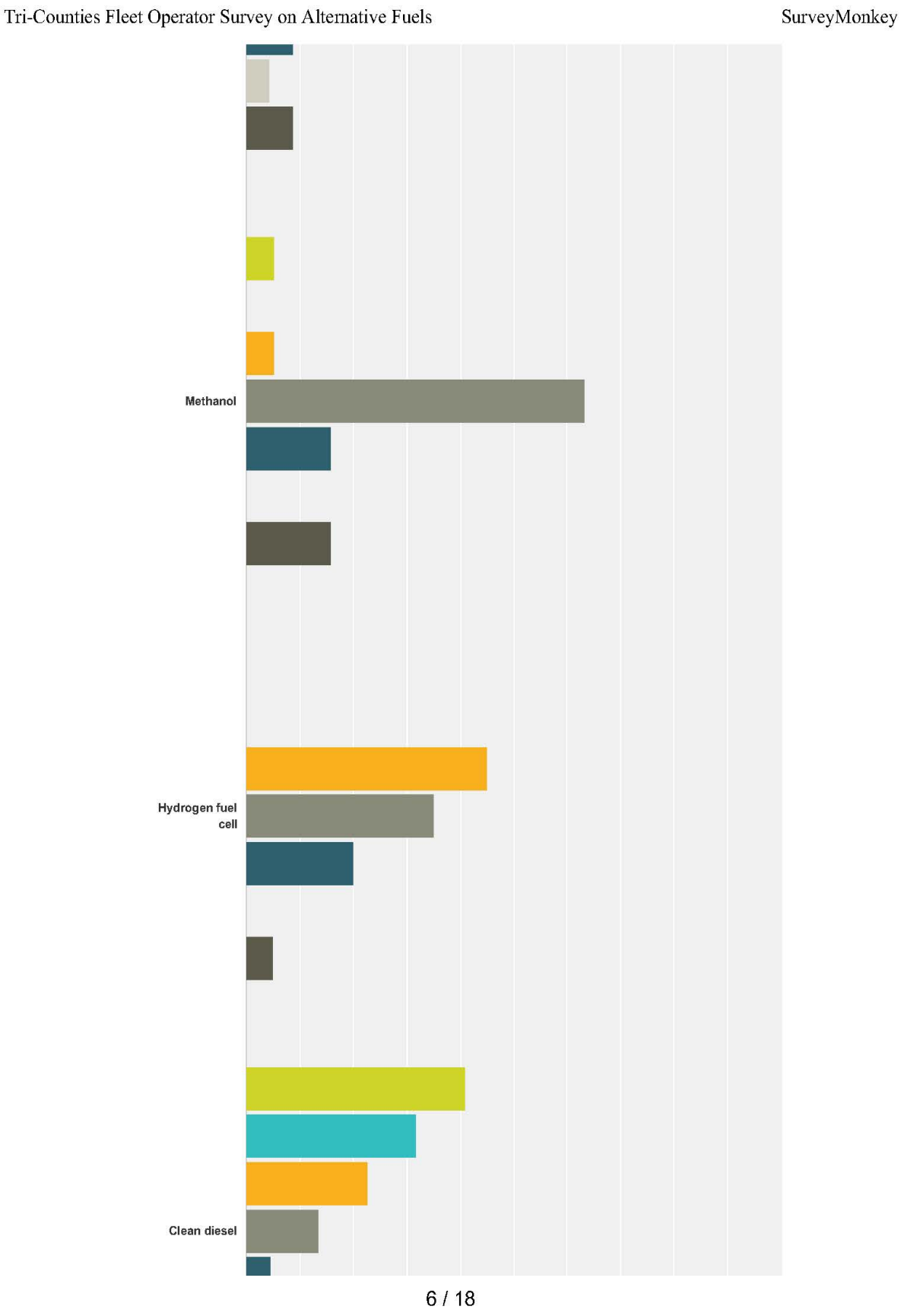


Figure 27: Tri-Counties Fleet Operator Survey on Alternative Fuels (cont'd)

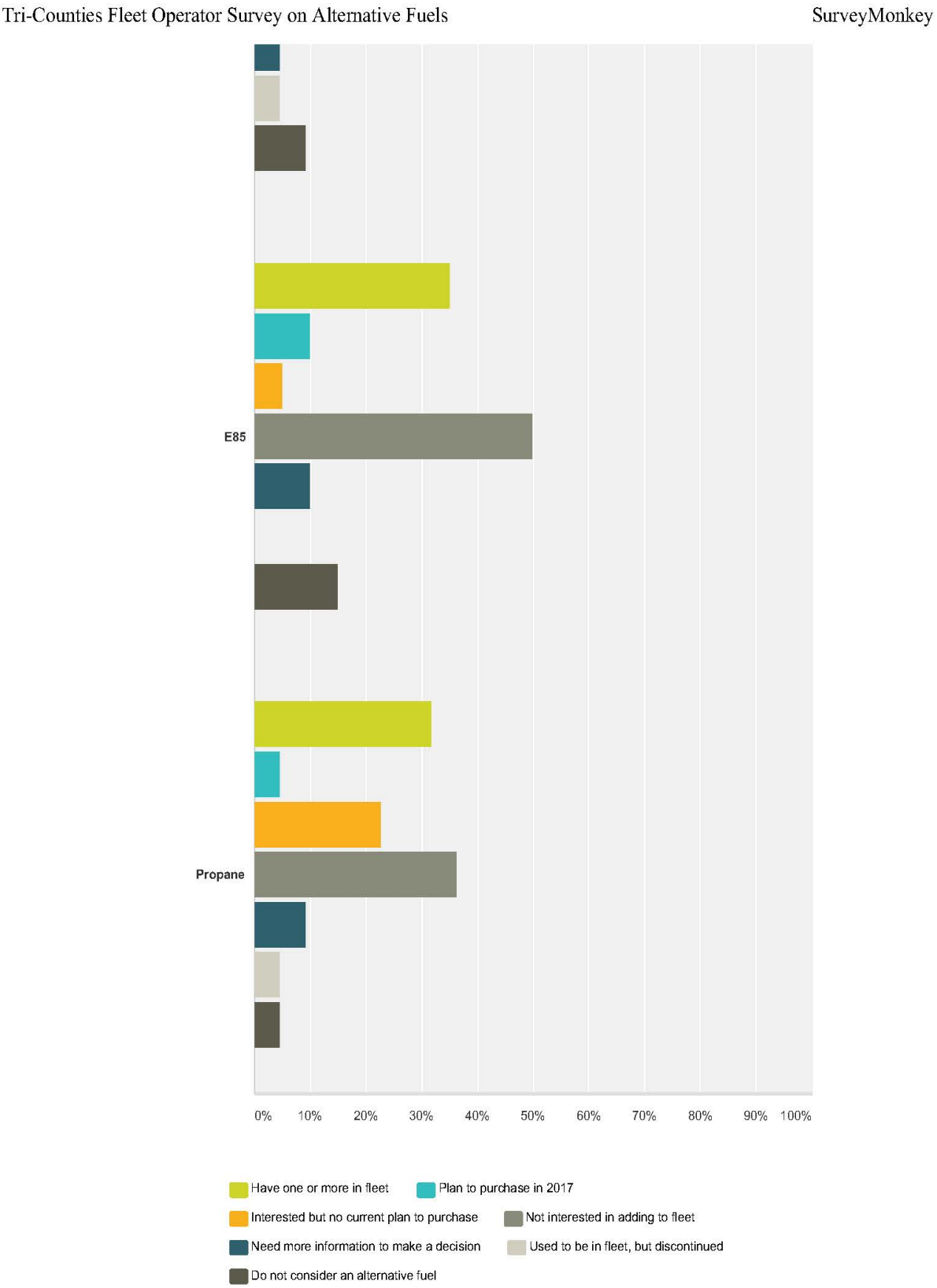


Figure 27: Tri-Counties Fleet Operator Survey on Alternative Fuels (cont'd)

Tri-Counties Fleet Operator Survey on Alternative Fuels SurveyMonkey

	Have one or more in fleet	Plan to purchase in 2017	Interested but no current plan to purchase	Not interested in adding to fleet	Need more information to make a decision	Used to be in fleet, but discontinued	Do not consider an alternative fuel	Total Respondents
Plug-in battery electric	42.86% 9	23.81% 5	38.10% 8	19.05% 4	4.76% 1	0.00% 0	0.00% 0	21
Plug-in hybrid or range extended electric	45.83% 11	29.17% 7	37.50% 9	16.67% 4	4.17% 1	0.00% 0	0.00% 0	24
Natural gas (CNG or LNG)	34.78% 8	4.35% 1	34.78% 8	21.74% 5	8.70% 2	4.35% 1	8.70% 2	23
Methanol	5.26% 1	0.00% 0	5.26% 1	63.16% 12	15.79% 3	0.00% 0	15.79% 3	19
Hydrogen fuel cell	0.00% 0	0.00% 0	45.00% 9	35.00% 7	20.00% 4	0.00% 0	5.00% 1	20
Clean diesel	40.91% 9	31.82% 7	22.73% 5	13.64% 3	4.55% 1	4.55% 1	9.09% 2	22
E85	35.00% 7	10.00% 2	5.00% 1	50.00% 10	10.00% 2	0.00% 0	15.00% 3	20
Propane	31.82% 7	4.55% 1	22.73% 5	36.36% 8	9.09% 2	4.55% 1	4.55% 1	22

Figure 27: Tri-Counties Fleet Operator Survey on Alternative Fuels (cont'd)

Q6 For each vehicle or fuel, please select the statements that are true for your fleet:

Answered: 21 Skipped: 4

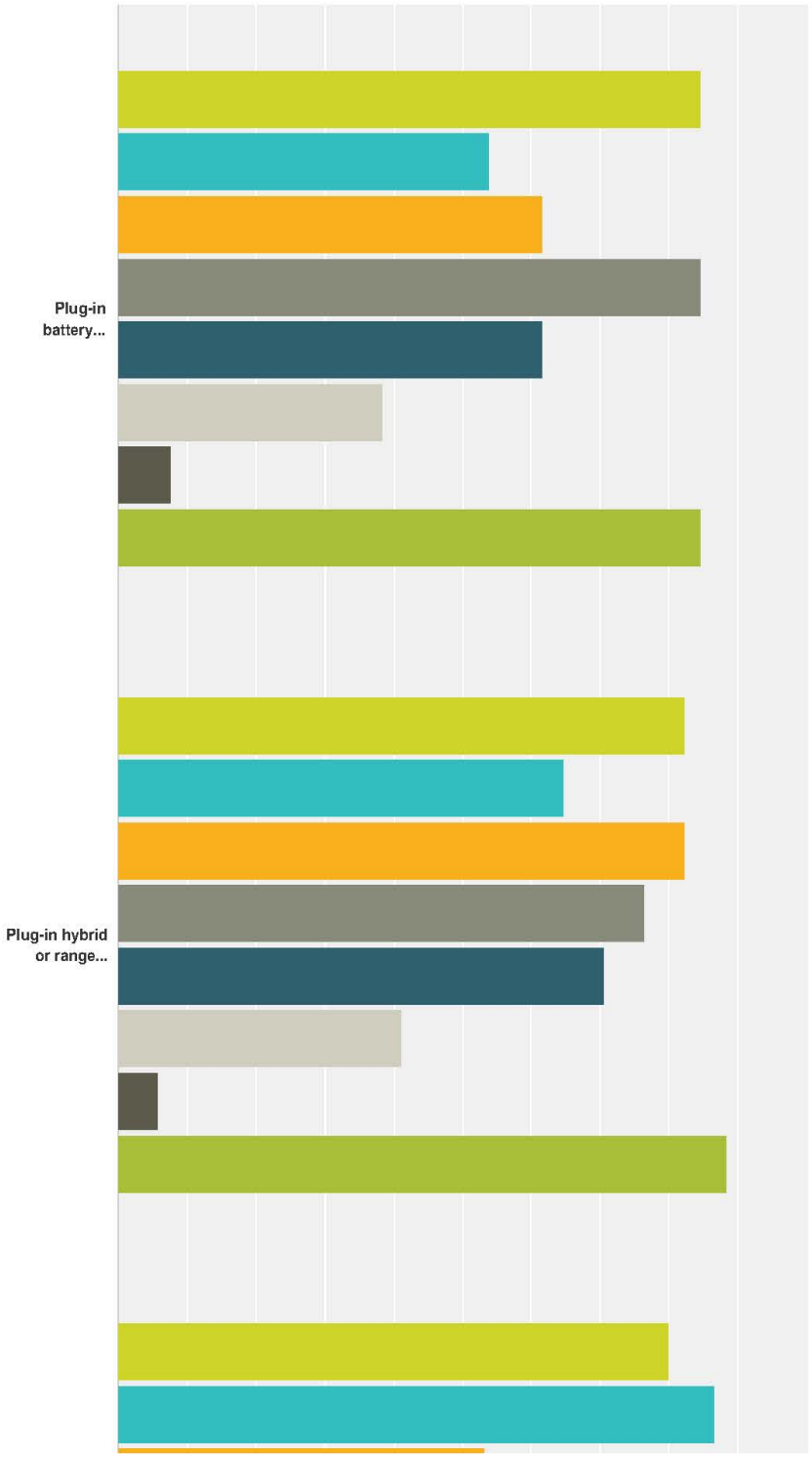


Figure 27: Tri-Counties Fleet Operator Survey on Alternative Fuels (cont'd)

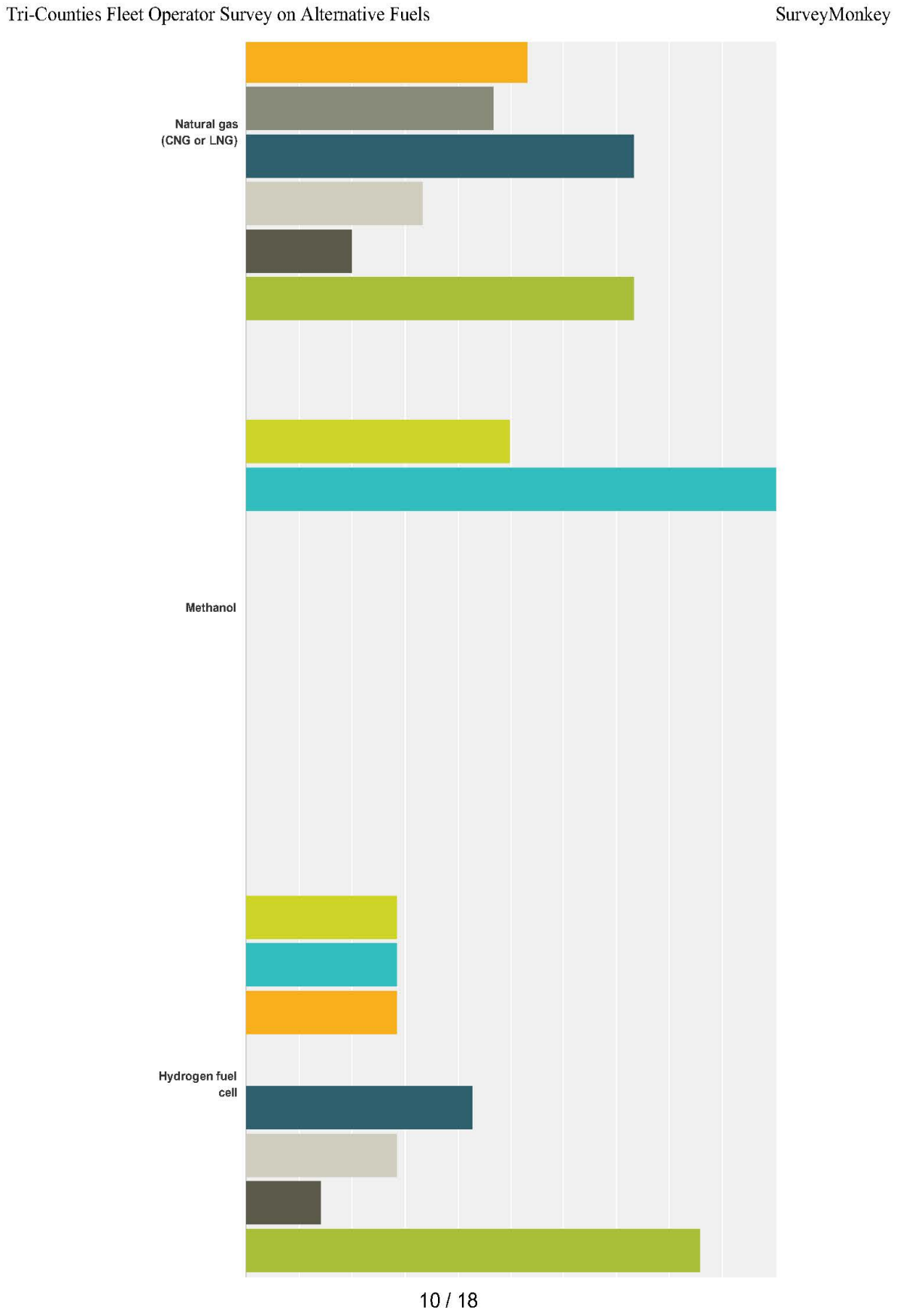


Figure 27: Tri-Counties Fleet Operator Survey on Alternative Fuels (cont'd)

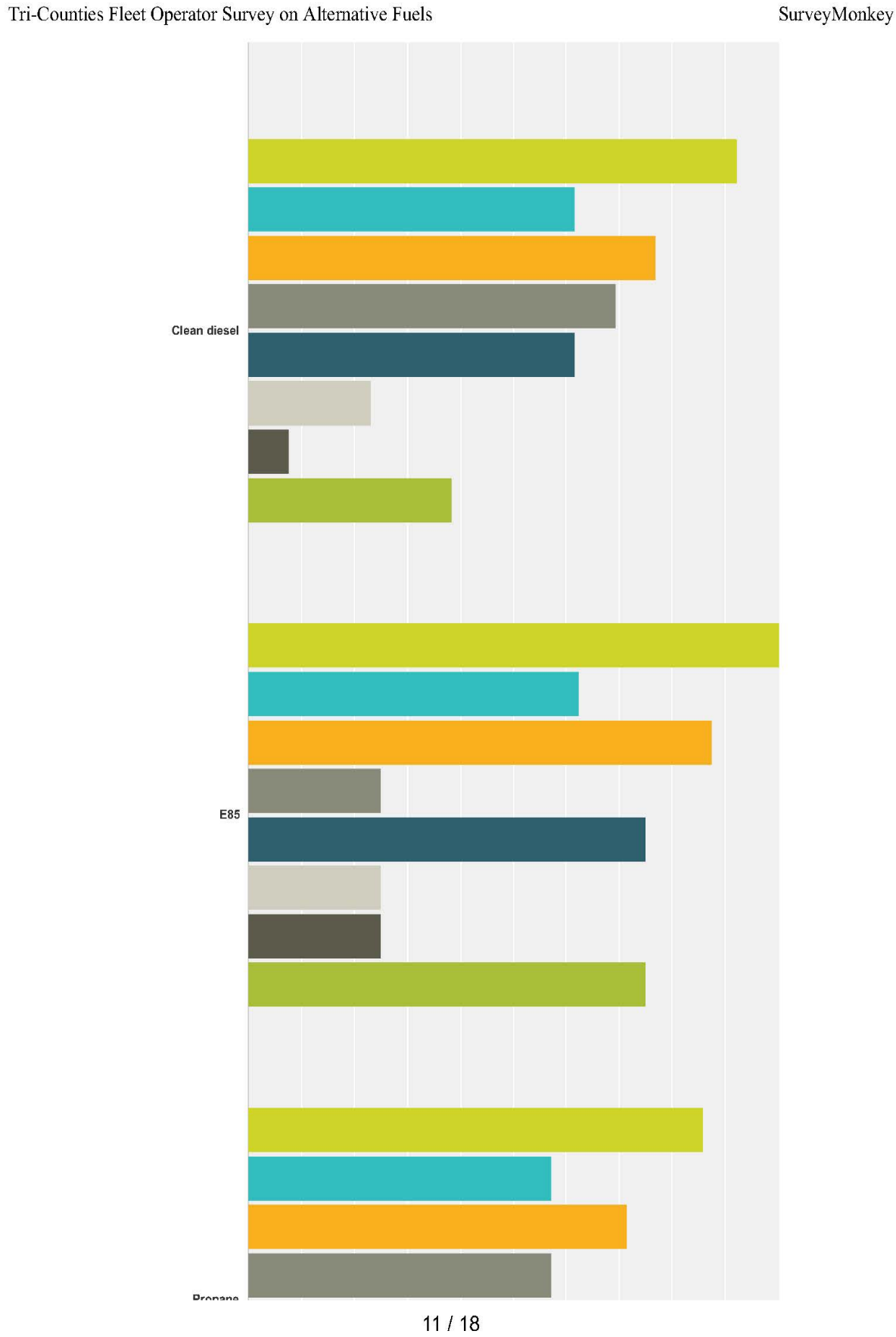
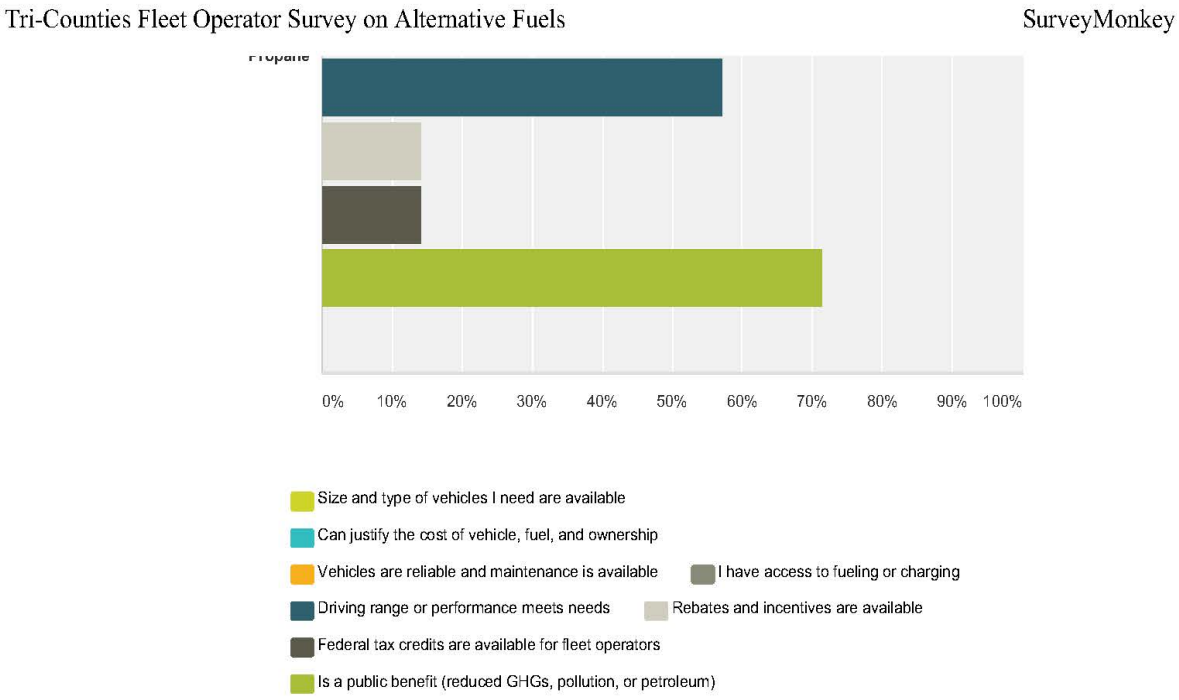


Figure 27: Tri-Counties Fleet Operator Survey on Alternative Fuels (cont'd)



	Size and type of vehicles I need are available	Can justify the cost of vehicle, fuel, and ownership	Vehicles are reliable and maintenance is available	I have access to fueling or charging	Driving range or performance meets needs	Rebates and incentives are available	Federal tax credits are available for fleet operators	Is a public benefit (reduced GHGs, pollution, or petroleum)	Total Respondents
Plug-in battery electric	**84.62%** 11	**53.85%** 7	**61.54%** 8	**84.62%** 11	**61.54%** 8	**38.46%** 5	**7.69%** 1	**84.62%** 11	13
Plug-in hybrid or range extended electric	**82.35%** 14	**64.71%** 11	**82.35%** 14	**76.47%** 13	**70.59%** 12	**41.18%** 7	**5.88%** 1	**88.24%** 15	17
Natural gas (CNG or LNG)	**80.00%** 12	**86.67%** 13	**53.33%** 8	**46.67%** 7	**73.33%** 11	**33.33%** 5	**20.00%** 3	**73.33%** 11	15
Methanol	**50.00%** 1	**100.00%** 2	**0.00%** 0	**0.00%** 0	**0.00%** 0	**0.00%** 0	**0.00%** 0	**0.00%** 0	2
Hydrogen fuel cell	**28.57%** 2	**28.57%** 2	**28.57%** 2	**0.00%** 0	**42.86%** 3	**28.57%** 2	**14.29%** 1	**85.71%** 6	7
Clean diesel	**92.31%** 12	**61.54%** 8	**76.92%** 10	**69.23%** 9	**61.54%** 8	**23.08%** 3	**7.69%** 1	**38.46%** 5	13
E85	**100.00%** 8	**62.50%** 5	**87.50%** 7	**25.00%** 2	**75.00%** 6	**25.00%** 2	**25.00%** 2	**75.00%** 6	8
Propane	**85.71%** 6	**57.14%** 4	**71.43%** 5	**57.14%** 4	**57.14%** 4	**14.29%** 1	**14.29%** 1	**71.43%** 5	7

Figure 27: Tri-Counties Fleet Operator Survey on Alternative Fuels (cont'd)

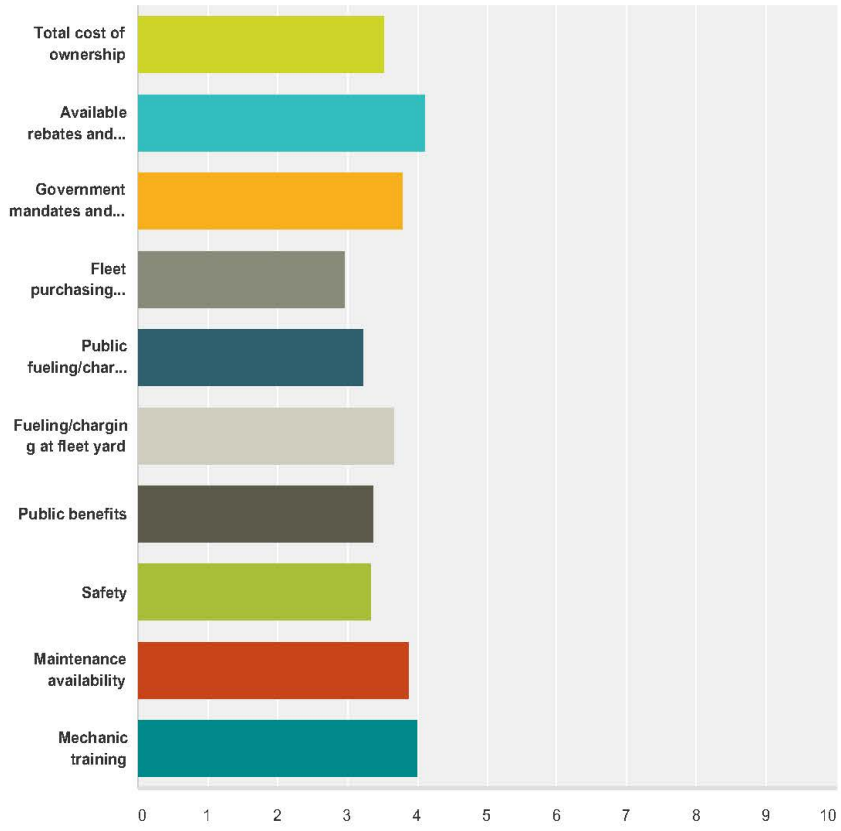
Q7 In a few words, please describe your biggest challenge or concern about adding alternative fuels and vehicles to your fleet.

Answered: 22 Skipped: 3

Figure 27: Tri-Counties Fleet Operator Survey on Alternative Fuels (cont'd)

Q8 Please tell us if information or education about the following would address your challenges related to alternative fuels and vehicles:

Answered: 25 Skipped: 0



	Not at all	Not much	A step in the right direction	Yes	Absolutely	Total	Weighted Average
Total cost of ownership	16.00% 4	4.00% 1	20.00% 5	32.00% 8	28.00% 7	25	3.52
Available rebates and incentives	4.00% 1	0.00% 0	16.00% 4	40.00% 10	40.00% 10	25	4.12
Government mandates and regulations	0.00% 0	12.50% 3	20.83% 5	41.67% 10	25.00% 6	24	3.79
Fleet purchasing language or policy	12.00% 3	24.00% 6	28.00% 7	28.00% 7	8.00% 2	25	2.96
Public fueling/charging availability and future growth	4.00% 1	36.00% 9	16.00% 4	20.00% 5	24.00% 6	25	3.24
Fueling/charging at fleet yard	12.00% 3	12.00% 3	8.00% 2	32.00% 8	36.00% 9	25	3.68

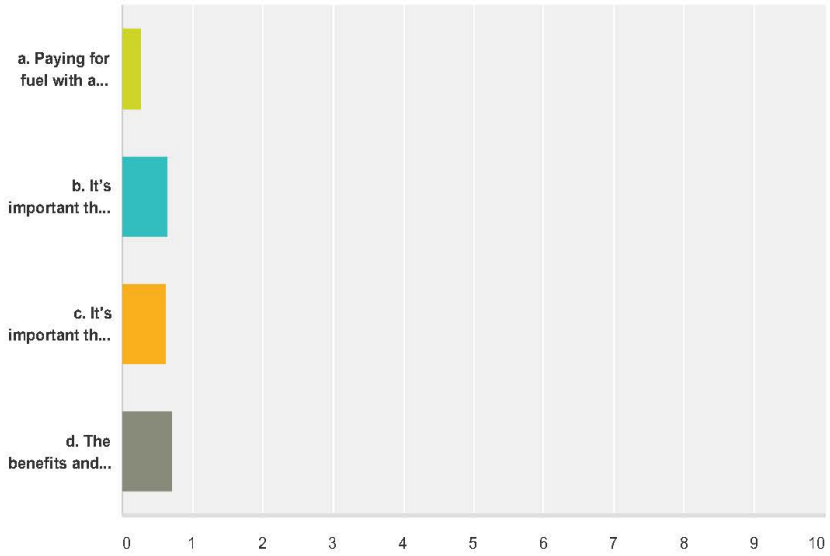
Figure 27: Tri-Counties Fleet Operator Survey on Alternative Fuels (cont'd)

Public benefits	**4.17%** 1	**20.83%** 5	**29.17%** 7	**25.00%** 6	**20.83%** 5	24	3.38
Safety	**4.35%** 1	**26.09%** 6	**26.09%** 6	**17.39%** 4	**26.09%** 6	23	3.35
Maintenance availability	**0.00%** 0	**4.17%** 1	**41.67%** 10	**16.67%** 4	**37.50%** 9	24	3.88
Mechanic training	**4.00%** 1	**8.00%** 2	**20.00%** 5	**20.00%** 5	**48.00%** 12	25	4.00

Figure 27: Tri-Counties Fleet Operator Survey on Alternative Fuels (cont'd)

Q9 Please read the following short paragraph about a new vehicle type that is coming to market and then answer three yes/no questions:Green fuel is a renewable, gaseous fuel used in vehicles that range from small off-road vehicles (forklifts, tugs) to passenger cars to transit buses. Green fuel is available at gas stations and the fuel's dispensers accept credit cards for payment. The vehicles fill in minutes, have range similar to their gasoline/diesel counterparts and have zero emissions. Operating the vehicles meets California's requirement for ZEVs and the vehicles are eligible for HOV stickers. Purchase price is higher than conventional vehicles, but can be offset with rebates and cost of ownership is similar to other alternative fuels.

Answered: 25 Skipped: 0



	Yes	No	Total	Weighted Average
a. Paying for fuel with a credit card would be a problem for my fleet.	**28.00%** 7	**72.00%** 18	25	0.28
b. It's important that we obtain ZEVs to meet state requirements.	**64.00%** 16	**36.00%** 9	25	0.64

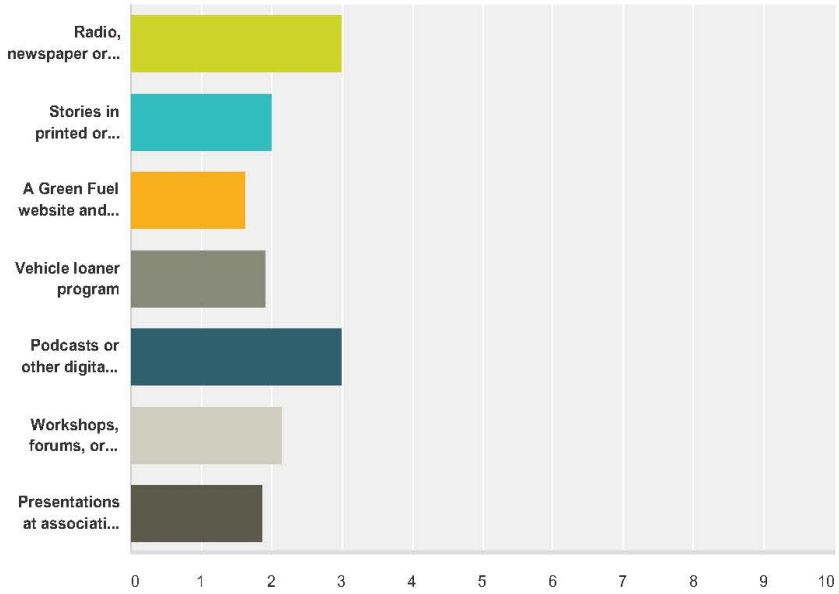
Figure 27: Tri-Counties Fleet Operator Survey on Alternative Fuels (cont'd)

c. It's important that we obtain ZEVs to meet local government requirements.	**62.50%** 15	**37.50%** 9	24	0.63
d. The benefits and rebate can justify the higher purchase price.	**70.83%** 17	**29.17%** 7	24	0.71

Figure 27: Tri-Counties Fleet Operator Survey on Alternative Fuels (cont'd)

Q10 If you wanted to learn more about green fuel and green fuel vehicles, which three (3) ways would be most effective for you?

Answered: 25 Skipped: 0



	Way 1	Way 2	Way 3	Total	Weighted Average
Radio, newspaper or magazine advertising	0.00% 0	0.00% 0	100.00% 2	2	3.00
Stories in printed or online magazines	22.22% 2	55.56% 5	22.22% 2	9	2.00
A Green Fuel website and social media	61.54% 8	15.38% 2	23.08% 3	13	1.62
Vehicle loaner program	33.33% 4	41.67% 5	25.00% 3	12	1.92
Podcasts or other digital media	0.00% 0	0.00% 0	100.00% 3	3	3.00
Workshops, forums, or training events	23.81% 5	38.10% 8	38.10% 8	21	2.14
Presentations at association meetings	40.00% 6	33.33% 5	26.67% 4	15	1.87

Source: Santa Barbara County Air Pollution Control District

Local Government Fleet Interview Template

Notes for Interviewers

This interview template is intended to provide a loose framework for obtaining information about fleet operators' interest and awareness in FCEVs. The goal of these interviews is to develop a more nuanced understanding of specific opportunities and barriers to FCEV deployment in municipal fleets, as well as fleet managers' openness to installing hydrogen refueling infrastructure at their agency/organization.

The information obtained through interviews with municipal fleet managers will supplement and build upon insights obtained from the online fleet manager survey. The template outlines *potential* areas of inquiry for interviewers, and some ideas for specific questions that could be asked. If it becomes clear over the course of the interview that there are specific issues or areas warranting deeper exploration, there's no need to stick to the template. The goal is to listen closely to people's responses and adapt questions as need, so the interview unearths information of the greatest relevance and significance.

Template

Introduction

- Take a moment to get acquainted and establish rapport.
  - "Hi. How is your day going?"
- Provide general background for the conversation, without revealing the specific focus on FCEVs.
  - "Over the last three years, a coalition of regional agencies and stakeholders have developed several Readiness Plans for alternative fuel vehicles with grant funding from the California Energy Commission."
- Help the interviewee understand why they are being interviewed.
  - "As we look ahead to the implementation of the readiness plans for the Tri-Counties region, we want to get a better understanding of the opportunities and challenges that managers are faced with as they seek to incorporate cleaner, lower-emission AFVs into their municipal/public fleets. And that brings us to today's conversation."

General Fleet Management Questions

- Challenges
  - "In general, what are the 3 foremost challenges you face with vehicle procurement? What about the 3 biggest challenges related to operating and maintaining your fleet?"
- Plans & Policies
  - "Has your agency/organization adopted any plans/policies related to the procurement of AFVs for their municipal fleet (for example, a Climate Action Plan)? If so, how have these policies influenced your procurement practices? Have they been helpful or burdensome?"
  - "Are you aware of resources such as the regional AFV Readiness Plan, EV Readiness, and forthcoming Hydrogen Readiness Plan?"

Alternative Fuels Questions

- Procurement
  - "What are the considerations that you weigh most heavily when making procurement decisions about AFV?"
  - "Are you open to leasing vehicles? Are you leasing any vehicles right now?"
  - "What factors are most influential in your decisions to purchase or not purchase an AFV?"
- Barriers
  - "What would you say are the 3 biggest barriers that stand in way of getting more AFVs into your fleet?"
  - "Are there unique challenges related to the procurement of AFVs. If so, what are they?"
  - "What, if any, are the operational challenges you face with incorporating AFVs into your fleet?"
- User Demand
  - "How is the demand for alternative fuel vehicles among staff that utilize your fleet services and vehicles?"
  - "If demand is lower for AFVs, have staff indicated why they are less inclined to use these vehicles? If so, what were there reasons?"
- Fuel
  - "Do you have fueling/charging infrastructure installed onsite for your AFVs?"
  - "Would you be open to incorporating AFVs that would need to refuel offsite if a fueling station for the AFV was nearby?"
  - "Do you prefer to have onsite fueling infrastructure for you AFVs? If so, why?"
- Maintenance
  - "How does the availability of maintenance for different AFVs affect your decision to include them in the fleet?"
  - "Do you feel that there are good programs and resources available for training your mechanics and technicians to work on AFVs? Would it be helpful if new training programs or resources were developed?"
  - "If a nearby dealership could maintain the AFV, would you be comfortable incorporating the AFV into your fleet without your mechanics/technicians being trained? If not, why?"

Hydrogen & Fuel Cell Electric Vehicles

- Lead-in
  - "We received California Energy Commission funding to develop a regional hydrogen readiness plan…"
- Awareness
  - "How familiar are you with FCEVs and hydrogen fueling infrastructure?"
  - "What are the benefits of FCEVs that you are aware of?"
- Adoption

    - "Would you consider incorporating FCEVs into your fleet despite the vehicles' higher upfront cost? Would you consider the vehicles if incentives or discounts for fleet operators could reduce the cost of purchasing or leasing an FCEV?"
    - "Toyota is offering to cover the cost of fueling their Mirai FCEV with hydrogen for three years, up to $15,000. If you did not have to pay to fuel FCEVs with hydrogen, would you be more likely to lease or purchase an FCEVs for your fleet?
- Stations
    - "Would you be open to hosting a hydrogen refueling station at your agency/organization? What if grant funding was available that would cover the station's installation costs?"
    - "If you hosted a hydrogen refueling station at your agency/organization, would you be open to making it publicly accessible?
    - Do you foresee any major barriers that would prevent shared public-private use of your hydrogen fueling station? If so, what are these barriers?"

Close Out

- Best Practices and Fleet Management Networks
    - "How do you stay informed about best practices for fleet management and AFV deployment?"
    - "What networks or groups are you a part of that discuss fleet management issues?
    - "Are there any fleet management symposiums or conference that you would recommend attending?
    - "Who coordinates these groups? Could you share their contact info with me?"
- Thank you!
    - "I really appreciate you taking the time to talk today."
    - "Is it alright if I follow up with you if any other questions come up?"
    - "Thank you!"

Table 28 displays interview notes from fleet managers.

Table 28: Fleet Manager Interview Notes

Interview Date	Notes
1/5/2017	The contact has 5 propane vehicles in operation today; received grant and used funds to purchase 4 Ford bi-fuel pick-ups but now use only gasoline for fuel because Original Equipment Manufacturer support dried up; previously leased 2 all-electric Ford Rangers and a Toyota RAV-4 electric vehicle. Per the contact, the government has no intention to add additional AFVs to the government fleet at this time. However, plans are in motion to replace 2 of the propane trollies in the next two years, with grant funding already secured; delivery hoped for in 2018. Seems like little consideration had been given to trying something different and moving to all-electric shuttles. The contact cited concerns about the ability to deliver air conditioning on all-electric shuttles. When asked about hydrogen and FCEVs, the contact indicated that they "knew a little bit" but was not interested in bringing FCEVs to the fleet, mentioning that hydrogen seemed to be in the very early stages. The contact is the sole mechanic of the fleet and is therefore very busy. The contact has a "minimal" amount of time to research alternative fuel options.
1/9/2017	Foremost challenges: (1) fueling/charging infrastructure and securing funding to install infrastructure; (2) availability of AFVs with range greater than 250 miles; (3) making case for AFV return on investment in fiscally conservative environment. Has 10 Chevy Volt PHEVs in fleet. The contact carefully considers whether fleet vehicles will be in demand and mentioned that County staff have been less inclined to drive battery electric vehicles. The contact guessed that this was due to range anxiety. Onsite fueling infrastructure for any alternative fuel vehicles is a must. The contact mentioned that it would be helpful if more Original Equipment Manufacturer training for automotive technicians were available, as would more tech/mechanic repair training programs from state and local governments. The contact is on a community college Board for their County and advocates for improved programs there that will better address repairs for the coming generation of AFVs. The contact said they would be open to installing a hydrogen dispenser on site if the high cost could be covered by a grant. "Hydrogen is fuel of future", not looking to procure FCEVs now. Would need in-house maintenance for FCEVs to incorporate them into the fleet, partly due to unionization of auto techs. Not comfortable with dealership maintenance due to slow turn around; per the contact, dealers don't make money off fleet vehicle repairs, so their maintenance teams haven't always provided the best service. Open to installing shared hydrogen fueling infrastructure. Member of NAFA, Municipal Equipment Maintenance Association, public fleet managers' association, CalStart, and local Gold Coast fleet manager group.

Interview Date	Notes
1/6/2017	Brief conversation. The contact has a very small fleet and is not looking to add any alternative fuel vehicles at this time. Fuel cell electric vehicles and hydrogen were not indicated as being of interest. Lessons: fleet size matters, and staff capacity is key.
1/23/2017	The contact indicated that their three major challenges as a fleet manager are: (1) time constraints, making it difficult to find time to research alternative fuel vehicles; (2) balancing the costs and benefits, as well as operating characteristics and vehicle applications; (3) poor availability of AFVs for certain vehicle classes or applications, especially larger light-duty vehicles and medium- and heavy-duty trucks. The contact also said that the lack of incentives available to public fleet operators makes it difficult to justify the higher upfront cost of the vehicles. Investment in fueling infrastructure is another hurdle. The contact's records indicate that user demand at the Government is lower for certain types of AFVs, particularly electric vehicles where range is a concern. The Climate Action Plan for the Government includes a goal to reduce emissions from fleet vehicles; however, it does not include specific targets. When asked, the contact indicated that targets would make fleet management more difficult and could increase costs for the Government. The contact was not supportive of such a move. The fleet has leased vehicles in the past but said that the experience was underwhelming in terms of cost efficiency. The contact is open to incorporating FCEVs into the fleet and would consider installing onsite hydrogen fueling infrastructure if it was cost effective or funded by an outside entity. The contact said that shared public-private fueling would not be an option for the Government due to the limited space in their fleet yard and its location. When asked about training for maintenance of new AFVs, he said that more local resources for his technicians would be helpful. They currently must travel to Los Angeles for trainings to work on electric vehicles. The contact has "sublet" maintenance to outside technicians/businesses. The contact prefers that this work be completed nearby but has to have some out-of-town repairs done on clean natural gas vehicles. The contact also indicated that they would be much less likely to incorporate a Mirai into their fleet if the vehicle's fuel incentive went away. The contact stays informed about AFVs through print materials/publications, the regional Gold Coast fleet group, the LA-based Municipal Equipment Management Group, NAFA, and attends one conference a year (usually GFX).
1/19/2017	The contact said that his challenges with incorporating AFVs include: (1) the availability of certain types of vehicles, especially larger light-duty service vehicles and medium- and heavy-duty trucks (anything like the Ford Transit is hard to come by); higher upfront vehicle costs for AFVs. The organization has over 400 vehicles. 95 percent of their purchases for light-duty vehicles are targeted to AFVs. The contact carefully considers fitting vehicles to their application, so they have not seen many issues with low user demand; in general, staff and fleet service users seem very open to using the Plug-in Electric Vehicles and other AFVs available today. The contact indicated that greening the campus fleet will be essential to achieving climate

Interview Date	Notes
	targets set by their organization, but the lack of available and affordable vehicles beyond the smaller light-duty vehicle class makes it difficult to begin implementation now. E85 is viewed as a bridge to meeting these goals and may be used more in the next 2-5 years. With regard to installing fueling infrastructure, stranded assets are a concern. A lack of available financial capacity to install new fueling infrastructure is a challenge. The contact felt that staff were well equipped to get training for maintenance on AFVs but said more local resources couldn't hurt. The contact is open to outsourcing maintenance if need be. For FCEVs, the contact would want onsite fueling since the local hydrogen fueling station is located more than 10 miles away in Santa Barbara. The contact likes the Mirai that they demoed a couple months ago and would love to incorporate it into their fleet if onsite fueling were available but doesn't see this being possible in the next couple years due to financial constraints. The free fuel incentive offered by Toyota does make the Mirai more attractive in their opinion. The contact felt that his managers would be open to exploring shared public-private fueling but grant funding for the station install would be key given current costs. The contact attends an annual fleet conference and has access to a fleet manager listserv. Can provide match funding for grant opportunities.
1/23/2017	This local governments fleet operator retired earlier this year, and a replacement has not yet been hired. The contact is filling in on an interim basis and did his best to answer interview questions. Per the contact, the government has a small number of hybrid vehicles in their fleet (not the plug-in variety). The major factor informing their vehicle procurement decisions is cost of purchasing and operating vehicles. AFVs have not factored prominently into their fleet accord to the contact because the government has not found them to be "cost effective", even though they have a large fleet (over 300 vehicles). Investing in fueling infrastructure is another challenge. When asked about FCEVs, the contact said that they would need more information about costs associated with purchase and use. The indicated that their organization was not interested in exploring hydrogen and FCEVs now. The contact also indicated that it required a great deal of staff time to access funding from state programs and secure vehicle incentives. The contact added that staff already struggle to meet existing state and federal requirements. Information about state programs focused on directing Greenhouse Gas Reduction Fund investment to Disadvantaged Communities was shared with the contact by the interviewer, who also offered to help the government procure funding through types of pathways for fleet modernization and emission reductions.
1/31/2017	The contact expressed support for incorporating alternative fuel vehicles into their local government fleet but indicated that supervisors who authorize vehicle procurement could use additional education on the benefits of alternative fuels and zero emission vehicles. It sounded like more internal support is needed, especially around upfront vehicle cost, incentives, and long-term operating costs. Infrastructure, especially for Plug-in Electric Vehicles, is a challenge. The local government only has a single electric vehicle charging station that is

Interview Date	Notes
	located at on facility. The contact would like to have fleet PHEVs for this location and the fleet yard, with electric vehicle supply equipment at both sites. The contact said that there are currently no plans or policies in place that require their fleet to move forward with AFV procurement, but the contact's goal is to make the organization green so they want to incorporate the lowest emission vehicles into their fleet that they can. The is leasing a vehicle currently but will purchase when the lease term ends.
2/1/2017	The contact indicated that their greatest challenge with incorporating alternative fuel vehicles is securing funding for vehicles that have a higher upfront cost and for installing additional fueling/charging infrastructure. They acknowledge that there is a tension between fiscal considerations and greenhouse gas/air quality benefits. The availability of alternative fuel vehicles for a wide range of duty classes and applications is another challenge. The contact said their local government has a policy on the books for vehicle depreciation cost collection, which provides a steady stream of additional funding for vehicle replacements. The contact also has a goal for 20 percent of all fleet vehicles to be alt-fuel vehicles. Major consideration that inform alt-fuel vehicle purchase include cost, safety, reliability, environmental benefits, and vehicle application. The organization has leased vehicles in the past, including a Toyota RAV4 electric vehicle, but prefers to purchase vehicles because it is more cost effective in the long run. User demand for alternative vehicles is high. The contact attributed this to the online checkout system they use for fleet vehicles, which provides training and information to staff about the vehicle they will be driving. This helps familiarize staff with new technologies. There are 22 government charging stations installed for electric vehicles. 19 of these stations are public and the other 3 are for private use by staff. The contact is open to fueling vehicles offsite if a station is within reasonable distance (3-5 miles), and the government uses fueling credit cards. Maintenance of the vehicles isn't an issue; the contact said that their technicians have access to good training, though more local resources would be welcome. If a vehicle is under warranty or if a major repair needs to be completed, the contact will send vehicles to dealership for repair as this is more cost effective. However, they are only comfortable using dealerships that are certified to work on new technologies if the repair is for an EV or other clean vehicle technology. The contact expressed openness to deploying FCEVs in the government fleet if fueling stations were located nearby. They seemed enthusiastic about piloting an FCEV and said that they'd be willing to drive longer distance to refuel the vehicle if need be. The contact indicated that a fuel incentive like the one offered by Toyota would factor into her consideration of piloting an FCEV. The contact didn't feel that the government would be able to accommodate shared public-private fueling infrastructure. Per their account, the government is small. Even with grant funding for a refueling station, they didn't think that a shared option would be viable. However, they were supportive of working with other private or public entities to explore the possibility of bringing hydrogen to their area.

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2/2/2017	The contact indicated that, in general, funding is the major challenge for their agency when trying to procure alternative fuel vehicles. They said that there are no internal policies or local government requirements for the transit agency to reduce emissions but was supportive of bring cleaner vehicles to the region. The agency has invested heavily in clean natural gas buses and fueling infrastructure. The fleet includes 56 clean natural gas busses, 24 paratransit vehicles, and 14 clean natural gas light duty vehicles. No other alternative fuels are in use at the agency, but the contact was open to exploring other options. However, they expressed reservations about being on the "bleeding edge" since it entails risks of stranded assets. The contact indicated that they are somewhat familiar with FCEVs but could not go into specifics. Details about the benefits of FCEVs and ongoing efforts to create a statewide hydrogen fueling network were explained to the contact. They would be open to incorporating FCEVs into their fleet. They felt that grant funding would be crucial to this endeavor and foresaw challenges with gain support from transit agency decision-makers. They also wondered about the potential risk of bring a new fueling technology to the agency. A new facility is currently under construction, and the contact felt that there would be plenty of room for an on-site hydrogen fueling station at its fleet yard. Shared public-private fueling at the site would not be an option, and sharing offsite hydrogen fueling infrastructure would present challenges; specifically, the union at the agency does not permit drivers to fuel vehicles. If hydrogen fueling happened offsite, the buses would need to return to the fleet yard so the appropriate staff member could refuel at the offsite location. The contact seemed happy with his current access to training resources for mechanic working on their clean natural gas busses. The Southern California Regional Transit Training Consortium provides training. Staff either travel to Los Angeles or The Southern California Regional Transit Training Consortium staff provide onsite training. The contact stays up-to-date on best practices by attending California Transit Association symposiums and American Public Transit Association conferences. They are also a member of the regional Gold Coast Fleet Managers group.
2/8/2017	The local government fleet management team was very supportive of efforts to green their fleet and has taken more steps to incorporate alternative fuel vehicles than most governments of their size. However, staff had limited knowledge of FCEVs and were not able to report the vehicle's operating characteristics or environmental benefits. The contacts were supportive of incorporating fuel cell electric vehicles once the interviewer provided more information about performance characteristics and environmental benefits. One of the foremost barriers for adoption due to the bid process used for vehicle procurement. The contacts indicated that the lowest cost bidder wins and that environmental benefits are not considered. Since financial considerations dominate, it will be difficult to adopt higher-cost FCEVs. Hydrogen is currently unavailable in their area, so additional financial outlays would be required for onsite fueling unless a public hydrogen station is constructed and operating nearby. One thing that was very clear from the conversation was staff's passion

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	for rolling out solutions that will address climate change. Both contacts were receptive to potential grant-funded pilot projects for hydrogen buses, shared public-private fueling, and FCEVs demonstrations. The main issue standing in the way of this work would be resource capacity, so outside dollars with no-to-low match funding requirements would be essential.
2/10/2017	The contact indicated that their local government was currently demoing an FCEV and is moving in the direction of acquiring an FCEV for their fleet. The primary consideration for new vehicle purchases is the return on investment, which is tied to both vehicle use and fuel costs. In general, the contact has found that EVs don't pencil out over their lifetime, with a cost that is $6,000 to $7,000 more than conventional automobiles. However, the fuel incentive on the Mirai made it attractive to lease. This will give the local government a chance to try the vehicle out before moving forward with a purchase. The contact was not sure about the possibility of installing onsite hydrogen fueling infrastructure. The thought that it would be possible to fit a hydrogen station into their fleet facilities but had questions about permitting requirements. In their opinion, installing onsite fueling infrastructure would only be a consideration if their organization procured several FCEVs for their fleet. With regard to shared public-private fueling, the contact foresaw several issues. Specifically, fleet fuel goes untaxed at their organization, but fuel sold to the public is taxed. If hydrogen is taxed for public sale, the contact felt that it would be unrealistic to provide shared public-private fueling due to the differences in tax assessment.
2/14/2017	This was a follow-up interview with the Energy Manager of the organization whose fleet manager was interviewed on 2/10/2017. Discussed opportunities for installing hydrogen at facilities operated by the local government entity. Per the contact, a fueling station located near one of their campuses could open up opportunities for fueling medium- and heavy-duty hydrogen trucks. Another opportunity would be to install a H2 station at a nearby gas station since this is located near some facilities. For the truck idea, the contact indicated that their government has 3 to 6 diesel trucks in operation 6 days a week at their campus. The estimates that each truck burns at least 70 gallons of fuel per day. Replacing these diesel vehicles to ZEVs could significantly reduce greenhouse gas and criteria air pollutant emissions.
2/14/2017	The major barrier to the deployment of more clean, low-emission vehicles is funding for the agency. Another significant barrier is past experiences experimenting with alternative fuels that have left a bad taste in the agency's mouth. Per contacts, the agency has a very strong clean diesel component that is reliable and low emission, but other efforts to incorporate non-diesel technologies got messy. Specifically, the agency tried to incorporate 4 hybrid electric diesel buses into their fleet several year ago, but these hybrid vehicles were very unreliable. The agency canceled their order for 2 of the 4 buses. A court battle also ensued. This experience

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	makes staff and their Board hesitant to experiment with hydrogen or all-electric options, despite their support for clean vehicle technologies. Overall, the contacts didn't think that the types of routes the agency runs would be conducive to many alternative fuel technologies because their fleet vehicles travel long distances. Mechanic training and maintenance were other significant issues. It can be difficult to get training for their staff, and new technologies can slow down work in their shop and overwhelm staff who are new to working on novel types of buses. The agency would need to know that they have strong support from Original Equipment Manufacturers and outside agencies to get their staff trained for maintenance of hydrogen vehicles. Infrastructure costs and building retrofits were another consideration. The contacts felt that a loaner program for hydrogen vehicles would be a good way to make sure that new technologies are a good fit for their operations. This could be supported by a mobile fueling station, such as the one Toyota has used in some regions. The contacts said that there are plans in development for a new fleet facility. They seemed to think that there could be opportunities for installing a hydrogen fueling station at this site, possibly with shared- public-private fueling since they are located near US 101. However, the agency would need to derive financial benefit from the station or have any financial risk assumed by an outside party who owns and operates the station. The challenge would be getting board approval given past experiences with alt-fuels.
2/14/2017	The contact shared that their local governments fleet management division is currently under resourced. The prevailing attitude among leadership is that fleet management and related emissions are not a priority right now. The contact said that other large infrastructure projects are getting the bulk of attention. The contact is filling in for a fleet manager who had to take leave as well as an operations manager who was eliminated due to budget issues. It is all they can do to keep the current fleet running. The local government has several clean natural gas vehicles, but do not have any BEVs or PHEVs. More support for training mechanics on new technologies would be beneficial. The contact would like more local training programs. The organization is part of a municipal planning group for LA and Orange County, but trainings are in these metropolitan areas. These travel requirements make it difficult for staff to attend because the organization eliminated budget for these trainings. The contact has test driven a Toyota Mirai and seemed impressed with the vehicle. They were familiar with the benefits of FCEVs but was less aware of state activities to help fund the creation of a robust hydrogen fueling network. The contact said that they would be open to leasing a Toyota Mirai or other FCEV; however, they were not responsible for making these decisions about lease agreements. That is up to higher-level decision makers their Finance division. The contact said that a fuel incentive such as the one available for the Mirai would be helpful in making a case. When asked about the possibility of installing onsite hydrogen fueling infrastructure, the contact was declined to make a statement but expressed support for alternative fuels in general. They also felt that space constraints at their fleet yard would make it difficult to justify

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	installing fueling infrastructure for hydrogen, especially if it is only used by a small number of vehicles. The contact said that there are several fueling station located near the fleet yard, including several Shell stations that the organization has a fleet fuel card agreement with. Installing hydrogen fueling stations at these Shell locations may be a better option since both the organization and residents could fuel FCEVs.
2/14/2017	The contact indicated that financial constraints are a barrier to FCEV adoption, as well as procurement of other alt-fuel vehicles. The limited availability of alternative fuels infrastructure and a lack of resources to fund installations of fueling/charging infrastructure was another barrier. The contact also said that they have a small staff of auto technicians working at the organization, so maintenance can be a challenge. To make maintenance more manageable, the contact is trying to consolidate like brands and technologies into the fleet, rather than diversifying. More local training programs would help train their team to work on a wider range of vehicles. Auto technicians currently must travel for trainings. There are currently 5 PHEVs in the fleet, and 5 or 6 standard HEVs (no plug). The local government has a Climate Action Plan in place that addresses fleet emissions; however, the contact was unable to recall specific details during the phone conversation. Procuring lower emission vehicles is a priority and environmental performance factors into purchasing decisions, but the dominant factor is the purchase price for vehicles. The contact had a basic knowledge of FCEVs, describing them as "very clean". The contact wasn't aware of FCEVs operating characteristics, so these were explained by the interviewer. The contact was also aware that the limited availability of hydrogen fuel is an issue but didn't know that the state was helping fund the construction of 100 hydrogen fueling stations. If FCEVs "penciled out" financially and fuel became available in their area, the contact would consider adding FCEVs to the fleet. They said that purchasing FCEVs wouldn't be an option due to the higher vehicle costs and a lease agreement would be the only way their organization could incorporate an FCEV until prices fall. The contact was supportive of installing onsite fueling infrastructure, but a decision to install a hydrogen fueling station would need to involve higher level officials. He also said that there are nearby fueling station located less than a quarter mile to US 101 that could support shared public-private fueling.
2/16/2017	The contact said that the most significant barrier to getting cleaner vehicles into their fleet is the long routes that their vehicles need to travel along daily (150 to 200 miles). Due to these long trip distances, the organization has focused on clean diesel technologies for their fleet. The organization also has 2 propane vehicles and is installing a large 1000-gallon propane storage tank onsite. Propane will be used to fuel vehicles traveling shorter distances. The contact did not feel that pure electric vehicles would be an option now but was open to incorporating all-electric options if they could reliably travel 200+ miles and fast charging infrastructure could be brought to the fleet yard. The contact said their organization fall outside of the two major areas where grant funds are being directed currently (i.e. very small and very large metropolitan

Interview Date	Notes
	organizations). The organization does not have any specific goals for reducing fleet emissions that they have adopted, but they do follow all CARB requirements for clean diesel vehicles. The contact indicated that more local programs to train mechanics would be helpful, especially for their propane vehicles. Specifically, mechanics are not trained to repair sensors on the propane vehicles that go out often, and Original Equipment Manufacturer repair facilities for their propane buses are located 5 to 6 hours away. The contact was not familiar with FCEVs, so the interview explained the technology and the vehicle's operating characteristics. Information about state activities to help fund a hydrogen fueling network was also provided. After being briefed on the characteristics and benefits of FCEVs, the contact said that she would be open to incorporating these vehicles into the fleet if hydrogen fuel and larger FCEVs were available. There are only 3 manufacturers offering vehicles that meet the state specifications for their fleet. The contact said that they had not heard of any FCEV that are currently available or planned for release by these manufacturers. Shared public-private fueling would not be an option for the organization per the contact, but they would be open to working with their board to bring private hydrogen fueling infrastructure to the fleet headquarters. The contact said they stay up to speed on fleet management and alt-fuels through conferences and print publications.
3/1/2016	The contact indicated that major barriers to the adoption of alt-fuel vehicles at their organization included (1) the lack of availability for three-quarter ton plus trucks using alt-fuels, (3) funding constraints, and (3) infrastructure issues. Per the contact, the organization does not have a centralized fleet and departments are required to come up with their own funding streams for new vehicle procurement or replacement of older vehicles. Consequently, vehicles tend to be used until the end of their life. Their organization is working to create a centralized fleet system to support better fleet management. For the most part, vehicles used in their fleet operate on-site but there are a smaller number of fleet pool vehicles that are used for longer trips. A large portion of the alt-fuel vehicles in use are neighborhood electric vehicles that are charged using a standard 120-volt outlet. There are level 2 electric vehicle charging stations in some parking lots. The organization also purchased 2 bi-fuel trucks that use gasoline and propane. However, the propane fuel system took up a significant amount of payload capacity. Manufacture support has also been limited. The contact indicated that their organization has signed on to a Carbon Neutrality policy which seeks to have net zero carbon emissions by 2030. The organization has also developed a climate action plan. There are no specific goals in place for reducing fleet emissions. However, transition to low- and zero-emission technologies is a priority. The contact felt that a specific goal could help create greater alignment in fleet purchasing policies. The contact does not make the final purchasing decisions for fleet vehicles and indicated that the decision-maker above them have signed off on the purchase of larger, less fuel-efficient trucks than were recommended. Specific policies could help to address this issue. The contact said that 95 percent of all vehicle

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	maintenance happens on-site, with repair services delivered by his team of automotive technicians. More local programs would help support training and cost savings. The contact also expressed a need for more manufacturer-specific training resources. The contact was not aware of the operating characteristics and benefits of FCEVs, nor were they aware of California's support for the construction of statewide hydrogen refueling network. After receiving basic information about fuel-cell electric vehicles and FCEVs, the contact indicated that they would be open to incorporating FCEVs into their fleet if they were affordable and hydrogen fuel was available on-site or nearby. Incentives such as free hydrogen fuel would help with FCEV adoption. The organization is located close to two major highways/freeways, so it could be an ideal location for hydrogen refueling infrastructure. The contact also indicated that there are several gas stations located nearby. If hydrogen were installed at these stations, FCEVs in their fleet could use a credit card to pay for hydrogen there. The contact relies heavily on a supervising technician for leading-edge information about the latest alternative fuels and technologies.

Source: Santa Barbara County Air Pollution Control District

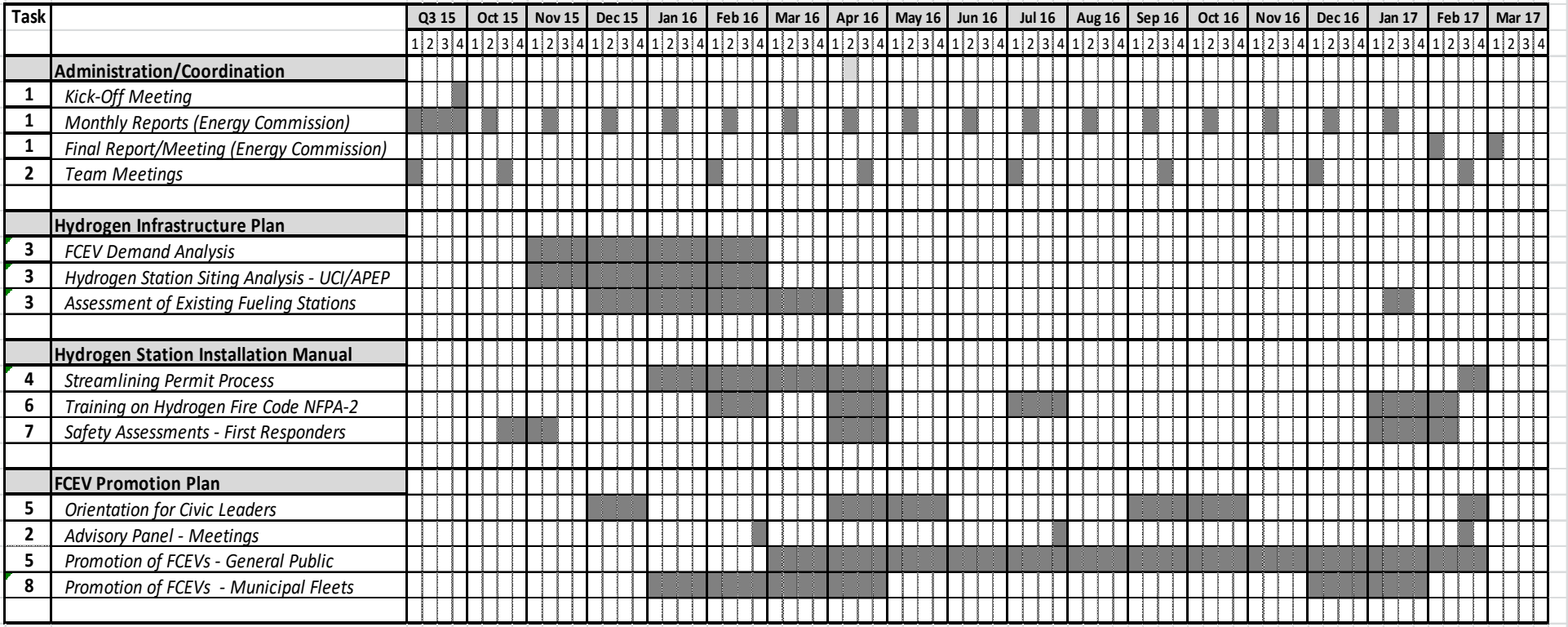
Appendix E: Administrative

Figure 28 shows the schedule of activities for the Tri-Counties Hydrogen Readiness Planning project.

Figure 28: Project Schedule - Final

Schedule of Activities - Tri-counties Hydrogen Readiness Planning

Final - February 2017



Notes by Task:

3	Assessment of existing stations was performed mostly in late 2015/early 2016, but some follow up work in Jan 2017 to assess station owner interest
4	Template materials for hydrogen station permitting were mostly assembled in first quarter of 2016, but additional materials became available in late 2016 (including guidance from DOE on H2Tools website).
4	Final packet circulated to permit agencies in Feb 2017 (panned)
5	Meetings with civic leaders took place at various time over the project period, as their availability allowed
5	Promotion activities included all tasks in the Greement, and also several unscheduled opportunities that emerged during the project period (e.g., Earth Day, National Fuel cell Day, UCSB Symposium, Station Openin
6	Taining on Hydrogen Fire Codes for Fire Department inspectors was coordinated with Task 4 relating to hydrogen permitting process for local permit agencies
7	Safety assessments for first responders included compilation of safety information and response guidance for Fire Department personnel
7	Task extended over longer period than anticipated because of operational priorities of key Fire Department personnel
8	Progress with municipal fleets was impeded by the lack of useful data on fleets in the Tri-Counties. Extensive effort was made to gather this information before administering survey

Source: Santa Barbara County Air Pollution Control District

Tri-Counties Hydrogen Readiness Planning

Performance Evaluation – Project Tracking Summary

February 2017

The ultimate success of the Tri-Counties Hydrogen Readiness Planning project will be the installation of an increasing number of hydrogen refueling stations in the Tri-Counties, situated in locations that are well suited to serve the growing numbers of hydrogen vehicles that are anticipated. However, for the planning phase, the outcome will be deemed successful if there is "buy in" for the plan from community leaders, with owners/champions for the plan in decision making positions.

Furthermore, the probability of success will be increased if the site property owners and operators have also indicated a willingness to consider the installation of hydrogen dispensers at their stations, as and when funding becomes available. In each jurisdiction where hydrogen stations could be located, a "champion" (individual or agency) would be identified to provide local support when needed.

The assumption is made that stations will be funded and installed in a staged manner, and as such, the goal of the plan is to develop a prioritized list of site locations within the Tri-Counties. Initial stations should be located in jurisdictions with anticipated demand – identified in the plan – and permitting and response agencies in those jurisdictions need to be prepared through orientation and training.

For each of the jurisdictions identified as higher priority locations, the following details were considered:

- Potential refueling sites identified and mapped
- Pros and cons of site (advantages and disadvantages)
- Within general location, actual site identified as potential host
- County/Air Pollution Control District
- Business Operator
- Business Owner
- Property Owner
- Decision Making Authority
- Planning/Permit Department
- Primary Response Agency
- Site Notes/Comments