California Hydrogen Highway Network

Year End Progress Report to the Legislature

December 2006

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Introduction

The California Hydrogen Highway Network (CaH2Net) was initiated in April of 2004 by Executive Order S-07-04. The mission of the CaH2Net is to support and catalyze a rapid transition to a clean, hydrogen transportation economy in California in order to:

- reduce our dependence on foreign oil
- reduce greenhouse gas emissions
- improve our air quality
- grow the California economy

The CaH2Net is a public-private partnership directed by the California Air Resources Board (ARB), using the California Hydrogen Highway Blueprint Plan (Blueprint Plan, May 2005) as its guiding document.

The Blueprint Plan outlines a three-phased approach toward implementation of the CaH2Net that will help set the stage for the eventual full-scale commercialization of hydrogen transportation. Primarily the three phases emphasize the need for the stations and vehicles to be deployed in tandem in order to maximize utilization of the stations. The first phase suggests that in 2010, 50-100 stations would support the introduction of up to 2000 hydrogen vehicles.

To help meet the goals of the Blueprint Plan, through Chapter 91, Statutes of 2005, the State Legislature authorized $6.5 million for the development of hydrogen stations and the deployment of hydrogen vehicles. Additional funding has also been authorized in fiscal year 2006/2007 for the continued implementation of the CaH2Net.

As required by Chapter 91, Statutes of 2005, this year-end progress report serves as a review of the Air Resources Board's (ARB's) progress in 2005/2006 to implement the CaH2Net. This executive summary provides a snapshot of progress regarding:

- Stations
- Vehicles
- Hydrogen business in California
- CaH2Net expenditures
- Future funding
- Public outreach
- Environmental impacts
- Recommendations for continued State efforts to facilitate commercialization of hydrogen transportation

In addition to this executive summary, there are a number of appendices that include the status of transportation-related hydrogen activities in other states (Appendix A), and the location and siting criteria used for the State-funded hydrogen fueling stations (Appendix B).

The CaH2Net is one of a number of State policy directives that will reduce California's dependence on foreign oil, reduce greenhouse gas emissions, expand markets for alternative transportation fuels and improve California's air quality.

Included in these directives are:

- The zero emission vehicle regulation that sets requirements for the production and sale of zero emission vehicles in California.
- Assembly Bill (AB) 32 that requires the State to achieve reductions in greenhouse gas emissions by 2020 and beyond.
- Executive Order S-06-06 that sets targets to increase the production and use of bioenergy including ethanol and biodiesel fuels made from renewable resources.
- The Bioenergy Action Plan for California that will be developed to show an integrated and comprehensive State policy on biomass, which includes electricity, natural gas and petroleum substitution potential.
- AB 1811 (Chapter 48, Statutes of 2006) that authorizes $25 million to provide incentives for the use and production of alternative fuels.
- AB 1007 that requires the California Energy Commission with the ARB to prepare a State plan no later than June 30, 2007, to increase the use of alternative fuels in California.

2005/2006 was a significant year for the CaH2Net as it saw the disbursement of the first state funds for the development of hydrogen fueling stations and the placement of vehicles in public fleets.

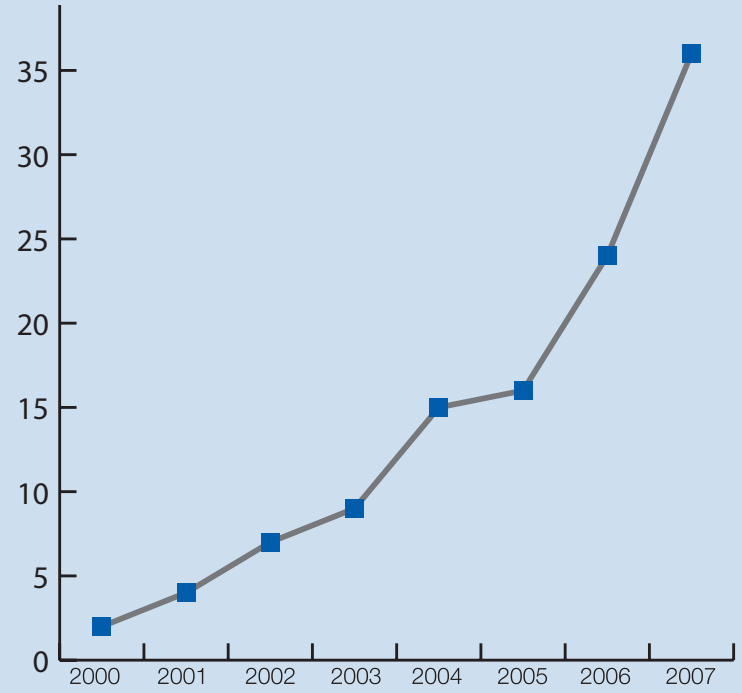
Key 2006 milestones:

- The opening of eight new hydrogen fueling stations and deployment of 47 hydrogen vehicles.
- Selection of contractors through a competitive bid process to cost-share the development of three hydrogen fueling stations that meet the goals of the Blueprint Plan.
- State procurement of five hydrogen passenger vehicles and two hydrogen shuttle buses to be operated in public fleets.
- Passage of AB 1505 putting into statute environmental and renewable-energy production standards for hydrogen transportation fuel.
- Initiation of the development of interim fuel quality standards for hydrogen by the Department of Food & Agriculture's Division of Measurement Standards (available in Appendix C).
- Creation of the Office of the State Fire Marshal's Hydrogen Highway Advisory Committee.
- Development of membership criteria and guidelines to incorporate existing hydrogen stations into the CaH2Net (available in Appendix D).
- Execution of proactive media, legislative and public outreach activities.

Hydrogen Stations

Currently, there are 24 hydrogen fueling stations operating in California and 13 more in the planning or development stages. Of the 24 existing stations, 15 are "publicly" accessible meaning that, with an agreement from the station, an approved hydrogen vehicle can fuel there. The other 9 stations are considered private, serving a restricted fleet of vehicles. A map with the station locations can be found on page 9.

Annual Growth in Hydrogen Fueling Stations 2000 – 2007



The number of H2 vehicles has grown since 2000 and is expected to continue to grow in the future. 2007 should see continued growth in the number of hydrogen stations with the three State-funded stations anticipated to be complete as well as the eight other planned stations.

2006 saw a significant increase in the number of stations and vehicles in California. Much of this was the result of the South Coast Air Quality Management District (SCAQMD) Five Cities Program. SCAQMD partnered with five Southern California cities to assist with the development of ultra clean hydrogen-fueled internal combustion vehicles and a hydrogen fueling network in the South Coast Air Basin. The program is aimed at stimulating demand for hydrogen fuel, accelerating the expansion of the region's hydrogen fueling network, and educating the public about clean running hydrogen-fueled vehicles.

The cities participating in the five-year program include Burbank, Ontario, Riverside, Santa Ana and Santa Monica. Each participating city purchased five converted Toyota Prius hydrogen hybrid electric vehicles that will be used daily in high mileage fleet applications.

In addition, the Alameda-Contra Costa Transit District's (AC Transit) Oakland Seminary Division energy station opened in March 2006 as a result of an innovative cooperative agreement between AC Transit and Chevron to build a state-of-the-art hydrogen energy station in Oakland. The station produces hydrogen fuel for AC Transit's fleet of three 40 foot Van Hool/UTC/ISE fuel cell buses and a fleet of Hyundai light duty fuel cell vehicles. The station uses small scale, onsite steam reforming of natural gas to produce hydrogen in the most cost efficient manner for commercial applications (see Appendix E, Hydrogen Tutorial, for more information about hydrogen production methods). The station will have the additional capability of utilizing excess hydrogen production to generate high quality electrical power from a stationary fuel cell.

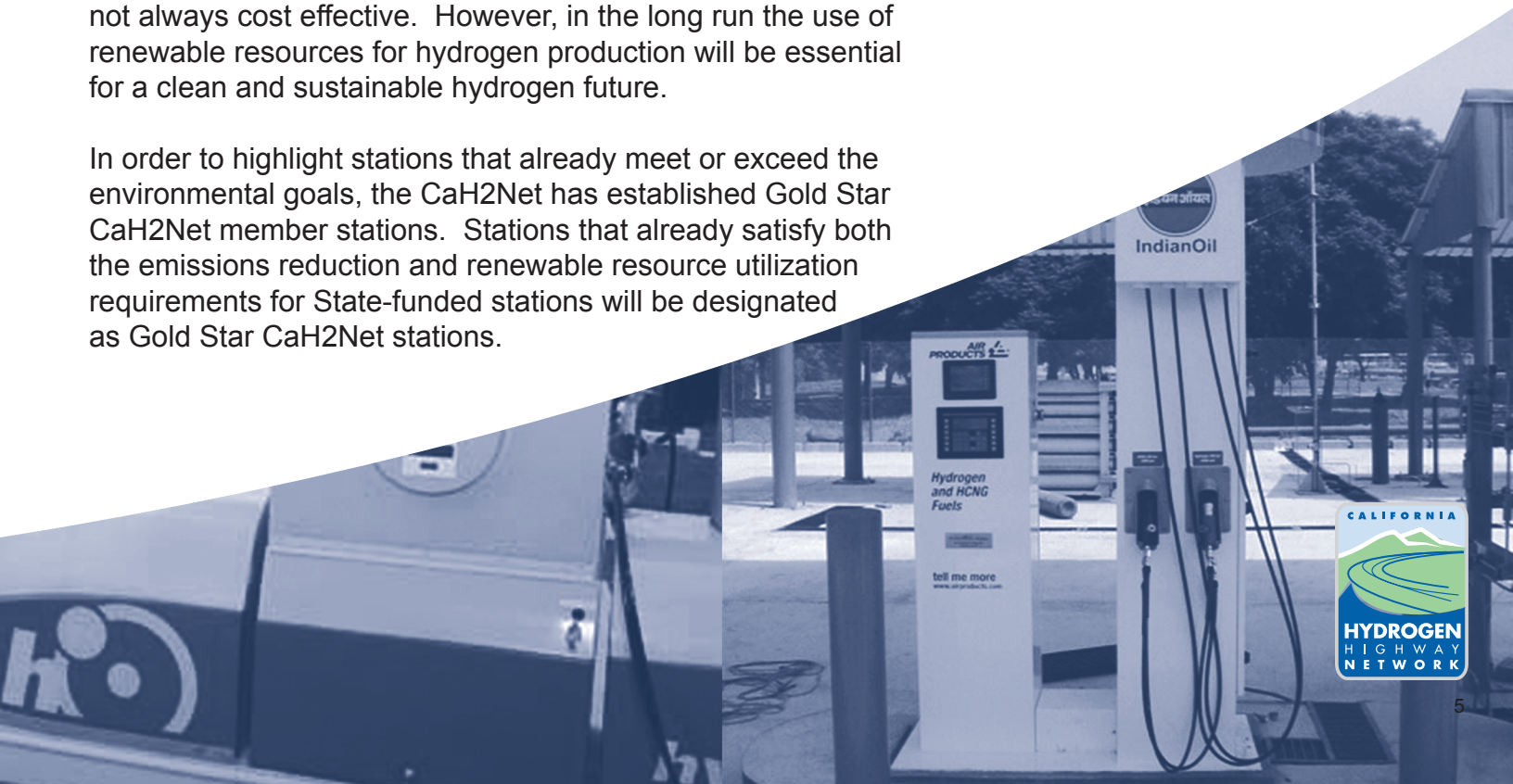
CaH2Net Membership

The goal of the CaH2Net is to create a network of publicly accessible hydrogen fueling stations that provides drivers with adequate and convenient fueling. In late 2006 all 24 stations were invited to join the CaH2Net (see Appendix D for a copy of the CaH2Net Membership Criteria and Guidelines). Members of the CaH2Net agree to adopt certain guidelines to ensure fuel is made accessible to the public, educational materials are made available and that they share environmental information with the ARB. In turn, stations receive support from the State with respect to access to educational materials developed by the ARB, promotional products, CaH2Net signage, information sharing opportunities with other stations, and operations templates. In addition, CaH2Net member stations will be listed in on-line directories allowing drivers to more easily locate and contact stations.

During these initial stages, membership criteria are intentionally broad and inclusive to support the expansion of the network, vehicle technology, and fueling infrastructure while satisfying increasing demand for hydrogen fuel. The ultimate goal is to develop a network of hydrogen fueling stations that function like today's retail gasoline stations.

While the use of renewable resources is not a requirement of CaH2Net membership, it is a significant part of the Blueprint Plan and CaH2Net goals moving forward. At this early stage of infrastructure development, using renewable resources is not always cost effective. However, in the long run the use of renewable resources for hydrogen production will be essential for a clean and sustainable hydrogen future.

In order to highlight stations that already meet or exceed the environmental goals, the CaH2Net has established Gold Star CaH2Net member stations. Stations that already satisfy both the emissions reduction and renewable resource utilization requirements for State-funded stations will be designated as Gold Star CaH2Net stations.



State-Funded Stations

To help meet the phase one goals of the Blueprint Plan, through Chapter 91, Statutes of 2005, the State Legislature authorized $6.5 million for the implementation of hydrogen stations and deployment of hydrogen vehicles. This section describes the State's progress to add hydrogen stations and cars to California.

Using the criteria described in Chapter 91, Statutes of 2005, the State selected three contractors through a public process to co-fund three hydrogen fueling stations. The public process included four workshops throughout the State and consultation with the Cal/EPA Environmental Justice Advisory Committee. The Location and Siting Criteria used to select the stations are provided in Appendix B. These criteria are consistent with the guidelines found in ARB's Land Use and Planning Handbook. The three stations awarded State funding are located in the San Francisco, Los Angeles, and San Diego areas. For copies of the Request for Proposal for the development of these stations, please see Appendix F.

A Hydrogen dispenser will be added to this island along side an existing CNG dispenser.

Pacific Gas and Electric Company

City: San Carlos, San Mateo County
Amount: $1,247,974.00
Partners:

- Gas Technology Institute (reformer technology)
- City/County Association of Governments (funding)
- West Valley College (education)

Station details:

- Natural gas-to-hydrogen reformation
- 12.4 kg/day dispensing at 5000 psi
- 60kg onsite storage capacity
- 35% new renewable energy using photovoltaics
- Co-located at existing public CNG station
- Potential for dispensing Hydrogen/natural gas fuel blend

California State University, Los Angeles

City: Los Angeles, Los Angeles County
Amount: $1,110,585.00
Partners:

- Quantum Technologies (production equipment)
- South Coast Air Quality management District (funding)
- Ahmanson Foundation (funding)
- College of Engineering, Computer Science and Technology (public education)

Station details:

- Water Electrolysis
- 20kg/day dispensing at 5000 psi and 10,000 psi
- 62 kg onsite storage
- 100% new renewable energy

Future station will be located on the empty lot. The site is adjacent to a parking lot on the east side across the street from the College of Engineering, Computer Science and Technology building and directly adjacent to several major freeways.

San Diego City Schools/Thurgood Marshall Middle School

City: San Diego, San Diego County
Amount: $1,250,000.00
Partners:

- UCSD (operation and education)
- Air Products (production equipment)
- Miramar College, Advanced Transportation Center (outreach/education)
- 3rd Rock Systems (renewable energy)
- U.S. Navy, Camp Pendleton (fleet refueling)

Station details:

- Water Electrolysis
- 39kg/day dispensing at 5,000 psi
- 100kg onsite storage
- 100% new renewable energy on-site photovoltaic
- 200kW fuel cell energy station
- Fueling facility for light, medium and heavy duty vehicles

The perimeter of the fence marks the future site of the San Diego City Schools hydrogen station. The site is located on top of a hill, southeast of the athletic fields at Thurgood Marshall Middle School.

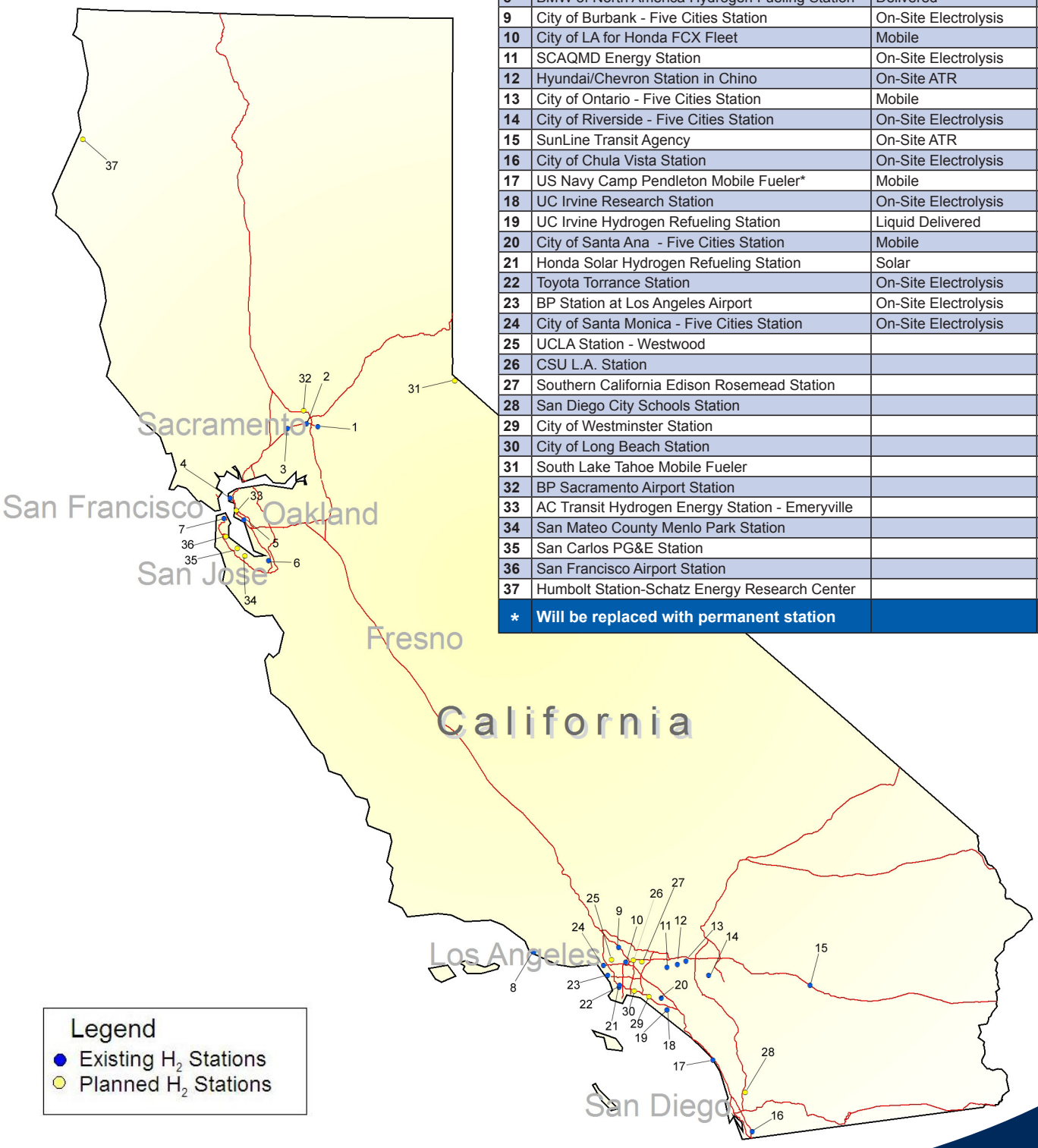
Station Outreach and Education

Hydrogen used as a consumer transportation fuel is a new concept to most people. Therefore, to help ensure community support for the State-funded stations, each contractor developed a community involvement plan. The plans include personal meetings with the local permitting and planning departments, fire marshals and other stakeholders well in advance of the permitting and construction phases.

In addition to early community involvement, each operator has developed plans to use the stations for educational purposes once they are completed. This includes coordination with other community organizations such as schools, local air pollution control district officials and local government officials. Copies of the outreach plans can be found in Appendix G.

Map of Existing and Planned Stations

	Station Name	Production Method	Access
1	SMUD Mobile Fueler*	Mobile	Public
2	CaFCP Station	Delivered	Private
3	UC Davis Station	Delivered	Public
4	AC Transit Hydrogen Energy Station - Richmond	On-Site Electrolysis	Public
5	AC Transit Hydrogen Energy Station - Oakland	On-Site SMR	Private
6	Santa Clara Valley Transportation Authority	Delivered	Public
7	San Francisco PG&E Station	Mobile	Public
8	BMW of North America Hydrogen Fueling Station	Delivered	Private
9	City of Burbank - Five Cities Station	On-Site Electrolysis	Public
10	City of LA for Honda FCX Fleet	Mobile	Private
11	SCAQMD Energy Station	On-Site Electrolysis	Public
12	Hyundai/Chevron Station in Chino	On-Site ATR	Private
13	City of Ontario - Five Cities Station	Mobile	Public
14	City of Riverside - Five Cities Station	On-Site Electrolysis	Public
15	SunLine Transit Agency	On-Site ATR	Public
16	City of Chula Vista Station	On-Site Electrolysis	Public
17	US Navy Camp Pendleton Mobile Fueler*	Mobile	Private
18	UC Irvine Research Station	On-Site Electrolysis	Private
19	UC Irvine Hydrogen Refueling Station	Liquid Delivered	Public
20	City of Santa Ana - Five Cities Station	Mobile	Public
21	Honda Solar Hydrogen Refueling Station	Solar	Private
22	Toyota Torrance Station	On-Site Electrolysis	Private
23	BP Station at Los Angeles Airport	On-Site Electrolysis	Public
24	City of Santa Monica - Five Cities Station	On-Site Electrolysis	Public
25	UCLA Station - Westwood		Planned
26	CSU L.A. Station		Planned
27	Southern California Edison Rosemead Station		Planned
28	San Diego City Schools Station		Planned
29	City of Westminster Station		Planned
30	City of Long Beach Station		Planned
31	South Lake Tahoe Mobile Fueler		Planned
32	BP Sacramento Airport Station		Planned
33	AC Transit Hydrogen Energy Station - Emeryville		Planned
34	San Mateo County Menlo Park Station		Planned
35	San Carlos PG&E Station		Planned
36	San Francisco Airport Station		Planned
37	Humbolt Station-Schatz Energy Research Center		Planned
*	**Will be replaced with permanent station**		



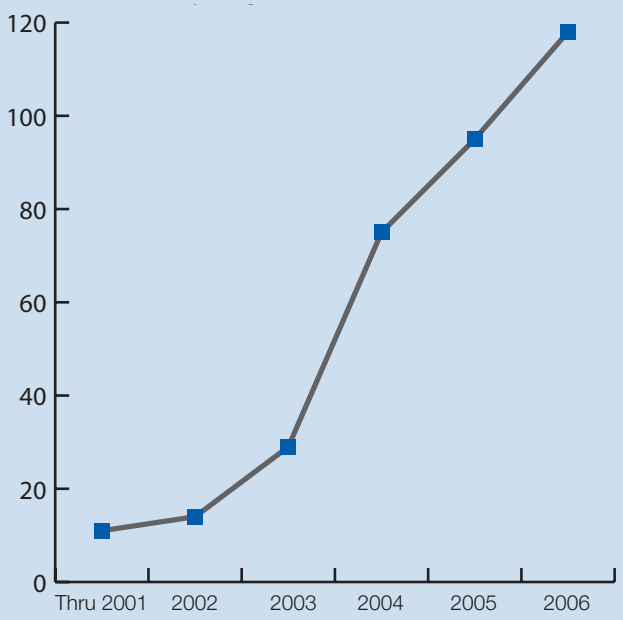
Hydrogen Vehicles

Currently there are 126 hydrogen vehicles on California's roads and 8 hydrogen transit buses. As you can see on the map on page 12, these vehicles and buses are centralized around the hydrogen stations primarily located in the Oakland/San Francisco, Sacramento, Los Angeles/Southern California, and San Diego regions and include fuel cell buses, both fuel cell and hydrogen internal combustion engine passenger vehicles and delivery vans. Vehicles are placed with a number of different customer types including State Universities, Transit Districts, State and Local government, Air Quality Management Districts, and Utility Companies.

The number of fuel cell vehicles will continue to grow with recent announcements by automakers. General Motors (GM) has announced plans to build the world's largest fuel cell vehicle fleet of more than 100 Chevrolet Equinox Fuel Cell vehicles for placement with customers in California, New York, and Washington D.C. in 2007/2008. BMW rolled out the world's first hydrogen-fueled internal combustion engine car at the Los Angeles auto show in November and plan to have it in serial production by April of 2007. In addition, Honda plans to place additional vehicles in California in 2008.

The State has several fuel cell vehicles in its fleet. Through agreements with DaimlerChrysler and Ford, the Department of General Services, the Air Resources Board and the California Energy Commission operate three DaimlerChrysler F-Cells and three Ford Focus FCEVs. Since the cars were delivered in the summer and fall of 2005, the 40 approved State employee drivers have logged a total of 60,000 miles. About half of these drivers are also refueling the vehicles. These vehicles are used for education and outreach, transportation and environment-related events, commutes for mileage accumulation, and other official State business. The fuel cell vehicles are all performing well.

Annual Growth in Hydrogen Vehicles



The number of H2 vehicles has been growing since 2000 and is expected to grow dramatically in the next decade.

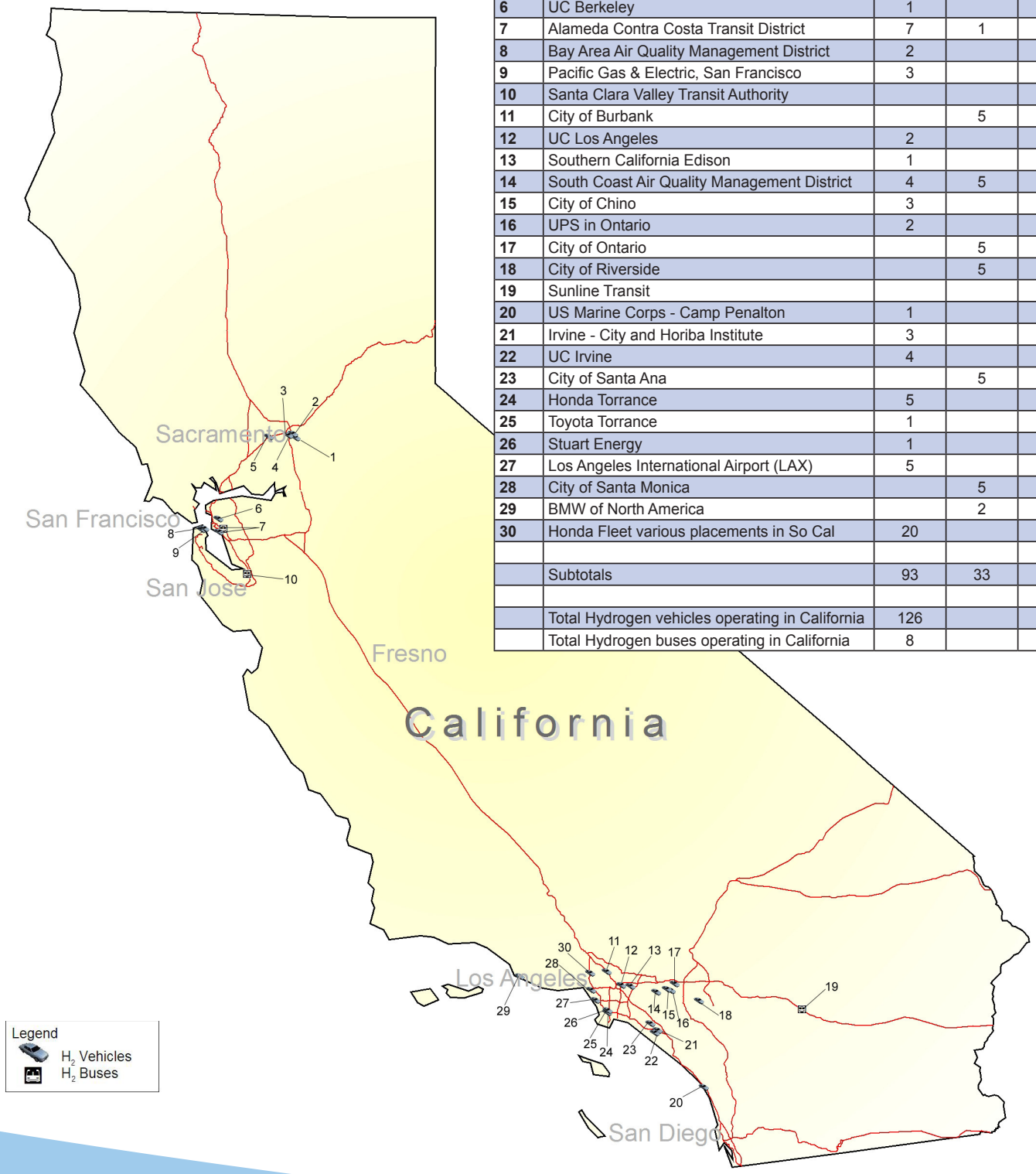
State-Funded Vehicles

Chapter 91, Statutes of 2005 authorized the State to lease a diverse fleet of up to 12 hydrogen-powered vehicles and to lease or purchase up to two hydrogen-powered internal combustion engine shuttle buses for operation in the State.

Through a competitive bidding process, the ARB solicited proposals from car manufacturers for the procurement of one General Motors fuel cell vehicle, four Toyota hybrid electric vehicles converted by Quantum Technologies to operate on hydrogen fuel, and two Ford hydrogen internal combustion engine (ICE) shuttle buses capable of carrying 12 passengers (see Appendix H for a copy of the Request for Proposal for the Procurement of Hydrogen Vehicles). The combined cost of the five vehicles and two shuttle buses is almost $1 million dollars, the amount allocated by Chapter 91 for the procurement of up to 12 vehicles. The ARB was able to procure fewer vehicles than originally anticipated due to the higher than anticipated cost of the vehicles. Efforts are underway to place these vehicles in fleets in order to gain acceptance and experience with fleet managers and to use them for public education and outreach.

Map of H2 Vehicles on the Road

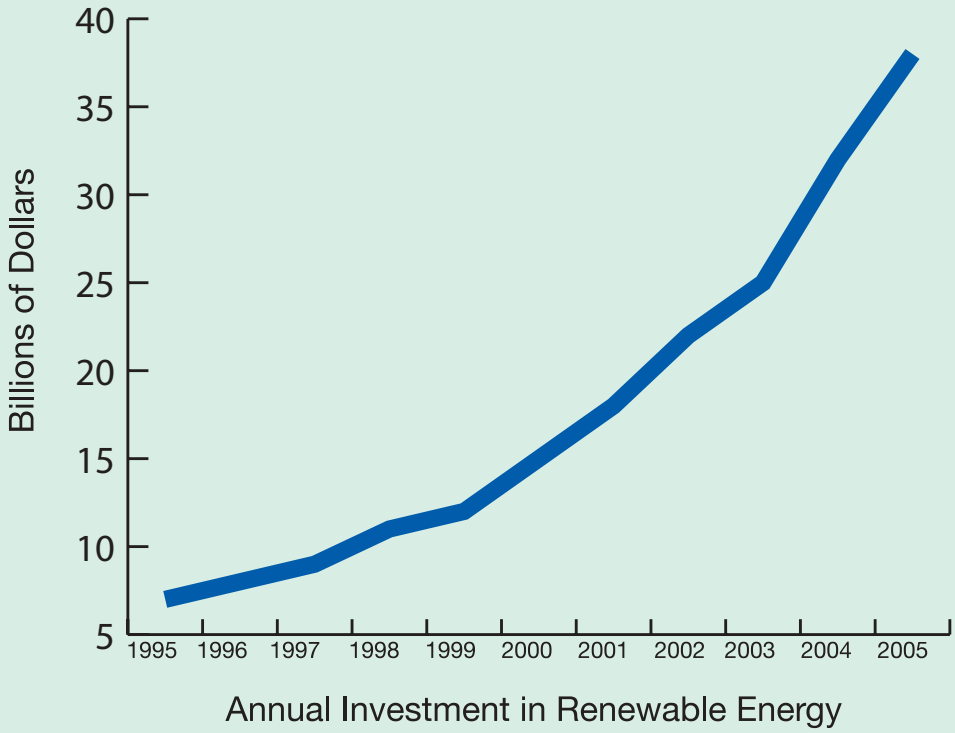
NUM	LOCATION	H2 FCVs	H2 ICE	FC Bus	H2 ICE BUS
1	Sacramento Municipal Utility District (SMUD)	7			
2	Caltrans	2			
3	State Agencies (DGS, ARB, CEC)	7			
4	California Fuel Cell Partnership including OEMs	10			
5	UC Davis	2			
6	UC Berkeley	1			
7	Alameda Contra Costa Transit District	7	1	3	
8	Bay Area Air Quality Management District	2			
9	Pacific Gas & Electric, San Francisco	3			
10	Santa Clara Valley Transit Authority			3	
11	City of Burbank		5		
12	UC Los Angeles	2			
13	Southern California Edison	1			
14	South Coast Air Quality Management District	4	5		
15	City of Chino	3			
16	UPS in Ontario	2			
17	City of Ontario		5		
18	City of Riverside		5		
19	Sunline Transit			1	1
20	US Marine Corps - Camp Penalton	1			
21	Irvine - City and Horiba Institute	3			
22	UC Irvine	4			
23	City of Santa Ana		5		
24	Honda Torrance	5			
25	Toyota Torrance	1			
26	Stuart Energy	1			
27	Los Angeles International Airport (LAX)	5			
28	City of Santa Monica		5		
29	BMW of North America		2		
30	Honda Fleet various placements in So Cal	20			
	Subtotals	93	33	7	1
	Total Hydrogen vehicles operating in California	126			
	Total Hydrogen buses operating in California	8			



Because renewable energy sources such as wind, solar, and biomass are important feedstocks for hydrogen production, strong investment in these areas is a favorable indicator for continued growth in the fuel cells and hydrogen sector. While much of this investment in renewables is being made in wind and solar energy, fuel cells and hydrogen make up an important and increasing share. An indicator of this is the Wilder Hill Clean Energy Index (ECO), a benchmark index for the renewable energy sector, which includes 11 fuel cell and hydrogen companies that represent approximately 22 percent of the weighted index. The combined market capitalization of these 11 companies is over $4.4 billion as of November 2006. Since its launch in August of 2004, the index has had strong performance with over 47 percent growth.

Other signs of a strong and growing hydrogen and fuel cell sector are equity investments as well as research and development dollars. There have been over $470 million in recent equity investment in fuel cell companies, and according to Business Banking Review, $3.7 billion has been allocated in the United States (U.S.) for fuel cell research over the next 10 years. The U.S. demand for fuel cells is estimated to reach $1.1 billion by 2008.

More broadly, worldwide investment in renewable energy capacity continues to grow significantly. As the graph below shows, from 1995 to 2005, annual investment in the renewable energy sector increased from approximately $7 billion to $38 billion worldwide. In addition, 2005 is being heralded as the year private equity investments in clean energy took off, with $7.2 billion invested worldwide, or more than double the investment of 2004. While Europe saw the most with $3.1 billion, the US was a close second with $2.7 billion.



Annual Investment in Renewable Energy

Source: REN21 Renewable Global Status Report 2006 Update, www.ren21.net

In California, increased activity in the renewable and clean technology sectors is also reflected in the level of activity in the area of hydrogen and fuel cells. Already a leader, California hydrogen business activity continues to be the most dynamic and closely watched in the world. Even hydrogen-related businesses located outside the State have significant presence and activities in California.

Hydrogen Business Highlights from 2006:

- General Motors committed to building the world's largest fuel cell vehicle fleet, saying it will build more than 100 Chevrolet Equinox Fuel Cell vehicles for placement with customers in California, New York, and Washington D.C. in 2007/2008.
- BMW announced it will roll out the world's first hydrogen-fueled car at the Los Angeles auto show in November and have it in serial production by April of 2007.
- Honda Motor Co., Ltd. held a demonstration drive of the next generation FCX Concept fuel cell vehicle. Limited marketing of the totally new fuel cell vehicle based on this concept model is to begin in 2008 in Japan and the U.S.
- Energy Conversion Devices, Inc. was awarded $1.2 million from the U.S. Department of Energy to develop a low-cost method to convert small gasoline internal combustion engines (under 25 horsepower) to run on hydrogen fuel, while maintaining the performance and durability of the unmodified engines.
- Ballard Power Systems has announced successful completion of alpha trials and plans for accelerated beta trials and managed commercial rollout of its air-cooled fuel cell, the Mark 1020 ACS.
- Officials of the US Postal Service (USPS) and General Motors participated in the September 27, 2006 unveiling of a hydrogen fuel-cell mail delivery minivan at the Irvine Post Office.
- Air Products installed a new 5,000 psi fueling station at UC Irvine with 25 kg/day capacity. Preparations are being made to implement 10,000 psi fueling in addition to the 5,000 psi capacity.
- Jon Spallino, of Redondo Beach, became the first real world consumer driver of a Honda fuel cell vehicle.
- South Coast Air Quality Management District's Five-cities program is operational in Riverside, Burbank, Santa Ana, Ontario and Santa Monica. Each has opened hydrogen fueling stations and added fleets of five Toyota Prius' converted by Quantum Technologies to run on hydrogen.
- ISE Corporation of Poway integrated four 40-foot hydrogen fuel cell transit buses. Three are in use at AC Transit, one at SunLine Transit. SunLine is also running a hydrogen internal combustion engine bus, converted by ISE.
- Advanced Technology Training Institute of San Diego recently updated hydrogen technician training and has announced its new public outreach tool, the Hydrogen Demonstration Trailer.

Map of Hydrogen Businesses

	Company		
1	Altergy Systems	28	CALSTART
2	ACM Systems	29	Fuel Cell Energy, Inc.
3	California Fuel Cell Partnership	30	GNR
4	Holt of California	31	Southern California Edison
5	Onsite Power Systems	32	Powerzinc Electric
6	Sequest Energy Marine	33	Hyundai-Kia America Technical Center, Inc.
7	Air Products & Chemicals, Inc.	34	Technip USA
8	Energy Conversion Devices, Inc.	35	Luxfer Gas Cylinders
9	Emerent Energy Services	36	Wintec Energy, LTD.
10	Praxair, Inc.	37	General Atomics
11	BOC Group	38	ISE Corporation
12	Hy-Energy	39	GE Global Research
13	Kainos Energy Corp.	40	Quantum Technologies
14	TIAX LLC	41	CH2MHill
15	PolyFuel	42	Newport Hydrogen, Inc.
16	Pacific Gas & Electric Company	43	Asia Pacific Fuel Cell Technologies
17	Chevron Energy Solutions	44	Brown Co.
18	Apollo Power	45	Nextgen Fueling
19	H2 Solutions Inc.	46	Clean Energy
20	BMW of North America, LLC	47	Intelligent Energy
21	California Motors, LLC	48	Praxair, Inc.
22	Hydrogenics Corporation	49	HbT
23	H2Scan	50	American Honda Motor Co.
24	Harvest Energy Technology	51	Toyota Technical Center, USA, Inc.
25	Sunergy Systems	52	Honda R&D Americas, Inc.
26	Southern California Gas Company	53	SAM
27	H2Economy	54	Hydrogen Ventures, LLC
		55	Bakman Clean Energy Center

As shown in this map, California is home to a significant number of fuel cell and hydrogen related businesses and institutions. Located in largely the same urban clusters as existing and planned hydrogen infrastructure, California's hydrogen businesses and institutions are well positioned to create regional concentrations of activity, which will help build a critical mass of hydrogen activity in the State.

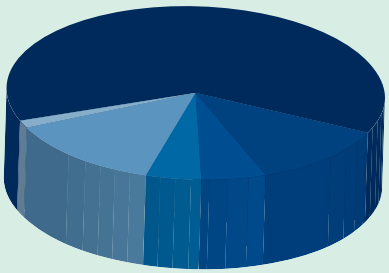
CaH2Net Financial Snapshot

2005/2006 Funding

Chapter 91, Statutes of 2005, appropriated $6.5 million as of January 1, 2006, to fund the State's share of various activities related to hydrogen vehicles and infrastructure. To date the State has encumbered $5,873,424. The appropriated funds were used for:

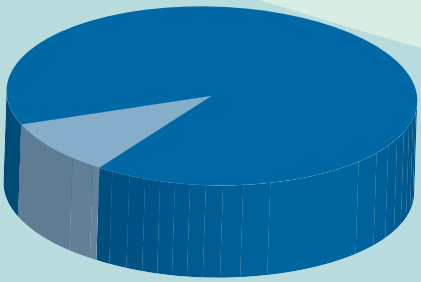
- The development of three hydrogen demonstration stations (up to $3.75 million).
- The procurement of hydrogen vehicles and shuttle buses (approximately $1 million).
- Staffing.
- Operating expenses including a contract with the California Department of Food and Agriculture to develop fuel specifications for hydrogen.
- Consulting services to assist the State with implementing infrastructure and demonstration targets identified in the Blueprint Plan; conduct targeted communication with environmental, industry, and public stakeholders; and assist with the development of education and communication materials.
- To supply the State's fuel cell vehicles with hydrogen fuel and provide training for vehicle refueling.

2005/2006 Expenditures



- Co-fund three H2 stations - $3,510,559
- Procure H2 vehicles - $968,200
- Operating expenses - $322,720
- Consulting services - $250,000
- Staffing - $747,945
- Hydrogen Fuel and Training - $74,000

2005/2006 Total Funds Encumbered



- Funds encumbered to date - $5,873,424
- Funds remaining - $626,576

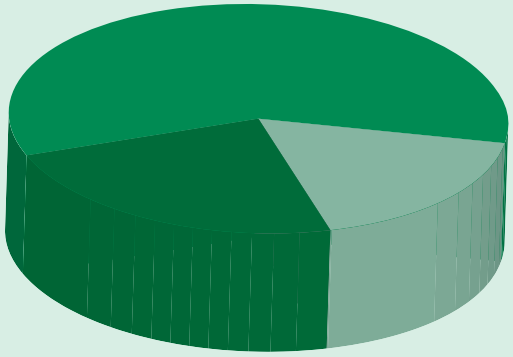
2006/2007 Funding

Through Chapter 48, Statutes of 2006, the State Legislature authorized an additional $6.5 million in funding to continue implementation of the CaH2Net. SB 1811 also included $25 million to increase the use and production of alternative fuels such as ethanol, biodiesel, and plug-in hybrid electric vehicles. The $6.5 million for hydrogen will be used to build three new hydrogen refueling stations and for hydrogen buses.

Request for proposals to fund the additional three stations will be released in early 2007. The maximum amount of co-funding available will be $500,000 per station for a total of $1.5 million. The renewable and environmental criteria for these new stations will meet the criteria set forth in Assembly Bill 1505.

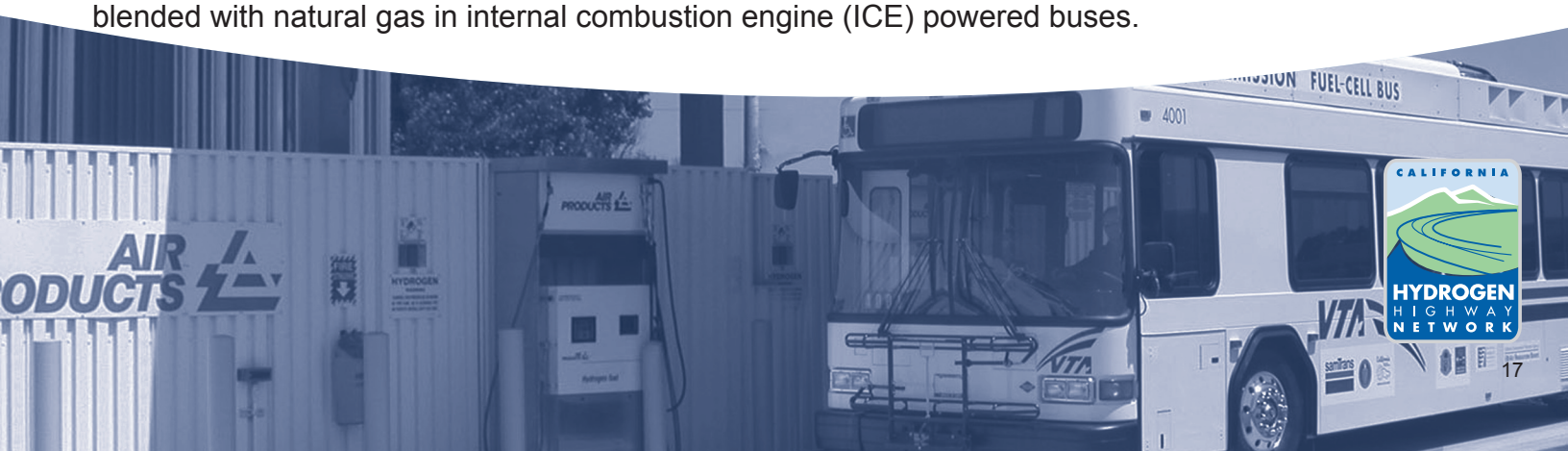
The remaining $5 million has been earmarked to support fuel cell bus demonstrations in California. The Department of Transportation (DOT) National Fuel Cell Bus Technology Development Program has awarded $12 million for fuel cell bus-related projects in California. The DOT program requires non-federal matching funds. Projects funded by DOT and under consideration for co-funding from the 2006/2007 budget allotment include new buses at SunLine Transit; an auxiliary power fuel cell hybrid bus at San Francisco Municipal Transit; and accelerated testing of fuel cell buses currently in operation at AC Transit and SunLine. (see Appendix I for more information about Federal Hydrogen Transportation programs).

2006/2007 Funding



- Fuel Cell Bus Funds - $5 million
- Additional Hydrogen Stations Funds - $1.5 million
- AFIP - $2 million

In addition, $2 million from the Alternative Fuel Incentive Program (AFIP) (Budget Act 2006) have been preliminarily allocated for zero and near zero emission transit bus projects. Solicitations will be requested for projects including, but not limited to, fuel cell bus demonstration projects; retrofitting and upgrading older generation fuel cell buses; and projects that would use hydrogen and hydrogen blended with natural gas in internal combustion engine (ICE) powered buses.



Communications

Ensuring access to objective and timely information about hydrogen vehicles and infrastructure technology is a critical component of the CaH2Net's implementation plan. In an environment where many new technologies and alternative fuels are developing, it is essential to get accurate information to priority audiences.

CaH2Net has focused its initial outreach efforts on three key audiences: news media, legislators and the environmental justice community. The California Fuel Cell Partnership (CaFCP) has also been instrumental in hydrogen communications with their community outreach workshops, emergency responder training and their annual Road Rally.

Media Outreach

Outreach to news media focused on reporters who cover automotive and environmental topics. Two media workshops, one in Northern California and one in Southern California, brought together experts from academia, the auto and energy industries, and environmental and public safety groups to provide an overview of the issues facing California as it moves toward commercialization of hydrogen and fuel cell vehicles.

Subsequent outreach targeted editorial writers. A similar mix of experts, teamed to visit targeted newspaper editorial boards across the State. To date, successful editorial board visits have been completed at the Sacramento Bee and the Oakland Tribune. A companion media kit was developed to support the editorial board visits. This team of experts plans to meet with additional newspapers in the coming months.

Legislative Outreach

As many legislators showed interest in the state of hydrogen and fuel cell vehicle technology in light of ongoing related legislative activity, the CaH2Net Team worked with one of the leading auto companies, Honda, to provide a detailed briefing for several legislators on fuel cell vehicle progress, cost, challenges, and possible commercialization opportunities in California. One on one briefings with legislators and staff provided a comprehensive update on the technology and candid responses to questions.

Environmental Justice Outreach

Per Chapter 91, Statutes of 2005, ARB made multiple presentations to the Cal/EPA Environmental Justice Committee (CEJAC) and solicited comments on the siting and location criteria for the State-funded stations. CaH2Net staff worked with a number of partner organizations to take CEJAC representatives on a multi-site tour of existing hydrogen fueling stations. The stations on the tour were representative of the types of stations likely to be built in the near term and was conducted using the City of Los Angeles Honda FCX fuel cell vehicles.

CEJAC's designated hydrogen representative visited the following hydrogen fueling stations:

- The City of Los Angeles station that uses trucked-delivered hydrogen.
- The South Coast Air Quality Management District that uses grid electrolysis with plans to add solar assist.
- The ChevronTexaco station in Chino that uses onsite natural gas steam reformation.
- Honda's station in Torrance that uses electrolysis powered by a Photovoltaic unit.

Targeting the Message

As with all of ARB's communications efforts, understanding the public's current perceptions about their cars and how they impact the environment, and how willing they are to consider alternatives to today's status quo must shape how communications are undertaken in the future. To this end, ARB conducted a series of focus groups around the State to gain a deeper understanding of attitudes and perceptions about cars, the environment and attitudes toward alternative fuels, including hydrogen. Below is a summary of the findings from these focus groups (see Appendix J for a copy of the Final Report for these focus groups).

Findings:

- Top decision factors when buying a vehicle:
  Environmental performance was either very low on the list or absent all together.
  Male participants: Space, power, size/utility, reliability, fuel economy, and safety
  Female participants: Cost, fuel economy, amenities, reliability, style, and safety

- Knowledge of advanced technology and alternative fuel vehicles:
  Hybrids, diesels and electric vehicles were most familiar to participants but overall there was a general lack of knowledge and substantial misinformation.

- Feelings/beliefs about advanced technologies:
  Respondents generally believed advanced technology vehicles to be small and not functional; lacking in power; unsafe; unattractive; too expensive to make up for the fuel economy improvement; and too early in development. Participants were skeptical of maintenance costs, resale value and overall reliability of the vehicles, and they didn't believe the vehicles were versatile and able to meet their family's needs of towing boats, putting down seats for extra cargo space, etc.

- Motivators / Deterrents in buying advanced technology vehicles:
  Respondents generally believed that new technologies need to mature more for them to have a sense of stability that auto mechanics would be trained, parts would be available and reasonably priced, fuel would be available and the resale value would be more certain. Financial incentives, tax breaks and warranties were big motivators. Helping the environment was mentioned by some, but respondents generally agreed that the vehicles would have to be proven to be just as good as traditional vehicles in all aspects before they would consider buying one. However, if these conditions were met, many participants were willing to spend more for a cleaner vehicle.

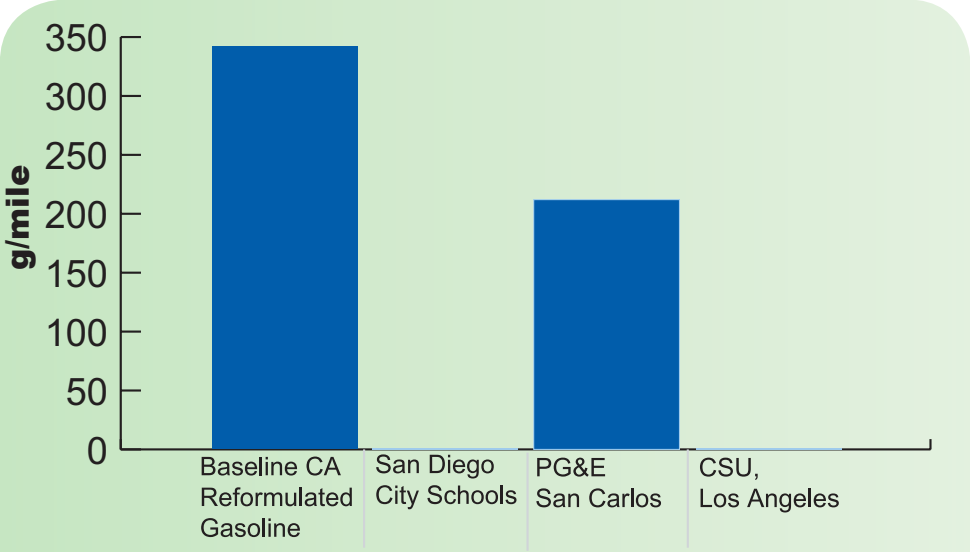
- Importance of environment / foreign oil dependence and global warming on car purchase decision:
  People were generally aware of these issues, and seemed to be more concerned with dependence on foreign oil. Only about half of the respondents indicated that these issues were "real". Most participants did not weight these concerns as part of their purchase decision, and did not foresee that they would in the future.

Using the findings from these focus groups, the ARB will target future outreach to demonstrate technical performance, show the range of clean vehicle choices, ensure fueling stations are available and work to educate consumers on the positive attributes of advanced technology, alternative fuel vehicles.

Environmental Impacts

Environmental Requirements

Chapter 91 statues of 2005 requires that the State-funded stations use 20 percent, with a goal of 33 percent, new renewable energy, for the production of hydrogen beyond the State's required renewable portfolio standard, achieve a 30 percent reduction in greenhouse gas emissions relative to comparable emissions from current year vehicles and have no increase in criteria or toxic pollutant emissions.



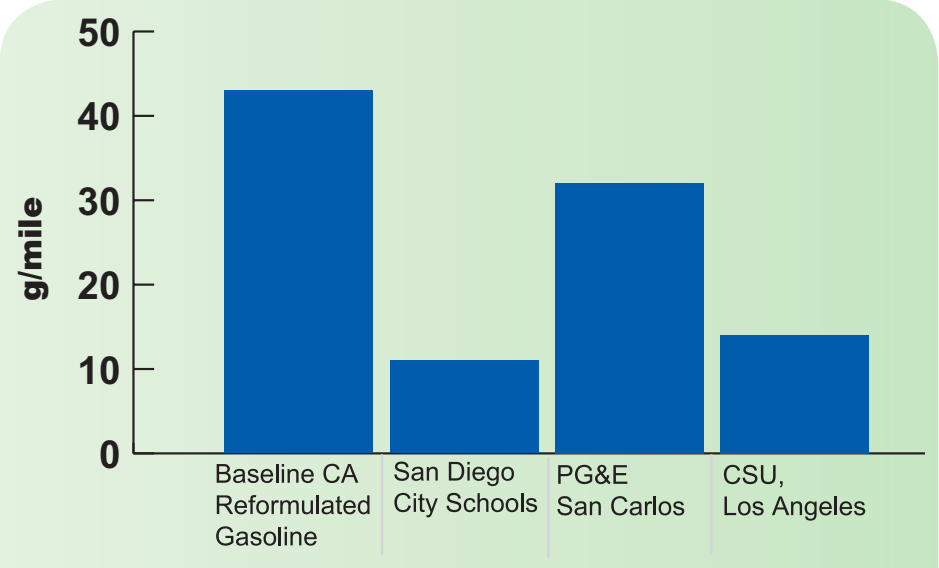
Greenhouse Gasses (GHG) on a Well to Wheel Comparison

Environmental Impacts of State-funded Stations

The stations funded by Chapter 91, Statutes of 2005, all meet or exceed the environmental requirements described in the law. The environmental impacts of the awarded stations will be a substantial improvement over an existing California reformulated gasoline station.

The San Diego and California State University, Los Angeles (CSU LA) stations will use 100 percent renewable clean energy to produce hydrogen. The PG&E station will use natural gas as its primary source of hydrogen however it will supplement this production method with renewable solar power, thus, preventing upstream power plant emissions. As shown in the graph above, on a well-to-wheel basis, the greenhouse gas emissions from these three stations is less than the greenhouse gas emissions of

a standard gasoline station on a gram per mile basis.
As illustrated below, all three of the State-funded stations will emit less criteria pollutants than the standard gasoline station. Although San Diego and CSU LA are both 100 percent renewable, some criteria pollutant emissions will occur due to the use of hydrogen fueled internal combustion vehicles at the stations which emit very low levels of oxides of nitrogen.



Criteria Pollutants (NOX and ROG) on a Well to Wheel Comparison

Senate Bill 1505

In 2006, Governor Schwarzenegger signed Senate Bill (SB) 1505 putting the environmental requirements described in the Blueprint Plan into statute. SB 1505 ensures that hydrogen production is done in a clean and environmentally responsible manner by requiring the ARB to adopt regulations that ensure that State-funded hydrogen stations contribute to the reduction of greenhouse gas, criteria air pollutant, and toxic air contaminant emissions. SB 1505 sets environmental requirements on all hydrogen used for transportation in California once hydrogen use reaches a certain level statewide.

Recommendations for Continued Deployment

Implementation of the Hydrogen Highway is well underway in California. California's recognized world leadership in the deployment of hydrogen transportation technologies is the result of a dynamic public-private partnership. While many states and nations are actively pursuing hydrogen technologies, California can maintain its leadership position by continuing to deploy hydrogen vehicles and stations per the recommendations of the Hydrogen Highway Blueprint Plan. (see Appendix A for a description of hydrogen activities outside California)

Long Term Commitment

In May of 2005, the Hydrogen Highway Blueprint Plan concluded that the transition to hydrogen fuel in California would best be accomplished through a multi-year, phased approach to station and vehicle deployment requiring a long-term commitment and regular progress assessments. Specifically, the Blueprint recommended a "station build-up" approach where fueling stations would initially be clustered in urban areas with a smaller number of stations linking these clusters. These early clusters were identified as the San Francisco Bay Area-Sacramento region and the Greater Los Angeles-San Diego region.

Fleet Development First

In the year and a half since the Blueprint Plan's recommendations, hydrogen stations and vehicles have been deployed along these lines in the Greater Los Angeles and San Francisco Bay Area regions. As predicted by the Blueprint Plan, these early stations serve primarily dedicated fleets rather than the motoring public. Hydrogen vehicles to date are largely placed within fleets operated by the State of California, local government, Universities and private companies.

State Incentives

State funding of stations has played a critical role in demonstrating hydrogen refueling stations with strong renewable energy components. Additionally, these stations are educational beacons for the public as well as key stakeholders such as

safety officials and students, to learn about the benefits of H2 transportation. The State should continue to support these showcase demonstration stations as an important element of building the H2 station network.

The State also needs to play a role in providing incentives for hydrogen vehicles in order to bridge the pricing gap during the critical pre-commercialization period and to meet customer demand. In addition, competing programs around the world are attracting the resources and attention of vehicle manufacturers, providing incentives for vehicle placements is necessary to encourage vehicle manufacturers to place additional fuel cell vehicles in California, to support development of the technology and to fully utilize the growing number or stations.

While co-funding stations will continue to be important in the near term, the State also has an important role to play in the coordination of station and vehicle deployment with private sector partners. The State is in a unique position to facilitate a statewide strategy to ensure the most efficient and efficacious rollout of hydrogen stations and vehicles.

Cluster Approach

Based on input from the Hydrogen Highway Advisory Panel and evaluation of the progress of station and vehicle deployment to date, the ARB will seek to refine the “station build-up” approach for the future deployment of stations and vehicles. ARB will work with private sector partners to pin-point specific station locations within existing hydrogen fueling clusters to form mini hydrogen networks. Future priorities also include work to expand and ensure public access at existing and future stations, and providing education for the public about hydrogen station and vehicle rollouts for key audiences.

Partnerships

The success of hydrogen activities in the State to date are the result of the collaboration of a large number of public and private sector entities which are motivated by hydrogen’s energy security, environmental, economic, and public health benefits. By continuing to thoughtfully deploy hydrogen vehicles and stations, California has an opportunity to realize all of these benefits.

Appendices

A. Activities in Other States
B. Station Location and Siting Criteria
C. Hydrogen Fuel Quality Standard
D. CaH2Net Membership Criteria and Guidelines
E. Hydrogen Tutorial
F. Request for Proposal for the Development of Hydrogen Stations
G. Outreach Plans for State Funded Stations
H. Request for Proposal for the Procurement of Hydrogen Vehicles
I. Federal Programs
J. Focus Groups - Final Report

ARB	California Environmental Protection Agency's Air Resources Board
ATR	Auto Thermal Reformation
Blueprint Plan	California Hydrogen Highway Blueprint Plan
CaFCP	California Fuel Cell Partnership
CaH2Net	California Hydrogen Highway Network
Cal/EPA	California Environmental Protection Agency
CEJAC	Cal/EPA Environmental Justice Advisory Committee
CSU LA	California State University, Los Angeles
FCV	Fuel cell vehicle powered by hydrogen fuel
GHG	Greenhouse gas
GM	General Motors
H2	Hydrogen. For purposes of this report, all hydrogen gas is assumed to be in gaseous, compressed form unless otherwise noted (see LH2)
H2CNG	Hydrogen-natural gas blended fuel
ICE	Internal combustion engine
H2ICE	Hydrogen-fueled internal combustion engine
kg/day	Kilograms of hydrogen per day
kW	Kilowatt (1000 watts)
LH2	Liquefied hydrogen fuel
OSFM	California Department of Forestry & Fire Protection's Office of the State Fire Marshal
PG&E	Pacific Gas & Electric
RFP	Requests for Proposals in response to funds allocated by the legislature within Senate Bill 76 (2005)
SCAQMD	South Coast Air Quality Management District
SMR	Steam methane reformation
WTW	Well-to-wheel: A calculation of the total emissions and/or energy consumed from the initial production and delivery of a vehicle's fuel, through the consumption of that fuel, to the emissions from the vehicle.

CALIFORNIA HYDROGEN HIGHWAY NETWORK

www.HydrogenHighway.ca.gov