

Why 100 Hydrogen Stations

A California Fuel Cell Partnership White Paper

The State of California committed funding to design, build and provide operation and maintenance support for 100 hydrogen stations. At the beginning of 2017, more than 45 hydrogen stations were open or in construction and the California Energy Commission had proposed funding for 16 additional stations. Outside of California, hydrogen stations in the Northeast U.S. began construction and nearly 100 stations were in operation around the world.

CaFCP and other organizations are planning the next phase of station deployment to support fuel cell electric vehicle (FCEV) expansion. During discussions, some stakeholders talk about California's 100 stations as a final number or the end point for government incentives. CaFCP has always seen 100 stations as a milestone. This white paper provides context about how 100 became "the number" so that all stakeholders understand its significance as we craft the post-100 station vision and plan.

2000 - 2008

California's First Hydrogen Stations

The first hydrogen stations, including the West Sacramento station at CaFCP's headquarters (*Figure 1*), were privately funded and built to prove out station and vehicle technology. By 2003, fuel cell vehicle technology looked promising and state, federal and local government begin funding or co-funding "demonstration" stations that would collect data to improve technology and reduce costs.

These early stations, often referred to as "Tech-Val stations" were primarily for fleet vehicles. Some stations were part of South Coast AQMD's Five Cities project and were access controlled (*Figure 2*). Other stations were part of California Air Resources Board's Hydrogen Highway (*Figure 3*), which was focused on publicly accessible stations.



Figure 1: Hydrogen station at CaFCP headquarters in West Sacramento in 2002



Figure 2: Hydrogen station at the City of Santa Monica fleet yard in 2006



Figure 3: The UC Irvine station in 2008

By 2008, automaker members were placing the first demonstration vehicles into consumers' hands, and AC Transit and SunLine were expanding their fuel cell bus programs. CaFCP automaker members determined that the early market for FCEVs would be retail consumers (Figure 4), not fleets, and hydrogen stations needed to be built with customers in mind.



Figure 4: In 2008, actress Q'orianka Kilcher was 17 when she became a Honda FCX customer.

A Short History of Early Station Funding

- 2003 President George W. Bush announced a \$1.2 billion hydrogen initiative¹
- 2004 Governor Arnold Schwarzenegger launched the Hydrogen Highway Network initiative.
- 2005-2008 Department of Energy, California Air Resources Board, South Coast Air Quality Management District, automakers, and energy companies invested in 25 "demonstration" hydrogen stations for FCEVs. Many of these stations were part of DOE's five-year Controlled Hydrogen Fleet and Infrastructure Demonstration and Validation Project (often called Tech-Val)² that collected data about included passenger FCEVs and hydrogen stations³ that would improve technology and reduce costs.
- 2007 California published the State Alternative Fuels Plan⁴ that called for state funding for infrastructure for all alternation fuels
- 2007 California legislation (AB 118)⁵ established the Alternative and Renewable Fuel and Vehicle Technology Program (ARFVTP) administered by the California Energy Commission. ARFVTP would provide up to \$100 million a year through 2014 for all alternative fuels and several vehicle technologies to help the state reach greenhouse gas and petroleum reduction goals.

¹ Bush's initiative also included funding for stationary fuel cells for power generation and R&D investments through national labs, universities, and with automakers via the FreedomCAR initiative.

² ARB invested \$19 million over three years, SCAQMD invested \$2 million over three years, and DOE invested \$175 million in the Tech-Val program that also included projects outside California. Industry matched government investments. www.arb.ca.gov/msprog/zevprog/hydrogen/hydrogen_cah2net.htm, articles.latimes.com/2004/mar/09/business/fi-hydrogen9, and www.nrel.gov/docs/fy08osti/42284.pdf

³ ARB, DOE, and the U.S. DOT also funded fuel cell buses and transit stations beginning in 2006 and continue today. Because the "100 stations" are focused on light duty vehicles, this paper doesn't include transit funding.

⁴ www.energy.ca.gov/2007publications/CEC-600-2007-011/CEC-600-2007-011-CMF.PDF

⁵ www.energy.ca.gov/altfuels/documents/ab_118_bill_20071014_chaptered.pdf

In 2009, automakers were planning the initial commercial launch of FCEVs. To understand where stations needed to be built, UC Irvine and the Institute of Transportation Studies at UC Davis conducted studies about how people drive and where they get fuel to get a sense of how many stations were needed and where they should be located.

Automakers needed stations to be open when customers started receiving their cars. Station developers were concerned about building stations that would see one or two cars a week, or that they would build a station only to have cars deployed elsewhere. To provide confidence about deployment to automakers and station developers, it was necessary to estimate the number of vehicles and basic geographical distribution. In 2009, the Energy Commission, Air Resources Board, and CaFCP conducted a confidential automaker survey to project total FCEVs in California over a seven-year period.

The result showed that market introduction was expected in 2014 with thousands of vehicles on California's roads if the hydrogen stations were in place. Data from this survey formed the basis for California station deployment planning and CaFCP published the *2009 Action Plan for FCEV and Hydrogen Station Deployment (Figure 5)*.⁶ Shortly after publishing this document, the Energy Commission announced the first ARFVTP awards that provided co-funding for public hydrogen stations.



Figure 5: Recommendations from CaFCP's 2009 Action Plan

As this planning was taking place, the recession hit, the oil companies left CaFCP membership, and negative comments from the then-Secretary of Energy⁷ impacted the global hydrogen industry. In a series of meetings in 2010, CaFCP worked on a deployment plan that balanced vehicles with stations. Members used automaker vehicle surveys, market research, and modeling to determine:

- The number of stations and geographic disbursement that would start the FCEV commercial market.
- A trajectory of station/vehicle deployment that would reach volume in a short amount of time.
- The point at which momentum would take over.

⁶ The *Action Plan* is no longer posted on CaFCP's website. To request a digital copy, please email info@cafcp.org.

⁷ In 2009, then-Secretary of Energy Steven Chu said it would take four miracles for hydrogen and FCEVs to come to the market. (Chu later recanted.)

Meeting participants identified that 68 well-placed hydrogen stations statewide could start the commercial market, but "upwards of 100 stations would be necessary to ensure the network had enough capacity for additional vehicle introductions."⁸ It was the first time that the number "100" appeared as a target for hydrogen station deployment.

ARFVTP would have, at the time, funded an estimated 37 stations,⁹ leaving 31 stations unfunded. CaFCP members worked with Energy Independence Now as they developed a model to analyze station costs and identified incentive funding required to reach 68 stations.¹⁰ During this time, an existing regulation, Clean Fuels Outlet (CFO), was identified as a potential source of funding for the "gap" stations and continued market growth. (Figure 6)

CFO had never been enacted, but could potentially be updated¹¹ to require oil companies to provide hydrogen stations. CFO looked like a promising tool to fund 100 or more stations, but it soon became clear that CFO would be difficult to implement.

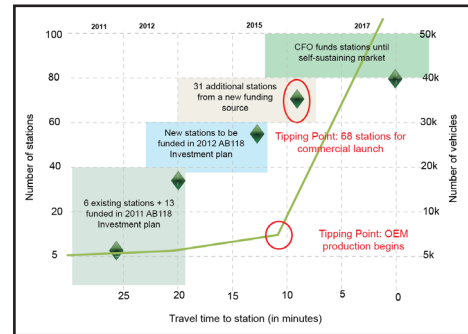


Figure 6: Projection of station deployment if CFO was enacted.

A group of CaFCP members, oil companies, and NGOs decided to work together to ensure that 100 hydrogen stations would be funded so that California would have enough hydrogen capacity to support tens of thousands of FCEVs. The group estimated that \$100 million in addition to the existing ARFVTP funding would be sufficient to build and operate 100 stations. The group began to explore mechanisms that included loan guarantees, cap & trade money, and private investments.

When Assemblymember Henry Perea (D-Fresno) introduced AB 8¹² in December of 2012, which would extend ARFVTP until 2024,¹³ stakeholders saw it as an opportunity to fund hydrogen stations. The stakeholder group successfully encouraged¹⁴ a multi-year designation of up to \$20 million a year for hydrogen stations through 2023 to fund a minimum of 100 hydrogen stations. AB 8 also required an annual evaluation to ensure that infrastructure and vehicles kept pace, and provided flexibility to adjust the funding in any year as recommended in the evaluation.¹⁵ The bill specified that Clean Fuels Outlet or a similar regulation would not be enforced.

8 CaFCP's *A California Road Map*, technical version, page 18 cafcp.org/sites/default/files/A%20California%20Road%20Map%20June%202012%20%28CaFCP%20technical%20version%29.pdf

9 The regulation called for an end of funding disbursements in 2014, although the program continued until 2016.

10 www.einow.org/images/stories/factsheets/ein_california_h2_infrastructure_cost.pdf

11 www.arb.ca.gov/regact/2012/cfo2012/cfoappa.pdf

12 leginfo.legislature.ca.gov/faces/billVersionsCompareClient.xhtml?bill_id=201320140AB8

13 Without AB 8, ARFVTP would stop collecting revenue in January 2014 and expend all funding by January 2015

14 Although CaFCP and ARB facilitated these meetings and provided factual information, neither organization participated in advocacy or lobby efforts for funding or regulation.

15 The most-recent report is [2016 Annual Evaluation of Hydrogen Fuel Cell Electric Vehicle Deployment and Hydrogen Fuel Station Network Development](#).

Commercial launch of FCEVs

2013 - NOW

With a designated funding stream in place, automakers had confidence that the station network would be deployed. The early commercial launch of FCEVs started in 2015 and 2016. In February 2017, more than 45 retail hydrogen stations were open or under construction in California, and the Energy Commission had issued a Notice of Proposed Award for an additional 16 hydrogen stations.¹⁶ Toyota, Hyundai, and Honda had jointly sold or leased nearly 1,500 FCEVs to customers and fleets. Mercedes had announced a fuel cell vehicle to be available in 2017. GM and Honda announced a joint venture to manufacture fuel cells at a Michigan facility.¹⁷

The "100 station" number provided a stake in the ground for commercialization, but was never intended to be the goal. CaFCP's 2012 *Road Map* mentions "100" only once, but discusses increasing capacity of hydrogen throughout the report. UC Irvine's STREET model¹⁸ recommended that hydrogen be available at 5-to-7 percent of retail fuel stations. ARB's 2016 *Annual Evaluation* stated, "Accounting for the expected growth in on-the-road FCEVs based on the auto manufacturer survey and business-as-usual growth in fueling capacity, there will be a statewide shortfall in hydrogen dispensing capacity as early as 2020."¹⁹

CaFCP members are simultaneously working on two plans:

1. A 2017 Hydrogen Progress, Priorities, and Opportunities report that will highlight necessary actions to deploy the 100 stations as effectively as possible.
2. A post-100 plan that will describe the next phases of hydrogen station deployment in and beyond California.

To start this process, it's important that all hydrogen stakeholders agree that California's "100 station" number is a milestone on the road to commercialization, not a destination. This will help investors, suppliers, construction companies, and additional automakers make the business case for FCEVs and hydrogen and start a self-sustaining market.

California Fuel Cell Partnership

www.cafcp.org

¹⁶ www.energy.ca.gov/contracts/GFO-15-605_NOPA.pdf

¹⁷ www.reuters.com/article/us-gm-honda-idUSKBN15B2EK

¹⁸ www.arb.ca.gov/fuels/altfuels/cf-outlets/meetings/uc%20irvine_street_cfo%20workshop_13jul2011_final.pdf

¹⁹ [2016 Annual Evaluation of Hydrogen Fuel Cell Electric Vehicle Deployment and Hydrogen Fuel Station Network Development](#), page 4