Incentivizing Hydrogen Infrastructure Investment

Phase 1: An analysis of the use of Cash Flow Support To Incentivize Early Stage Hydrogen Station Investment

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ENERGY INDEPENDENCE NOW

Acknowledgement and Disclaimers

Many individuals provided guidance and input on this work; however, Tyson Eckerle and Remy Garderet of Energy Independence Now (EIN) are the primary authors of this report and the underlying modeling work, and take full responsibility for the analysis and opinions contained in this report. Any errors or omissions are the sole responsibility of EIN.

In what follows, the hydrogen costs and retail margins are provided for analytical purposes only. Fuel providers and retailers are each independently responsible for determining the wholesale and retail price of hydrogen fuel.

Introduction

This paper is a summary of analysis conducted within the context of an industry and government collaborative effort, launched in July 2011 to examine investment options for early commercial hydrogen infrastructure in California.

Objective:

The objective of the analysis was three-fold:

1) Analyze likely cash flow scenarios of early commercial hydrogen stations, with sensitivity analysis to identify the key variables affecting rates of return.
2) Examine the impact of a Cash Flow Support incentive payment on the attractiveness of investments in such stations.
3) Estimate the total size of the incentive fund required to provide such cash flow support to the first 68 stations in California.

Context and Current Incentives

Compared to gasoline stations, hydrogen stations require relatively high up front capital costs and maintenance expenses. These costs can ultimately be offset by potentially large margins on every kilogram (kg)[1] of hydrogen sold, but for the early hydrogen stations, when vehicles numbers are still low, fuel revenues are insufficient to offset the costs for many months. Some incentive funding is broadly acknowledged to be necessary to make a business case for investing in these early commercial stations.

The focus of current State incentives for station deployment has been on driving the cost of equipment down through cost-share grants to hydrogen station equipment developers. While this model has been successful in making stations cheaper, it does not address operations and maintenance costs incurred by station owners, nor does it leverage the potential private investment from station developers who are not equipment manufacturers.

The current analysis looks at a different form of incentive, aimed to attract this broader set of private investors to hydrogen station investment. The underlying premise of the analysis is that:

1. Companies that currently invest in gasoline stations (including energy companies, fuel marketing intermediaries, and others), may be interested in investing in hydrogen stations.
2. These companies are accustomed to seeing positive cash flows within a matter of months, and are highly averse to extended periods of negative cash flow, even if long term profit potential and rates of return are high.

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[1] Hydrogen will be certified and sold by the kilogram (kg). 1 kg of hydrogen fuel has roughly the same energy content as 1 gallon of gasoline. On average, fuel cell vehicles can travel 2.5 times as far on 1 kg of hydrogen as an internal combustion engine vehicle can travel on 1 gallon of gasoline.

The core assumption of this analysis is therefore that businesses will be motivated to invest in hydrogen if they can break even in the early months, and make money in the later years.

A "Cash Flow Support" Incentive

To motivate this investment, a 'cash flow support' payment is offered to these investors during the early months to offset their losses until sales and revenues reach a break-even point.

This analysis assumes that hydrogen station developers will obtain financing (from a bank or other lender) for the purchase and installation of hydrogen equipment. From the outset, they will therefore need to make financing payments to their lender, as well as pay for operating and maintenance costs of the equipment.

As hydrogen sales rise, their revenues will also, until they reach and surpass their financing and operation costs. The cash flow support incentive described in this analysis is provided to them up until that point, when hydrogen sales become sufficient to generate a positive cash flow.

Report Organization

In the following text, we start by examining the costs and anticipated support needs from an individual station perspective. We then aggregate this individual station information to estimate system-wide costs, and introduce the potential to payback early investments or create a self-sustaining fund system. Finally, we compare this cash flow approach to the capital cost buy down approach. For reference, a summary table of assumptions is included at the end of the document.

Hydrogen Station Costs, Revenues & Cash Flows

A number of variables define the profitability of a hydrogen station. We define the expected costs and revenues in the following sections.

Costs

Expected costs include three primary categories: 1) equipment and installation; 2) operations and maintenance (O&M); and 3) financing.

Equipment, Installation, and O&M: Table 1 presents the expected capital and O&M costs for a variety of stations, as collected from industry and presented by UC Davis. Capital cost includes equipment purchase, permitting fees, and construction. Fixed O&M includes rent, maintenance, insurance, property tax, and permit fees. Variable operations costs are directly tied to hydrogen sales: each kilogram of hydrogen sold requires delivery and compression.

Table 1: Hydrogen Station Infrastructure Costs[2]

Time frame/Station Types	Capital Cost	Annual O&M cost $/yr
Phase I (<2013) 100 kg/d -> 170 kg/d 250 kg/d (has more ground storage)	 $1 million $1.5 million	$100 K (fixed O&M) + 1 kWh/kgH2 x kg H2/yr x $/kWh (compression elec cost) + H2 price $/kg x kg H2/y (H2 cost delivered by truck)
Phase 2 (2014) 100 -> 170 kg/d 250 kg/d	 $0.9 million $1.4 million	Same as above
Phase 3 (2015+) 100 -> 170 kg/d 250 kg/d 400 -> 500 kg/d	 $0.5 million $0.9 million $1.5-2 million	Same as above

Financing: For the purpose of this analysis, we assume that a hydrogen station developer would borrow 100 percent of the money needed to install hydrogen-fueling equipment. Typically, a gasoline station developer obtains a 7-year loan to construct a station and convenience store, and realizes a positive cash flow after one year (i.e., sales revenue pays for the loan and O&M costs). A hydrogen station will take longer to reach positive cash flow in the early market, and may require a longer loan-term loan to create a feasible business case.

[2] UCD, 2011. University of California, Davis. Ogden, Joan et al. UCD Institute of Transportation Studies. "Analysis of a "Cluster" Strategy for Introducing Hydrogen Fuel Cell Vehicles and Infrastructure in Southern California." Sept. 16, 2011. Revised Oct. 5, 2011.

Revenue

Sales of hydrogen will ultimately drive the success of the commercial retail hydrogen market. These sales are wholly dependent on the deployment of fuel cell vehicles generating demand for hydrogen fuel. The benefit to the retail hydrogen seller can be quantified by multiplying fuel sales by an anticipated retail margin.

Revenue = (kilograms of hydrogen sold)(retail margin)*

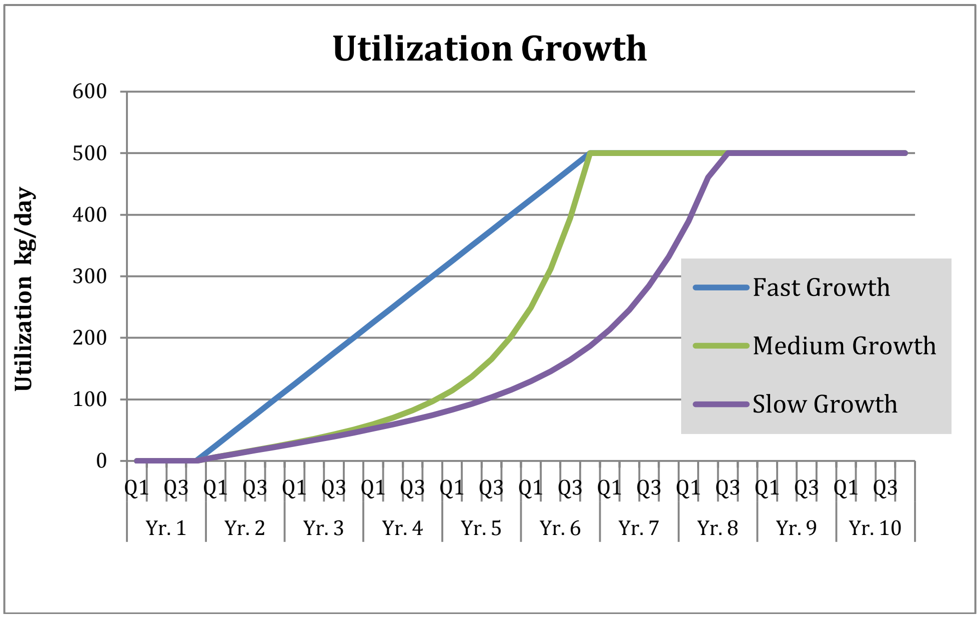
Hydrogen Demand: To estimate the demand for hydrogen at an individual station, we used three potential deployment scenarios: Fast, Medium and Slow growth (Figure 1). The Medium Growth curve is loosely based on the vehicle deployment projection curve provided by the California Fuel Cell Partnership in their *Progress and 2011 Actions for Bringing Fuel Cell Vehicles to Market in California*,[3] and represents growth that an early commercial station might face. The Slow Growth curve represents the very early commercial phase (likely for stations installed in or before 2014), while the Fast Growth curve represents an expanding commercial market (25 kg/quarter sales increase). Each of these curves can be capped at any station capacity. Figure 1 caps the utilization at 500 kg/day (based on the largest station capacity assumed in this analysis). To estimate fuel consumption, we assume that each vehicle consumes an average of 0.6 kg of hydrogen per day.[4]

The growth curves below begin with a full year during which there are no sales, to represent the conservative position that financing and other costs will begin to be incurred from the outset, while the station may only be open for much later. We have modeled station financials both with and without this "lag time" effect.

[3] Published February 2011: http://cafcp.org/sites/files/CaFCPProgressand2011Actions_0.pdf

[4] Fuel consumption based on actual UC Irvine fueling station use. Other generally accepted estimates include 0.7 and 1 kg H2/vehicle/day. 0.6 kg/vehicle/day represents a conservative estimate for the purposes of this analysis and is based on the best available data.

Figure 1: Utilization Scenarios



Price of Hydrogen: We cannot predict the retail price of hydrogen fuel. For the purposes of this analysis, we assume that hydrogen will be sold anywhere from $8 – $10/kilogram, including sales tax. These costs include $6/kg wholesale cost,[5] sales tax of 8% ($0.64 to $0.80/kg) and with retail margins of $2 – 4/kg.[6] Hydrogen is not currently subject to fuel excise taxes administered by the State of California Board of Equalization.[7]

Given that 1 kg of hydrogen holds approximately same energy content as 1 gallon of gasoline, and that hydrogen FCEVs are about 2.5 times as efficient as conventional gasoline engine vehicles,[8] $8 – 10/kg hydrogen represents gasoline priced between $3.20 and $4.00 per gallon. Value to the consumer will largely depend on the price of gasoline: if gasoline prices continue to rise, FCVs will become increasingly attractive to consumers from an operation standpoint. [9]

Cash Flow Projections

Figure 2 illustrates cash flow projections of a potential hydrogen fueling station, defined by the following parameters:

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[5] Based on industry estimates. Wholesale costs will vary by location.

[6] The retail margins are provided for analytical purposes only. Study participants and fuel retailers are each independently responsible for determining the retail margins to be assumed in any analysis and the prices they will charge.

[7] "Selling Hydrogen Fuel in a Pre-Commercial Environment within California". California Department of Food and Agriculture, Division of Measurement Standards. November 2011.

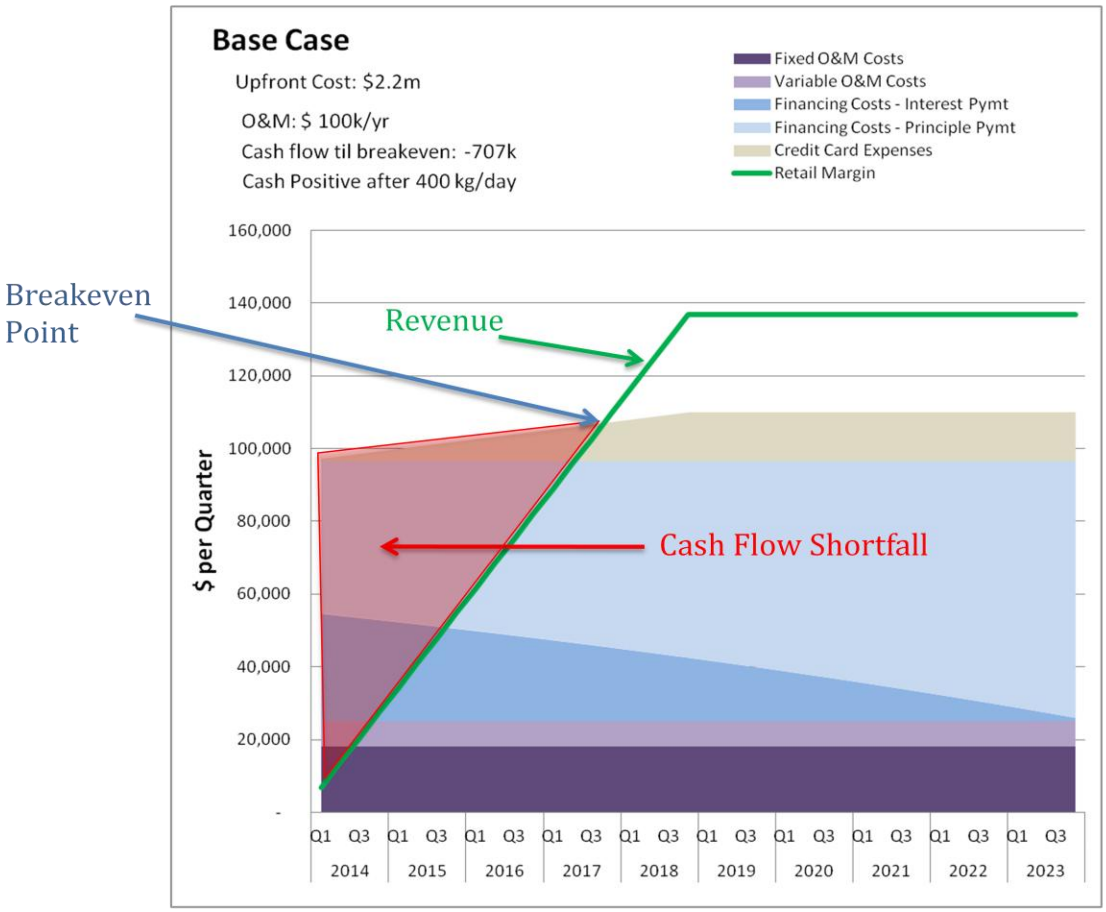
[8] Proposed Amendments to the Low Carbon Fuel Standard. Staff Report: Initial Statement of Reasons for Proposed Rulemaking. California Air Resources Board. October 2011, adopted December 2011.

[9] As a rule of thumb, we assume that auto companies will be able to market a fuel economy benefit if a kilogram of hydrogen costs twice as much as a gallon of gasoline.

- A maximum 500 kg/day capacity
- \$2m Capital Costs +10% Contingency fees, 100% financed
- 5.5%, 10 year loan
- \$100k/year fixed O&M
- \$3/kg retail margin, \$6/kg hydrogen cost
- Capacity utilization capped at 100%
- Fast growth curve with 25 kg sold on day one.

Costs are represented by the block colors, as labeled. For example, the top beige wedge represents credit card fees.

Figure 2: Base Case



Given all of the parameters listed above, this station would take four years to reach a positive cash flow, and breaks even once 400 kg/day are sold (approximately 130 individual fills).[10] In this case, a station owner would be faced with a \$707,000 cash

[10] Two FCEVs are available to select consumers: the Honda Clarity and Mercedes F-cell. The Clarity's tank holds 3.92 kgs, and the F-cell holds 3.7 kgs. Assuming vehicles visit with the need for 3 kgs, 400 kg/day represents 133 individual fill events).

flow shortfall over the first four years of the station (represented by the red colored "cash flow shortfall" wedge).[11]

Incentive Funding Requirements for Base Case

To incentivize investment, we consider the possibility of using incentive funds to cover a station's cash flow shortfall until revenue exceeds costs. In the case of the station presented in Figure 2, the hydrogen station owner would receive $707,000 in funding to avoid losses in the early years.

In what follows, we work to better define the expected cash flow shortfall on both a station and system basis. The goal is to estimate the amount of incentive money necessary to bridge the gap from government cost-shared hydrogen stations, to commercially viable stations:

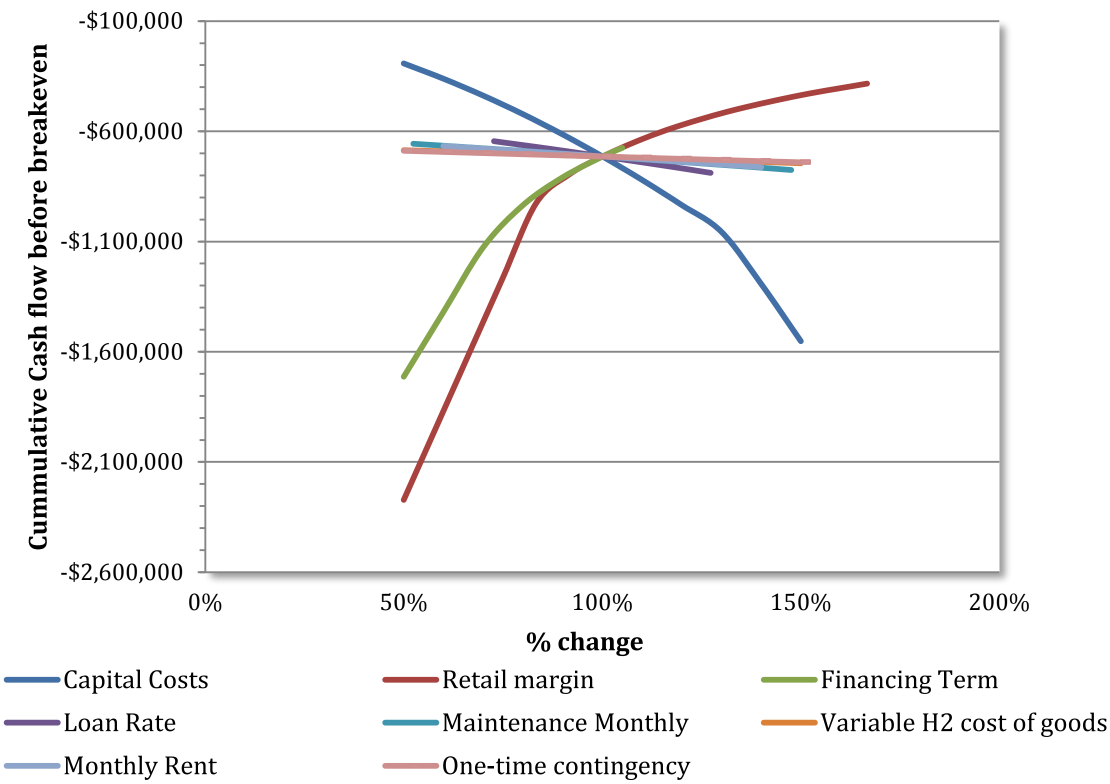
Incentive Fund Needed = (Cost per Station)*(# of stations)

Sensitivity analysis on cost variables

To determine the relative importance of each parameter on station cash flow, we conducted sensitivity analysis on the key cost variables of the base case described above, holding station utilization constant. Figure 3 shows the effect of altering these variables down to 40% of the original assumption, and up by almost 180% (assuming 100% as the base case). The steeper sloped lines indicate variables that have a greater impact on the overall cash flow: in this case, the retail margin, capital costs, and financing term have the strongest effect on the cash flow.

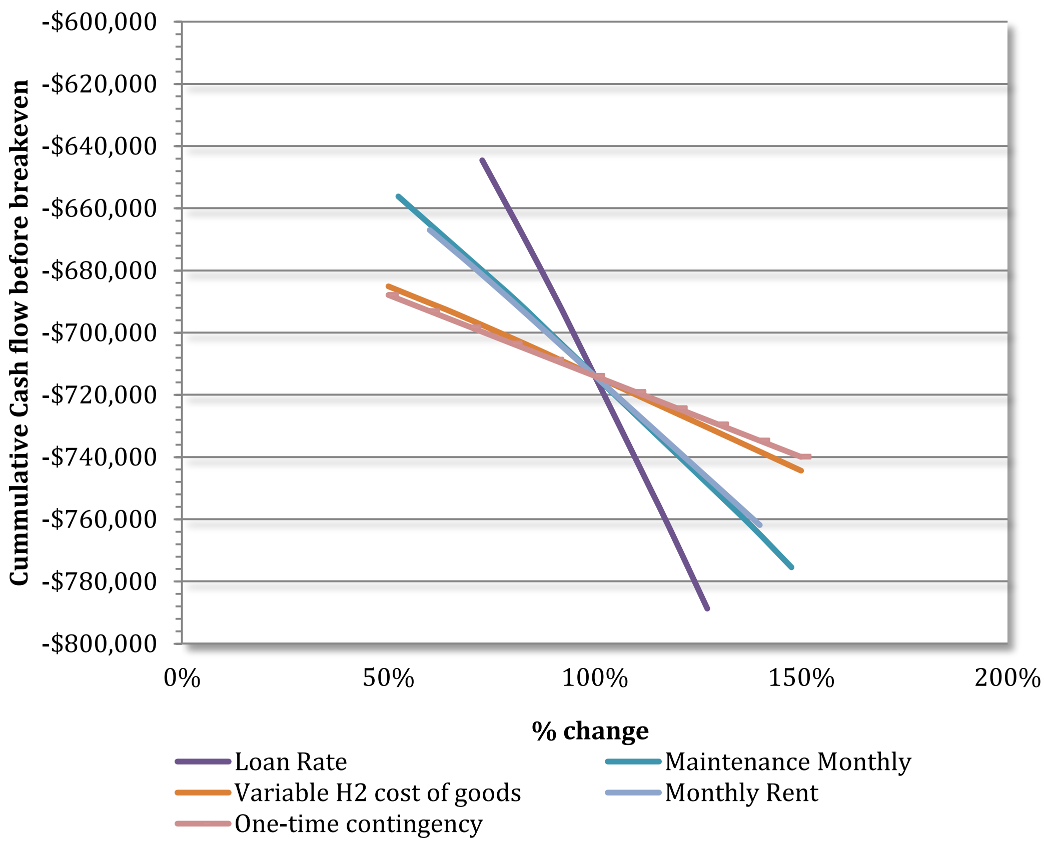
[11] By category, relative expenses break down as follows: 66% for financing (43% principle and 23% interest); 28% for O&M (18% Fixed and 10% Variable); and 6% for credit card fees.

Figure 3: Parameter Sensitivity Plot



If we remove the three largest contributing factors (retail margin, capital cost and financing term) and focus on the smaller variables (Figure 4), it is then apparent that cash flows are also sensitive to loan rates, followed by monthly maintenance, rent, and finally contingency and hydrogen cost of goods. It should be noted that within this modeling effort, hydrogen cost of goods has very little impact on cash flow, as retail margin is the main concern of the station owner. However, the cost of wholesale hydrogen significantly impacts the price to the consumer: if hydrogen is priced too high, FCEVs and hydrogen fuel will not be marketable.

Figure 4: Smaller Variable Sensitivity Plot



To illustrate the impact of the three primary variables, we compare the impact of varying retail margin, capital cost, and loan term. As shown in Table 2, if capital costs increase by 50 percent (from $2 to $3 million), and retail margin decreases by 25 percent (from $3.00 to $2.00), cash flow support needs quadruple, to $2.98 million.

Table 2: Retail Margin and Capital Costs impact on Base Case Cash Flow Needs

		Capital Costs		
		$1m	$2m	$3m
Retail Margin*	$2.00	-435k	-1,441	-2,871k
	$3.00	-269k	-707k	-1,525k
	$4.00	-191k	-509k	-978k

In Table 3, we look at the effect of a shorter-term loan than our base case of 10 yrs. If a station owner procures a 7-year loan, they would have to be able to earn a $4 retail margin to keep costs in line with the base case of $707,000 cash flow shortage (Table 3).

Table 3: Retail Margin and Loan Term impact on Base Case Cash Flow Needs

		Loan Term		
		15yrs	10yrs	7yrs
Retail Margin*	$2.00	-724k	$1,441k	-1,888k
	$3.00	-463k	-707k	-1,104k
	$4.00	-331k	-509k	-798k

Estimating the Range of Incentive Needs

The base case presented in Figure 2 represents a foundation designed to gain understanding of the cash prospects of a generic hydrogen station. From this foundation, we examine the impact of the following variables on cash flow support needs:

- Costs of smaller, expandable stations
- Cheaper stations
- Construction time lag
- Utilization

Station Size

As shown in Figure 5, we have cost data for four station types.[12] In the expansion case, the $500,000 capital cost represents the incremental cost required to expand a 250 kg/day station to 500 kg/day.[13]

Figure 5: Per Station Capital Cost by Size

	Built in	Capital Cost	Notes
170 kg/day	2014	$900K	very difficult to make money. Without expansion, would need to subsidize through life of the loan or have Retail Margin > $4/kg
250 kg/day:	2014 2015+	$1.4m → $0.9m →	Need Retail margin > $3.60/kg to break even (w/o expansion) 10 yr Profit Range: $60K - $122K
Expansion (250->500)	2014+	$500k	Incremental cost High Profit Potential
500kg/day	2015+	$1.5m - $2m	10 yr Profit Range: $300K - $900K (depending on cost and utilization)

Larger stations have the greatest profit potential, while smaller stations may have to collect a greater retail margin to break even. The expansion model is an attractive option, as upfront costs (and therefore risk) can be minimized, and station expansion can be done once sales pick up, with a quick payback (assuming demand continues to grow quickly).

[12] UCD, 2011. University of California, Davis. Ogden, Joan et al. UCD Institute of Transportation Studies. "Analysis of a "Cluster" Strategy for Introducing Hydrogen Fuel Cell Vehicles and Infrastructure in Southern California." Sept. 16, 2011. Revised Oct. 5, 2011.
[13] Conversations with Air Products and Chemicals Inc., Fall 2011.

Construction Time Lag

Based on OEM and industrial gas company experience, from the time an agreement is reached to build a station, it should be able to be constructed within 7 to 12 months, depending on a number of steps:[14]

- Design: 2 to 3 months
- Permitting: 3 to 5 months
- Construction: 2 to 4 months

As businesses gain more experience, these timelines are expected to decrease. From a station owner perspective, lag time represents money spent without the potential for revenue generation. With the recognition that early stations could face considerable delays, we take a relatively conservative approach and consider a one-year lag time, with full expenditure from day one.

Utilization

To examine the impact of station utilization on cash flow needs we hold the following variables constant:

> *Retail Margin: $3/kg.* Each hydrogen station owner will determine this number. Based on our cost inputs, $3/kg creates a workable balance between cost to the consumer and loan payback and profits. $2/kg may be too little to pay back a loan in a reasonable timeframe, and $4/kg may make hydrogen too expensive to effectively market.
>
> *Loan: 10 years, 5.5% interest rate*. Typically, fueling equipment loans are issued based on a 7-year loan term, but can be extended with justification.[15] As shown in Table 3 above, a 7-year loan places considerable additional financial pressure on a project. For the purposes of this exercise, we assume that strong package can be put together to attract longer financing. If not, each project would require additional funding, a lower interest rate, a back-loaded payback structure, or a greater retail margin to make up the difference.
>
> *Construction Time Lag: 1-year time lag*. Justification described above.
>
> *Capacity Utilization.* To explore the breakeven points, we assumed that given sufficient demand, stations would be able to reach 100 percent of their maximum capacity on a daily basis.[16]

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[14] As presented by GM and confirmed by Air Products and Chemicals, Inc., both of which have extensive experience installing hydrogen infrastructure.

[15] Conversation with Patriot Capital Corporation. http://www.patriotcapitalcorp.com/about-us.

[16] In reality, a typical station is expected to deliver 70% of its capacity daily, given the fact that fueling often occurs during peak hours. By allowing the model to go to 100%, we were able to explore the entire spectrum of break-even points.

Table 4 shows how the utilization growth curves (as shown in Figure 1, Utilization Scenarios) impact the cash flow support required in each station configuration. In short, the slower the utilization growth, the longer a station returns a loss to the hydrogen equipment owner. For reference, the one year time lag pushes the base case (i.e., 500 kg/day, $2 million capital cost, fast growth curve) cash flow needs from $707,000 to $1.09 million.

Table 4: The Impact of Utilization on Cash Flow Support Needs

		CASH FLOW SUPPORT NEEDED IF (in millions of $'s):		
	Yr Built (Capital Cost)	*Slow Growth*	*Medium Growth*	*Fast Growth*
250 kg/d Station	2014 ($1.4m)	$1.66	$1.49	$1.06
	2015+ ($0.9m)	$1.10	$0.93	$0.51
500 kg/d station				
	2014 ($2m)	$2.07	$1.70	$1.09
	2015+ ($1.5m)	$1.57	$1.31	$0.78

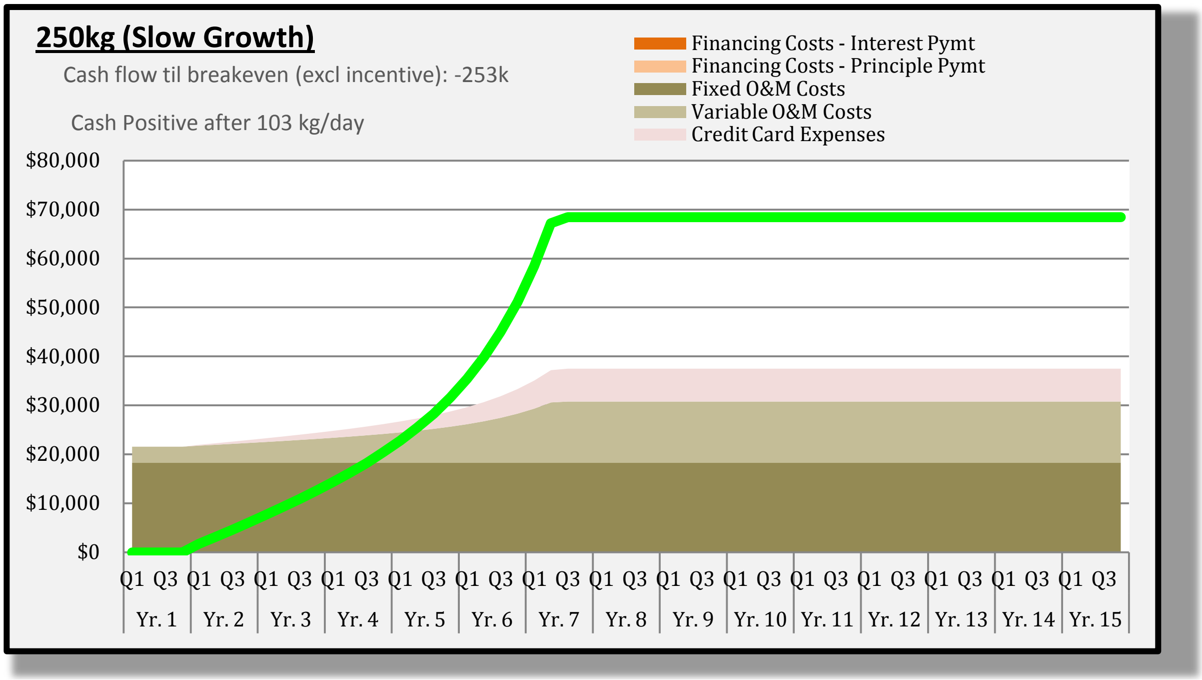
Support for Existing Stations

In addition to the cost of installing and operating new stations, some existing stations operate at a loss and will continue to do so until enough FCEVs are in the market to purchase fuel. To estimate potential support needs, we consider a station funded under the current AB 118 Alternative and Renewable Fuel and Vehicle Technology Program.[17] This program has been used to buy down the capital costs of a station: AB 118 funds are used to cover 50 to 70% of a station's capital and installation cost, with industry covering the remaining costs.

Figure 6 below shows the financial profile of a station with capital costs cost-shared between government and industry. On a daily basis, such a station is faced with fixed and variable O&M, as well as credit card fees on hydrogen sold. Given a slow growth pattern, a station would have to sell 103 kilograms per day to break even on expenses, for a total support need of approximately $253,000. Similarly, a station facing a medium growth curve would face a $232,000 shortfall.

[17] California Energy Commission: http://www.energy.ca.gov/2010-ALT-1/index.html

Figure 6: O&M Support for a Capital Cost Buy Down Station



Estimating System Wide Costs

We use the costs presented in Table 4 (as well as the O&M only expenses in Figure 6) as the foundation for estimating the amount of incentive funding required to bridge the gap to hydrogen station commercial viability.

How Many Stations Do We Need?

Based largely on UC Irvine's Spatially & Temporally Resolved Energy Environment Tool (STREET) Model developed at the National Fuel Cell Research Center (NFCRC), 68 optimally placed stations are expected to provide sufficient fueling accessibility in California's key markets.[18] This represents a driving time of less than 6 minutes to access fuel in key markets, an initial expansion into additional markets, and connector and destination stations. In other words, 68 stations can provide the *coverage* necessary to launch a commercial market. [19]

Assuming funds are executed as planned, California will be more than halfway to the 68-station marker by 2015. By 2015, approximately 37 small (i.e., 100 to 240 kg/day), government cost-shared stations are expected to be operational:

Table 5: Stations expected by 2015

6	Existing Public Stations
11	California Energy Commission (CEC) AB 118 cost-shared stations awaiting contract
13	CEC AB 118 cost-shared stations expected with funds allocated in the 2011-2012 Investment Plan for the Alternative and Renewable Fuel and Vehicle Technology Program
7	CEC AB 118 cost-shared stations expected with funds allocated in the 2011-2012 Investment Plan for the Alternative and Renewable Fuel and Vehicle Technology Program
37	Total Stations Expected

This analysis targets the installation of an additional 31 stations, which would bring the total to 68 stations by the end of 2015.

Station Development Scenario

Efficient development of hydrogen infrastructure relies on two primary factors: coverage and capacity. In the early years, coverage is the critical component, as FCEVs can only be successfully marketed if fueling stations are available in locations that fit potential owner driving patterns. Once the key areas are covered, or stations

[18] The UC Davis Sustainable Transportation Energy Pathways (STEPS) Program Fuel Cell Vehicle Roadmap Project independently arrived at a similar conclusion. While the UC Davis model does not point to 68 stations specifically, it validates that 68 stations is solid target.

[19] This station approximation is contingent on having a complete network of public, optimally located and standardized (i.e., SAE J2601 Type A) stations with sufficient capacity.

become heavily used, capacity becomes the primary factor. Fuel needs to be available for anyone who comes to a station.

As noted above, 68 stations are expected to provide sufficient coverage to offer FCEVs a fueling experience similar to gasoline in key markets. To ensure these stations can meet growing demand, sufficient capacity needs to be built into the system. Perhaps the most useful capacity target comes in the form of the Clean Fuels Outlet Regulation (CFO), which was adopted by the California Air Resources Board in January 2012. According to the regulation, once automakers project 10,000 FCEVs in an air basin, or 20,000 FCEVs across the state, oil importer refiners will be required to ensure sufficient hydrogen fueling capacity is available to fuel expected FCEVs. Establishing fueling for 20,000 FCEVs will ensure that the CFO can be implemented so that hydrogen infrastructure will continue to be built to match demand.

For planning purposes, it is widely accepted that each FCEV adds the need for 1 kg of hydrogen per day.[20] Therefore, to support 20,000 FCEVs and trigger the CFO, the system needs 20,000 kg/day available. Table 6 shows a scenario that would create 68 stations with the capacity to serve 20,000 FCEVs. Such a scenario would cover both the initial coverage and capacity needed to launch the early commercial FCEV market.

Table 6: System Capacity

Station Type	Station #'s	Per Station Capacity (kg/day)	Total Capacity (kg/day)
Planned	37	185*	6,845
Gap, larger station	22	500	11,000
Gap, smaller station	9	250	2,250
Totals	**68**		**20,095**

* Average size of planned stations

Each of the stations in Table 6 will face unique utilization growth curves depending on timing, placement, and vehicle deployments. In general, we assume that larger stations are placed in the areas with the greatest expected utilization. To estimate the cash flow support needs of the entire network, explore a variety of utilization and capital cost scenarios.

[20] This measure builds sufficient overhead into the system to allow for fueling during peak traffic times.

Capital Costs
Just as FCEV deployments are expected to increase over time, station costs are expected to decrease. The costs in Table 7 are from the previously presented UC Davis data.

Table 7: Expected Capital Costs per Station

	2014	2015
250 kg/d	**$1.4M**	**$0.9M**
500 kg/d		**$1.5 - 2M**

To estimate the total incentive need to ensure 68 stations can be constructed and operated, we explore two cost cases: high capital cost and low capital cost. For the high cost case, we assume that 250 kg/day stations cost $1.4 million, and 500 kg/day stations cost $2 million, to build. The low cost case assumes $0.9 million and $1.5 million, respectively. In both cases, we include a 10 percent contingency to account for unexpected price increases.

Incentive Support Scenarios
The following scenarios consider high and low capital costs, coupled with slow and medium growth projections (from the utilization scenarios in Figure 1), for the stations build out needs presented in Table 6. To estimate total needs, we multiply the number of stations by the estimated cash flow shortfall. For example, a $1.4 million, 250 kg/day station facing a slow growth curve would cost $1.66 million to support on a cash flow basis. Nine of these stations would require $15 million of support. Each scenario adds the cash flow support expected for all new stations with O&M support for the 37 stations expected to be on the ground by the end of 2014.

Table 8: High Capital Cost, Low Utilization

New Stations:	Cash Flow Shortfall per Station (in millions of $)	2014 (# of stations added)*	2015 (# of stations added)	Total Cost over Station Life (in millions of $)
500kg (slow growth)	$2.08		22	$45.8
250kg (slow growth)	$1.660		9	$14.9
O&M Support				
Slow Growth - Over 115 kg/day	$0.253	37		$9.4
Medium Growth- Over 115 kg/day				
# of Stations by Year		37	31	68 Total Stations
*The 2014 Stations include all operating stations by EOY 2014			**Total Cost**	**$70.1**

Table 9: Low Capital Cost, Low Utilization

New Stations:	Cash Flow Shortfall per Station (in millions of $)	2014 (# of stations added)*	2015 (# of stations added)	Total Cost over Station Life (in millions of $)
500kg (slow growth)	$1.53		22	$33.7
250kg (slow growth)	$0.916		9	$8.2
O&M Support				
Slow Growth - Over 115 kg/day	$0.253	37		$9.4
Medium Growth- Over 115 kg/day				
# of Stations by Year		37	31	68 Total Stations
*The 2014 Stations include all operating stations by EOY 2014			**Total Cost**	**$51.3**

Table 10: High Capital Cost, High Utilization

New Stations:	Cash Flow Shortfall per Station (in millions of $)	2014 (# of stations added)*	2015 (# of stations added)	Total Cost over Station Life (in millions of $)
500kg (medium growth)	$1.70		22	$37.4
250kg (medium growth)	$0.777		9	$6.9
O&M Support				
Slow Growth - Over 115 kg/day				
Medium Growth- Over 115 kg/day	$0.232	37		$8.60
# of Stations by Year		37	31	68 Total Stations
*The 2014 Stations include all operating stations by EOY 2014			**Total Cost**	**$52.9**

Table 11: Low Capital Cost, High Utilization

New Stations:	Cash Flow Shortfall per Station (in millions of $)	2014 (# of stations added)*	2015 (# of stations added)	Total Cost over Station Life (in millions of $)
500kg (medium growth)	$1.27		22	$27.9
250kg (medium growth)	$0.777		9	$7.0
O&M Support				
Slow Growth - Over 115 kg/day				
Medium Growth- Over 115 kg/day	$0.232	37		$8.60
# of Stations by Year		37	31	68 Total Stations
*The 2014 Stations include all operating stations by EOY 2014			**Total Cost**	**$43.4**

The above scenarios bound the potential incentive fund needs. Table 12 below summarizes the costs in millions of dollars:

Table 12: Incentive Funding Needs Matrix

Incentive Fund Needs, in Millions of Dollars:

	Low Cost	High Cost
Slow Growth	$51.3	$70.1
Medium Growth	$43.4	$52.9

Thus, given all of the assumptions in the model, the incremental cost to build, maintain, and operate a 68-station network should fall between $43 and $70 million.[21]

To arrive at a single cost estimate, we take a conservative but realistic approach. In terms of cost, we consider the higher capital cost case, given that a number of factors could drive the business cost of a station up (i.e., higher interest rates, shorter loan term, decreased capacity utilization, retail margin). In terms of utilization, we assume that the early stations (i.e., the 37 planned stations) will face a slow growth curve, as they will be installed prior to the planned 2015-2017 commercial push for FCEVs. For the new 31 stations, we assume that the 9 smaller, 250 kg/day stations will be placed in areas with lower early growth expectations, and that the 22, 500 kg/day stations will be placed in areas with higher growth projections. This scenario is presented below in Table 13.

Table 13: High Capital Cost, Likely Utilization

New Stations:	**Cash Flow Shortfall per Station (in millions of $)**	**2014 (# of stations added)***	**2015 (# of stations added)**	**Total Cost over Station Life (in millions of $)**
500kg (**medium growth**)	$1.70		22	$37.4
250kg (**slow growth**)	$1.66		9	$14.9
O&M Support				
Slow Growth - Over 115 kg/day	$0.253	37		$9.4
Medium Growth- Over 115 kg/day				
# of Stations by Year		37	31	68 Total Stations
*The 2014 Stations include all operating stations by EOY 2014			**Total Cost****	**$61.7**

[21] As a reminder, these incentive pot estimates are based on the assumption that retailers will be able to recoup a $3/kg margin on hydrogen, secure 10 year, 5.5% loans, and face a one-year lag time (except for the 37 first stations, which would already be in operation). Changes to these values will impact the amount of incentive funding required.

Capital Cost Buy-Down
To gain comfort around this cost estimate, we consider a capital cost buy-down approach for high capital cost stations. This approach would rely on paying for a percentage of capital and installation costs upfront, as well as support operations and maintenance of all stations to ensure they remain open during commercial launch.

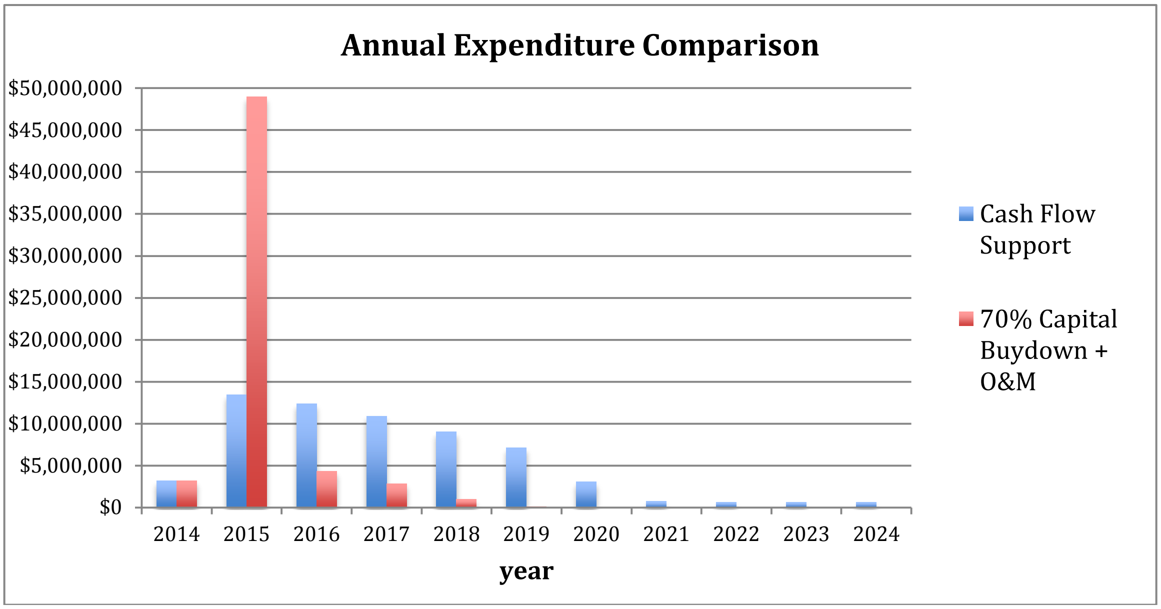
			50% Buydown	60% Buydown	70% Buydown	100% Buydown
New Stations:	**2014**	**2015**	Cap Cost Buydown (in millions of $)	Cap Cost Buydown (in millions of $)	Cap Cost Buydown (in millions of $)	Cap Cost Buydown (in millions of $)
500kg ($2.2M Station)		22	$24.2	$29.0	$33.9	$48.4
250kg ($1.54M Station)		9	$6.9	$8.3	$9.7	$13.9
O&M Support						
Slow Growth - Over 115 kg/day	37	9	$10.7	$10.7	$10.7	$10.7
Medium Growth- Over 115 kg/day		22	$5.6	$5.6	$5.6	$5.6
# of Stations by Year	37	31				
		Total Incentive Need	**$47.4**	**$53.6**	**$59.9**	**$78.6**
		Required Industry Capital Contribution	*$31.2*	*$25.0*	*$18.7*	

It should be noted that the capital cost buy-down approach assumes that industry players will be willing to pay 30-50% of the capital costs upfront. These cost estimates do not include paying for any financing costs associated with industry contribution.

Incentive Fund Timing
One of the advantages of the cash flow support approach is that less money is needed on an annual basis. Figure 7 compares the 70% capital cost buydown approach to the $61.7 million cash flow scenario on annual basis.

In terms of cash flow support, two primary factors dictate how much incentive money is needed each year: the number of stations and quantity of hydrogen sales. In the early years, as more stations come on line, increasing levels of cash flow support is required. As hydrogen sales increase, the need for incentive support decreases until stations begin to pay for themselves. In contrast, the capital cost buy-down requires substantial upfront investment.

Figure 7: Annual Expenditure Comparison



In reality, the 68-station build out will require a combination of cash flow support and capital cost buy down. High utilization areas will be prime candidates for a cash flow support approach, but expansion markets and connector stations are unlikely to attract business interest until the FCEV market reaches a commercial tipping point.

Recommendation

Given that some administration costs can be expected to efficiently manage the 68 station build out plan, we recommend budgeting **$65 million** to meet the goal of constructing, operating and maintaining a 68 station hydrogen station network:

$62 million – Incentive Support
+ $3 million – Administration and Contingency
$65 million

This number covers expected costs from both a cash flow and capital cost buy-down perspective. It assumes the Clean Fuels Outlet will be positioned to continue build-out of the network beyond 68 stations to a point when private investors will enter the hydrogen infrastructure market without the need for incentive support.

Conclusion and Next Steps

This effort has been conducted to develop a defensible, first cut estimate for the funds necessary to establish a 68 stations hydrogen-fueling network. The critical next step is to take the cash flow support concept to more players in the private business community to determine which stations are likely to fit the cash flow concept, and which are more likely to rely on a capital cost buy-down approach.

Phase 2 of this effort will add key financial measurements for potential station developers to consider (i.e., net present value, internal rate of return, and tax implications for any investment made towards a station). Through this effort, we will cap station capacity utilization to match real world fueling experience, and look for ways to increase the probability that $65 million sufficiently ensures that a 68 station network is fully operational by the end of 2015. This network is expected to support the early commercial FCEV push projected by the California Fuel Cell Partnership.

Appendix A - Assumptions

Parameter	Value	Source	Rationale
Retail Margin	$3/kg		Provides reasonable, cost competitive H2 compared to gasoline (*$6 wholesale H2+$3 retail margin+taxes < $10/kg at pump*). $2/kg and $4/kg also considered, but not analyzed in depth.
Capital Cost			
100-170 kg/day Station	$0.5M-$1M	UC Davis, Industry	Includes upfront permitting fees, and training & labor costs. Costs come down over time; before 2013=$1M; 2014=$0.9M; 2015=$0.5M
250 kg/day Station	$0.9M - $1.5M	UC Davis, Industry	Includes upfront permitting fees, and training & labor costs. Before 2013=$1.5M; 2014=$1.4M; 2015=$0.9M.
500 kg/day Station	$1.5M - $2.0M	UC Davis, Industry	Includes upfront permitting fees, and training & labor costs. 2015+ Range of projected costs
Expansion, 250 to 500 kg/day	$500,000	Industry	Represents the incremental cost of expansion.
Expansion, 500 to 1,000 kg/day	$500,000 to $600,000	Industry	Represents the incremental cost of expansion.
Utilization			
Fast Growth	25 kg/quarter increase		Commercial phase. Cluster station.
Medium Growth	exponential, about 4 years to reach full capacity	CaFCP Projections	This curve loosely tracks CaFCP aggregate projections. Early commercial (i.e., 2015)
Slow Growth	exponential, about 6 years to reach full capacity		Very early commercial (i.e., installed 2014 or before or outside cluster region later).

Loan Term	10 years	Patriot Capital, Ken Gunn	7 years is normal for station development business; 10 years allows a more reasonable payback and is considered doable with solid financial backing.
Loan Rate	5.5%	Patriot Capital, Industry	Conservative, inclusive loan rate based on what is currently available
Operations & Maintenance			
General Proxy/Groundtruth	$100K/yr	UC Davis, Industry	Used for all station types in UC Davis numbers. Represents sum of all fixed O&M.
Fixed:			
Rent	$2,500/yr	Industry - $2,500; Ken Gunn - $500	$500/month could be enough to rent space that will bring in customers. $2500 based on IGC experience & AB 118 Applications
Insurance	$1,600/yr	Federated Insurance	Same as CNG = Twice normal gasoline station.
Property Tax	$5,000-$20,000/yr	CaFCP	1% of assessed value
Permit Fees	$3,680/yr	CaFCP Station	$3,678 for West Sac Station
Fixed Electricity	$100/month		Back calculated from $100K/yr fixed O&M estimate and other fixed assumptions
Variable:			
Variable Electricity	6% per 25kg increase		This figure of 6% is used to arrive at the O&M cost profile that ranges from 85k to 165k for the 500kg station. It is not based on a specific source.
Incremental Electricity	$0.30/kg		This figure also used to arrive at the O&M profile for the generic station. Stations will likely vary greatly depending on the technology and compression. Other sources have included 1 kWh/kg of H2. (Source: UCD), which at $0.10/kWh. would be lower.

Fuel Use	0.6 kg/vehicle/day	UC Irvine Station	1 kg/day used to plan capacity needs; 0.6 kg/day based on data - represents conservative estimate from individual station perspective.
Credit Card Fee	3%	Industry	Fees can be more, based on card used.
Sales Tax	9%		Sales tax increases credit card fees. Note: assumption is that sales tax does not cut into $3/kg margin. Sales tax paid by consumer in model.
Cost of Goods	$6/kg	Industry	Based on industry input, this is a reasonable proxy. Plug Power, currently the largest purchaser of retail hydrogen, averages less than $6/kg to purchase hydrogen from various IGCs to supply to fuel cell forklifts.
Contingency	10%		Built in buffer to protect against unexpected contingencies
Construction Time Lag	1 year		Target = 6 month construction time lag (i.e., time from lending to opening). 1 year likely represents realistic scenario for early stations.