A Venture Capitalist's Look at H2 Station Economics

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Presenting

Discussion Agenda

- Background and Overview
- The “Farmer’s Math” Model
- Comparison with H2Fast Model
- Challenges and Recommendations

Background and Overview

- Formed H2 Challenge (H2C) in mid-2012 to consider the potential of a private equity fund to finance H2 fueling infrastructure
  - Excellent team with deep H2 background
  - Built large scale system model
  - Talked to many key players in HFCV world
  - Gathered data on all aspects of HFCV roll-out and infrastructure
  - Gave multiple presentations on findings

HFCV -- Hydrogen fuel cell vehicle

Background and Overview…

- Eventually H2C's efforts focused on the details of H2 station economics to
  - Define the critical parameters impacting return on investment
  - Establish conditions that must be met to make financing H2 stations an attractive investment
- This presentation
  - Summarizes our analytic results from a "Farmer's Math" model
  - Compares them to results from H2Fast using the same assumptions
  - Flags key challenges that must be met to achieve a financially viable H2 infrastructure business
  - And offers some recommendations on addressing those challenges

The “Farmer’s Math” Model

- The first step in analyzing the financial viability of a business is usually to construct a simple economic model that captures the impact of a few critical parameters. We call this the “Farmer’s Math” model.

- We know that if the “Farmer’s Math” model doesn’t yield an acceptable economic return, adding more variables most likely will not – a conclusion we will affirm later

The “Farmer’s Math” Model…

- Think of an H2 station business in the simplest possible terms:
  - It’s a one-product business – kg of H_2
  - The revenue side of the business is driven by:
    - The number of vehicles buying H_2 at the station
    - Gross margin/kg on H_2 sold
  - On the expense side all the possible costs can be condensed into:
    - Cost of the capital required to site and build the station
    - Total operating and maintenance cost

The "Farmer's Math" Model…

- This simple model of the H2 station business ignores:
  - Capacity Factor: It assumes the station runs at 100% instead of the usual 70% or less
  - Time to permit and install the station and bring it up to capacity: 1 month installation time and zero time to ramp up is assumed
  - Various fees and taxes: In a venture fund situation (an LLC) the taxes on income would be paid by the various investors
  - Escalations of cost or revenue, and assumes flat dollars over 20 years
- It is designed to establish the boundary conditions, or "must haves", that have to be met to have any chance of making money

The "Farmer's Math" Model…

So we condense the analysis to just Four Key Variables – among the many that to some degree drive the economic viability of H2 fueling stations

- Vehicle Numbers:
  - For every 100 kg/day dispensing capacity, we have found it is necessary to have 150-200 vehicles fueling routinely at the station (based on 0.5-0.7 kg/day/vehicle use)
  - Clustering of vehicle sales around stations is essential to achieve the density required
  - The OEM roll out strategy in the U.S. over the next few years makes it very unlikely that the needed vehicle density/station can be achieved, except possibly in California

The "Farmer's Math" Model…

   - The latest projections in California are 34,300 vehicles by 2021, and 86 stations (each around 200 kg/day capacity) are planned, so vehicle density will be close to the needed 400 vehicles/ station, on average, at the end of this period

- <u>Station Capital and Installation Cost</u>: assuming adequate vehicle density
   - If a 200 kg/day station can be built for \$1.0M (hardware, site rent, site work and permitting) the economics begin to look acceptable
   - At ≤ \$1.0M they look quite interesting
   - An analysis of mass-produced modular, drop-in stations sited in large parking lots suggests that the ≤ \$1M target could potentially be met

The “Farmer’s Math” Model…

- Gross Margin on the Sale of H2:
  - Initially we were in a \$3.50-\$4.50/gal gasoline market, in which case
  - H_2 prices at \$8-\$10/kg, perhaps a bit more, would be acceptable to customers seeking fuel price parity on a miles basis
  - As we will see, a gross margin on H_2 sales of at least \$3/kg is needed at the station to make the economics work
  - Thus delivered or produced costs for H_2 of \$5-\$7/kg are needed
  - CGH2 at 500 bar or more can very likely be delivered at this price range if the quantities are substantial, the delivery distance is <50 miles and new high pressure tube trailers are permitted
  - Electrolytic production at 1 MW scale is getting close, if ¢/kwh costs are reasonable
  - However, with gasoline in the \$2.00-\$3.00/gal range the economics are more challenging.

The "Farmer's Math" Model…

- Operating & Maintenance Costs:
  - » Annual station operating costs in the $100K-$125K range (exclusive of fuel costs) are needed to make the economics work
  - » Modular, unmanned, remotely controlled stations with:
    - – Centralized, dispatchable maintenance ability (much like DG)
    - – Station to vehicle/customer communication
    - – Automated billing
    - – Customer assistance, if needed, from a control center operator

    are needed to keep O&M costs low
  - » Vehicle density is critical to keeping the O&M cost/vehicle in an acceptable range (The chiller example illustrates the point)

The "Farmer's Math" Model: Results

- **Base Case**: Suppose there are **100,000 FCEV's** in a reasonably compact geography. If we assume:
  - Clustering sufficient to have **400 vehicles** fueling at each station
  - Then there will need to be only **250 stations**
  - If each vehicle consumes **0.5 kg/day** of H2, then each station will dispense **200 kg/day**
  - If the margin on H2 sales is **$3.00/kg**, then each station generates **$600/ day of gross profit**, or **$219,000/year**
  - If **O&M costs** are **$100,000/year**, that leaves **$119,000/year** to cover the amortized cost of the station
  - If the station **capital cost** is **$1M**, and a zero down note with 5% interest over 20 years is available, then payments of about **$80K/year** would be required. Obviously these loan parameters reflect a very optimistic case
  - In this favorable base case, the **operating profit** on each station would be **$39,000/year**

"Farmer's Math" Model: Impact of Key Variables

- Variations on the Base Case:
  - » If total vehicle numbers and clustering are such that there are only **250 vehicles/ station**, but all else remains the same, then each station dispenses **125 kg/day** for a gross margin of **$375/day** or **$136,875/year**. These stations **lose ($43,125/year)**. If consumption/vehicle is **0.7 kg/day**, the station makes **$11,625/year**
  - » Back to the base case of 400 vehicles/station, if O&M costs are **$125,000/year**, the operating **profit drops** to an unexciting **$14,000**
  - » If the station capital cost is **$1.5M**, and all else remains as in the base case, an annual payment of about **$120,000** leads to a **($1,000) loss**
  - » If all the base case parameters stay the same except for the margin on H2 sales, which drops from $3.00/kg to **$2.00/kg**, the station loses **($34,000/year**)
  - » If there are only **250 vehicles/station**, the gross **margin/kg** is only **$2.00/kg**, the **O&M** costs are **$125,000/year**, and the **capital cost** of the station is **$1.5M**, the result is a ***disaster***

    250 x 0.5 x 2.00 x 365 -125,000 -120,000 = 91,250 - 245,000 = **($153,750)/year**

NOT A VIABLE BUSINESS!

“Farmer’s Math” Model: Impact of Key Variables…

- On the other hand, if one were confident that the base case parameters could be hit and one had $250M available in a venture capital fund to build out those 250 stations all in one year, and did not have to finance them, then the investment would make $39,000 + $80,000 (add back of financing costs) = **$119,000/station/year** or **$29,750,000/year** on the investment in all 250 stations, or **11.9%/year** – a reasonable rate of return on invested capital.
- If one adds back salvage value of $500K at the end of 20 years, the IRR improves to 12.9% (assuming no inflation)
- So raising one or more large investment funds to build out the H2 infrastructure might be interesting, if there were a reasonable prospect of getting to 100,000 vehicles quickly. That’s the catch!

The "Farmer's Math" Model: Conclusions

- The point of this little "Farmer's Math" exercise is to show that if the stars are properly aligned, H2 stations can make a modest profit, but if any one of the four critical parameters:
  - Vehicles/station (400 at 0.5 kg/day)
  - Margin on H_2/kg ($3.00/kg)
  - O&M cost/year ($100,000/year)
  - Capital cost of the station ($1,000,000)

  is not at or better than the reasonably optimistic base case threshold shown, then the economics can range from not exciting to disastrous

Comparison with H2Fast

- Now let's see how the "Farmer's Math" assumptions play in the H2Fast model
  - » First the <u>Basic Version</u> in which a lot of assumptions are hidden
    - – The base case assumptions led to a negative IRR
    - – Increasing the H2 gross margin from $3.00/kg to $4.50/kg brings the IRR up to 11.3% (See appendix, Exhibit 1)

Comparison with H2Fast…

- Next let's look at the Advanced Version of H2Fast, in which essentially all of the assumptions can be adjusted
  - With all of the other cost parameters (credit card fees, sales tax, etc.) left in the base case IRR was only 2.7%, considerably less than the 11.9% IRR result from the "Farmer's Math" model; and with H2 gross margin raised to $4.50/kg the IRR is 12.91% (See appendix Exhibits 2&3)
  - When all the extraneous expenses except income tax were set to zero, the IRR jumped to 7.72% with base case inputs. If income tax is eliminated at the fund level, then IRR is 9.53%, still less than "Farmer's Math" result of 11.9% IRR with similar inputs

Comparison with H2Fast…

- The important point here is that the investment return results from a more complete model like H2Fast are uniformly less attractive than those from the very simple “Farmer’s Math” model. So the base case parameters set the boundary conditions for any reasonable hope to achieve an acceptable return

Challenges and Recommendations

- The major challenges flagged by our "Farmer's Math" model and confirmed by running H2Fast are these:
  - On the cost side:
    - The total capital cost of installing a station must be reduced to at most $1M for a 200 kg/day station. As station capacities increase, if costs do not increase proportionally, that certainly helps a lot
    - Keeping O&M costs below $100K/year is necessary and probably achieveable if
      - The stations are highly automated and can be monitored remotely
      - Hardware reliability is very high (i.e., long MTBF for all components)

Challenges and Recommendations…

» On the <u>revenue side</u>:

– The margin on H2 sales must be above \$3/kg, which may be challenging (margins on gasoline at the pump are very small). There will be constant pressure between suppliers wanting higher delivered prices and customers wanting lower retail prices (preferably less than gasoline on a miles basis). Ability to produce H2 at the station could help relieve this pressure if production costs are below delivered cost

– The really big issue is **vehicle density**. This will require rapid increase in total vehicles sold and clustering in the early days

Challenges and Recommendations…

- Recommendations to address these challenges:
  - » On the cost side:
    - – Support innovative R&D on station design and components aimed at cost reduction. Modular, mass-producible drop-in stations requiring little site work would be one potential approach
    - – Gather data on costs for operations, monitoring and maintenance in the early stations supported by government grants to identify problem areas and opportunities for improvement (see appendix Exhibit 4)

Challenges and Recommendations…

- On the revenue side:
  - Support intensive development efforts to reduce the cost of hardware (micro-SMR's and electrolyzers) so that H2 can be produced competitively on site
  - Look very hard at ways to reduce the cost of production systems that could be used at homes (a small system able to provide 350 bar, providing a partial fill overnight, would be very attractive if priced in the $5,000 range)
  - Provide incentives that would encourage customers to purchase HFCV's in rapidly growing numbers (for example: no sales tax or registration fees on the vehicles)

Fundamental Conclusions

- The Good News: **If** the critical economic targets on
  - Total capital cost of the H2 station: <$1M for a 200 kg/day capacity
  - Total operating and maintenance costs: < $100K/year
  - Gross margin on sale of H2 molecules: >$3/kg

  can all be met, which seems possible over time, then H2 fueling infrastructure could be sufficiently attractive economically to attract private capital, **if** vehicle density per station is sufficient: 300-400 vehicles/200 kg station capacity

Fundamental Conclusions…

- The Bad News: However, given the relatively slow roll out of vehicles that the OEM's are projecting, it will be challenging to achieve sufficient vehicle density (absolute numbers ***and*** clustering) to construct a business model that will make attracting private capital feasible, unless investors are willing to accept significant losses in the early years.

Closing Perspective

- Ignoring the challenges that must be faced to achieve economically attractive H2 fueling infrastructure would be a very bad idea
- If private capital is not willing to invest, then the HFCV option may not have a future, and that would be a tragedy
- Aggressive cooperative efforts involving governments, auto OEM's, H2 suppliers, and fueling equipment manufacturers are urgently needed to insure that H2 stations can be built and operated economically

Appendices

- Exhibit 1: H2Fast Basic Model run, showing base case results with margin on H2 sales at $4.50/kg
- Exhibit 2: H2 Fast Advanced Model run, showing base case results with margin on H2 sales at $3.00/kg
- Exhibit 3: Same parameters as Exhibit 2 except margin on H2 sales is $4.50/kg
- Exhibit 4: Suggested financial data to be gathered from government supported H2 stations

Exhibit 1

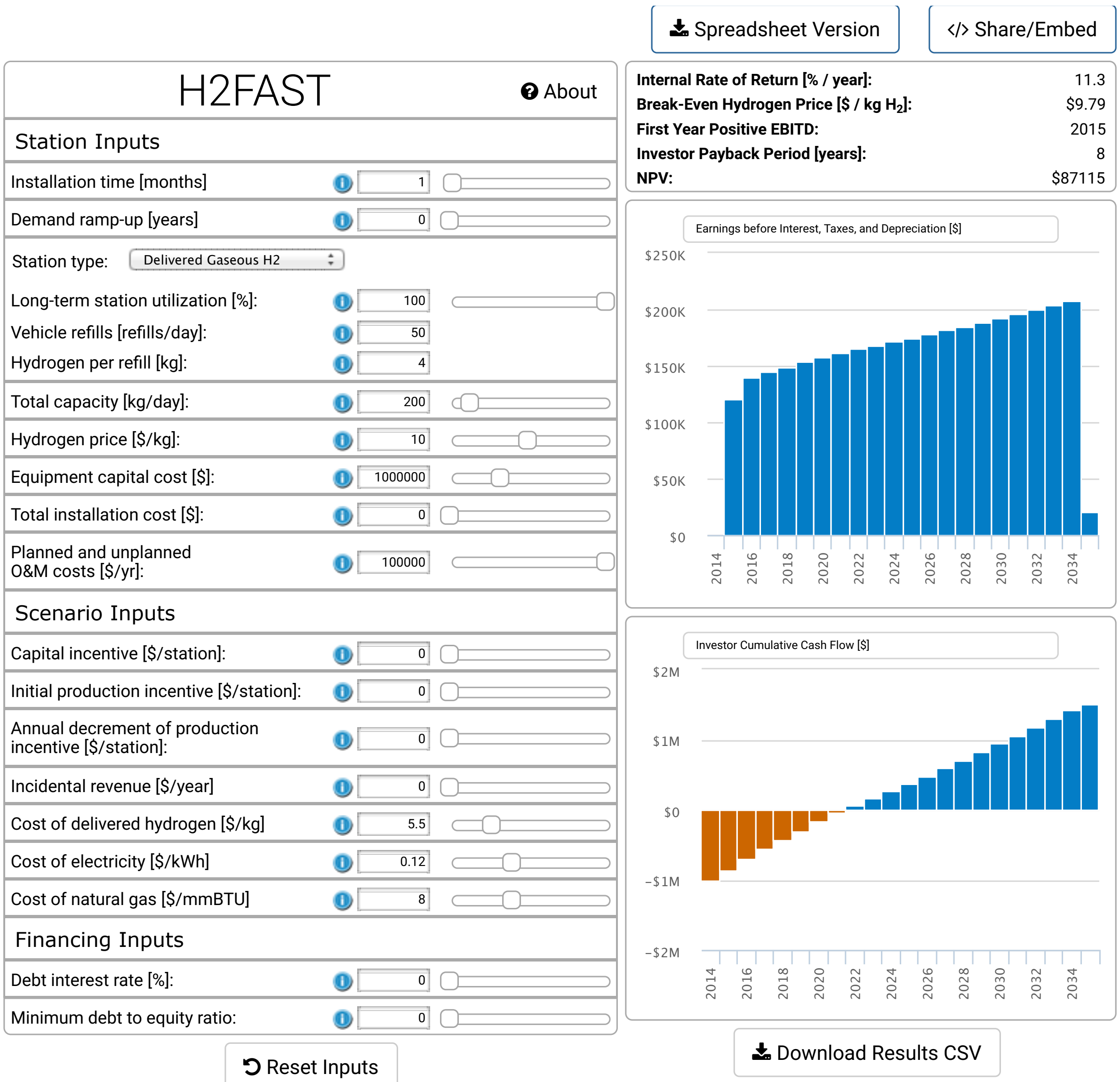

Spreadsheet Version
</> Share/Embed
H2FAST
About
Station Inputs
Installation time [months] 1
Demand ramp-up [years] 0
Station type: Delivered Gaseous H2
Long-term station utilization [%]: 100
Vehicle refills [refills/day]: 50
Hydrogen per refill [kg]: 4
Total capacity [kg/day]: 200
Hydrogen price [$/kg]: 10
Equipment capital cost [$]: 1000000
Total installation cost [$]: 0
Planned and unplanned O&M costs [$/yr]: 100000
Scenario Inputs
Capital incentive [$/station]: 0
Initial production incentive [$/station]: 0
Annual decrement of production incentive [$/station]: 0
Incidental revenue [$/year] 0
Cost of delivered hydrogen [$/kg] 5.5
Cost of electricity [$/kWh] 0.12
Cost of natural gas [$/mmBTU] 8
Financing Inputs
Debt interest rate [%]: 0
Minimum debt to equity ratio: 0
Reset Inputs
Internal Rate of Return [% / year]: 11.3
Break-Even Hydrogen Price [$ / kg H2]: $9.79
First Year Positive EBITD: 2015
Investor Payback Period [years]: 8
NPV: $87115
Earnings before Interest, Taxes, and Depreciation [$]
$250K
$200K
$150K
$100K
$50K
$0
2014
2016
2018
2020
2022
2024
2026
2028
2030
2032
2034
Investor Cumulative Cash Flow [$]
$2M
$1M
$0
−$1M
−$2M
2014
2016
2018
2020
2022
2024
2026
2028
2030
2032
2034
Download Results CSV

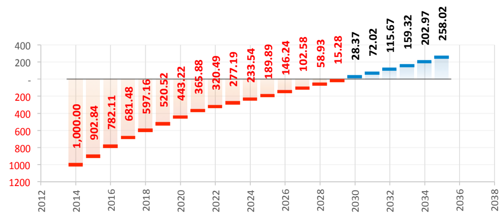
Exhibit 2

H2FAST: Hydrogen Financial Analysis Scenario Tool

Overall Financial Performance Metrics	Restore defaults
Leveraged, after-tax, nominal IRR	2.70%
Investor payback period	16 years
First year of positive EBITD	analysis year 1
After-tax, nominal NPV @ 10% discount	$ (380,575)
Estimated break-even leveraged price ($/kg)	$ 10.56

Chart Selector & Description	Toggle chart labels
Cumulative investor cash flow	
Investor contribution + previous year investor contribution	

Station 2: Cumulative investor cash flow, (Thousands)



Station(s) Information	
Select interface type	Basic / Advanced
Enter number of stations to model	6
Total dispensing capacity (kg/day)	200
Equipment capital cost	1,000,000
Installation cost	-
Planned & unplanned maintenance ($/year)	100,000
Maintenance escalation (% annually)	0.0%

Incentives Information	
One time capital incentives (grant or ITC)	$ -
Annual operating incentives (grant or PTC)	$ -
Operating incentives decay rate (%/year)	10%
Operating incentives sunset (years)	10
Incidental revenue	$ -
Incidental revenue escalation rate (%/year)	0.0%

Demand Projection	$ 4.06
Price of hydrogen at project onset ($/kg)	9.50
Project start year	2015
Price escalation rate (% annually)	0.00%
Installation time (months)	1
Demand ramp-up (years)	0.0
Long-term nominal utilization (%)	100%

Feedstock Information	
Cost of delivered hydrogen ($/kg)	$ 6.50
Escalation rate of hydrogen cost (% annually)	0.0%
Price of electricity ($/kWh)	$ 0.120
Escalation rate of electricity cost (% annually)	0.0%
Price of natural gas ($/mmBTU)	$ 8.00
Escalation rate of natural gas cost (% annually)	1.9%

Other operating expenses	
Credit card fees (% of sales)	2.50%
Sales tax (% of sales)	2.25%
Road tax ($/kg)	$ -
Road tax escalation rate (%/year)	1.90%
Staffing labor hours (h/year-station)	-
Labor rate ($/h)	$ 40
Labor escalation rate (% annually)	1.9%
Licensing & permitting ($/year-station)	$ -
Licensing & permitting escalation rate (%/year)	1.9%
Rent of land ($/station-year)	$ -
Rent escalation (% annually)	1.9%
Property insurance (% of dep capital)	0.0%
Selling & administrative expense (% of sales)	0.0%

Financing Information	
Project operational life (years)	20
Total tax rate (state, federal, local)	38.50%
Is installation cost depreciable?	No
Are operating incentives taxable?	No
Is capital incentive depreciable?	Yes
Are tax losses monetized (tax equity application)	Yes
Allowable tax loss carry-forward	7 year
General inflation rate	0.00%
Depreciation (MACRS)	7 year
Leveraged after-tax nominal discount rate	10.0%
Debt/equity financing	0
Debt type	Revolving debt
If loan, period of loan (years)	20
Debt interest rate (compounded monthly)	6.00%
Cash on hand (% of monthly expenses)	100%

Multi-Station Inputs			
Select station(s) to analyze	2		
Station being analyzed (yellow background)	1	2	3
Station type	Delivered gas	Delivered gas	Delivered gas
Total dispensing capacity (kg/day)	100	200	300
Equipment capital cost	$ 930,156	$ 1,000,000	$ 1,000,000
Installation cost	$ 213,936	$ -	
Planned & unplanned maintenance ($/year)	$ 82,852	$ 100,000	$ 100,000
One time capital incentives (grant or ITC)	$ -	$ -	$ -
Annual operating incentives (grant or PTC)	$ -	$ -	$ -
Annual incidental revenue	$ -	$ -	$ -

Real levelized values ($/kg H_2)

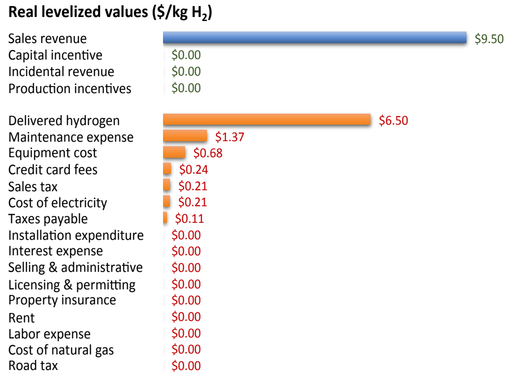
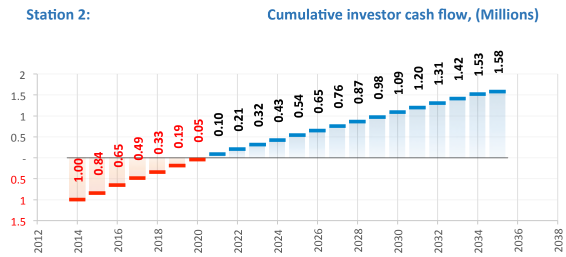


Exhibit 3

H2FAST: Hydrogen Financial Analysis Scenario Tool

Overall Financial Performance Metrics	Restore defaults
Leveraged, after-tax, nominal IRR	12.91%
Investor payback period	7 years
First year of positive EBITD	analysis year 1
After-tax, nominal NPV @ 10% discount	$ 181,412
Estimated break-even leveraged price ($/kg)	$ 9.50

Chart Selector & Description	Toggle chart labels
Cumulative investor cash flow	
Investor contribution + previous year investor contribution	



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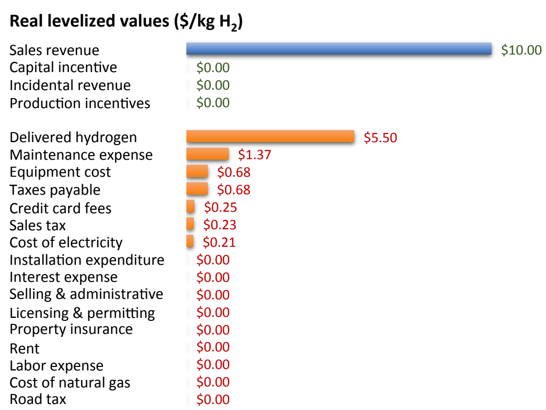
Long-term nominal utilization (%)	100%



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If loan, period of loan (years)	20
Debt interest rate (compounded monthly)	6.00%
Cash on hand (% of monthly expenses)	100%

Exhibit 4

Suggested Requirements for Reporting
Financial/Performance Data for Each H2 Fueling Station

1. Capital Costs: Both for initial construction and later additions (i.e. more storage, increased capacity, equipment upgrades)
    - Component level costs for all station equipment, e.g.
        - » Compressor(s)
        - » Chiller
        - » Dispenser
        - » Storage tanks: CGH2/LH2
        - » Monitoring and control equipment
        - » On site H2 production equipment if appropriate
        - » Containment/building(s)/trailers as appropriate; other
    - Site work, broken out in detail
    - One time costs of energy supply (e.g. electric connection)
    - Permitting and approval costs; other

2. Hydrogen Costs and Pricing: by calendar quarter
    - Delivered cost/kg if appropriate, specifying
        - » Mode of delivery: tube trailer, liquid carrier, pipeline, other
        - » Typical kg/delivery if appropriate
    - Cost of production if H2 is produced on site: by electrolysis or with small SMR
    - Price charged to customer/kg
    - From which gross margin/kg on H2 sales can be determined

3. Operating Costs (other than H2): At a detailed quarterly income statement level, including as appropriate
    - Labor: salaries and benefits
    - Rents/lease costs: e.g. land, equipment, etc.
    - Energy (electricity, natural gas, propane)
    - Insurance
    - Taxes, if any
    - Maintenance of capital equipment
    - Services (e.g. site cleaning, snow removal, etc.)
    - Other (e.g. incentive awards, bad credits, theft, damage)

4. Cost of Capital
    - By financing source (debt: senior, junior; equity: common, preferred; grant, gift, internal corporate capital)
    - How measured if appropriate: interest, shares (price/share)

5. Operations Data:
    - Total unique vehicles filled or served/day: recorded daily, reported quarterly
    - High, low, and average amount/fill
    - Total kg of H2 sold/day, reported quarterly
    - Daily sales: average, maximum, minimum, per quarter
    - Station capacity factor: each quarter
    - Annual return (or loss) on total invested capital (including grants)