NREL
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Expanded Capabilities for the Hydrogen Financial Analysis Scenario Tool (H2FAST)




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Project ID: SA062

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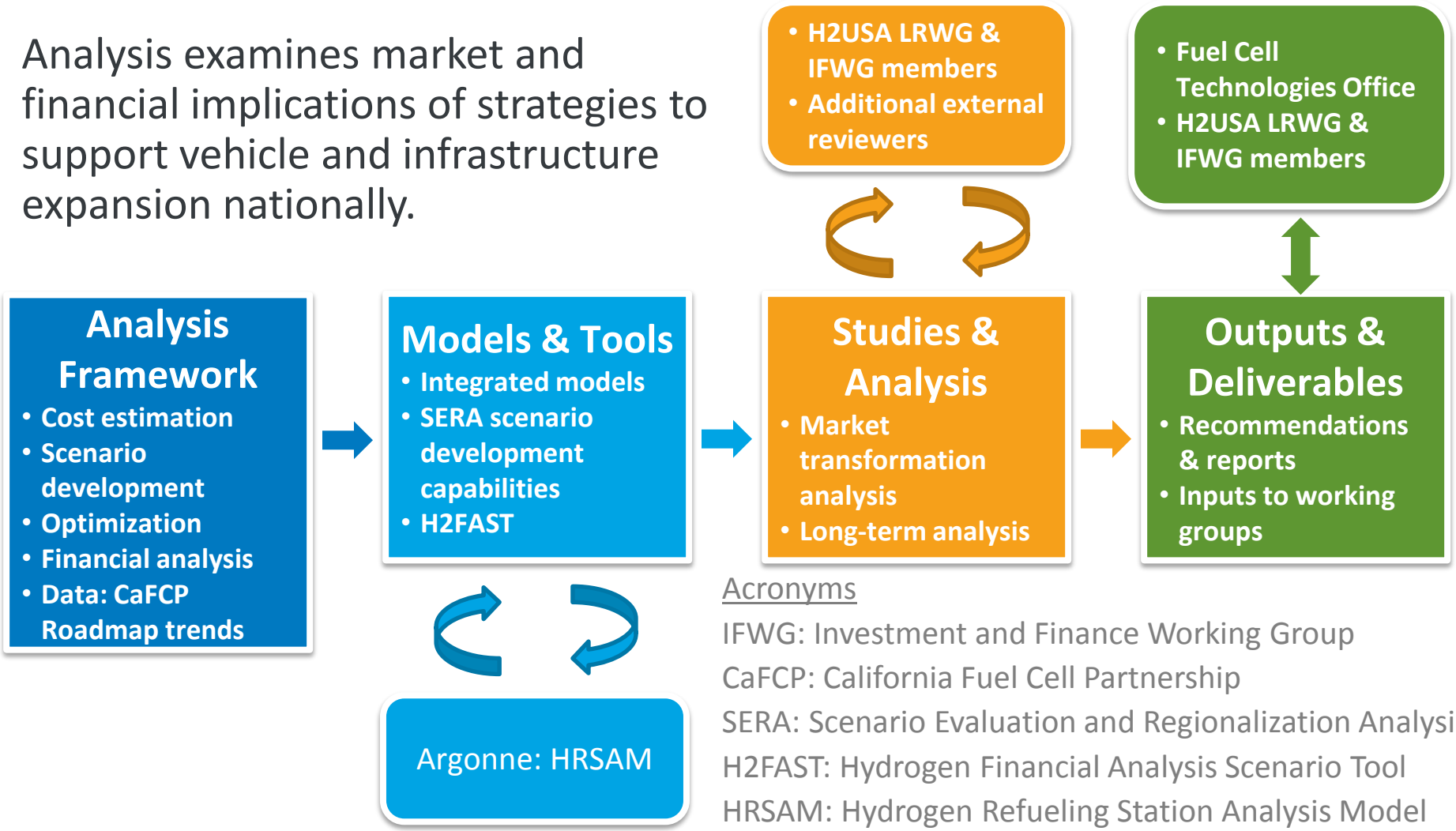
Overview

Timeline	Barriers
Start: September, 2014 End: September, 2016* * Annual project direction determined by DOE	**4.2 Technical Approach:** Infrastructure Analysis **4.5 A. Future Market Behavior:** Scenarios to understand vehicle-fuel interactions **4.5 E. Unplanned Studies and Analysis** Response to H2USA public-private partnership and infrastructure deployment goals
Budget	**Partners**
FY15 DOE Funding: $100K FY16 Planned DOE Funding: $100K Total DOE Funds Received to Date: $200K	• H2USA Investment and Finance Working Group • Multiple external and internal subject expert reviewers • Fuel Pathways and Integration Tech Team (FPITT) • Independent and in-depth technical review by financial analysis consultant

Relevance: H2FAST enables detailed financial analysis for hydrogen infrastructure – for either novice or expert users

Analysis examines market and financial implications of strategies to support vehicle and infrastructure expansion nationally.



Acronyms

IFWG: Investment and Finance Working Group
CaFCP: California Fuel Cell Partnership
SERA: Scenario Evaluation and Regionalization Analysis
H2FAST: Hydrogen Financial Analysis Scenario Tool
HRSAM: Hydrogen Refueling Station Analysis Model
LRWG: Location Roadmap Working Group

Relevance

Objectives

- Provide convenient detailed hydrogen infrastructure financial analysis to facilitate investments in hydrogen refueling stations and improve policy-design decisions to support early hydrogen station and fuel cell electric vehicle (FCEV) market development
- Inform multiple stakeholders: policy and government decision makers, station operators, equity investors, strategic investors, lenders
- Enable transparent incentive analysis
- Provide embedded investment risk analysis

Impacts on FCTO barriers during reporting period

- Enhanced analysis of future hydrogen fueling market behavior (Barrier A)
- Provided timely analytical capabilities to H2USA partnership and FCTO (Barrier E)

Approach

- The spreadsheet version of the Hydrogen Financial Analysis Scenario Tool (H2FAST) was enhanced.
- The tool offers basic and advanced user interface modes for modeling individual stations or groups of stations.
- It provides users with detailed annual finance projections in the form of income statements, cash flow statements, and balance sheets; graphical presentation of financial performance parameters for common metrics; lifecycle cost breakdown for each analysis scenario; and common ratio analysis results such as debt/equity position, return on equity, and debt service coverage ratio.
- It is designed for user-friendly use by novices and experts
  - Enables generally accepted accounting principles (GAAP) accounting and articulation
  - Enables International Financial Reporting Standards (IFRS) accounting and articulation
  - Provides easily accessible analysis for many hydrogen infrastructure components

Accomplishments and Progress: Added Analysis Capabilities (Highlights)

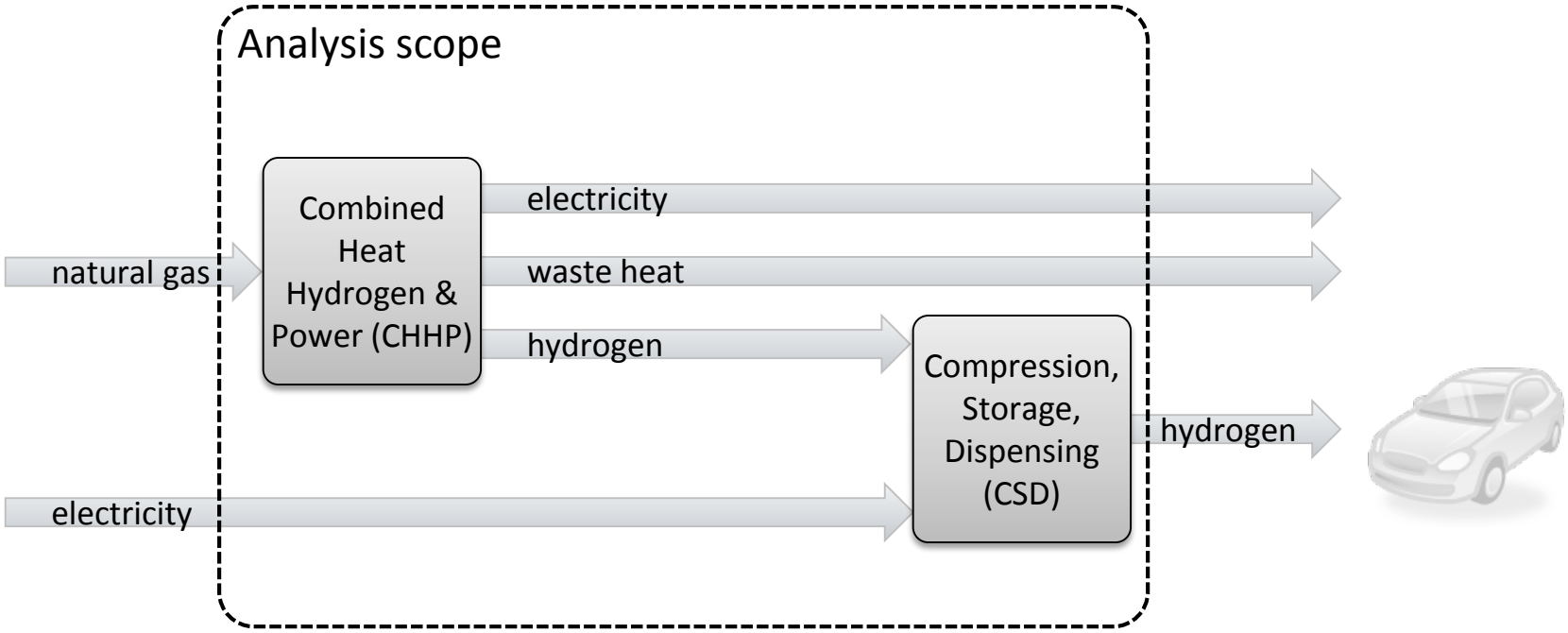
1. Added consideration of byproducts such as grid service, waste heat, user-defined co-products (enabling combined heat hydrogen and power [CHHP] and other non-conventional system analysis)
2. Added per-kilogram ($/kg) revenue for modeling: Low Carbon Fuel Standard (LCFS), Renewable Identification Number (RIN) credits, others
3. Incorporated take-or-pay contract specifications
4. Added more feedstocks – allowing custom station modeling (e.g., half delivered, half produced hydrogen; H_2A case implementation)
5. Added linear depreciation – enabling International Financial Reporting Standard (IFRS) analysis
6. Added consideration of non-depreciable assets (e.g., land)
7. Added salvage value and capital gains considerations (allowing land sale and equipment salvage considerations)
8. Expanded case count to 300 for larger portfolio analysis
9. Increased maximum project life to 100 years (allowing pipeline analysis)

Accomplishments and Progress: Added Computational Capabilities (Highlights)

1. Added risk analysis with triangular distribution for any input parameter (lowest, most likely, highest values)
2. Added quick visualization for any input or output stochastic distribution
3. Enabled reporting of 5^{th}, 50^{th}, and 95^{th} percentile for each input or output parameter
4. Added ability to specify fixed hydrogen price or fixed internal rate of return (IRR)
5. Added profitability index (PI), a robust financial performance metric (unlike IRR, which sometimes does not yield a value)

Accomplishments and Progress: Example Analysis – CHHP, Hypothetical 200 kg/day

Hypothetical system scenario



Note: Breakdown of system is not necessary but is instructive to model flexibility and ease of use.

Accomplishments and Progress: Example Analysis – CHHP, Hypothetical 200 kg/day

Preliminary

Step 1: Specify installation & maintenance costs

Station being analyzed (yellow background)	1	2	3
Station name	200 kg/day CHHP (production only)	200 kg/day CSD	200 kg/day CHP & CSD (sum of 1 & 2)
Capacity (kg/day)	250	250	250
Equipment capital cost	$ 3,000,000	$ 1,500,000	$ 4,500,000
Non-depreciable fixed assets (e.g. land)	$ -	$ -	$ -
Installation cost	$ 500,000	$ 500,000	$ 1,000,000
End of project sale of non-depreciable assets	$ -	$ -	$ -
Planned & unplanned maintenance ($/year)	$ 200,000	$ 150,000	$ 350,000

Step 2: Specify feedstock & co-product volumes

Coproduct specifications			
Usable waste heat (mmBTU/kg)	0.040	-	0.040
Electricity co-production (kWh/kg)	44.41	-	44.41
User defined co-product (units/kg)	-	-	-

Feedstock use			
Delivered hydrogen gas trailer (kg/kg)	-	-	-
Delivered hydrogen liquid trailer (kg/kg)	-	-	-
Delivered hydrogen pipeline (kg/kg)	-	1.00	-
Electricity use (kWh/kg)	-	1.72	1.72
Natural gas use (mmBTU/kg)	0.384	-	0.384
User defined feedstock (units/kg)	-	-	-

Column 1

- Reflects CHHP production only
- Co-product generation normalized per kilogram of hydrogen produced

Column 2

- Reflects dispensing only
- Hydrogen purchased from CHHP system
- Electricity purchased for compression and cooling

Column 3

- Reflects the entire system

Note: Breakdown of system is not mandatory but helps with clarity. Only highlighted entry (yellow) is analyzed.

Note: Costs are fictitious and intended to show analysis methodology—not showcase the application.

Accomplishments and Progress: Example Analysis – CHHP, Hypothetical 200 kg/day

Preliminary

Step 3: Specify feedstock & co-product pricing

Products Value		
Price of hydrogen at project onset ($/kg)		10.00
Price escalation rate (% annually)		1.9%
Usable waste heat ($/mmBTU)	$	5.00
Escalation rate of cost (% annually)		1.9%
Electricity co-production ($/kWh)	$	0.10
Escalation rate of cost (% annually)		1.9%
User defined coproduct ($/unit)	$	-
Escalation rate of cost (% annually)		1.9%

Feedstock Cost		
Cost of delivered hydrogen via gas truck ($/kg)	$	-
Escalation rate of cost (% annually)		1.9%
Cost of delivered hydrogen via liquid truck ($/kg)	$	-
Escalation rate of cost (% annually)		1.9%
Cost of delivered hydrogen via pipeline ($/kg)	$	2.00
Escalation rate of cost (% annually)		1.9%
Cost of electricity ($/kWh)	$	0.100
Escalation rate of cost (% annually)		1.9%
Cost of natural gas ($/mmBTU)	$	5.00
Escalation rate of cost (% annually)		1.9%
Cost of user defined feedstock 1 ($/unit)	$	-
Escalation rate of cost (% annually)		1.9%

Note: Price of hydrogen can be specified as for price-taker modeling or set equal to "Estimated break-even leveraged price ($/kg)" for price-setter modeling.

Only relevant costs need to be updated. Feedstock or co-products that are not used do not impact analysis.

Accomplishments and Progress: Example Analysis – CHHP, Hypothetical 200 kg/day

Preliminary

Step 4: Specify project financial circumstances

Other operating expenses	
Credit card fees (% of sales)	2.50%
Sales tax (% of sales)	2.25%
Road tax ($/kg)	$ 0.36
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)	$ 1,000
Licensing & permitting escalation rate (%/year)	1.9%
Rent of land ($/station-year)	$ 3,000
Rent escalation (% annually)	1.9%
Property insurance (% of dep capital)	1.5%
Selling & administrative expense (% of sales)	0.5%

Financing Information	
Total tax rate (state, federal, local)	38.50%
Capital gains tax	15.00%
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	1.90%
Depreciation method	MACRS
Depreciation period	7 year
Leveraged after-tax nominal discount rate	10.0%
Debt/equity financing	0.5
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%

Sales Specification	
Project start year	2015
Project operational life (years)	20
Installation time (months)	18
Demand ramp-up (years)	0.0
Long-term nominal utilization (%)	80%

Take or Pay Contract Specification	
Price of unsold hydrogen	-
Price linear decay (% of initial/year)	0%
Contract sunset (years)	15.00
Utilization supported up to (% of capacity)	50%

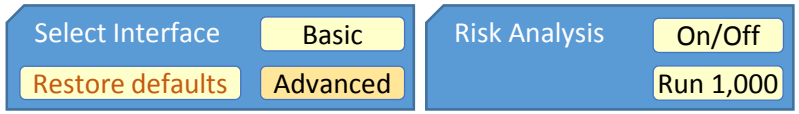
Note: Take-or-pay contract specifications allow for utilization risk mitigation strategy analysis.

Accomplishments and Progress: Example Analysis – CHHP, Hypothetical 200 kg/day

Preliminary

Step 5: Specify uncertainties & run risk analysis

- Click “Advanced”
- Click “Risk Analysis On/Off”
- Specify uncertainty of parameters (triangular distribution)



	Most likely value	Minimum value	Maximum value
Capacity (kg/day)	250	250	250
Equipment capital cost	4,500,000	3,150,000	6,750,000
Non-depreciable fixed assets (e.g. land)	-	-	-
Installation cost	1,000,000	1,000,000	1,000,000
End of project sale of non-depreciable assets	-	-	-
Planned & unplanned maintenance ($/year)	350,000	350,000	350,000
Maintenance escalation (% annually)	1.9%	1.9%	1.9%
Coproduct Specifications			
Usable waste heat (mmBTU/kg)	0.040	0.020	0.040
Electricity co-production (kWh/kg)	44.41	44.41	44.41
User defined co-product (units/kg)	-	-	-

For example, equipment capital cost and heat utilization varied.

Model uses triangular distribution.

- Click “Run 1,000” – to perform Monte Carlo analysis with 1,000 iterations.

Accomplishments and Progress: Example Analysis – CHHP, Hypothetical 200 kg/day

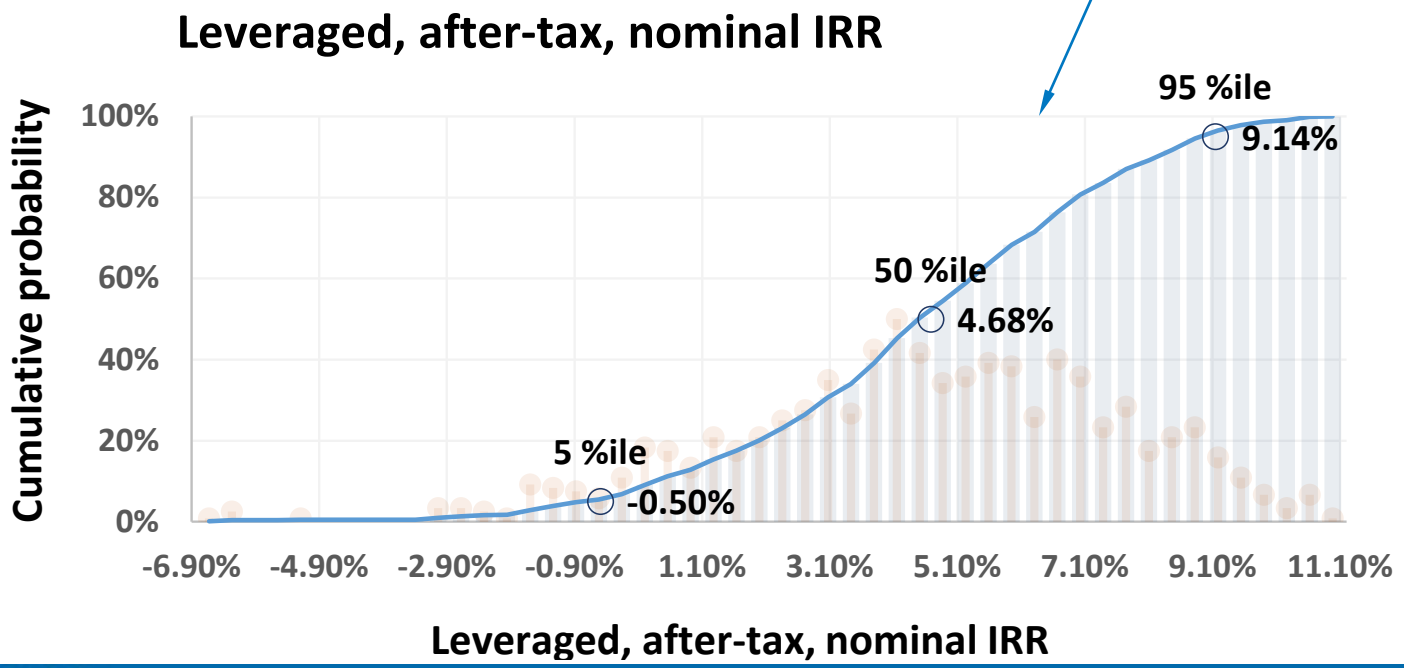
Preliminary

Examine results

Overall Financial Performance Metrics	Most likely value	5%'ile	95%'ile	Plot
Leveraged, after-tax, nominal IRR	5.88%	-0.54%	9.50%	
Profitability index	1.35	0.83	1.78	
Investor payback period	10 years	8	16	
First year of positive EBITD	analysis year 2	2	2	
After-tax, nominal NPV @ 10% discount	$ (894,655)	$ (2,345,175)	$ (102,307)	
Estimated break-even leveraged price ($/kg)	$ 12.45	$ 10.28	$ 16.42	

Click to select distribution to plot

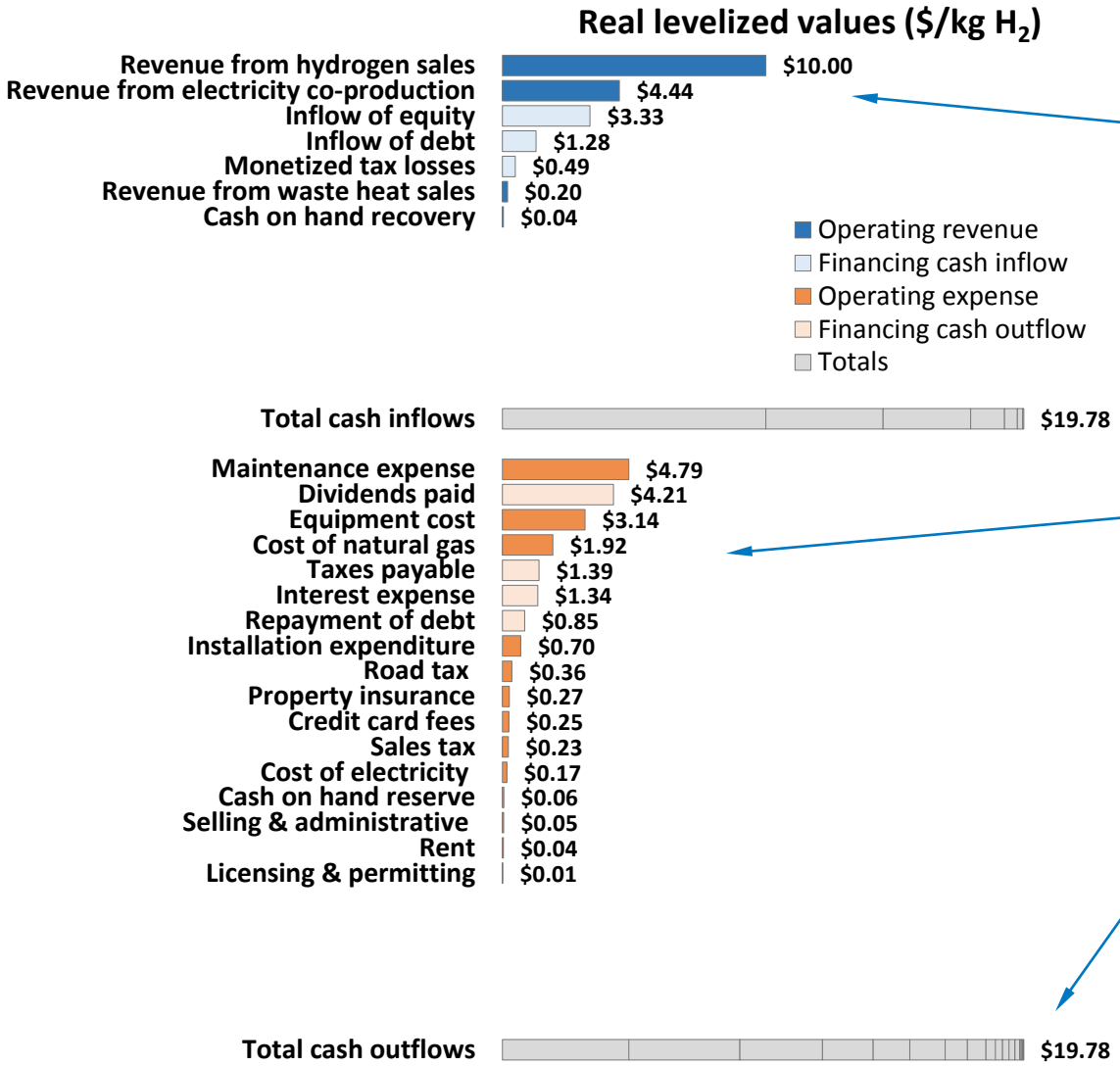
Breakeven leveraged price can be used to yield IRR target.



Accomplishments and Progress: Example Analysis – CHHP, Hypothetical 200 kg/day

Preliminary

Examine results - continued



Operating revenues and financing cash inflows are normalized for ease of comparison.

Operating expenses and financing cash outflows are normalized for ease of comparison.

Total cash inflows and outflows are reported to demonstrate consistency.

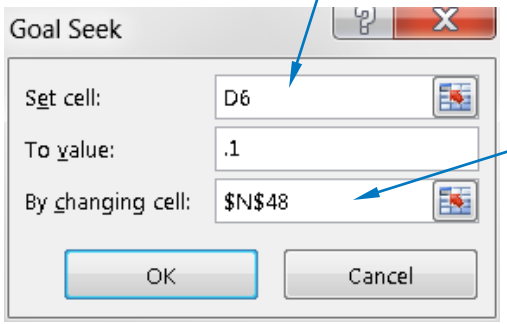
Accomplishments and Progress: Example Analysis – CHHP, Hypothetical 200 kg/day

Preliminary

Example: Estimate capital incentives for $10/kg hydrogen

Overall Financial Performance Metrics	Most likely value
Leveraged, after-tax, nominal IRR	5.88%
Profitability index	1.35
Investor payback period	10 years
First year of positive EBITD	analysis year 2
After-tax, nominal NPV @ 10% discount	$ (894,655)
Estimated break-even leveraged price ($/kg)	$ 12.45

Station being analyzed (yellow background)	1	2	3
Station name	200 kg/day CHHP (production only)	200 kg/day CSD	200 kg/day CHP & CSD (sum of 1 & 2)
Incentives Information			
One time capital incentives (grant or ITC)	$ -	$ -	$ -
Annual operating incentives (grant or PTC)	$ -	$ -	$ -
Per kilogram incentive	$ -	$ -	$ -
Incidental revenue ($/year)	$ -	$ -	$ -



Goal Seek can be used to solve for inputs.

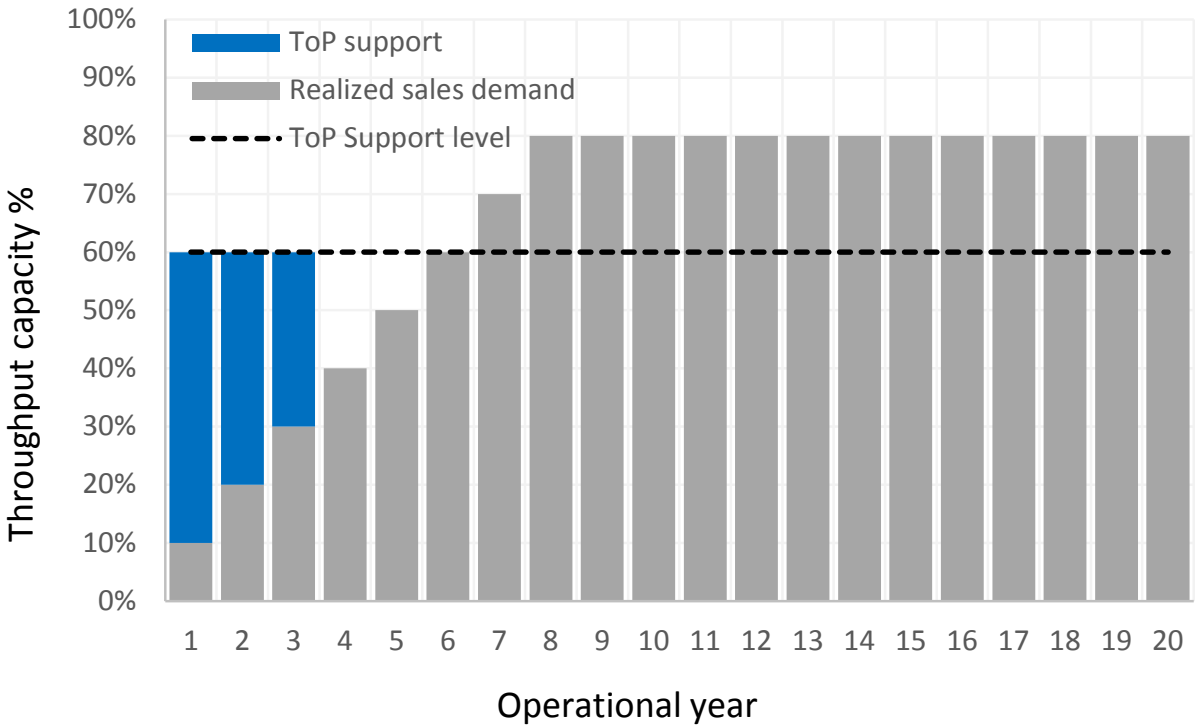
In this example, it takes $1.097 million of capital incentive to yield $10/kg hydrogen @ 10% IRR.

Overall Financial Performance Metrics	Most likely value
Leveraged, after-tax, nominal IRR	10.00%
Profitability index	1.84
Investor payback period	8 years
First year of positive EBITD	analysis year 2
After-tax, nominal NPV @ 10% discount	$ (1)
Estimated break-even leveraged price ($/kg)	$ 10.00

Station being analyzed (yellow background)	1	2	3
Station name	200 kg/day CHHP (production only)	200 kg/day CSD	200 kg/day CHP & CSD (sum of 1 & 2)
Incentives Information			
One time capital incentives (grant or ITC)	$ -	$ -	$ 1,096,987
Annual operating incentives (grant or PTC)	$ -	$ -	$ -
Per kilogram incentive	$ -	$ -	$ -
Incidental revenue ($/year)	$ -	$ -	$ -

Accomplishments and Progress: Take-or-Pay (ToP) Contract Modeling Considerations

Preliminary



Take or Pay Contract Specification	
Price of unsold hydrogen	4.00
Price linear decay (% of initial/year)	0%
Contract sunset (years)	3.00
Utilization supported up to (% of capacity)	60%

- Separate price applied to unsold hydrogen
- Allowance to decrease coverage price over time
- Limit for duration of ToP contract
- Limits quantity of unsold hydrogen coverage

Accomplishments and Progress: Example Analysis – CHHP, Hypothetical 200 kg/day

Preliminary

Example: Evaluate take-or-pay (ToP) contract impact on IRR

Overall Financial Performance Metrics	Most likely value
Leveraged, after-tax, nominal IRR	5.47%
Profitability index	1.41
Investor payback period	12 years
First year of positive EBITD	analysis year 5
After-tax, nominal NPV @ 10% discount	$ (956,463)
Estimated break-even leveraged price ($/kg)	$ 13.33

Example assumptions:
- 5-year demand ramp to 70%
- ToP support up to 60% utilization

Take or Pay Contract Specification	
Price of unsold hydrogen	-
Price linear decay (% of initial/year)	0%
Contract sunset (years)	3.00
Utilization supported up to (% of capacity)	60%

Change price of unsold hydrogen to $4/kg

Take or Pay Contract Specification	
Price of unsold hydrogen	4.00
Price linear decay (% of initial/year)	0%
Contract sunset (years)	3.00
Utilization supported up to (% of capacity)	60%

Overall Financial Performance Metrics	Most likely value
Leveraged, after-tax, nominal IRR	6.36%
Profitability index	1.49
Investor payback period	11 years
First year of positive EBITD	analysis year 2
After-tax, nominal NPV @ 10% discount	$ (750,158)
Estimated break-even leveraged price ($/kg)	$ 12.61

Financial impact:
- Earnings before interest, tax, and depreciation (EBITD) positive 3 years earlier (important for securing debt)
- IRR increases by 0.9%
- Payback decreases by 1 year
- Net present value (NPV) improves by $200,000
- Breakeven hydrogen price decreases by $0.72/kg

Collaboration (Contributors & Stakeholders)

Industry

- H2USA Investment and Finance Working Group (IFWG) Provided requirements & review
- Bill MacLeod (Hyundai Motor Group) Provided requirements & review
- Sanjeeva Senanayake (Welford Energy) Provided review & methodology guidance
- Mike Curry, MBA (Curry & Co.) Provided requirements & review
- Mike Levy, MBA (Aaquis) Provided requirements
- Remy Garderet (Energy Independence Now) Provided model review

State & Federal Government

- H2USA Investment and Finance Working Group (IFWG) Provided requirements & review
- California Energy Commission Provided review & model utilization
- Tyson Eckerle (California Governor's Office) Provided model review & incentive framework

Federal Laboratory & University

- Ricardo Bracho, MBA and Michael Elchinger, MBA (NREL) Compliance with accounting & finance standards
- Jeff Grover, DBA (CEO, Grover Group Inc.) Line-by-line model review & validation

Proposed Future Work

- Enable multi-timeframe project stacking
  - Allow analysis of non-simultaneous projects
  - Allow portfolio analysis for stakeholders
    - Policymakers
    - Investors
    - Lenders
    - Operators
    - Automotive OEMs
- Add emissions calculations
- Support model use for informing stakeholders (CEC, DOE, H2USA, others)
- Expected publication date: 9/30/2016

Summary

- The Hydrogen Financial Analysis Scenario Tool (H2FAST) provides quick and convenient in-depth financial analysis for hydrogen fueling stations.
- The spreadsheet version of H2FAST was improved, including capabilities to analyze:
  - Risk analysis for any input parameter
  - Multi-product configurations (such as ancillary grid services and CHHP)
  - Multiple feedstock consideration (allowing for partial production/delivery and other custom analysis)
  - Non-depreciable assets accounting (e.g. land)
  - Take-or-pay contract arrangements
  - Expanded concurrent analysis of up to 300 hydrogen stations
  - Numerous usability enhancements
- These improvements enhance the use of H2FAST to facilitate investments in hydrogen refueling stations and improve policy-design decisions to support early hydrogen station and fuel cell electric vehicle market development.

Questions?

Contact us by email:

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Or by phone:

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Accomplishments and Progress: Responses to Previous Year Reviewers' Comments

Reviewer Comment: The project is definitely relevant to the DOE goals, in particular for getting the venture capital community engaged. It would be useful to consider (when designing the tool) the policy and regulatory community as well, because that community includes stakeholders involved in understanding costs and risks of infrastructure deployment.

Response: The model now has an enhanced capability to evaluate finances from policy and regulatory point of view. It allows for analysis of capital incentives, operating incentives, per-kilogram incentives, low carbon fuel standard credits, and take-or-pay contracts. The model allows users to tailor possible incentives and observe their impact on investor performance and risk.

Reviewer Comment: It would be useful to look at interfacing with international databases (i.e., in Germany and Japan) to have a common tool for investors.

Response: The model has been enhanced toward this goal. International financial reporting standards (IFRS), has some differences from U.S. generally accepted accounting principles (GAAP). This gap is largely addressed by the addition of linear depreciation to the model, as IFRS does not allow for accelerated depreciation. Additionally, non-depreciable assets must be accounted for such as land – which has also been addressed in the model update.

Accomplishments and Progress: Responses to Previous Year Reviewers' Comments

Reviewer Comment: Potential stakeholders are not likely to use the tool for their primary financial analysis, given that companies tend to develop their own tools.

Response: We don't expect this model to replace any in-house models within large organizations. However, we expect this model to provide a common framework between stakeholders. We have found a positive response to the model from many stakeholders – including equipment manufacturers, policy makers, station operators, and investors. Comments have shown that this tool has good agreement with in-house models, and often provides significantly increased functionality over in-house models. This may vary substantially depending on organization size and resources it dedicates to financial modelling.

Reviewer Comment: A button could be added on the Internet model for user suggestions. The team may want to add a few "standard" cases to the model as a starting point for new users.

Response: We will likely address this. We have been receiving comments from users, and streamlining a feedback method would be useful.

Accomplishments and Progress: Responses to Previous Year Reviewers' Comments

Reviewer Comment: FCTO has sponsored a number of very valuable tools, but these tools are not advertised appropriately, partly because the DOE website is so cumbersome to navigate. There should be a website on which all these tools are found, with easy explanations of their uses. In the next report-out, it would be good to read about the reaction of a financial institution to the outputs of the tool and find out whether the financial institution would find the information sufficient to make a decision.

Response: The keyword "H2FAST" yields correct Google search results for the first 7 entries. It is also listed on http://www.nrel.gov/hydrogen/energy_analysis.html. Additional model advertising should indeed help inform potential new stakeholders.

Accomplishments and Progress: Responses to Previous Year Reviewers' Comments

Reviewer Comment: The fact that the model is being released in a protected manner is disappointing. Aside from transparency issues, there should be an option for an advanced user to unprotect the model and adapt it for his or her own use. After all, this is a publicly funded effort, so the product should be a public-domain tool. The project should consider opening up the H2FAST cells and code so that advanced users may modify the model for their purposes. To address concerns over making this too easy, the project could code a pop-up disclaimer stating that further modification may render the results invalid and requiring the user to acknowledge this fact.

Response: We agree with the spirit of this comment, and are pursuing options to make the model more transparent.