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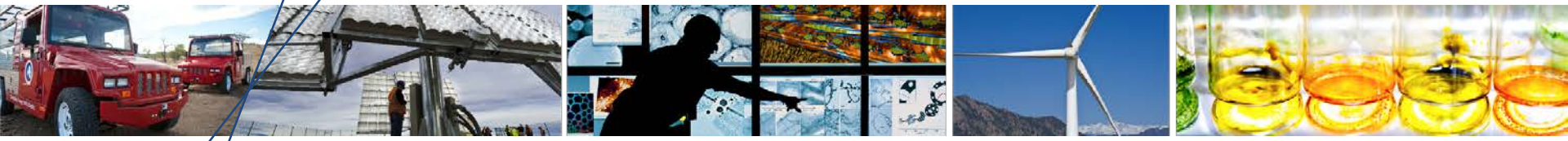
Infrastructure Investment and Finance Scenario Analysis



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2015 U.S. DOE Hydrogen and Fuel Cells Program and Vehicle Technologies Office Annual Merit Review and Peer Evaluation Meeting

Arlington, VA
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Project ID:
SA051

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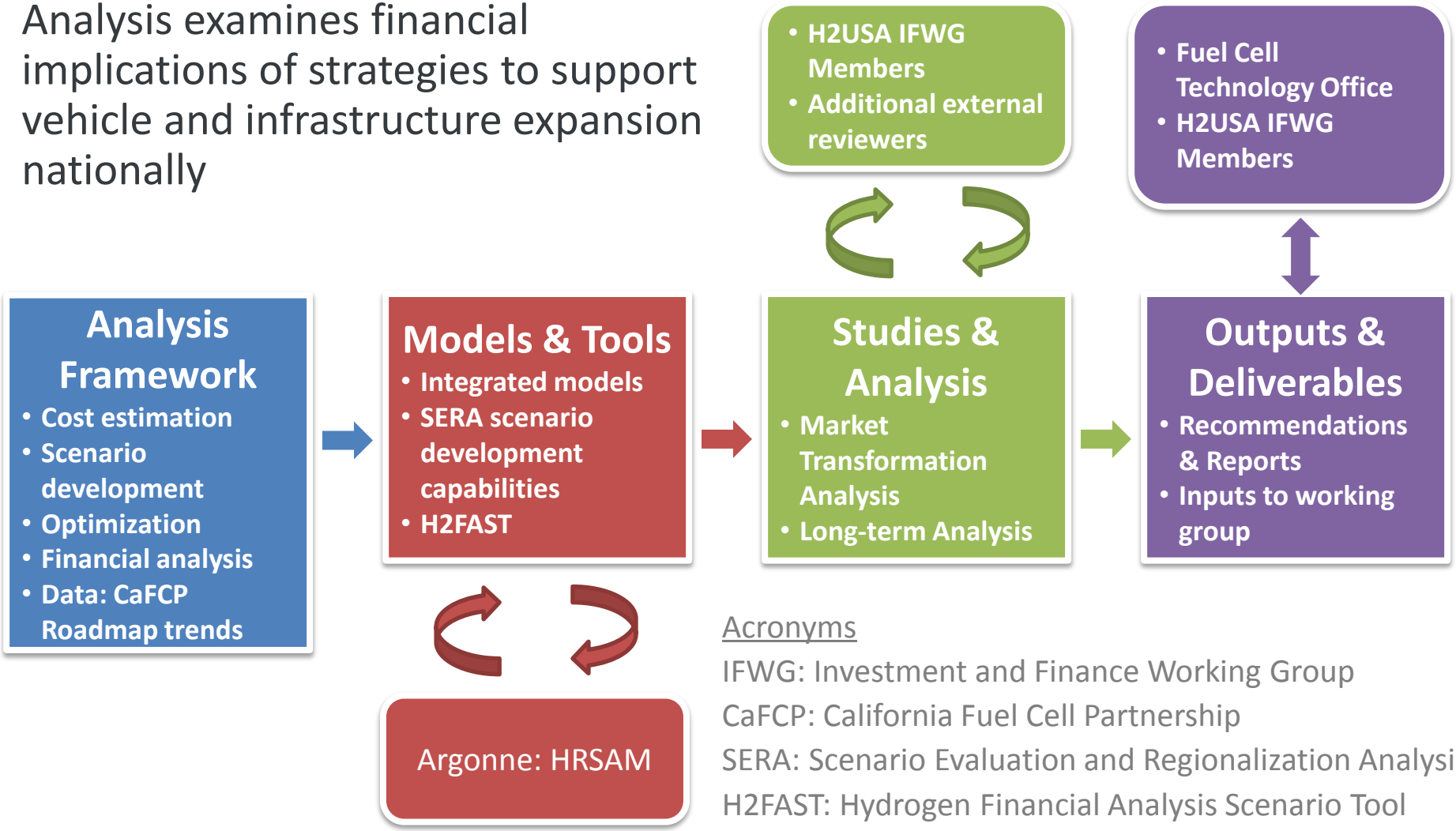
Overview

Timeline	Approach and Barriers
Start Date: Sept 2013 End Date: Oct 2015 Percent Complete: 66%	**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**
Total project funding • FY 2014: $75,000 • FY 2015: $100,000	• 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

Infrastructure Investment and Finance Scenario Analysis

Systems Analysis

Analysis examines 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

Importance of financing to understand infrastructure expansion options

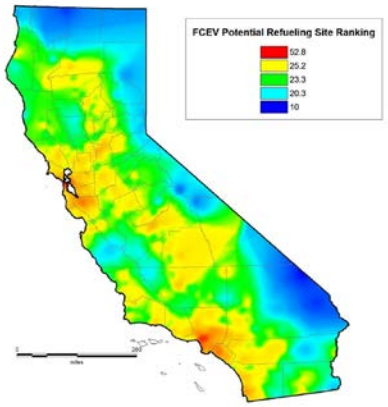
Relevance [1]

Infrastructure cost and risk analyses must be communicated in a manner accessible to stakeholders and potential investors

- **Reduce early mover risk barriers**. The business case for early stations is challenging due to uncertainty around demand. This can be a barrier to investment without insight into financial implications.
- **Partnership coordination and communication.** Successful partnerships can help mitigate project and investment risks. The use of public independent third-party finance tools can help improve coordination and communication at the project level.

Deployment in Perspective

- There are about 150,000 U.S. gasoline retail stations
- Converting 0.5% would require ~$1.5 B investment for 750 stations
- Capacity for first ~200,000 FCEVs(1)



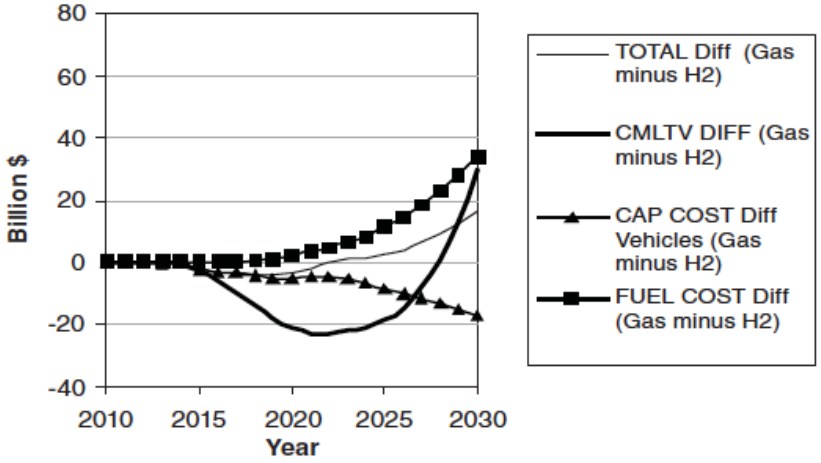
100 Stations Currently Funded in California

Represents 1% of the total ~10,000 stations in the state(2)

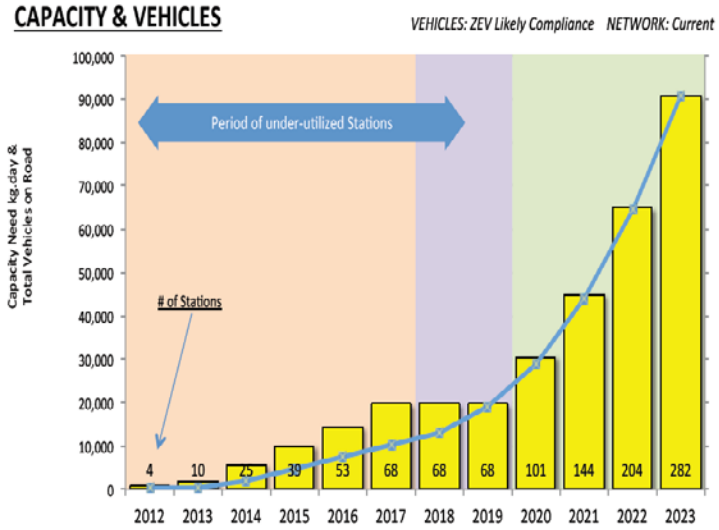
Framework contributes refinements and standardization to previous approaches

Relevance [2]

- National Research Council (NRC) and UC Davis studies focused on cash flows
- Energy Independence Now (EIN) analysis examined financing for stations

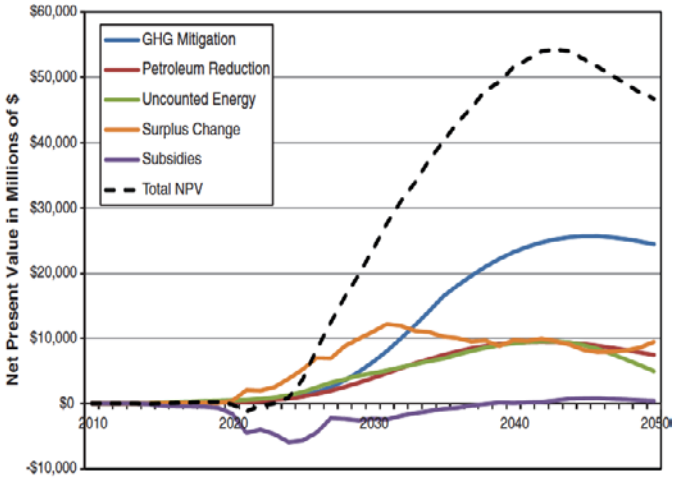


A Focus on Hydrogen (NRC 2008)



H2NIP (EIN 2013)

Transition to Alternative Fuels (NRC 2013)



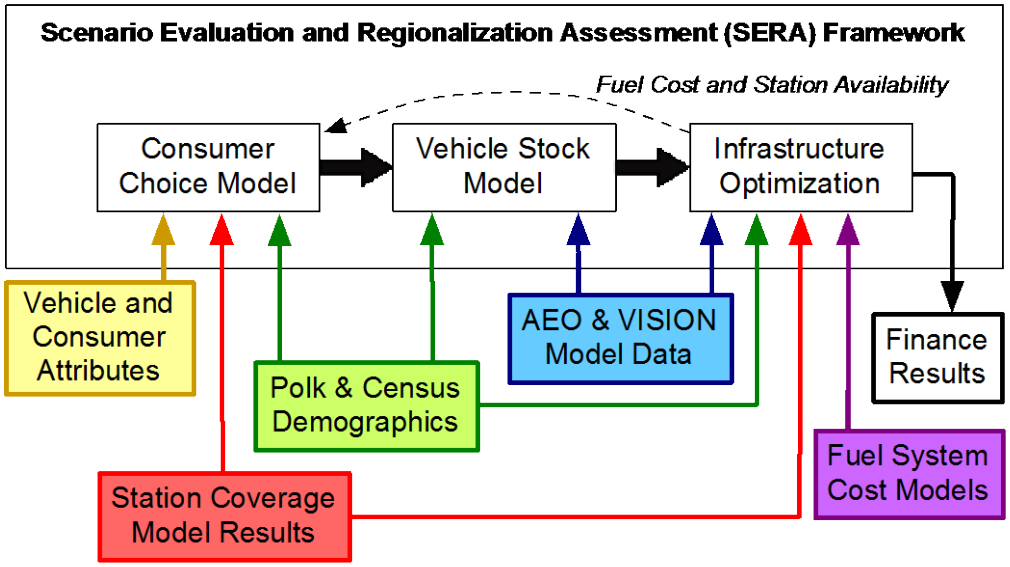
Hydrogen infrastructure transition costs and financing have been examined in many previous studies – H2FAST builds upon these

Standard financial accounting and reporting practices applied to hydrogen infrastructure

Approach [1]

Hydrogen infrastructure cost model results from SERA have been fully integrated with the finance framework

- H2A cost details, infrastructure timing, and logistics information are integrated across all finance calculations (see figure below)
- Maintain consistency with other models



Key H2FAST Outputs

- Annual projection reports for:
  - Income Statement
  - Cash Flow Statement
  - Balance Statement
- Key Metrics:
  - IRR, EBITD, NPV, ROE, break-even price, payback
- Ratio analyses, for example:
  - Debt / equity
  - Debt Service Coverage Ratio
- Calculations adhere to international and generally accepted accounting practices

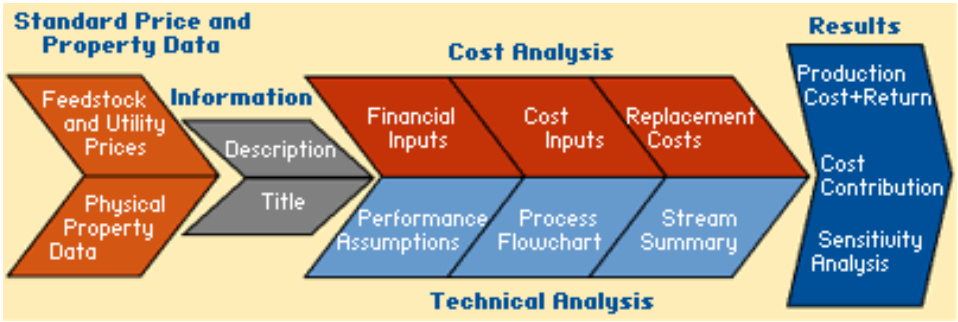
The Scenario Evaluation and Regionalization Analysis model (SERA) integrates multiple data sources and sub-modules into an optimization routine

H2FAST Web and Spreadsheet designs are aligned with end-user requirements

Approach [2]

H2FAST provides a quick and convenient in-depth financial analysis for hydrogen station projects and investments

- H2FAST builds upon the industry-vetted DOE H2A discounted cash flow framework
- The H2A interface was primarily designed for technology analysts
- More extensive post-processing of cost results allows for reporting on a range of financial performance metrics of interest to investors
- The user interface for accessing cost and finance results has been completely reworked based upon feedback from reviewers with finance industry experience



H2A Discounted Cash Flow Framework

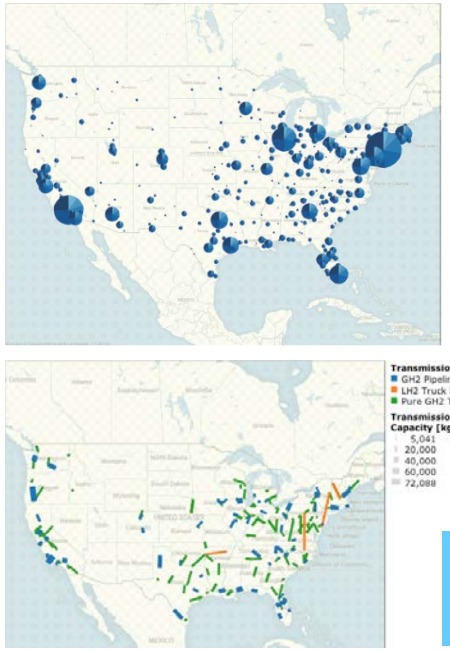
Many business or finance sector end-users will have less time to access relevant financial information than a typical H2A model end-user

Multivariate visualization tool provides access to large scenario data results

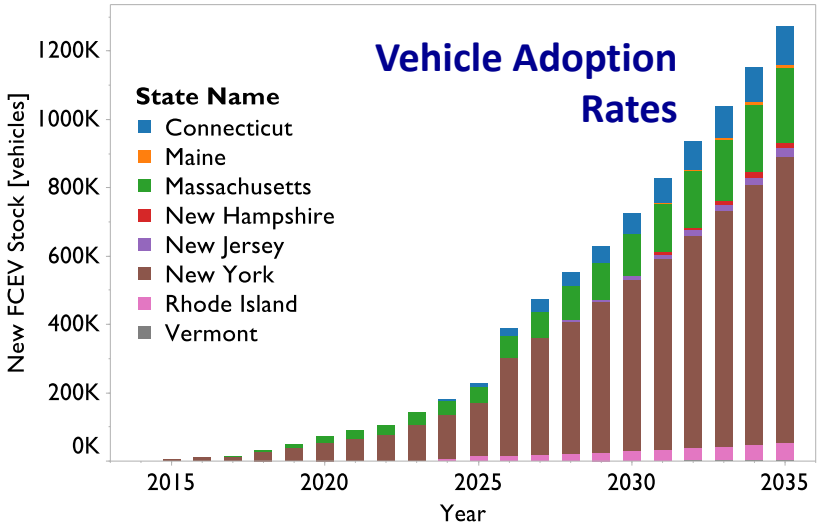
Approach [3]

- The SERA model can generate a large volume of scenario results
- The H2FAST framework can be applied across the entire hydrogen supply chain system and a broad range of scenario parameters
- Some engaged audiences, such as H2USA WG members, are interested in exploring ranges of inputs assumptions and multiple sets of scenario outputs

Demand and Delivery by City



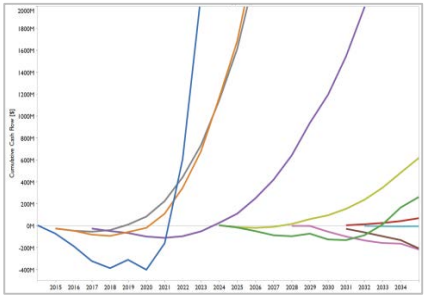
Regional/State-level Subsets of Results



Stand-alone reports cannot capture the full range of possible outputs

Station Placement

Cash Flows



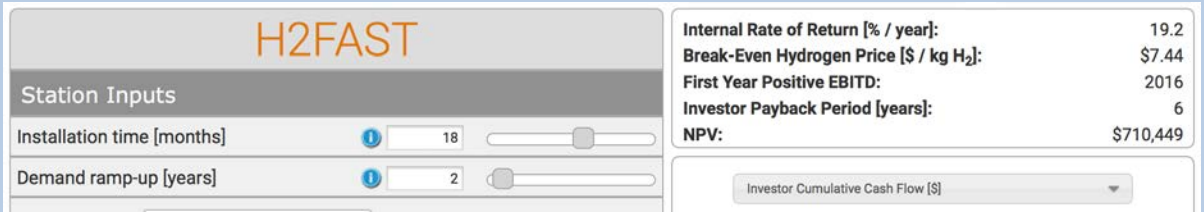
The Business Case Scenario Visualization tool (BCS-Vis) is being developed to allow end-users to explore a wide range of inputs and outputs

The H2FAST framework has been implemented within multiple tools

Accomplishments and Progress [1]

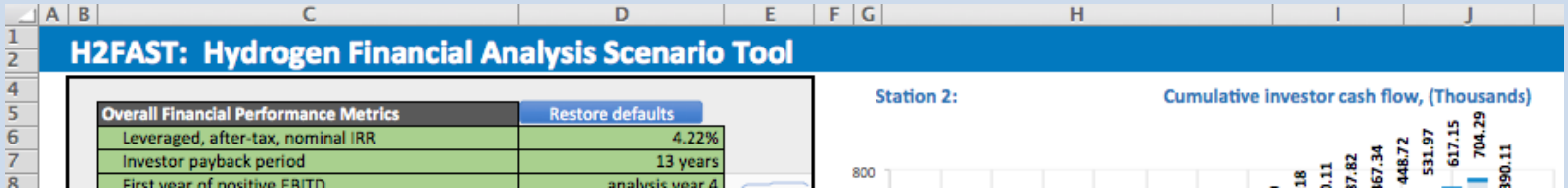
Consistent financial calculations are deployed across the H2FAST web and spreadsheet tools and SERA scenarios

H2FAST-Web is a simple, easy to use online calculator

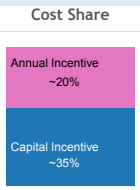


Tool interface designs have been tailored to distinct end-user groups

H2FAST-Excel allows for more detailed inputs and elaborate outputs



Business Case Scenario tool explores the full range of SERA outputs



Internal Rate of Return over 15-Year Period (capital incentive and annual incentive)

Capital Cost [$]	Hydrogen Price [$/kg] 8.50	9.00	9.50	10.00	10.50	11.00	11.50	12.00
800,000	4.0%	10.6%	14.9%	18.3%	21.2%	23.7%	26.0%	28.1%
900,000	4.7%	10.8%	14.9%	18.2%	20.9%	23.4%	25.6%	27.6%
1,000,000	5.2%	11.0%	14.9%	18.1%	20.7%	23.1%	25.2%	27.1%
1,100,000	5.7%	11.2%	15.0%	18.0%	20.5%	22.8%	24.8%	26.7%
1,200,000	6.2%	11.4%	15.0%	17.9%	20.3%	22.5%	24.5%	26.3%

H2FAST-Web: deployed as a simple, user-friendly online tool

Accomplishments and Progress [2]

Instant visual results as graphical and numeric outputs

Introductory Language

Inputs

Download full financials for case

Reset Inputs

Links to Download Spreadsheet Version

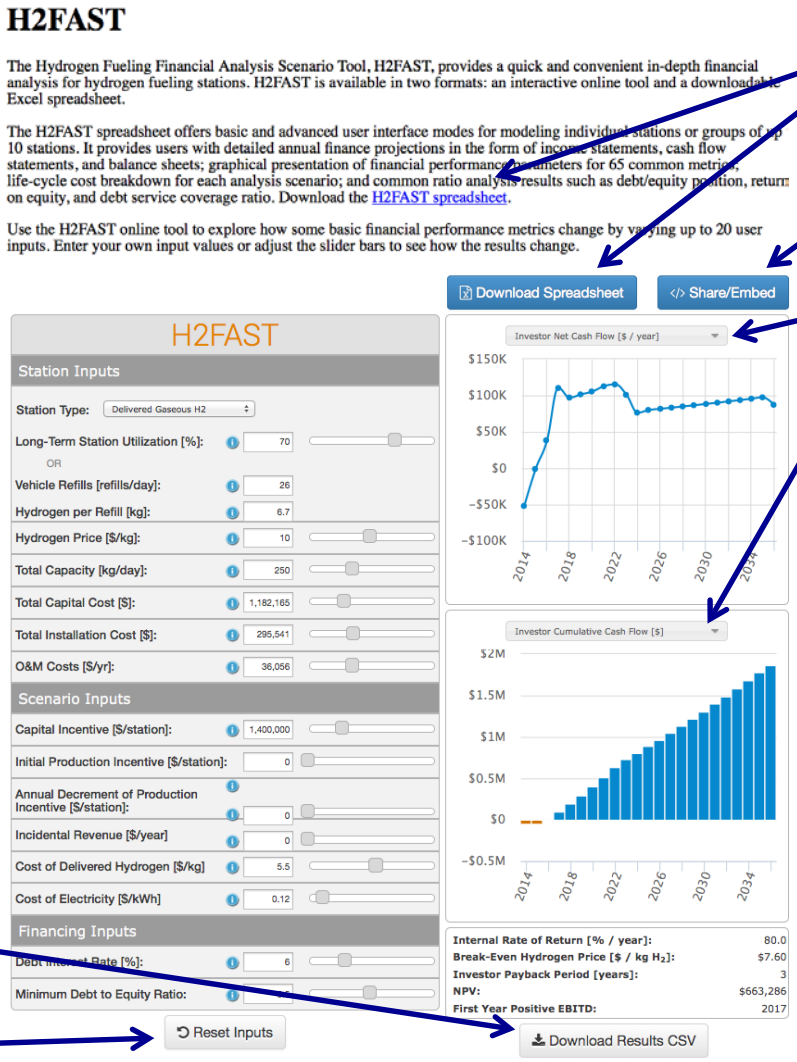
Embed widget

Change Graphical Output metrics

Graphical Outputs (1)

Graphical Outputs (2)

Single Value Results



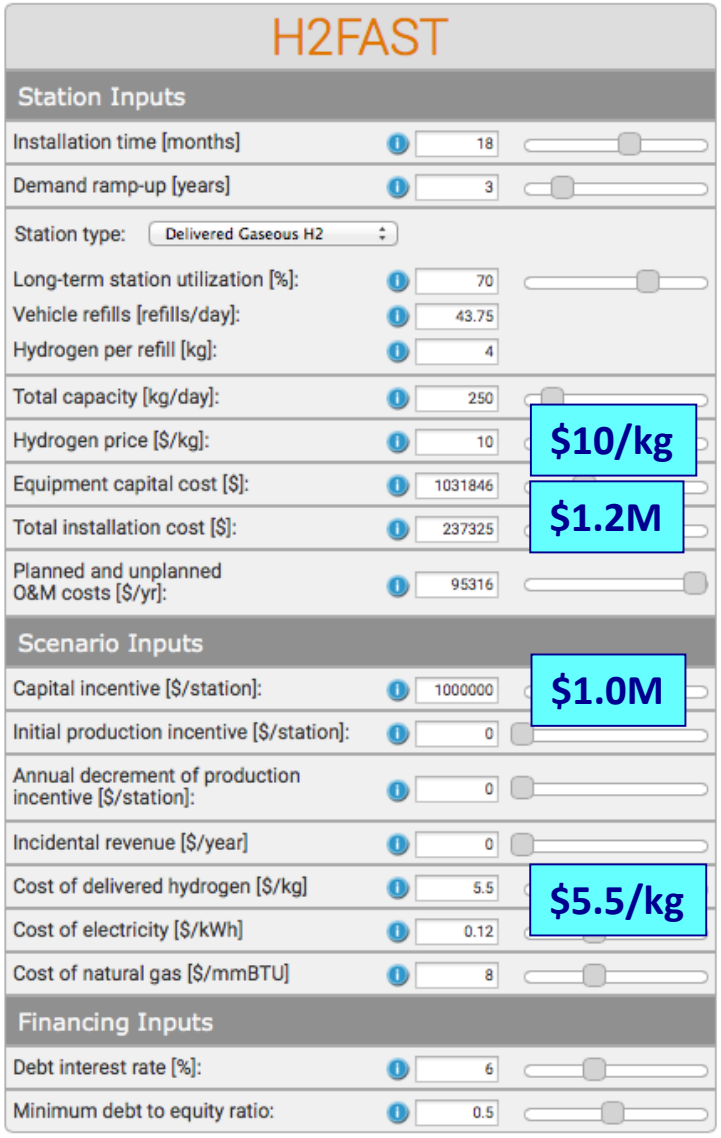
H2FAST-Web: Example Scenario with $1 M subsidy and $10/kg price

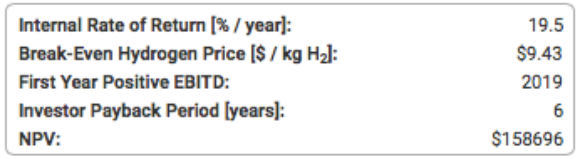
Accomplishments and Progress [3]

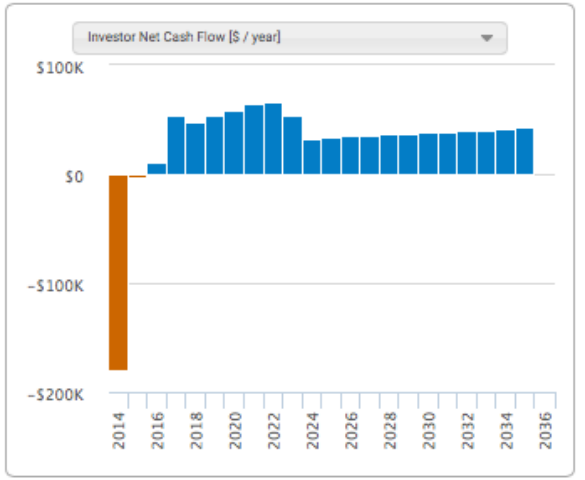
- A nominal GH2 tank truck delivery station: 250 kg/day
- $1.2 million in capital and installation (HRSAM)
- $1.0 million subsidy
- Hydrogen delivered for $5.50/kg, sold for $10/kg
- Top graph shows net investor cash flow; Bottom graph shows cumulative investor cash flow
- Result: $9.43/kg as breakeven price (10% IRR)

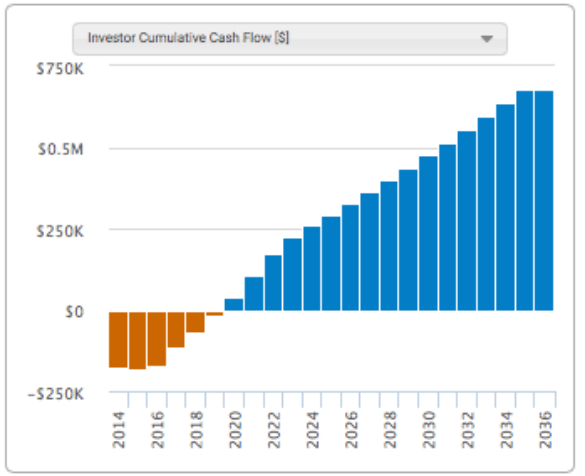
For this Scenario: 19.5% IRR, 6 yr investor payback

User must input best available cost data









H2FAST-Excel: summary of capabilities, inputs and outputs

Accomplishments and Progress [4]

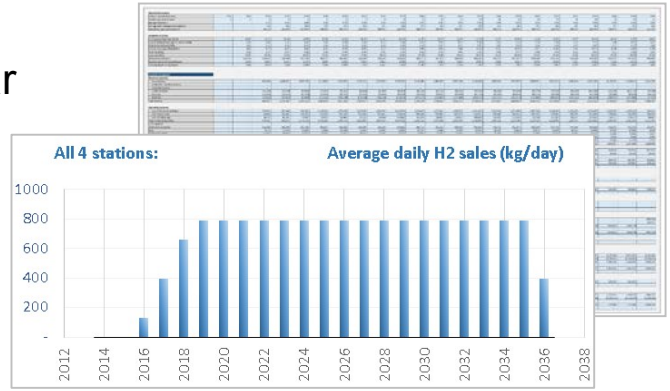
The spreadsheet version allows for greater control of inputs, analysis of multiple stations, and more elaborate exploration of outputs

Inputs

- Ability to enter information for up to 10 stations, and assess finances for each individually or as a cluster of station projects.
- This allows for side-by-side comparison of station projects
- There are two modes for users to provide inputs:
  - Basic mode: 20 parameters
  - Advanced mode: 51 parameters
- Inputs and outputs have hover-over descriptions to orient users

Outputs

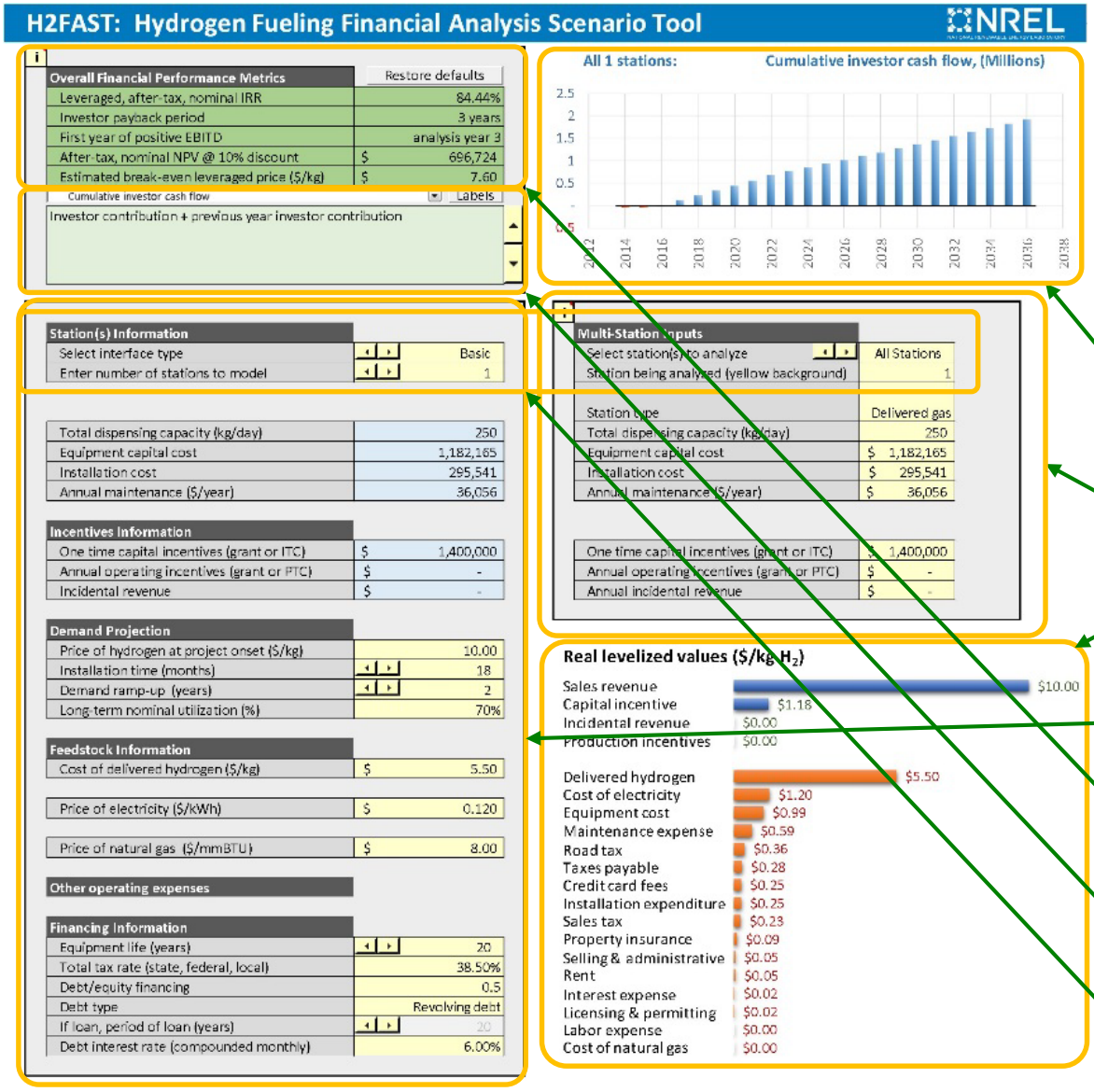
- Detailed report tables are provided for each project year
  - Scenario parameters (e.g. volumes of sales)
  - Income statement
  - Cash flow statement
  - Balance sheet
  - Select ratio analyses



A spreadsheet environment may be preferable for some end-users

H2FAST-Excel: Review of Basic User Interface mode attributes

Accomplishments and Progress [5]



Basic Interface

- Basic user inputs
- Advanced user inputs
- Calculated values
- Key results

Detailed graphical display

Station costs specifications

Revenues, cost breakdown

Financial specifications

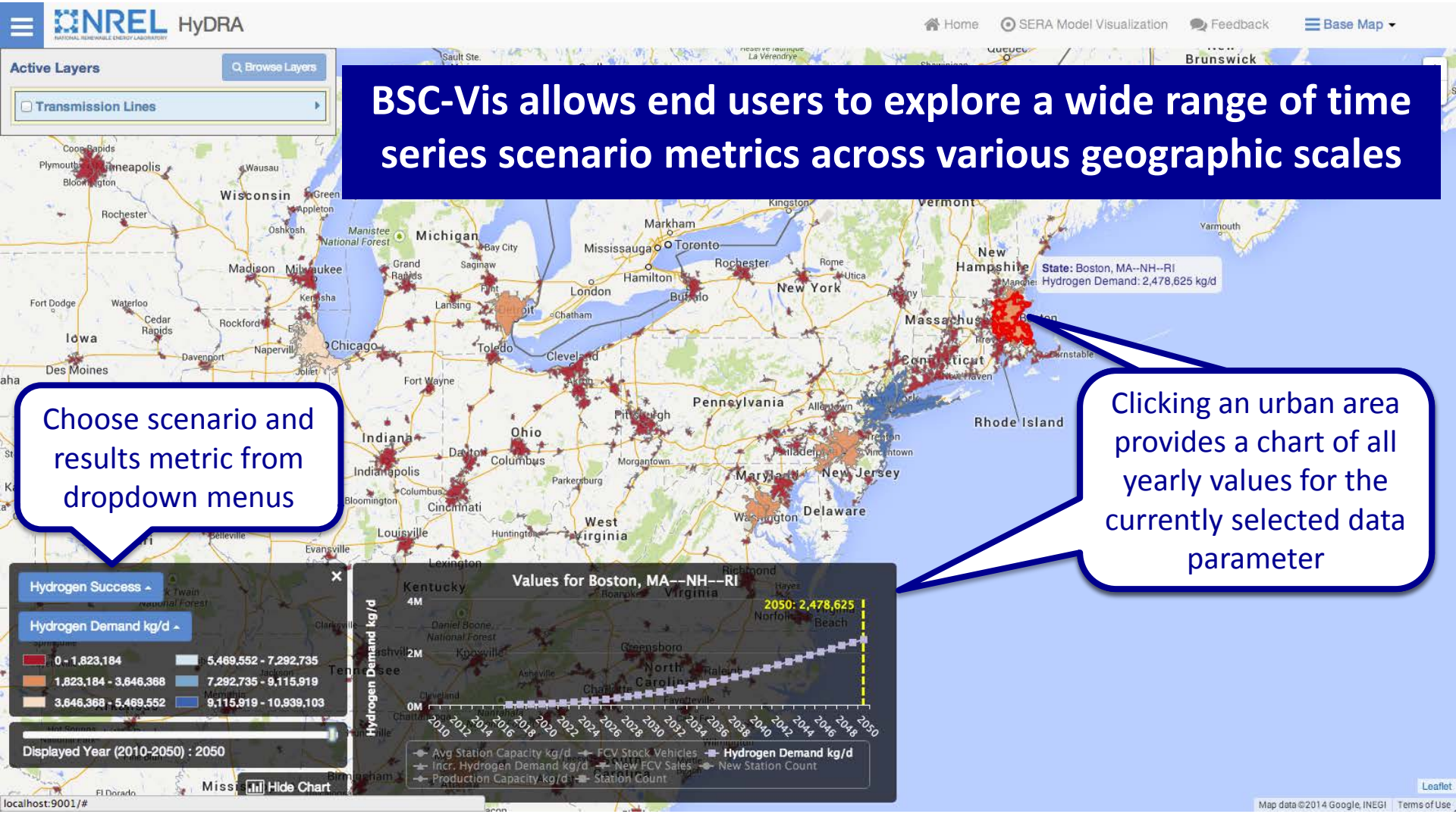
General outputs

Graphical display selector

Mode & stations toggles

Multivariate visualization tool for BCS results (beta version)

Accomplishments and Progress [6]



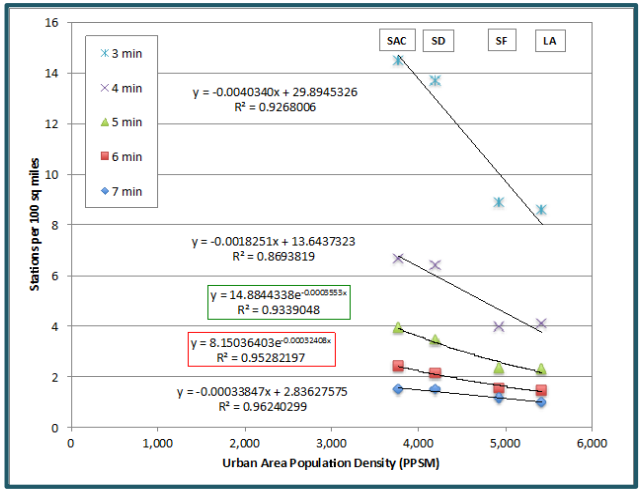
4-min video demonstrates the multivariate visualization tool: http://youtu.be/J7y51c-dldo

Integration with Station Location and Cost analysis for a national rollout

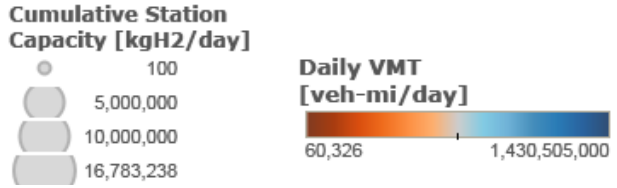
Accomplishments and Progress [7]

A simple *Early Adopter Metric (EAM)* has been used to identify an effective sequencing of coverage stations for urban areas

- EAM is based upon registered hybrid, plug-in, and luxury vehicles, as well as household incomes.
- Coverage stations required varies with population density (Nicholas et al., 2004)(C)



Multiple rollout scenarios are of interest. The maps below illustrate one possible market growth scenario with urban area sequencing.



2023-2027

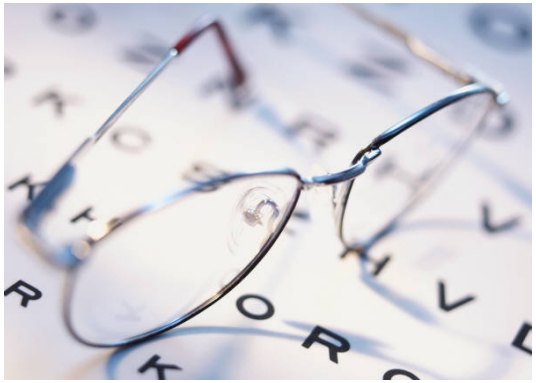
2028-2032

Integrated reviewer feedback and conducted independent review

Collaborations [1]

Feedback on beta version of H2FAST Web and Spreadsheet tools integrated to improve design and functionality

- Extensive review with members of the H2USA Investment and Finance Working Group, as well as reviewers from the following internal and external organizations:
  - Welford Energy
  - Aaqius
  - Go-Biz (California Governor's Office)
  - Energy Independence Now
  - NREL's project finance group



- Presentation to the U.S.DRIVE Fuel Pathways Integration Tech Team (ExxonMobil, Chevron, Shell Oil Products, and Air Products and Chemicals, Inc.)
- Independent and in-depth technical review by financial analysis consultant (DBA Consulting)

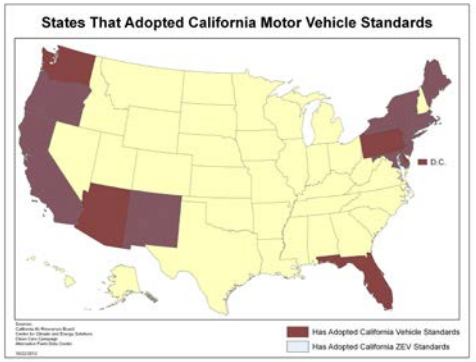
Continue to engage with stakeholders to improve analysis framework

Proposed Future Work [1]

Scenarios and framework will continue to be refined in response to ongoing discussions with stakeholders and potential investors

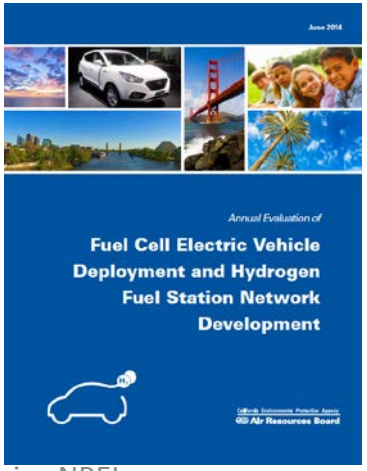
- Direct support for H2USA Working Group activities
- Integration of information relevant to financial analysis provided by various stakeholders engaged in deployment activities, including:
  - California Energy Commission (H2USA Member)
  - California Air Resources Board (H2USA Member)
  - Multi-State ZEV Action Plan (NESCAUM)

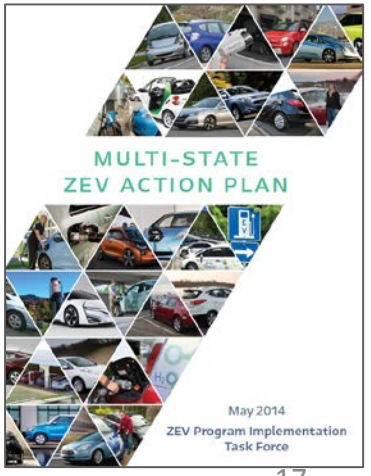
H_2USA



Municipal and state level plans can be incorporated into national scenarios

- Analysis framework can account for market factors or support mechanisms at any geographic scale (HOV lanes, etc.)
- Learning can be shared across markets



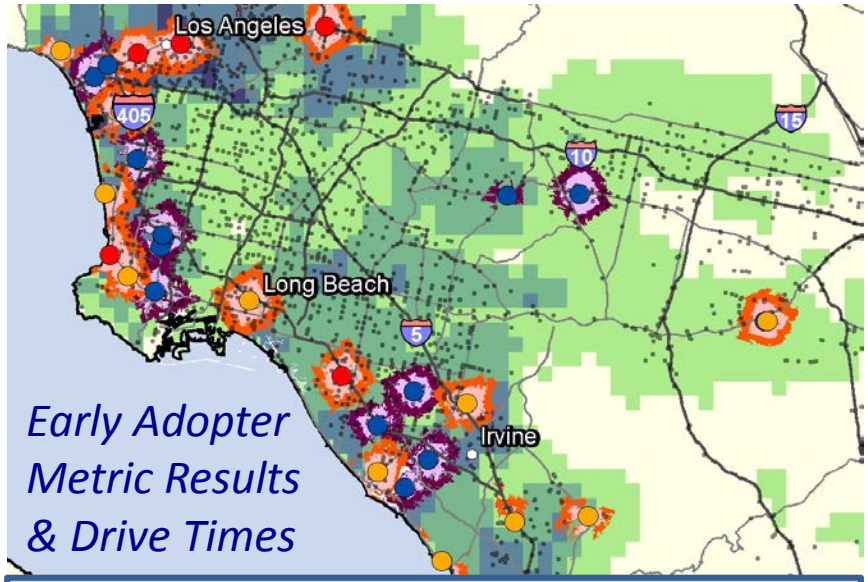


Refine analysis of finance strategies to be responsive to risks factors

Proposed Future Work [2]

Existing scenarios and sensitivity analyses could be improved to account for uncertainty and variability – to the degree that relevant data exist

- FCEV demand is a major uncertainty that could be characterized with more information on vehicle attributes (price, acceleration, etc.)
- Other risk factors can be quantified as more market data become available:
  - Attributes of early adopters
  - Attributes of competing vehicles
  - Shifts in demand among stations as networks expand
  - Influence of policy incentives on investors and consumers



Vehicle choice models, such as MA3T and ADOPT, can estimate market shares for advanced vehicles.

Investment decisions should be assessed in the context of both risk characterizations and incentives designed to mitigate investment risk

Project Summary

Relevance

- Infrastructure costs and risks must be communicated to stakeholders & investors
- H2FAST framework builds upon and extends previous financial analyses

Approach

- Calculations adhere to standard financial practices
- H2FAST Web and Spreadsheet interfaces designed for finance user group needs
- H2FAST BCS-Vis can convey large volumes of multivariate scenario results

Technical Accomplishments and Progress

- *Web version* provides quick and convenient in-depth financial analysis for stations
- *Spreadsheet version* provides more inputs and end-user flexibility
- *Beta version of BCS-Vis* demonstrations the multivariate visualization capability
- Multiple national finance strategies have been developed and explored
- Scenarios have been integrated with Station Location and Cost analysis activities
- Effectiveness of early adopter coverage used to prioritized urban area markets

Collaboration

- Reviews with multiple stakeholders and collaborative scenario development

Proposed Future Research

- Continue to engage stakeholders and investors; incorporate risk metrics

Technical Backup Slides

H2FAST Station Input Influence on ROI

Station Inputs			
Input	**Units**	**Description**	**Impact of Increase on ROI**
Installation time	months	Integer number of months from start of station construction to start of operation.	↓
Demand ramp-up	years	Years it takes demand to reach its long-term maximum.	↓
Station type	—	Four types: delivered gaseous/liquid hydrogen, onsite electrolysis/steam methane reforming.	—
Long-term station utilization	%	Stations may require reserve capacity for network robustness for events such as nearby station maintenance downtimes and special traffic events. Default of ~70% advised.	↑
Vehicle refills	refill/day	Number of vehicles refueling at the station per day.	↑
Hydrogen per refill	kg	Quantity of hydrogen per vehicle refill.	↑
Total capacity	kg/day	Average daily dispensing capacity such that station can adequately refuel cars during peak-demand days throughout year.	↑
Hydrogen price	$/kg	Total cost to end customer including all transaction costs such as credit card fees and sales taxes. Price is for beginning of project.	↑
Equipment capital cost	$	Cost of equipment only, not including other expenses such as engineering, permitting, and installation. Model assumes salvage value equals decommissioning costs for end-of-life treatment.	↓
Total installation cost	$	All installation costs such as engineering, permitting, lot/utility upgrades, etc.	↓
Planned and unplanned O&M costs	$/yr	Levelized annual maintenance costs for planned/unplanned equipment servicing and overhauls. Assumed to be non-depreciable.	↓

From H2FAST-Web User's Guide, available online: http://nreldev.nrel.gov/hydrogen/h2fast/

H2FAST Scenario and Finance Input Influence on ROI

Station Inputs			
Input	**Units**	**Description**	**Impact of Increase on ROI**
Scenario Inputs			
Capital incentive	$/station	Provided at beginning of project (during financing phase, Dec. 31, the year before construction begins). Can be grant or investment tax credit.	↑
Initial production incentive	$/station	Performance-based incentive beginning the month of station commissioning. Can be grant or production tax credit.	↑
Annual decrement of production incentive	$/station	Amount by which annual operating incentives are reduced each year. Allows this revenue stream to be ramped to zero by fixed annual amount.	↓
Incidental revenue	$/year	Other station revenue enhancements from presence of hydrogen, expressed as (marginal revenue − marginal expenses).	↑
Cost of delivered hydrogen	$/kg	Delivered hydrogen price defined at start of project (not at start of operation).	↓
Cost of electricity	$/kWh	Electricity price for hydrogen production (for reformers and electrolyzers), compression, and pre-cooling.	↓
Cost of natural gas	$/mmBtu	Cost of natural gas delivered to stations.	↓
Financing Inputs			
Debt interest rate	%	For loan and revolving debt calculations.	↓
Minimum debt to equity ratio	—	Initial financing capital structure (ratio of debt to equity financing).	↑

From H2FAST-Web User's Guide, available online: http://nreldev.nrel.gov/hydrogen/h2fast/

List of H2FAST-web output Graphs

Web-Based H2FAST Output Graphs

Graph Title	Description
Cost of Goods Sold [$/kg H_2]	Total operating expenses, plus depreciation, plus interest, minus selling and administrative expenses, divided by annual hydrogen sales.
Cost of Goods Sold [$]	Total operating expenses, plus depreciation, plus interest, minus selling and administrative expenses.
Earnings before Interest, Taxes, and Depreciation [$]	Total annual revenue minus total operating expenses.
Gross Margin [$/kg H_2]	Total revenues minus total expenses, discounted by the inflation rate and divided by the total sales of hydrogen.
Gross Margin [$]	Total revenues minus operating expenses.
Hydrogen Sales [kg H_2/day]	Total annual hydrogen sales divided by the length of the year.
Incidental Revenue [$]	Other station revenue enhancements from presence of hydrogen. Expressed as marginal revenue minus marginal expenses.
Investor Cumulative Cash Flow [$]	Net investor contributions plus previous year investor contribution.
Investor Equity [$]	Total equity.
Investor Equity Less Capital Incentive [$]	Total equity minus capital incentives.
Investor Net Cash Flow [$/year]	Investor withdrawals minus investor contributions.
Monetized Tax Losses [$]	Tax loss credits that could be applied when the majority equity holder has tax liabilities in excess of any credits.
Net Income [$]	Revenues, minus operating expenses, minus interest expense, minus taxes payable, minus depreciation expense.
Net Issuance of Debt [$]	Cash flow associated with acquisition of debt financing, or associated with repayment of debt. In the case of revolving debt, repayment is done in full at the end of the equipment's lifetime.
Net Issuance of Equity [$]	Cash flow from or to equity investors (i.e., investment, dividends, or owner withdrawals).
Production Incentive [$]	Annual revenue derived from production incentives.
Receipt of One Time Capital Incentive [$]	Cash flow from receipt of capital incentives, grants, or tax credits.
Station Utilization [%]	Annual dispensed hydrogen divided by design annual capability. Design capacity hinges on no excessive customer wait times during peak demand during the year.
Total Expenses [$/kg H_2]	Total expenses discounted by the inflation rate, divided by the total sales of hydrogen.
Total Revenues [$/kg H_2]	Total revenues discounted by the inflation rate, divided by the total sales of hydrogen.

From H2FAST-Web User's Guide, available online: http://nreldev.nrel.gov/hydrogen/h2fast/

Notes

1) Total retail fueling site count in 2013 was 152,995, source: National Petroleum News' MarketFacts 2013, cited by NACS Online, The US Petroleum Industry: Statistics, Definitions, accessed April 14, 2015, available online: http://www.nacsonline.com/YourBusiness/FuelsReports/2014/Statistics-And-Historical-Context/Pages/The-US-Petroleum-Industry-Statistics-Definitions.aspx ; Number of FCEVs supported by 750 stations based upon average station capacity of 200 kg/day, assumed average station utilization rate of 70% (assuming variation in ramp-up rates across stations, and 80% max. utilization), average on-road FCEV fuel economy of 65 mpgge, and 12,000 miles per year per FCEV. Total station cost based upon assumed average station cost of $2M per station (420 100 kg/d stations a $1.5M each; 230 250 kg/d stations at $2.2M each; 100 500 kg/d stations at $4M each). Values are approximate estimates for illustrative purposes only.
2) Total stations in California from the California Energy Almanac Retail Fuel Report and Data, available online: http://energyalmanac.ca.gov/gasoline/piira_retail_survey.html ; AB8 Legislation reviewed by: Ben Xiong, 2013,Governor Brown Signs AB 8, California Fuel Cell Partnership blog, available online: http://cafcp.org/getinvolved/stayconnected/blog/governor_brown_signs_ab_8

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