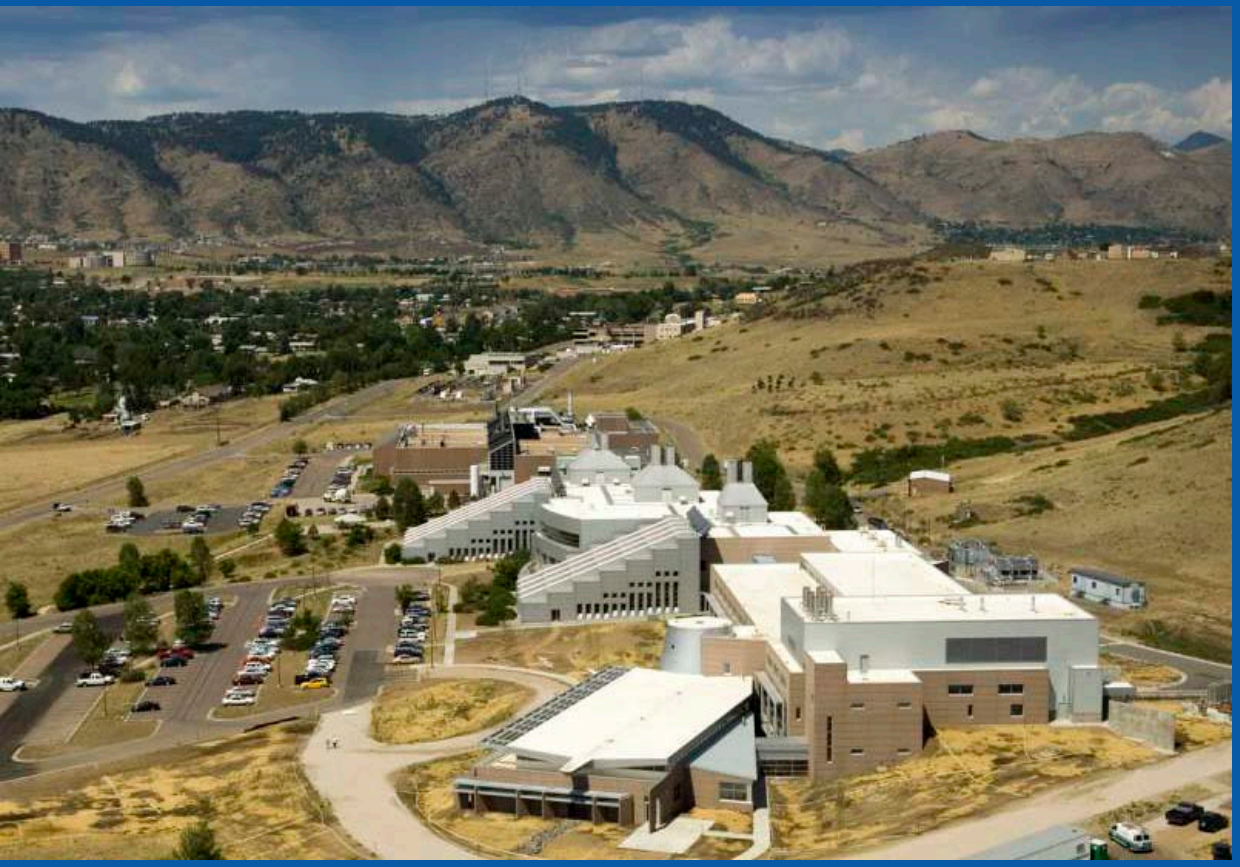
National Renewable Energy Laboratory
Innovation for Our Energy Future

Analysis of Business Cases with the Fuel Cell Power Model



Marc Melaina
Darlene Steward

National Renewable Energy Laboratory

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Overview

Timeline

- Start: September 2009
- Finish: August 2010
- Complete: 70%

Barriers

- Stove-piped/Siloed Analytical Capability [4.5.B]
- Suite of Models and Tools [4.5.D]
- Unplanned Studies and Analysis [4.5.E]

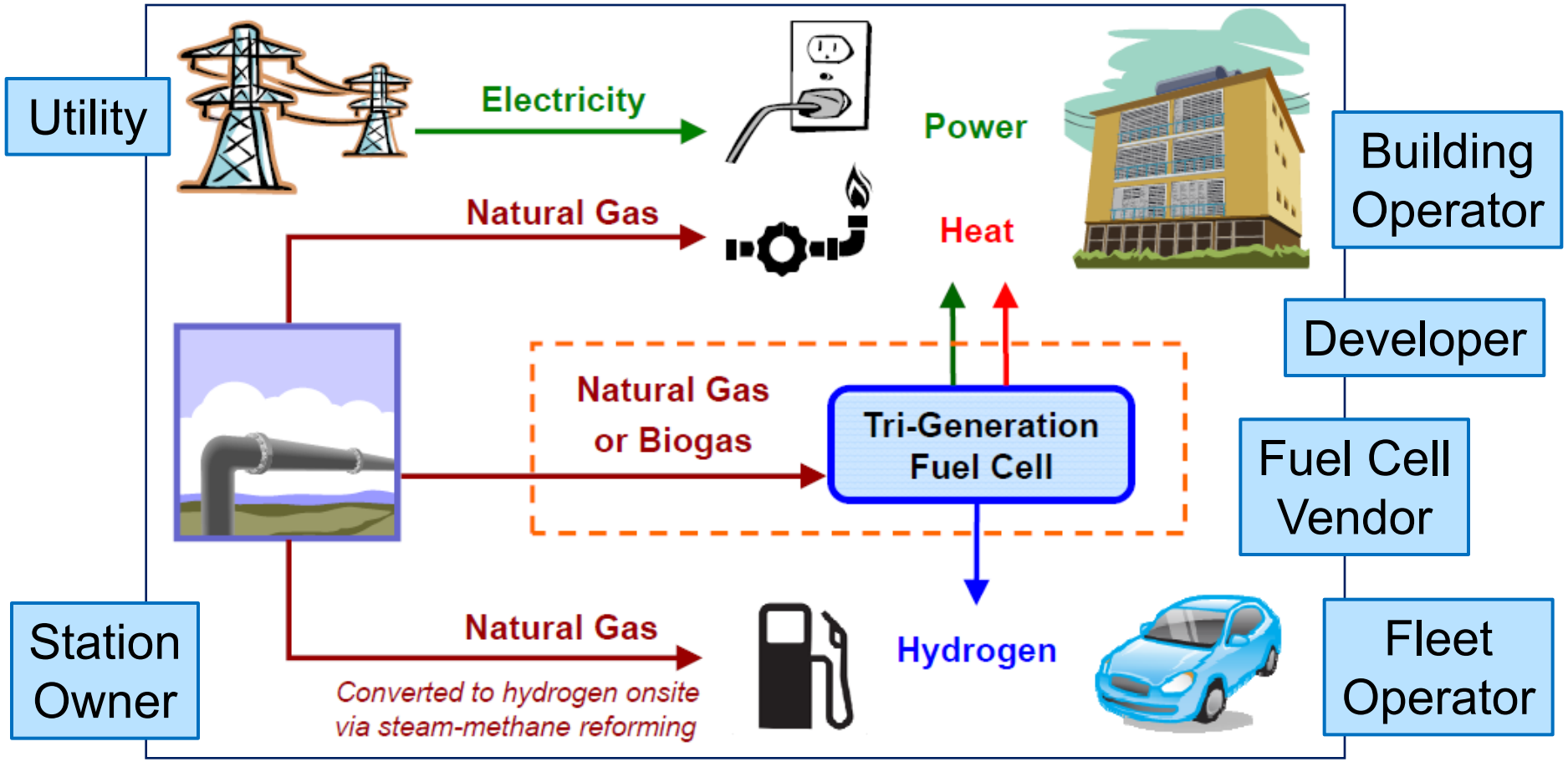
Budget

- Total Project Funding: $200k
  - 100% DOE-funded
- FY09 funding: $100k
- FY10 funding: $100k

Partners

- IDC Energy Insights

Relevance: Investing in Tri-Generation Stationary Fuel Cells



The installation of combined heat, hydrogen and power (CHHP) systems will involve strategic business decisions by multiple stakeholders.

Relevance: The FCPower Model Was Developed to Meet the Needs of a Technical Audience and Technical End-Users

Built on the H2A platform

Need for "common ground" in technical characterizations and economic analyses of near- and long-term hydrogen systems

- Agreement on reasonable financial assumptions
- Common economic analysis methodology (discounted cash flow)
- Allows users to focus on technology rather than different economic approaches

New Need: Communicate financial advantages (or disadvantages) of CHP/CHHP systems to a non-technical, business-oriented end-user .

Modified model will be useful for multiple parties

- **Building owners** (first-pass estimates of fuel cell CHP system feasibility)
- **Fuel cell vendors** (transparent communication of bid and performance claims)
- **Developers** (third party owning fuel cell system and selling products)
- **Fleet operators** (understand hydrogen production potential and location)
- **Utilities** (impacts of distributed generation and rate structures)
- **Station owners** (supply potential and factors influencing hydrogen cost)

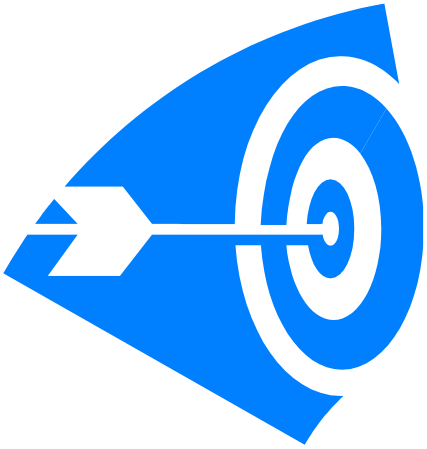
Relevance: Project Objective

Objective: Revise the H2A Fuel Cell Power model to suit the needs of business and finance decision makers and model end-users .

To meet this objective, a **Business Case Tab** will be developed.

- Tab will not replace in-house financial models, but it will extend the capability to do financial and business analysis within H2A.
- This is especially valuable for tri-generation systems due to multiple revenue streams.
- Understanding this objective will require stakeholder feedback.

We anticipate the following pattern of model use: A facility manager would first adjust the FCPower model to represent a particular building, then a business end-user would use that version to explore different financial criteria and what-if inquiries.



Relevance: Impact on Barriers

Barrier	***Impact***
Stove-piped/Siloed Analytical Capability [4.5.B]	• Expand the usefulness of the FCPower model for a broader range of end-users with more diverse and business or finance backgrounds
Suite of Models and Tools [4.5.D]	• Add analysis capabilities to existing FCPower model
Unplanned Studies and Analysis [4.5.E]	• Extend scope of techno-economic analysis capabilities to address previously unanticipated questions for a particular audience

Approach: Project Plan

Use Internal Resources

- Review H2A model structure to identify possible extensions of existing analysis capabilities.
- Collect feedback from NREL staff in Deployment, FEMP and Strategic Analysis centers.

Outreach to External Stakeholders

- Present Business Case Tab revision concepts to pertinent stakeholder groups
  - California Hydrogen Business Council (CHBC)
  - Hydrogen Utility Group (HUG)
  - California Fuel Cell Partnership (CaFCP).
- Connect with broader network of stakeholders (facilitated by IDC Energy Insights).
- Collect feedback from specific stakeholders on value of different Business Tab enhancements.

Approach: Milestones

One milestone specific to the Business Case Tab project

Milestone	***Date***	***Status***
Presentation on stakeholder feedback to DOE	May 28, 2010	On Schedule

Other milestones related to completion of the Business Case Tab (from the FCPower model project)

Milestone	***Date***	***Status***
Complete scoping of additional FY10 FCPower model capabilities	May 31, 2010	On Schedule
Release updated version of the FCPower model and users manual	September 30, 2010	On Schedule

Approach: Facilitated Dialogue by IDC Energy Insights

Subcontractor Outreach Project

- IDC Energy Insights in a research-based advisory and consulting group focused on market and technology developments in the energy and utility industries (www.idc-ei.com).
- IDC Energy Insights will coordinate a web-based dialogue to collect feedback on user-friendly designs and additional capabilities to enhance the Business Case Tab.

This activity will involve the following tasks:

- ✓ Complete independent review of the FCPower model and offer recommendations for Tab enhancements
- ✓ Confirm appropriate segmentation and type of stakeholders
  - Utilities, big box stores, auto dealers, university campuses, hospitals, hotels and convention centers, government, etc.
- ✓ Develop web-based dialogue materials in coordination with NREL staff
- ✓ Analyze and report on feedback from various stakeholder groups

Technical Accomplishments & Progress

Internal Accomplishments

- Reviewed H2A model structure to identify possible extensions
- Collected feedback from internal NREL MBA review team; staff from Deployment, FEMP and Strategic Analysis centers
- Outlined theoretical tab format and “to-do” list of potential revisions

External Accomplishments

- Initiated IDC Energy Insights subcontract (tasks outlined above)
- Presented FCPower model and proposed Business Case tab revisions to the California Hydrogen Business Council (March 4, 2010), collected feedback on analysis priorities

Accomplishment: Reviewed H2A Structure for Extensions

The discounted cash flow framework allows for significant flexibility with financial input and output parameters.

Example: variations on method of solving for revenue streams

- Model solves on total cost per total energy output ($/kWh), where "kWh" includes heat, hydrogen and power
  - CHP default: heat based on NG price, solve for cost of electricity.
  - CHHP default: heat based on NG price, electricity based upon grid, solve for cost of hydrogen.

- **Alternate 1:** specify all output costs, solve for IRR
- **Alternate 2:** specify heat and hydrogen, solve for cost of electricity
- **Alternate 3:** specify multiple IRRs, solve for cost of product of interest
- **Alternate 4:** input escalating use of hydrogen, solve for cost per kg

The question becomes: Which types of metrics and analytic capabilities should be made available through the Business Case Tab, and how?

Accomplishment: Feedback from Internal NREL Review

NREL's Internal MBA Review team provided additional suggestions to tailor the FCPower model to a business end-user.

Big Picture Issues

- Make costs and benefits prominent
  - Motivation to endure transaction costs
- Provide access to technological information
  - Counter information imbalance; build confidence

Examples of Specific Recommendations for Tab

- Provide one-sheet printout for executive reading
- Have IRR as output and as function of "what if" assumptions
  - Stakeholders will know their own hurdle rates
- Facilitate spot checking of basic financial assumptions
- Need significant flexibility on treatment of tax credits
- Allow exploration of alternative future feedstock prices (e.g., natural gas)
- Visual display of how demand and peak demand would be offset

Accomplishment: Outline of Theoretical Tab Format

Summary of Costs
Capital, variable, interest rate, debt/equity, feedstock prices

Summary of Benefits
NPV, IRR, net revenue, energy and GHGs avoided

Priority "What if" capabilities and results
Change assumptions; compare results

Learn more about Fuel Cells

Taxes and Incentives

Detailed balance sheet and cash flow

System performance

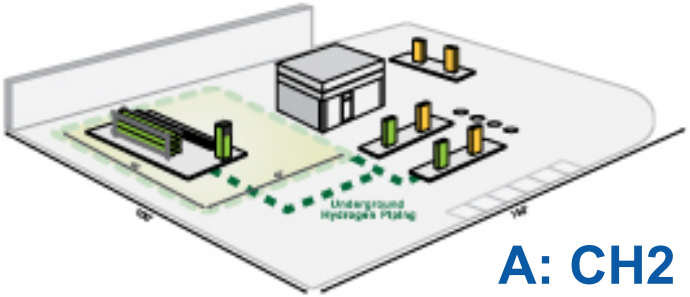
Utility and feedstock assumptions

Advanced or less common analytic capabilities

Title | Description | PFD | Input_Sheet_Template | Business Tab | Results | Key Figures | Tornado Chart | Sensitivity_Analysis | Replacement Costs

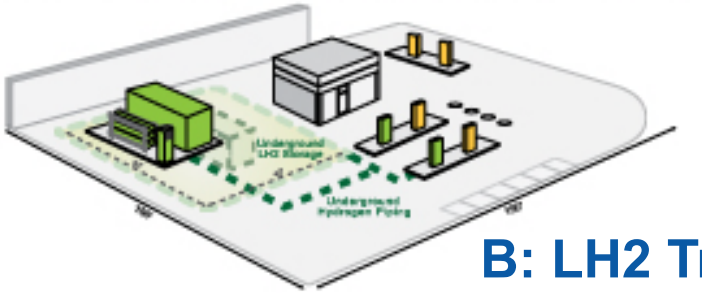
Accomplishments: Contribution to—and Feedback from—IPHE Infrastructure Workshop (Feb 25-26, Sacramento, CA)

Station A: Hydrogen is delivered as a compressed gas



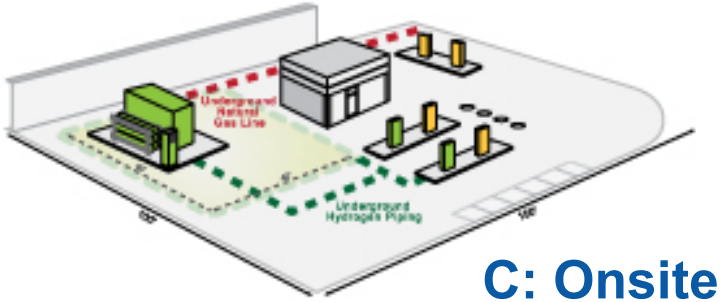
A: CH2 Truck

Station B: Hydrogen is delivered and stored as a liquid



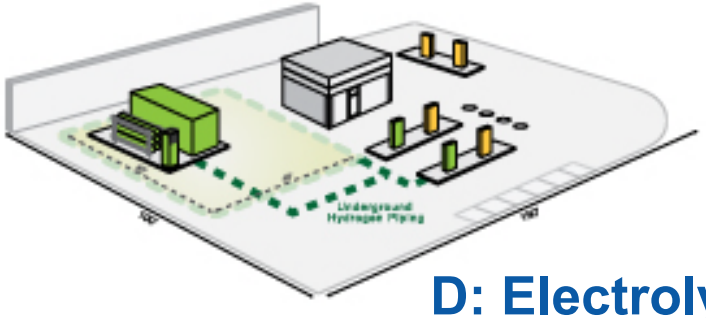
B: LH2 Truck

Station C: Hydrogen is produced onsite from natural gas



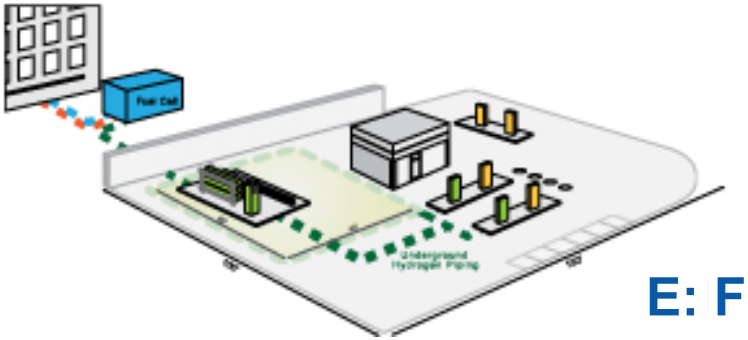
C: Onsite SMR

Station D: Hydrogen is produced by electrolysis



D: Electrolysis

Station E: An offsite fuel cell uses natural gas to produce electricity, heat and hydrogen



E: Fuel Cell CHHP

Focus Group was presented with five 700 kg/d business case stations

Accomplishment: IPHE Workshop Feedback

The workshop generated significant feedback related to retail station designs, station owner concerns, and education needs.

Some of this feedback was pertinent to the FCPower model Business Tab

- Operate on very slim margins
- Typical expected payback time for new equipment is 1-5 years
- “Green fuel” seen as positive but mostly a side benefit
- Station owners associate “alternative fuel” with biofuels; have very little familiarity with hydrogen fuel cell vehicles and their benefits
- Interest in “starting slow” to learn about technology and market potential before making major investments
- Begin with small starter stations
- Willing to rely on incentives but need to see clear path to commercialization
- Acknowledge the advantages of partnerships and financing mechanisms in reducing risk

Accomplishment: Presented Proposed Business Tab Revisions to the California Hydrogen Business Council (1)

- A presentation on the FCPower model and proposed Business Case Tab revisions was given to the CHBC on March 4, 2010.
- A questionnaire was circulated with "high to low" priority scales for different types of enhancements that could be made to the Business Case Tab.
- Small sample of 6 responses ranked in aggregate. Results are shown below.

Input Type	Total Score
Cost data (verified)	6.0
fuel costs	5.0
ability to specify baseline system	2.9
Tax Credits and incentives	2.5
financing options	2.1
Taxes and depreciation	1.7

Take away from this result: end users are very interested in knowing <u>actual</u> costs – but this is best communicated by vendors.

Accomplishment: Presented Proposed Business Tab Revisions to the California Hydrogen Business Council (2)

"Rank the importance of the following existing model output categories"

Output Type	Total Score
Total levelized cost of energy	4.8
yearly cash flow	3.3
Annualized cost breakdown	3.3
GHG emissions	2.7
Sensitivity analysis	2.4
"Baseline" system costs	2.1
Chart of cumulative cash flow	2.0

Accomplishment: Presented Proposed Business Tab Revisions to the California Hydrogen Business Council (3)

"How important are these additional capabilities for a business or finance oriented end user?"

Input Type	Total Score
Calculate total lifecycle cost	5.5
Simple payback period calculation	4.3
Enter revenue and IRR and solve for NPV	4.3
Calculate benefit to cost ratio	4.3
Enter expected revenue and solve for IRR	4.0
Cost without IRR	2.8
Calculate savings to investment ratio	2.8
Monte Carlo analysis	1.7
Other	0.0

Collaborations and Future Work

Collaborations internal to NREL

- Advisory team within NREL with staff from Technology Deployment, FEMP, and Strategic Energy Analysis

Collaborations external to NREL

- Presentations to external groups: CHBC, HUG, CaFCP
- IDC Energy Insights: Facilitate stakeholder dialogue

Future Work

- Present proposed revisions to the Hydrogen Utility Group (HUG)
- Present proposed revisions to the California Fuel Cell Partnership (CaFCP)
- Compile stakeholder feedback from IDC Energy Insights dialogue
- Complete revisions to Business Case Tab based upon an assessment of all stakeholder feedback

Summary

Relevance	• New end-user community for H2A models • Address complex financials of FCPower model • Tailor revisions to feedback from stakeholders
Approach	• Tailor revisions to feedback from stakeholders • Present to pertinent groups; facilitate dialogue (IDC)
Accomplishments	• Outline proposed tab format • Compiled potential revision “to do” list • Collected feedback from internal NREL staff • Presented to CHBC and collected feedback
Collaborations	• Internal NREL staff across multiple centers • IDC Energy Insights and their stakeholder network
Proposed Future Work	• Present to HUG, CaFCP; Collect IDC feedback • Make Business Case Tab revisions