A Business Case for Stationary Fuel Cells and Hydrogen Co-Production

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for the

Hydrogen Program Annual Merit Review

May 18, 2009

Project anp_04_brown

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Overview

Timeline

- Project start: 01/09
- Project end: Ongoing
- Percent complete: 5% (estimate)

Barriers Addressed

- Inconsistent and limited data
- High reliance on assumptions

Partners

- NREL and ANL H2A Modelers

Budget

- Total project funding
  - TBD
- Funding received in FY08
  - $0
- Funding for FY09
  - TBD

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Relevance and Objectives

Objectives: Develop a business case for on-site stationary fuel cell electricity generation with and without co-production of hydrogen and evaluate and validate decisional *information, data, and 1st generation tools*.

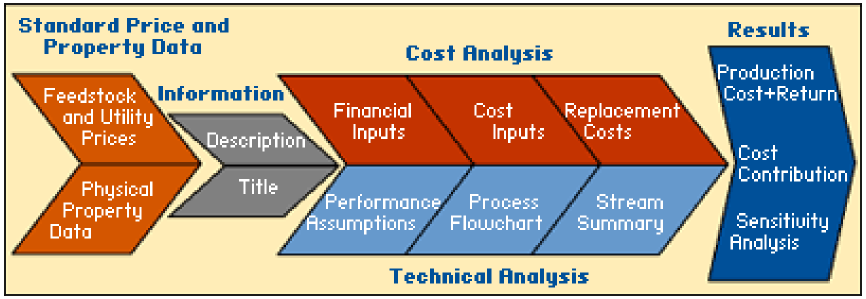
Rationale:

- Early market purchasers of fuel-cells (FCs) and FCs with hydrogen co-production systems need easy-to-understand and transparent financial information to help them understand the "business case" for purchasing these systems.
- The first generation discounted cash flow decision tool for hydrogen co-production has been developed based on the original H2A hydrogen analysis model developed for dedicated hydrogen production and delivery systems.
- Early market decision makers need information and tools developed with a consistent set of financial parameters and analytical methodology.

The H2A Model

- H2A, or <u>*Hydrogen Analysis*</u> was developed in 2003. It is a *discounted cash flow model* that values hydrogen production and delivery system projects. The model incorporates the time value (discounts) of all future revenue and expenses so the decision maker sees all values in present time. (The discount rate used is generally the appropriate cost of capital and may incorporate the uncertainly or riskiness of future cash flows.)

H2A Production Cash Flow Analysis Tool



- A new version of H2A is being developed for stationary fuel cells, including co-production of hydrogen within the fuel cell system.
  - Consistent with LCC approach and assumptions used by H2A production and delivery models
  - Hourly electricity, thermal energy, and hydrogen demands
  - Variable electricity and fuel price inputs
  - Reformer based fuel cell, hydrogen fuel cell, hydrogen separation from anode exhaust gas, auxiliary heater (furnace or boiler), electrolyzer, PV, wind and electric grid components

Fuel Cells with Hydrogen Co-Production

- PEM and PA fuel cells can co-produce hydrogen by over-sizing the fuel processor relative to the needs of the fuel cell stack, benefiting from size economies-of-scale.
- MC and SO fuels can co-produce hydrogen by extracting hydrogen from the mixture of gases leaving the fuel cell anode. Hydrogen can be separated from the anode exhaust gas via pressure-swing adsorption or electrochemical means.
- Co-produced hydrogen can be used for in-house applications, such as fuel-cell powered fork lifts or sold in the market.

Note: All fuel cells need hydrogen supplied to the anode, but the purity requirement varies. In general, the purity requirement declines with increasing fuel cell operating temperature. PEM and PA fuel cells require relatively pure hydrogen, generally provided by an integrated fuel processor. MC and SO fuel cells process fuel either directly or in close proximity to their fuel cell stacks.

Approach

- Evaluate discounted cash-flow analysis methodology for relevance to early market decision makers
- Validate/verify data used for (or missing from) 1st generation H2A co-production tool
  - costs: capital (purchase), installation, depreciation, fuel, technology efficiency/performance, operating and maintenance, replacement parts
  - incentives: Federal tax credits (investment or production), state and local rebates, utility renewable energy portfolio standards, emission offset credits (both conventional and greenhouse gas)
- Examine valuation approaches for intangible benefits such as electricity reliability, quality, noise reduction, on-site permits, etc.

Project Status

- Project began in January 2009.
- PNNL gathered information on technology costs, federal tax credits, price of emission offsets, and state incentives (in California).
- PNNL produced examples of discounted cash flow calculations.
- Preliminary data indicates that a strong business case for co-production using a stationary fuel cell system in ***California***.

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Preliminary Information
Federal Energy Tax Credits

- Production Tax Credit (PTC)
  - In-Service Deadline: 12/31/2013
  - From qualified resource
  - 10 Year duration
  - Cannot claim credit if using ITC
  - Electricity-only generation efficiency greater than 30%.

Resource Type	PTC Credit Amount
Closed-Loop Biomass	2.1¢/kWh
Open-Loop Biomass	1.0¢/kWh
Landfill Gas	1.0¢/kWh
Municipal Solid Waste	1.0¢/kWh

- Investment Tax Credit (ITC)
  - Eligible until 1/12017
  - Cannot claim credit if using PTC
  - Commercial, Industrial, Utility Sectors
  - Minimum size 0.5 kW, electrochemical only, electricity-only, generation efficiency greater than 30%

Tax Credit Basis	ITC Credit Amount – Lesser of the 2
Basis of Property installed during tax year	30% of fuel cell plant
	OR
Killowatt capacity of property	$3000/kW capacity

Preliminary Information
California State Incentives

Self-Generation Incentive

- Only applicable to commercially-available, new systems
- Incentive tends to change annually

Capacity	Renewable Fuel Cells	Non-Renewable Fuel Cells
	Min Size – 30kW Max Size – 5MW	Min Size – none Max Size – 5MW
0kW to 1MW	0.45 ¢/kW	0.25 ¢/kW
1MW-2MW	0.225 ¢/kW	0.125 ¢/kW
2MW-3 MW	0.1125 ¢/kW	0.0625 ¢/kW

Preliminary Information
Southern California Criteria Air Pollutant Emission Credits

California Air Resources Board Emission Offset Credit Prices

Price per ton (2007) – South Coast Management District

	NO_x	HC	PM_{10}	CO	SO_x
Average	$486,575	$27,686	$399,075	$20,185	$187,363
Median	$547,945	$32,877	$375,940	$31,090	$186,301
High	$602,740	$95,616	$1,293,151	$35,616	$356,164
Low	$186,301	$0	$0	$0	$0

Preliminary Information
Carbon Dioxide (CO_2) Offset Incentives

Carbon offsets: Financial instruments used internationally and in the United States on a compliance or voluntary market basis.

- Compliance US Market (Cap-and-Trade)
  - Regional Greenhouse Gas Initiative (RGGI) - *Trading started Jan 1, 2009*
  - Midwest Greenhouse Gas Reduction Accord - *Under Development*
  - Western Climate Initiative (WCI) - *Under Development*
- Voluntary US Market
  - Possible Applications: Fuel switching, renewable energy, T&D efficiency improvements
  - Prices Vary
  - US weighted average (2007)[1] = \$4.5/metric ton of CO_2-eq

(1) Ecosystem Marketplace & New Carbon Finance. *State of the Voluntary Carbon Markets 2008.*

Conclusions

- Discounted cash flow model can provide early market decision makers with useful business case information for on site electricity generation and hydrogen co-production.
- Factors such as investment tax credits, state incentives (particularly in California) and emission offset prices will affect the model’s analytical results.
- Early market decision makers need information and tools developed with a consistent set of financial parameters and analytical methodology.

Future Work

- Complete review of 1st generation H2A coproduction model
- Make site visits to existing large fuel cell facilities in California and New York
- Complete information and data gathering for visited sites
- Examine valuation approaches for intangible benefits such as electricity reliability, quality, noise reduction, on-site permits, etc.