X.16 DOE Hydrogen Program Risk Analysis in Support of EERE's Portfolio Analysis

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Project End Date: Project continuation and direction determined annually by DOE

Objectives

- Near-Term: Develop and test questionnaires and analytical tools that will be useful in assessing and analyzing expert opinions with regard to potential improvements in hydrogen technologies.
- Long-Term: Assist project, program, and portfolio decision-making that aligns and balances the Office of Energy Efficiency and Renewable Energy (EERE) portfolio with strategic goals.

Technical Barriers

This project addresses the following technical barriers from the Systems Integration Section (5.4) of the Hydrogen, Fuel Cells and Infrastructure Technologies Program Multi-Year Research, Development and Demonstration Plan:

(C) Inherent Uncertainty in Research and Development (R&D)

Technical Targets

This project is assisting in estimating the likelihood that the following key technical targets will be achieved:

- Production
  - Total hydrogen cost
  - Efficiency
- Storage
  - System gravimetric capacity
  - System volumetric capacity
  - On-board system cost
- Fuel Cells
  - System cost
  - System specific power
  - System power density

Approach

The Office of EERE of the U.S. Department of Energy (DOE) is tasked with assessing the risk and uncertainty in estimates of the benefits of its Technology Development programs. These risk assessments require subject-matter experts to express their best judgments about uncertain future performance–resulting from R&D within each technology–in the form of estimated probability distributions.

The Hydrogen, Fuel Cells and Infrastructure Technologies (HFCIT) Program has responded to EERE's risk analysis request by developing questionnaires and analytical tools that can be used to assess expert opinions of the potential future performance improvements resulting from R&D efforts within the program. A modified Delphi process was used to elicit expert opinions regarding the minimum, median (or mode), and maximum improvements for each key performance parameter associated with a particular technology pathway. A triangular probability density function (pdf) was created for each expert's response. Using a Monte Carlo simulation approach, the individual pdfs then were aggregated into a single pdf, capturing the overall opinions of all experts responding to a particular technology pathway–performance parameter combination.

Accomplishments

A pilot application was conducted to determine the uncertainties with respect to achieving key technological performance levels. Individual expert opinions were obtained and aggregated to estimate future (2010 and 2015) performance improvements for the following pathways under two different budget scenarios (HFCIT's requested budget and a 50% increase over the requested budget):

- Hydrogen production pathways:
  - Central biomass
  - Central natural gas reforming
  - Forecourt natural gas reforming
- Hydrogen on-board storage pathways:
  - 700 bar compressed hydrogen
  - 350 bar compressed hydrogen
  - Liquid hydrogen
  - Cryo-compressed hydrogen
  - Adsorbents
  - Metal hydrides
  - Chemical hydrides
- Polymer electrolyte membrane (PEM) fuel cells.

The aggregated pdfs for hydrogen production were used as inputs to the Hydrogen Analysis (H2A) models to calculate the uncertainty in the future cost of hydrogen at the plant gate. Aggregated pdfs for fuel cells were used as inputs to the Directed Technologies, Inc. (DTI) Fuel Cell Cost Model to calculate the uncertainty in the future cost of PEM fuel cell systems. The outputs from the DTI model together with the aggregated pdfs for onboard storage were used as inputs to the Powertrain System Analysis Toolkit (PSAT) model to calculate the uncertainty in future hydrogen-fueled vehicle cost and performance. Outputs from both the H2A and PSAT models then were used as inputs to the National Energy Modeling System and MARKAL models to calculate future fuel-cell vehicle penetration by 2010, 2015, 2030, and 2045.

Future Directions

The questionnaires and analytical tools will be revised based on lessons learned from this pilot application and a more rigorous analysis will be conducted to support the Fiscal Year 2010 budget submittal process.

FY 2008 Publications/Presentations

1. *Risk Analysis for the Hydrogen, Fuel Cells and Infrastructure Program: Predecisional Report*, Michael Duffy, Marc Melaina, Michael Penev, and Mark Ruth, NREL/MP-15–43250, May 2008, Not for External Distribution.

2. A poster of this project was presented at the 2008 Annual Merit Review and Peer Evaluation in June 2008.