VII. SYSTEMS ANALYSIS

VII.0 Systems Analysis Sub-Program Overview

Introduction

Systems Analysis supports decision-making by providing a greater understanding of technology gaps, options and risks, and the contribution of individual technology components to the overall system i.e., from fuel production to utilization, as well as the interaction of the components and their effects on the system. Analysis is also conducted to assess cross-cutting issues, such as integration with the electrical sector and use of renewable fuels. Particular emphasis is given to assessing fuel quality impacts on fuel cell performance and infrastructure implications.

The Systems Analysis activity made several significant contributions to the Hydrogen, Fuel Cells and Infrastructure Technologies (HFCIT) Program during Fiscal Year 2009. Several analytical tools including the Stationary Fuel Cell Power Model, Agent-Based Model and Macro-System Model (MSM) were completed and peer reviewed to support the analytical process. Resource, infrastructure and early market analyses were conducted to better understand supply and demand issues. Analysis of environmental impacts of hydrogen on the atmosphere was completed in FY 2009 which showed minimal impacts on atmospheric conditions. Hydrogen quality was modeled and evaluated to examine the impact on fuel production cost to achieve the quality specifications required for the fuel cell to maintain performance and durability. The Greenhouse gases, Regulated Emissions and Energy use in Transportation (GREET) model was modified to enable greenhouse gas emissions and petroleum use to be evaluated on a well-to-wheels (WTW) basis for fuel cell vehicles in comparison to other options such as plug-in hybrid vehicles.

Goal

Provide system-level analysis products to support the overall Program by evaluating technologies and pathways, guiding the selection of research, development and demonstration projects, and determining technology gaps, risks and benefits.

Objectives

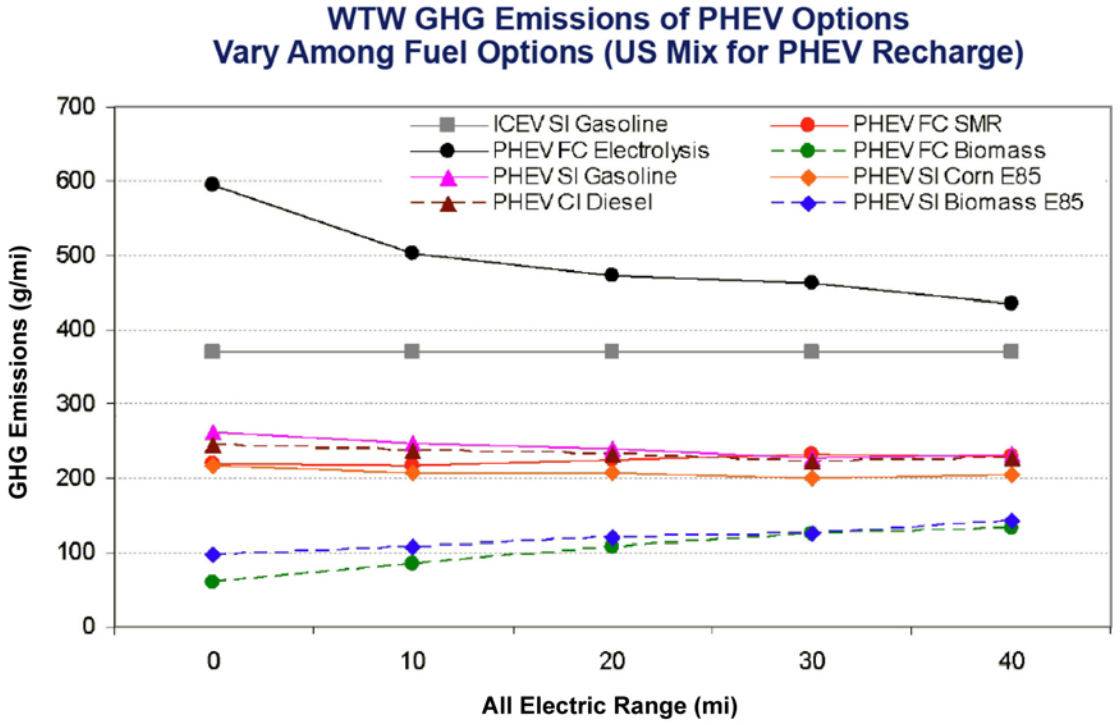
- By 2011, enhance the MSM to include the stationary electrical generation and infrastructure.
- By 2014, complete environmental studies that are necessary for technology readiness goals.
- By 2015, analyze the potential of fuel cells for multiple applications such as portable, stationary, and backup power generation. The analysis will address necessary resources, infrastructure, and interactions with electrical sectors.
- Provide analysis of Program milestones, including risk analysis, independent reviews, financial evaluations and environmental analysis, to support the Program's needs prior to the technology readiness milestone.
- On an annual basis, update the WTW analysis for technologies and pathways for the overall Program by including technological advances or changes.

FY 2009 Status

Systems Analysis was established within the Program to develop a consistent, comprehensive framework for examining the economics, benefits, risks, opportunities, and impacts of fuel cells and renewable fuels. Analysis was also conducted in FY 2009 to identify early markets for fuel cells and opportunities to reduce cost through various mechanisms, such as tax credits and other legislation.

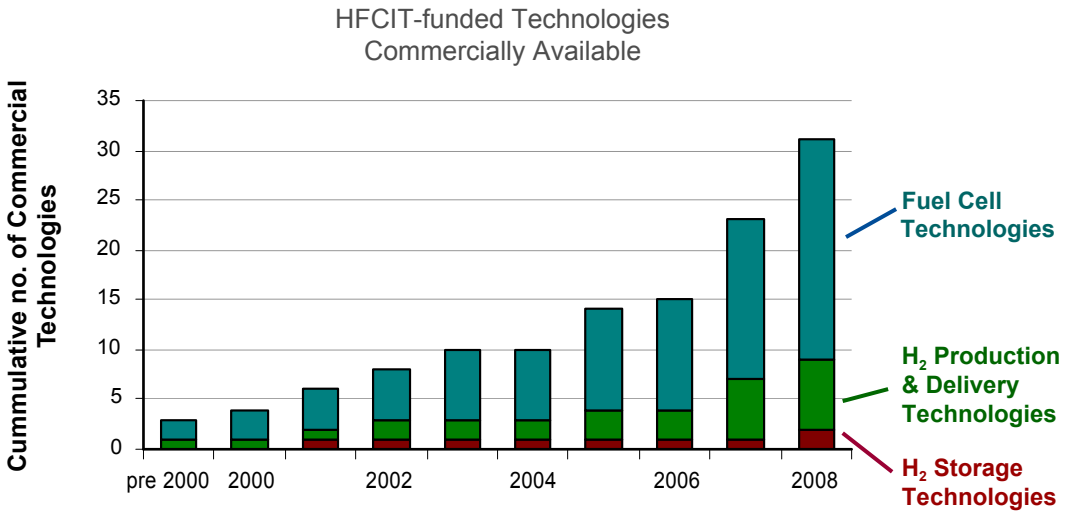
FY 2009 Accomplishments

- The MSM, a dynamic engineering transition model, was updated to include new hydrogen production pathways. The model is used for the simulation of the performance and evolution of hydrogen infrastructure using a distributed architecture to link existing and emerging models for system components. The model was used to analyze the delivered hydrogen cost, WTW parameters (greenhouse gas emissions, petroleum energy use and total energy use) and hydrogen losses for several pathways. The new models added to the MSM were the resources model, HyDRA, the infrastructure model, HyPRO, and the updated delivery model, HDSAM.
- Oak Ridge National Laboratory performed sensitivity analysis with the HyTrans model based on the previously published scenario analysis to understand the sensitivity of the fuel cell vehicle penetration to the vehicle on-board storage targets. This analysis showed the vehicle penetration rates would be reduced from 95% to 50% by 2050 if storage research and development was only capable of attaining a storage cost of $17/kWh versus the target of $2/kWh.
- The H2A Stationary Power Model was developed and reviewed by industry, academia and national laboratories to address combined heat and power generation for proton exchange membrane, phosphoric acid and molten carbonate fuel cells. The model features analysis of power, heat and hydrogen fuel costs based on capital equipment costs, feedstock prices, operating climate conditions and the heat and power loads for demand systems. The format of the model features a graphical user interface for data input. The model and fuel cell analysis cases will be posted on the Energy Efficiency and Renewable Energy Web site for public access in the fourth quarter of FY 2009.
- The WTW analysis capabilities were enhanced by modifying the GREET model to include conventional and alternative fuel plug-in hybrid electric vehicles. The plug-in vehicle represents the emerging technology for comparison to the vehicle technology portfolio. The analytical capabilities also include the comparison of plug-in hybrid electric vehicles with fuel cells. The WTW analysis enables the evaluation of greenhouse gas emissions for various electrical sources such as U.S. average, California, and Illinois grid mixes. An example is shown below with the U.S. grid mix which shows that plug-ins with fuel cells would have lower greenhouse gas emissions than conventional fuel plug-in vehicles.



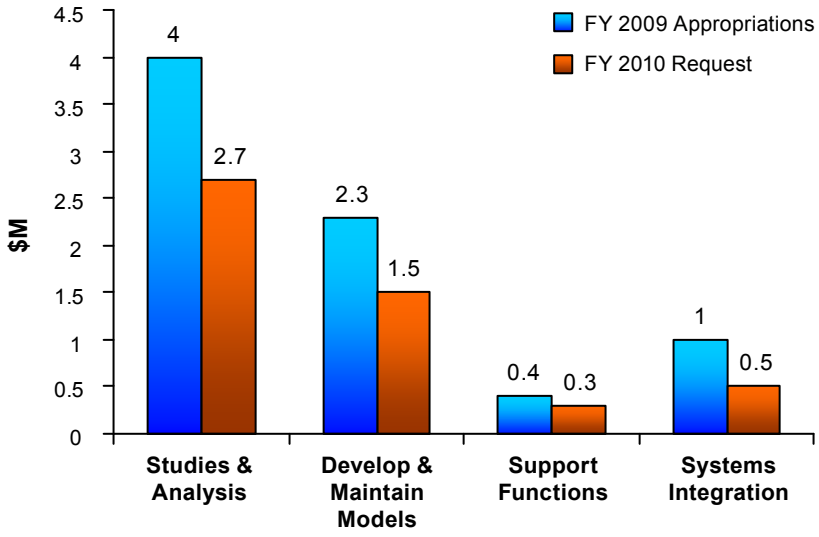
Source: Argonne National Laboratory
Note: The source of electricity for the "PHEV FC Electrolysis" pathway is U.S. grid mix electricity.
ICEV – internal combustion electric vehicle; PHEV – plug-in hybrid electric vehicle; SI – spark ignition; FC – fuel cell, CI – compression ignition; SMR – steam methane reformer; E85 – 85% ethanol, 15% gasoline; GHG - greenhouse gas

- Argonne National Laboratory developed a model for analyzing the impact of hydrogen quality on fuel cell performance and the hydrogen production costs associated with meeting the required hydrogen quality specifications. The hydrogen production technologies modeled included distributed natural gas and auto-thermal reforming. Analysis showed that key impurities such as carbon monoxide and sulfur required to sustain fuel cell performance can be removed with adjustment to operating parameters of separation equipment associated with the production technologies. The impact of meeting the hydrogen quality specifications resulted in a cost increase of less than $0.05/gasoline gallon equivalent.
- Water Analysis: The analysis of the impact of water on a future hydrogen economy, including the economic impact of water prices on hydrogen production and the impact of hydrogen production on regional water resources has found water to have minor impacts on hydrogen deployment. The assessment included an initial examination of water permitting on water cost but was found to be region-specific and highly contentious so in-depth analysis was not pursued. Instead a methodology was developed for determining the upper bound for hydrogen cost with respect to water use.
- Pacific Northwest National Laboratory analyzed the commercial benefits of the HFCIT Program by tracking the commercial products and technologies developed from the support of the Program. The results show that over 140 patents were awarded and over 20 products were commercialized as a result of research funded by HFCIT in the areas of storage, production, delivery and fuel cells.



Budget

The budget for the Systems Analysis activity is consistent with the goals and objectives of the sub-program and is responsive to assessing early market opportunities for fuel cell applications. The FY 2010 budget request includes funding for resource and infrastructure analysis, as well as fuel quality evaluation, environmental analysis, overall program analysis, modeling, and systems integration.



FY 2010 Plans

The Systems Analysis activity for FY 2010 will focus on conducting analyses to determine technology gaps for fuel cell systems and infrastructure for different applications. Analyses will be focused on understanding the tradeoffs and regional impacts of fuel cells with other alternative fuels and the electrical sector on a WTW basis, and the synergies of linking stationary fuel cell power generation with the electrical sector. The FY 2009 appropriation included $7.7 million for Systems Analysis; the FY 2010 request is $5 million. The budget request for FY 2010 reflects the focus on early market analysis, fuel cell technology evaluations, renewable fuel benefits, as well as resource and infrastructure analysis.

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