U.S. Department of Energy Hydrogen Program

Systems Analysis

Fred Joseck

2008 DOE Hydrogen Program Merit Review and Peer Evaluation Meeting



June 9, 2008





Goals and Objectives

GOAL: Provide system-level analysis to support hydrogen infrastructure development and technology readiness by evaluating technologies and pathways, guiding the selection of RD&D technology approaches/options, and estimating the potential value of RD&D efforts.

- Develop a Macro-System Model for the analysis of the hydrogen fuel infrastructure to support transportation systems by 2008; enhance the model to include the stationary electrical generation and infrastructure for long-term applications analysis by 2011.
- Identify and evaluate early market transformation scenarios consistent with infrastructure and hydrogen resources by 2009.
- Complete environmental studies that are necessary for technology readiness by 2014.
- Update the Well-to-Wheels analysis for technologies and pathways for the Hydrogen Program to include technological advances and changes on an annual basis.



Systems Analysis Budget



FY2009 Budget Request = \$7.7M

FY2008 Appropriations = \$11.5M

FY09 Emphasis

- Conduct cross-cutting life cycle analysis, emissions, environmental and systems integration analysis to identify the impacts of various technology pathways
- Assess associated cost elements and drivers
- Identify key cost and technological gaps



Challenges

- Establish consistent data, assumptions and guidelines for analysis tasks
- Understand behaviors and drivers of the fuel and vehicle markets
- Coordinate and integrate analysis resources and capabilities across analytical domain
- Understand vehicle, fuel and socioeconomic policy impacts
- Establish and develop an integrated portfolio of models and tools

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Analysis Portfolio

Programmatic Analysis

- Risk analysis of Hydrogen Program targets and goals
- Petroleum and CO₂ reduction benefits
- Analysis of integrating stationary and transportation fuel cells
- Program benefits for programrelated product commercialization

Program Element Analysis

- Hydrogen production and delivery pathway analysis
- Platinum recycling impact on fuel cell cost

Environmental Analysis

- Atmospheric impacts of hydrogen
- Well-to-Wheels analysis of greenhouse gas (GHG) emissions

Policy Analysis

- CO₂ analysis
- Fuel, infrastructure and vehicle subsidy evaluation

Early Market Analysis

 Cost and GHG benefit analysis of early market applications





2008 Accomplishments/Results Modeling and Model Development

Macro-System Model

Completed first version of the model

- · Completed peer review of the model
- Analyzed the hydrogen cost and greenhouse gas emissions for 7 hydrogen pathways
- Utilized model for EU/US model comparison

H2A Production Model Update

Completed peer reviewed revision of H2A model

- Added scaling feature for various production rates
- Added cost for CO₂ sequestration
 - Capital cost
 - Pipeline cost
 - Cost of CO₂ injection



The MSM eases comparisons of levelized cost at the pump

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2008 Accomplishments/Results Analysis

CO₂ Analysis

Preliminary analysis shows the marginal cost of CO_2 cost for hydrogen pathway policy options ~\$15-20/ton of CO_2

 Preliminary sensitivity analysis of hydrogen pathways show CO₂ reduction benefits of 1.7 to 2.3 gigatons of CO₂/yr

Marginal Cost and Capture for CO₂ in 2050



Source: Brookhaven National Laboratory MARKAL model

Hydrogen Production with CO2 Seq. for Biomass

Platinum Recycling Cost Analysis

Preliminary analysis of recycling platinum from the fuel cell can reduce the fuel cell cost by ~\$1-4/kW

Currently, platinum only regarded as cost input for fuel cell analysis

Hydrogen Quality Analysis

Preliminary analysis shows the hydrogen production cost increases ~\$0.20-0.40/gge to meet hydrogen quality specifications for the fuel cell

 Preliminary analysis determined hydrogen cost to achieve quality to optimize fuel cell performance.



2008 Accomplishments/Results Analysis

Resource Analysis

Developed "Well-to-Wheels"

analysis approach for water

- Utilized for hydrogen pathways and conventional fuel pathways analysis
- Used as a screening tool to create a Water Resource Analysis project with LLNL



- Water requirements for hydrogen based on H2A model.
- Used ANL Water report for analysis data.
- Distributed electrolysis assumes electricity is coming from the grid.

Early Market Analysis

 Preliminary Well-to-Wheels analysis for GHG emissions for early market shows H₂ forklifts lower than fossil fuel pathways



Fuel-cell Forklift: (Source:Toyota)



Source: ANL GREET model



International Collaboration

International Partnership for the Hydrogen Economy

- Issued findings of the EU HyWays and US modeling and analytical comparison
 - EU approach focused on social benefits
 - US approach focused on business/ financial benefits

www.hyways-iphe.org



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Analysis and roadmapping workshops will be held with other IPHE countries in Australian and China during 2008.



Future Plans







Systems Analysis Team

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