DOE Hydrogen Transition Analysis Workshop

U.S. Department of Energy - Washington, DC
January 26, 2006

DISCUSSION COMMENTS, QUESTIONS, AND ACTION ITEMS

Agenda

1. Welcome and Introduction – Steve Chalk, DOE-HFCIT

2. Agenda and Purpose – Sig Gronich, DOE-HFCIT

3. HyTrans Model – David Greene, ORNL

4. Market Based Approaches – K.G. Duleep, EEA

5. H2-MARKAL – Harry Vidas, EEA and Chip Friley, BNL

6. H2-NEMS – Frances Wood, OnLocation, Inc.

7. Agent Based Modeling System – Marianne Mintz, ANL

8. Macro-System Model – Mark Ruth, NREL

9. Hydrogen Production Infrastructure Options Analysis – Brian James, DTI

10. Geographically Based Infrastructure Analysis – Keith Parks and Margo Melendez, NREL

11. Early Transition Scenarios – Sig Gronich, DOE-HFCIT

Discussion

Discussion Summary

- The purpose of this meeting is to begin a discussion and gather feedback from industry on DOE's emerging hydrogen transition analysis efforts. The purpose is not to build a consensus on the "right" set of transition options from the current gasoline-based transportation system to a nascent hydrogen economy. DOE is looking for input on the set of penetration scenarios and transition models currently under development to explore these issues. The expectation is that these models and scenarios will be used to develop a plausible set of options, including policy actions, that will provide decision makers with choices going forward. A major assumption before proceeding into this set of options is that DOE research targets have been met, at least in the laboratory. The goal is to obtain feedback from industry on whether the scenarios presented by DOE are reasonable and inclusive; whether the models are adequate to complete the task; what types of policy options have been or could be effective in affecting both industry and consumer behavior; and so forth.

- DOE is interested in continuing discussions and sharing analyses with industry on the plausibility of a "network" or "lighthouse" structure for building hydrogen production/fueling stations in the transition timeframe. Where and how big does the network need to be in order to be both effective and satisfactory to customers? Are clusters sufficient or is an interstate network also needed (and at what point is it needed)?
    - ACTION: Shell will coordinate an effort to develop a set of lighthouse or network infrastructure options; these will be shared publicly and provided to DOE as input.

- ACTION: Using input from energy companies, automobile companies, the California Hydrogen Highway Blueprint, DOE models, and other sources as available, DOE will prepare model networks for representative cities (including a nascent interstate network) for review and comment.
- ACTION: DOE will consider the physical plant and delivery system integration of a nascent hydrogen infrastructure into the existing gasoline infrastructure.

- DOE is interested in industry feedback on the types of fleet programs that should be considered. Are large, mixed-model fleets required? What sponsorship would be most effective—e.g., municipalities, states, federal, private? Can fleets really be effective for technology demonstration and/or supporting mass market penetration? Original equipment manufacturers (OEMs) respond that in the past fleets have worked for technology testing and validation but they do not provide market data or help with broad customer acceptance.
  - ACTION: Include this as a topic for discussion at the meeting of OEMs on "lessons learned" (see bullet later in this report for more information)

- There was general agreement that DOE should include existing hydrogen production capacity (at merchant hydrogen production facilities and petroleum refineries) as a potential source of hydrogen in its transition models. One industrial gas company representative stated that it would be possible to increase capacity at existing hydrogen plants by as much as 10%. Refineries are not likely to be a source of hydrogen unless and until gasoline consumption drops significantly – right now refineries need more hydrogen than they produce. Going forward, DOE will investigate the options presented and would like more input on these issues. How much capacity might be available from merchant hydrogen producers and when? How does this capacity fit in with the delivery and fueling infrastructure? When, if ever, would refineries be able to provide a source of hydrogen?
  - ACTION: DOE transition models will include supply and demand curves for merchant hydrogen producers and refineries as part production and delivery modeling.
  - ACTION: DOE will examine several clusters to estimate how much existing capacity could be used and what expected increases of capacity might be accommodated to meet the new demand.

- With respect to hydrogen production options, DOE will not support options that have greater CO2 emissions than gasoline hybrid vehicles (e.g., coal without sequestration; electrolysis solely from the current grid mix). However, during the transition, a short-term increase in CO2 emissions could be tolerated as long as the long-term outcome is CO2 mitigation.
  - ACTION: Modeling efforts should be restricted in some way from choosing such options (e.g., through carbon taxes).

- The transition to a hydrogen economy will create impacts throughout the energy sector and the U.S. economy. For example, as hydrogen utilization for transportation fuel increases, the impacts on the supply and demand of various petroleum products must be assessed. Another example is that the price elasticity of coal can be affected by limitations in the railway system to transport more coal. These types of interactions need to be captured in the models.

- ACTION: there are several DOE models designed to capture these kinds of interactions in the economy, specifically NEMS, MARKAL, and the ABMS model. DOE will work with industry going forward to ensure that critical interconnections are recognized and captured in the models.

- Land availability in major urban environments is recognized as a major issue and DOE would like more feedback from industry on these kinds of questions: How plausible is it to put distributed hydrogen production and fueling stations in major urban environments? Is the land really available (at any price)? Is the space at existing fueling sites adequate for hydrogen forecourt needs? Will it be possible to get air permits for forecourt steam methane reforming in non-attainment areas (e.g., Los Angeles)?
  - ACTION: DOE will investigate these questions and use the learnings in developing its model infrastructure networks.
  - ACTION: DOE will investigate actual sites where stations are being considered to determine the practicality of installing hydrogen retail stations.

- There is general agreement that demand for vehicles is heavily influenced by the number of makes and models offered—and that demand for fuel cell vehicles (FCVs) will be strongest if multiple car companies offer FCVs in a range of sizes and models. Do any of the scenarios presented by DOE offer enough support for the number and diversity of vehicles required to create a sustainable market?
  - ACTION: DOE will seek feedback on whether the range of options being studied is sufficient to accomplish the task and whether a sustainable hydrogen fuel cell vehicle market is plausible by 2025 at the lessons learned meeting with the OEMs.

- DOE is undertaking a number of different hydrogen modeling projects, some of which build on past models (e.g., HYTRANS, H2-NEMS, H2-MARKAL) and some of which are new efforts (e.g., ABMS, H2A models, etc.). It would be useful to have an understanding of how all the models work together – what questions each one answers; the strengths and weaknesses of each; etc.
  - ACTION: DOE will develop a detailed list of questions that each model is attempting to answer and a diagram/description of how the models work together.

- Participants agreed that it would be useful to hold additional workshops to provide general feedback on the modeling efforts. For detailed, company-sensitive information, one-on-one meetings would be better.
  - ACTION: DOE plans to hold meetings in July 2006 (review of preliminary results of transition models) and November 2006 (public forum to discuss transition scenarios) that will include this group and others for feedback.
  - ACTION: DOE will plan individual meetings with OEMs and energy companies in the March-April 2006 timeframe and decide on the need for an interim, general meeting prior to the scheduled meeting in July.
  - ACTION: DOE will convene a meeting(s) with OEMs to specifically address lessons learned from market successes and failures and to review/discuss data on customer behavior that the OEMs are willing to share.

- Transitioning to hydrogen fuel cell vehicles is one way to meet the ultimate objectives (reducing CO2 emissions and reducing dependence on oil). Other strategies may also be

able to meet these goals and the supply curves for these options should be developed and compared to the hydrogen FCV option. Alternative options could have a bigger impact in the short term, especially, which could push the commercialization date needed for FCVs back. Should DOE consider these as part of its transition analysis?

- ACTION: DOE will benchmark other alternative strategies in the transition analyses. Both complementary and competitive influences will be analyzed.

- There are two purposes for FCV demonstration programs: (1**) technology development** – vehicle testing and validation for day-to-day operation and to refocus research and development activities, and (2) **market development** – building and testing the infrastructure network, customer acceptance of vehicles and infrastructure, and safety issues. These two things must happen *in parallel* in the scenarios developed during the period from 2010 to 2015, which involves risk and the need for the development of several alternative options.
  - Serving these two purposes may require two different programs. The first could potentially be accomplished with the use of advanced technology "mules" served by a small number of fueling stations (e.g., as part of a fleet). The second would require a much larger number of vehicles (at least 100s; maybe 1000s) and a network of fueling stations. Some key questions include: Who would pay for all these FCVs—is a 50/50 cost share affordable or is an incremental buy down program required? Assuming the need to demonstrate vehicles in large numbers in the 2012-2015 timeframe, how do we validate data from all OEMs and certify that the FCVs are ready for market demonstration? How do we best sequence both phases (technology development and market development) and conduct them most cost-effectively? Are demonstrations even the right way to go--are there other, more cost-effective options? (e.g., data certification programs).
  - ACTION: DOE will investigate one scenario that conducts "technology development" demonstrations in multiple geographic locations (for different climates, etc.); while the "market development" demonstrations would be concentrated in one to three marketplaces to capture more of the market.
  - ACTION: DOE will investigate the use hydrogen-ICEs to provide the ability to exercise a network of fueling stations during the 2010 to 2015 period so that the number of hydrogen FCVs needed is reduced
  - ACTION: DOE will study the ability to consider international programs. Could demonstrations be funded around the world that would be cost-shared by an international fund? Or would it be better to have national programs with each country paying for its own demonstrations and some information exchange? One OEM noted that it would be detrimental for OEMs to have to establish duplicative programs in every country in which they operate. All agreed that international information exchange is useful.

Action Items Noted for Specific Models/Modeling Activities

Model Name	Recommended Action
HyTrans	• Consider a less-than perfect market prediction model to factor in more risk as against assuming "perfect foresight" • Consider adding supply/demand price curves for merchant hydrogen producers • Consider running the model on hybrid vehicles to see how accurately it

	predicts the market situation • Consider adding market incentive(s) to lower the risk of capital investment (e.g., shorter depreciation schedules)
NEMS	• Ensure that NEMS captures effects of reduced gasoline demand on diesel markets (and economic ripple effects)
DTI—H2 Production Infrastructure Options Analysis	• Add a factor that links the cost to build plants with the number that get built • Consider increasing land costs in the model, particularly for urban areas • Concentrate on existing infrastructures in existing cities and on distributed options
NREL—Geographically Based Infrastructure Analysis	• Include the number of vehicle makes/models as a demand metric • Consider traffic flow on interstates and local streets • Consider current gasoline station demands as a criteria for placing hydrogen stations

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