2007
Systems Analysis
Summary of Annual Merit Review Systems Analysis Subprogram

Summary of Reviewer Comments on Systems Analysis Subprogram:

The reviewers considered the Systems Analysis Subprogram essential component to the Hydrogen Program mission and critical to the President's Hydrogen Fuel Initiative and AEI. The projects are considered appropriately diverse and focused on addressing technical barriers and meeting targets.

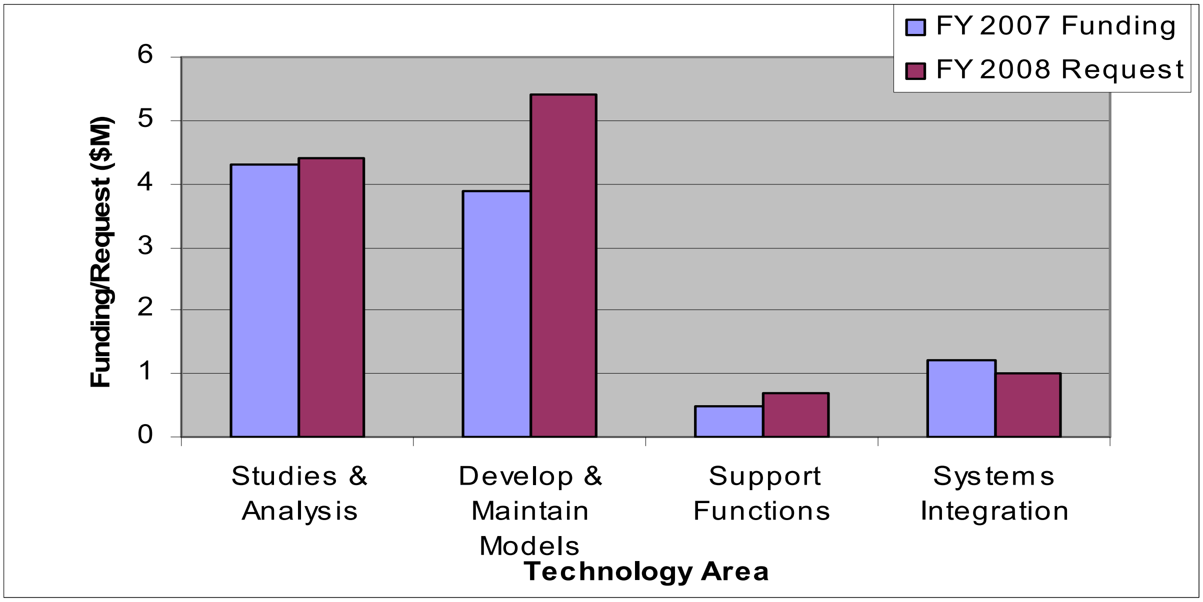
In general, the reviewers noted that Systems Analysis is a complex subprogram but is receiving the appropriate management attention. Some reviewers commented that the subprogram is well managed and has adopted an organized approach for analytical support of the Hydrogen Program, which is consistent with addressing the comprehensive list of identified barriers.

The major concerns identified by the reviewers for Systems Analysis were: 1) safety variables should be considered in systems analysis and consumer choice modeling; 2) fuel purity and the impact on performance and cost tradeoff analysis should continue; and 3) model validation and peer review is critical for sound and creditable analysis. The Systems Analysis subprogram will continue to address these issues and will be incorporated in the Systems Analysis Plan..

Finally, the reviewers commented the analysis and model portfolio was complete and covered the analysis topic. They indicated the analysis Multi-Year Research, Development and Demonstration Plan (MYPP) barriers were being covered and put into the proper perspective.

Systems Analysis Funding:

The funding portfolio for Systems Analysis primarily addresses the model development and required analysis to support the Technology Readiness Goal. The requested 2007 funding profile, subject to Congressional appropriation, addresses the National Academies' Report recommendations and provides greater emphasis on transition, resource, and infrastructure analysis.



Majority of Reviewer Comments and Recommendations:

In general, the maximum, minimum and average scores of the reviewers of the Systems Analysis projects were 3.5, 2.4 and 3.1, respectively. The Systems Analysis project portfolio includes a mix to address the "analysis and modeling gaps" of the subprogram and the transition requirements. The major recommendations for the Systems Analysis projects are summarized below. DOE will act on the reviewer recommendations for the overall Systems Analysis effort.

- **Impact of Hydrogen Production on U.S. Energy Markets Project:** Focus on the linkage and integration with other models to insure consistent inputs and assumptions are being used. Need to include the impact of highly visible government programs and policies.

- **Analysis of the Hydrogen Production and Delivery Infrastructure as a Complex Adaptive Model Project:** Ensure the agents representing industry include risk profiles, spending practices and business goals to maximize profit within companies which can increase or decrease adoption rate. Need to develop a validation method for the model.

- **HyDRA-Resource Analysis:** Ensure this model is beta tested and aligned with business/industry decision makers. Need to add sites for geologic storage of hydrogen.

- **Macro-System Model Project:** Ensure common and consistent assumptions and inputs are utilized in the linked models. Need to add hydrogen quality/cost tradeoff and stochastic modeling in the model.

- **Hydrogen Quality Analysis: Production to Fuel Cell:** Ensure the model is peer reviewed. Focus on fuel cell performance in the model. Need more collaboration outside the tech team.

- **Hydrogen Transition Modeling and Analysis: HyTrans v.1.2:** Ensure the model is validated and peer reviewed. Focus future studies with the model on sensitivity analysis.

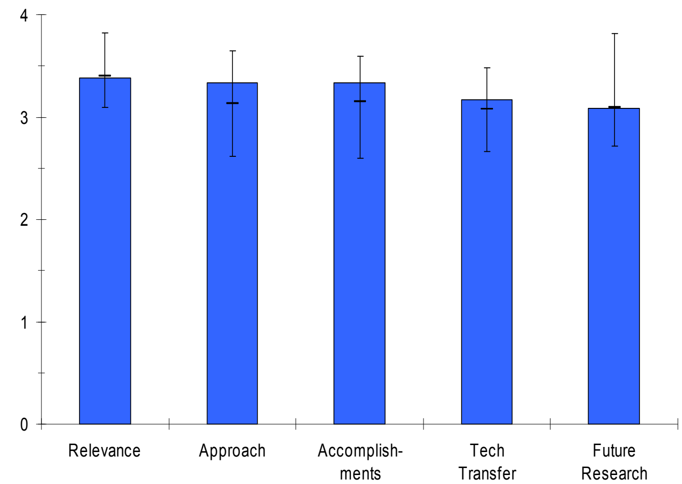
- **Well to Wheels Analysis of Hydrogen Pathways with the GREET model:** Need to add plugins representation in the model. Need to obtain feedback from users and interface with stakeholders.

Project # AN-01: Hydrogen Production Infrastructure Options Analysis
Brian D. James; Directed Techs.

Brief Summary of Project

The objectives of this project are to 1) create an analytical tool robust enough to assess the impact of different assumptions on hydrogen infrastructure development; 2) exercise the tool to determine the key drivers of the hydrogen transition; and 3) suggest to DOE areas of further research based on the most influential parameters in the infrastructure development. The unique features of HyPro include its ability to evaluate infrastructures with varying utilization over lifetime; its ease of use; an interface aimed for use by a wide audience; a structure that can be incorporated into the Macro Model; the allowance for investor demand foresight; incorporation of stranded asset logic; user input of yearly varying hydrogen demand, unit efficiencies, and capital costs.

Overall Project Score: 3.3 (6 Reviews Received)



Question 1: Relevance to overall DOE objectives

This project earned a score of **3.4** for its relevance to DOE objectives.

- Model designed to analyze the transition to H_2 infrastructure.
- Supports objectives of H_2 production and delivery cost.
- The model is useful for calculating the capital and operating costs of a hydrogen infrastructure and the resulting hydrogen fuel costs.
- The model is useful for evaluating sensitivities to differing assumptions and scenarios.
- I like the incorporation of NPV calculations to the techno-economic models previously used.
- This is an important project that will help DOE understand the key drivers of a hydrogen transition.
- This project is one of several that are addressing the issue of transition to hydrogen-based transportation vehicles and infrastructure.
- It is not clear how the results of this analysis will be used and by whom.

Question 2: Approach to performing the research and development

This project was rated **3.3** on its approach.

- Approach assumes a H_2 demand as a yearly input.
- Based on demand, model grows infrastructure by building H_2 production and delivery capacity.
- The objective function to minimize cost is a good approach.
- Uncertainties in technology development and capital cost reduction appear to be well captured via use of sensitivity analysis (optimistic vs. pessimistic brackets).
- While the results are very well documented and understood, the project is based on perfect foresight of demand which in a real world is unrealistic. The PI could evaluate the use of a probabilistic approach (via Monte Carlo simulation) in order to simulate demand and examine the impact on the results.
- The modeling approach to production options and costs is sound, given a somewhat simplistic user-defined demand. The model incorporates all realistic production pathways.

- The basic structure is there, and the incorporation of NPV calculations is very nice. As a potential future user I would like to see more validation, and more collaboration with existing OEMs especially in the area of forecourt reforming. I caution you to not rely on new vendors like H2Gen for FC CAPEX reductions over time.
- Might want to consider a more detailed understanding of tradeoffs between potential scale of a technology, building multiple units to reach capacity, etc. This would add robustness to the model results and would help give the model more credibility.
- Model development in MATLAB is a good approach.
- Although better than last year, still too much input from distributed hydrogen production developers, especially SR.
- Lowest cost options won't/can't always be selected. In reality a mix of production/dispensing options will be developed.
- The project is using an Excel-based database (from H2A) and MatLab algorithms, where the user enters the annual hydrogen demand.
- The model then selects the least-cost production pathway.
- The model incorporates many different production (both central and forecourt, including nuclear hydrogen and hydrogen from coal) and delivery pathways.

Question 3: Technical accomplishments and progress toward project and DOE goals

This project was rated **3.3** based on accomplishments.

- Project is on schedule & producing predictions of H_2 cost from various production and delivery options
- The model projections to date are limited by the input assumptions, and produce fairly obvious (in hindsight) results.
- I think the valuable contribution of this project will be the development of the approach, which should pay-off if it can be incorporated into the MSM.
- Economic analysis (such as costs) have been well revised since 2006 in order to capture the wide range of distributed SMR costs and the PI appears to be interacting very well with the relevant industry partners in obtaining costs. Therefore, he is well placed to reach consensus with industry on economic analysis.
- Good enhancements to the model were added during the past year.
- The model was exercised, and sensitivities were analyzed. The net result was that some key drivers were identified.
- New HyPro is much more useful than H2 Sim 1.0.
- HyPro still hasn't been used to evaluate some key drivers/barriers (e.g., >> 40 stations initially required)
- Many assumptions appear to be too optimistic (e.g., number, utilization, and cost of forecourt stations; carbon sequestration costs; cost/size of pipelines; redundant components in the early years).
- Although given a very difficult task, HyPro model doesn't appear to be very easy to use and may be too complex for error-free, transparent results.
- Analyzed the Los Angeles basin as a base case.
- It is interesting that for many of the cases shown, the cost of hydrogen is essentially flat from 2020 to out-years.
- The cost difference with or without carbon capture and sequestration is very small.
- Even with a renewable mandate, ethanol only plays an interim role at low demand levels.

Question 4: Technology transfer/collaborations with industry, universities and other laboratories

This project was rated **3.2** for technology transfer and collaboration.

- Good collaborations with university (UC Davis) and some industrial partners.
- The project appears to be very well connected with the H2A, UCDavis, HDSAM and HyTrans. The PI could consider interfacing with an agent-based modeling approach (such as the work done by RCF), which could impact the demand scenario based on actions taken by investors (on whether or not production capacity will be expanded or added).
- Collaboration with industry is evident. Information flow seems to be mostly in the form of input from industry; not clear to what extent the model and model results are being used by others, or for others.

- Not well-coordinated with the latest H2A model development work.
- Doesn't appear to be thoroughly vetted by industry, especially auto OEMs.
- The project has several companies on the advisory board.
- It is not clear how actively involved the advisory board is in the conduct of the project.

Question 5: Approach to and relevance of proposed future research

This project was rated **3.1** for proposed future work.

- Project is nearing completion.
- Future plans for the model need to focus on how it can be coupled to the Macro-system model in a way that eliminates the requirement to assume a H_2 demand in time.
- Plans for the next stage are clear and consistent.
- Planned updating of databases with latest H2A and HDSAM values is essential.
- Further sensitivity analyses are likely to be more useful, than simply running the model for additional cities, in terms of identifying incentives required or areas for further DOE research.
- National trends should also be included in the scope of work.
- Update data and parameters in/from contributing models, such as HDSAM.
- Examine other scenarios, regions (New York?).
- Identify needed incentives and research areas for DOE to consider.
- The "value" of the identified future work was not clear.

Strengths and weaknesses

Strengths
- The computation algorithm to choose production technology for build-out to meet demand should be useful to the MSM effort.
- I like the build-out approach, but the results to date seem a bit obvious in hindsight; I think the approach will prove it's usefulness if it can be combined into the MSM.
- Project objectives are clearly stated and well defined.
- Industry input is a strength of the project.
- NPV capability.
- Despite the enormous amount of information to cover, the presentation was clearly presented.
- The model includes a fairly comprehensive set of hydrogen production pathways.

Weaknesses
- The need to input a demand curve in time is the main limitation.
- This project does not include investor risk profile/behavior and decision behavior in order to make key business decisions to install capacity.
- Competitive analysis among distributed SMR investors is also not included in the analysis.
- Need to increase the amortization time allowed for pipelines to more than the 20 years currently in the model.
- Would work on obtaining more realistic Capital Expenditure estimates.
- The model has not been used to understand key drivers and, more importantly, potential technical/cost barriers to a hydrogen transition (i.e., some assumptions are too optimistic).
- Need to show examples of effective use of results from the model.
- The degree of confidence in some data (production pathways) is greater than in others, e.g., steam-methane reforming versus nuclear hydrogen. This needs to be clearly accounted for, even if the data come from other models, such as H2A.

Specific recommendations and additions or deletions to the work scope

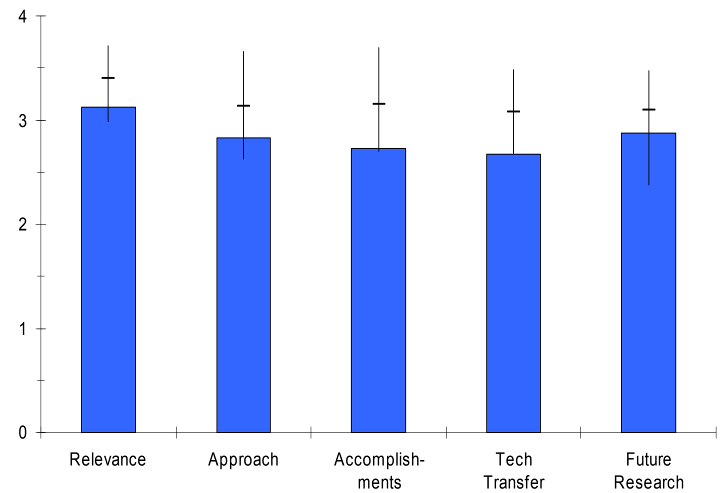
- The fixed demand curve limitation is not a problem if the model can be incorporated into the MSM in a way that the demand is determined by another model.

- User control (possibly through integration with MSM) of the pathway definitions would be useful; for example, different lifetimes for pipelines or other technologies.
- The project would benefit more if investor analysis and/or risk analysis studies are integrated into the decision-making process on whether or not to build capacity every year.
- Hydrogen fuel purity requirements could alter the relative costs of hydrogen from the different pathway options, and adding this should be considered.
- While the model does calculate stranded assets, no quantitative results were presented to indicate how significant an issue this may or may not be, or what policies, if any, should be considered to ameliorate the effects.
- Project needs closer coordination with hydrogen delivery analysis teams and thorough vetting by industry (especially auto OEMs and energy companies).

Project # AN-02: Impact of Hydrogen Production on U.S. Energy Markets
Harry Vidas; EEA

Brief Summary of Project

Overall Project Score: 2.8 (7 Reviews Received)



The objectives of this project are to 1) develop a consistent, integrated framework for evaluation of the impacts of hydrogen production within U.S. energy markets using a regionalized version of the MARKAL model; 2) evaluate costs and timeliness of various scenarios of a developing hydrogen supply infrastructure; 3) evaluate the impacts on U.S. energy markets including price and consumption changes for coal, natural gas, renewables and electricity; and 4) identify the most economic routes and financial risks of hydrogen production. The objectives for FY 2007 were to complete regional supply and cost analyses of coal and carbon sequestration, develop regional biomass supply curves, develop fuel and feedstock transportation capacity and cost, perform a study of natural gas infrastructure constraints and costs, and produce and test an initial multi-regional version of MARKAL.

Question 1: Relevance to overall DOE objectives

This project earned a score of **3.1** for its relevance to DOE objectives.

- I applaud the efforts of the PI in order to understand the impact not only on resources infrastructure but also on CO_2 sequestration.
- Good alignment with DOE Hydrogen Program.
- It is important to articulate the impact of hydrogen on other alternative fuels as well as to evaluate the impact of other alternative fuels on hydrogen and to compare the impacts of greenhouse gas emissions limits and other "drivers" on all alternative fuels.
- This project is evaluating the effects of the introduction of hydrogen into the energy marketplace on the price and consumption changes for other sources of energy, such as coal, natural gas, renewables and electricity.

Question 2: Approach to performing the research and development

This project was rated **2.8** on its approach.

- The technical approach is based on the well-developed MARKAL model. Extending the model to 10 regions provides the ability to analyze regional differences.
- Important contribution to DOE's overall R&D scope.
- Will be made more powerful by integrating with the Macro System model in the future.
- The approach seems to be very robust and to rely on robust data.
- The approach does not seem to take into account certain very well-known government policies and programs that favor certain fuels, such as tax reductions, tax exemptions for biodiesel or natural gas and such as government subsidies for biomass.
- The approach also needs to take into account that in certain states or regions, there may be localized government policies and programs that favor particular alternative fuels or all alternative fuels. For example, a state may require fleets to participate in the Chicago Climate Exchange or to waive all taxes on alternative fuels.
- The analysis is based on the MARKAL model, actually on a new regionalized version of the model.
- Additional analyses will be based on other databases and models that the PI has.

- There was no explanation of how MARKAL works, so it is difficult to assess what is included and what is not.
- Pipeline delivery from distributed production site may have some advantages and be consider.

Question 3: Technical accomplishments and progress toward project and DOE goals

This project was rated **2.7** based on accomplishments.

- The focus is too much on coal and biomass even though these do not provide major sources of H_2. The presentation did not include details to back up its accomplishments and preliminary findings (e.g., "significant reduction in tax revenue", or "limited impact" on natural gas demand and price).
- Technical accomplishments provide significant progress in addressing an analysis of the coal and biomass markets.
- The PI did not make clear what the technical barriers are that encumber attainment of the objectives of the research.
- The PI did not show how the accomplishments relate to the objectives of the research. For example, having completed the coal resource base, how much more work and what else has to be done to evaluate impacts on U.S. energy markets (objective 3 listed on viewgraph 3)?
- The first set of accomplishments is heavily weighted towards coal.
- The underlying assumption seems to be that bulk of the hydrogen would be produced from biomass gasification and coal, with carbon capture, sequestration, and disposal. Both of these are highly developmental (speculative?) at this stage, so this type of analysis is premature, at least.
- Not clear what is the significance of the "full market penetration" curve on slide 15, and that of the corresponding petroleum products demand in 2050 (slides 16 and 17), since that scenario is totally at odds with the HFCIT and NAS scenarios.

Question 4: Technology transfer/collaborations with industry, universities and other laboratories

This project was rated **2.7** for technology transfer and collaboration.

- This project appears to be working in isolation as compared to DTI, HDSAM and the other systems analysis work presented during this session. It is not clear to me on how this project will interface with other models being developed in other projects in systems analysis.
- Infrastructure design could benefit from consideration of work done by HyDRA and UC Davis and others – appearance is that this is being done in isolation of other potential sources.
- Collaboration with industry is not very evident.
- Good progress has been made in linking the model to sources of data, it isn't clear how the results of this project are linked to other models or making an impact on other related modeling efforts.
- Need to work more with others doing similar work. It seems to me that you are operating in a bit of a vacuum.
- The PI seems to have coordinated the research well with other organizations that are part of DOE or are DOE-funded.
- However, the PI seems to not have collaborated with subject matter experts outside of the DOE community, especially those outside the U.S., such as members of the Intergovernmental Panel on Climate Change or IPHE.
- The project team includes Brookhaven National Laboratory and Power & Energy Analytic Resources (PEAR).
- Not clear what the role of PEAR is in the project.

Question 5: Approach to and relevance of proposed future research

This project was rated **2.9** for proposed future work.

- Next steps are clear and consistent based on the analysis of the preliminary results and project goals.
- It's not clear what is being done to address the barriers listed.
- The plans for future work include examining alternative scenarios and sensitivities without much specificity.
- I don't see any reference to validation or collaborative validation in your future proposed work.
- Plans for future work identified at very high level.

- More details needed on what "finalize data inputs for MARKAL" and "examine integrated scenarios" mean and how these relate to the objectives for the research project.
- The major activities are additional data input and some additional scenario analyses.
- Not clear as to what use would be made of the results.

Strengths and weaknesses

Strengths
- The project is providing useful information on carbon sequestration.
- The project has provided a detailed and carefully thought-out analysis of the issues and impacts regarding carbon capture and sequestration.
- Your incorporation of new technologies for different pathways into MARKAL.
- This project is sorely needed to fill a need.
- Presumably, MARKAL has been used extensively in industry.

Weaknesses
- It was difficult to assess progress due to lack of details. Only general statements were provided. Work seems to have drifted off the objectives.
- Need to work more closely with others to calibrate / validate your model results and assumptions.
- Research project needs to identify areas of high uncertainty and data that have very high uncertainty – such as sequestration. These areas need to be identified upfront and highlighted as visibly as the assumptions in the model.
- Research project needs to include the impact of very highly visible government programs and policies that incentivize certain alternative fuels and their impact on different types of energy consumption, such as tax reductions or tax credits or greenhouse gas emission limits, such as the recent Supreme Court ruling against EPA on interpretation of the Clean Air Act.
- The rationale for the project objectives is not self-evident, neither was it explained in the presentation.
- Used acronyms and abbreviations without explanation (weakness in the presentation, not in the project).
- Methodology was not transparent (at least to this reviewer who did not know anything about MARKAL).
- Model needs to be calibrated.
- Data handling screens appear busy and distracting and should be simplified, similar to Macro-System Model.

Specific recommendations and additions or deletions to the work scope

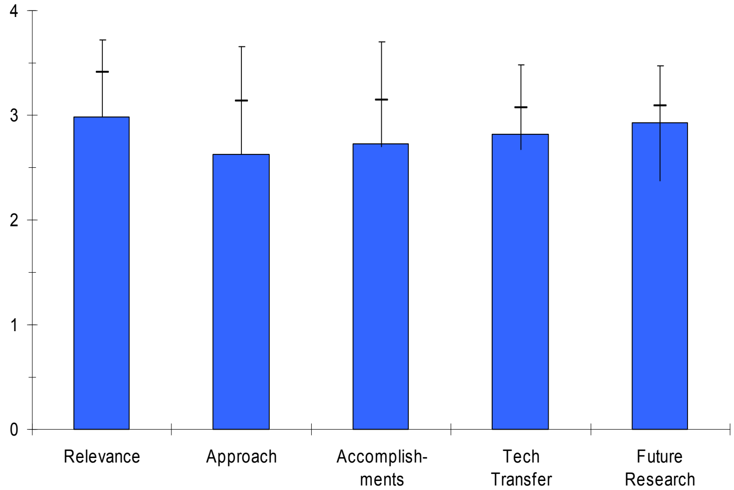
- The project would benefit from more integration with other systems analysis modeling efforts at DOE particularly sharing of inputs and outputs to DTI, HDSAM, etc.
- It appears to me that there appears to be some duplication of the same efforts by other groups within the systems analysis group at DOE, e.g., demand estimates, but I suspect this is not really the case as the estimates are derived from different directions.
- Focus more on the stated purpose of the program and more on typical hydrogen production methods such as SMR rather than CO_2 sequestrations and coal/biomass.
- The weaknesses identified above should be addressed in the future.

Project # AN-03: Analysis of the Hydrogen Production and Delivery Infrastructure as a Complex Adaptive System
George Tolley; RCF, Inc.

Brief Summary of Project

The objectives of this project are to 1) use agent-based modeling to provide insights into likely infrastructure investment patterns; 2) deal with the chicken-or-egg aspect of early transition; and 3) provide an answer to the question, "Will the private sector invest in hydrogen infrastructure?" These objectives will be met by focusing on investments as business decisions, developing a basis for preliminary assessment of profitability, and preparing an agent-based model for detailed simulations.

Overall Project Score: 2.8 (7 Reviews Received)



Question 1: Relevance to overall DOE objectives

This project earned a score of **3.0** for its relevance to DOE objectives.

- A very interesting approach to transition scenario analysis, i.e., includes behavioral/interaction type analysis between relevant agents and thus may potentially be integrated with the other deterministic economic analysis done by most of the other project teams in systems analysis.
- Better to focus on specific technology, in the short term, that enables the rollout. Expensive program and results will need to be commensurate with cost.
- Complex model, but one that would be a great contribution to DOE's model framework.
- The type of modeling that is the objective of this research is both consumer-oriented and investor-oriented.
- Consumer-oriented modeling is really market research and not a valid, legitimate subject for any government funding.
- Market research is best left to the private sector, which is best suited to do this type of research.
- Investor-oriented research is really financial planning and is not a valid, legitimate subject for any government funding.
- Investor-oriented research is best left to the private sector, which is best suited to do this type of research.
- This project is trying to assess how the private sector might invest in the hydrogen infrastructure as part of the transition to hydrogen as an automotive fuel.
- You are doing a very useful modeling effort that will help vehicle manufacturers, refueling station builders, and users. This type of project benefits many players and it is important that the DOE funds it so that each individual player does not need to build their own models based one more limited data.
- This type of collaboration is an excellent example of a value-added project for multiple participants.

Question 2: Approach to performing the research and development

This project was rated **2.6** on its approach.

- The project would benefit from a better/more complete understanding of the business goals of energy companies such as their risk profiles, attitudes and spending practices rather than assuming certain risk profile/utility curves.
- The project appears to only include capital spending on building fueling stations, i.e., primarily distributed hydrogen generation. A central production with pipeline delivery may alter spending profile of investors. Have the PIs considered this scenario?

- Generally, energy companies spend a very small fraction of the capital budget on station development/construction. Has the PI considered the impact of this on the overall interaction?
- For the task at hand, the approach seems effective.
- Topic is timely, but the model needs to be validated, i.e., get stakeholder buy-in.
- The approach is confusing in that agent is both the consumer and investor.
- The same socioeconomic approach, same investment approach, and same risk approach cannot and should not be taken for both.
- The consumer has totally different motives, values, norms, expectations, and risks from the investor.
- The consumer has a totally different amount of capital to work or play with from the investor.
- The consumer has a totally different capitalization rate from the investor.
- The results of this agent-based modeling would be strongly influenced by the assumptions made about agent behavior and response to various parameters.
- Some of the assumptions about driver agents are not consistent with this reviewer's own (admittedly subjective) feelings.
- Assumptions about the other agents' behavior also do not inspire confidence in the response and the results.
- The model appears to be very subjective. Assumptions are heavy based on the socioeconomic status of people, but weighting is not described or discussed.
- Much of the behavior model is based on perception, education, communications and patterning. As such, the model is lacking factors such as the education and training of the population, and safety, utilizing current local infrastructure. (Integration with Hydra would help).
- Model needs to list all input factors and prioritize or weight them in some fashion. More thought needs to go into input parameters.
- This is not least cost optimization but modeling behavior of agents – agent-based modeling; takes each individual agent and models his behavior.
- This modeling approach takes into account feedback from customers and response by suppliers, incrementally over time. This approach is extremely useful for modeling incremental fueling station adoption.
- Please show the different in revenue streams (or profits) to vehicle sellers with slow versus fast learning.
- Please show the difference with an initial government fleet adoption into an area (LA county police gets H_2 cars).

Question 3: Technical accomplishments and progress toward project and DOE goals

This project was rated **2.7** based on accomplishments.

- It is personally difficult for me to assess overall value while only considering distributed infrastructure in this model. Also the investor risk profile of auto OEMs has not yet been incorporated in this model.
- The focus of the presentation concentrated more on consumer purchase of vehicle as opposed to decision by an infrastructure provider.
- Very tough topic to tackle. I commend you on your work, but need to stress again that validation is key to making this a useful model.
- Effect of consumer learning was quantified.
- However, it is *not* clear what consumer learning is required. What is so different about driving a conventional car from driving a fuel-cell car that a driver must learn?
- Second, economics is a much greater driving force or factor than consumer learning. Nowhere does the research seem to take into account the base price of a fuel-cell vehicle in market penetration or market share.
- The significance of the results of sensitivity to parameters is not well explained. For example, it is not clear what is meant by "Consumer Learning Behavior." In any case, for a 50% hydrogen vehicle sales share, there is a difference of only 8 years between the extreme cases considered.
- No vehicle production constraints appear to have been considered.
- The investor risk aversion cases examined show only a 2-year difference for 50% of vehicle sales share.
- Other results presented are strongly influenced by the assumptions, some of which were not transparent.
- New project understand results preliminary.

- You stated that you are assuming a risk return rate borrowing rate of 12% which is constant over time. My impression is that this rate of return is too low for the level of risk being taken on by investors and consumers. It should probably start out high and then decline over time as people's perceived risk changes.

Question 4: Technology transfer/collaborations with industry, universities and other laboratories

This project was rated **2.8** for technology transfer and collaboration.

- I see a good list of project partners/advisors but I am concerned over value of their contribution since some assertions don't seem to be valid, e.g., investment levels by major energy companies.
- The presentation did not elaborate on interaction with the private companies listed and it's not clear if their input is included. This is important since they are the ones being evaluated on whether they will invest. Need input from them on what risk they might accept.
- Could also interface with other Analysis projects evaluating infrastructure rollout options to minimize risk.
- Would recommend that you work closely with OEM's to validate your model against either Diesel breakthrough in Europe over the past 30 years and or hybrid breakthrough here in the US over the past 5 years.
- The research focuses on the chicken-egg problem nature between hydrogen fuel infrastructure and hydrogen vehicle market share.
- The research project fails to coordinate with, collaborate with, or take advantage of other research done on the chicken-egg problem solving done by Argonne National Laboratory, namely in project ANP-3, "System Dynamics: HyDIVE — Hydrogen Dynamic Infrastructure and Vehicle Evolution Model."
- The project team includes companies, universities, and research laboratories.
- It is not clear how involved the other partners are in the actual research being conducted.
- This project could use a team of collaborators to vet the input parameters. Team should include modelers, oil companies, auto companies, behavioral psychologist.
- The project is working with Ford Motor company closely and Argonne National Labs and companies (BP, Air Products) and University of Michigan.

Question 5: Approach to and relevance of proposed future research

This project was rated **2.9** for proposed future work.

- Next steps are clear and aligned with project goals.
- However, it is not clear to me from the presentation whether the interaction of auto OEM will be captured in future work?
- There was no clear approach to how to overcome the barriers listed, such as lack of good data.
- Future plans are discussed at a fairly high level with very little detail.
- The model fails to make important distinctions in the types of agents and their values, norms, expectations, risks, and the amount/type of capital. Unless the model is revised in the future to take those distinctions into account, it is of little value.
- Future work will further expand the model to include additional production and delivery options, additional agent behavior patterns, and market structures and incentives.
- Please take the time to collaborate with integrating your model into the Macro-Systems Model.
- Please expand the model to answer some of the additional questions mentioned here.
- Please meticulously document all assumptions and data sources in the model so that others can use it correctly and integrate it consistently with other models.

Strengths and weaknesses

Strengths
- Extremely interesting; and uncertainty and consumer learning parameters are very well captured.
- Interesting data on factors to speed adoption.
- If properly validated, to the point where stakeholders accept the results, this would be a great tool to investigate different roll out scenarios and may even be a learning tool for policymakers.

- Research project considers effect of government incentives.
- With proper input parameters considered and prioritized, this could be a very good predictive model on how people will respond to new or disruptive technologies.
- They got more funding this year, which enabled them to expand the model.

Weaknesses

- It is not very clear as to how this project integrates with other systems analysis project (such as HDSAM, DTI, etc.).
- No discussion on liability affecting private sector investment, or how to get over initial low return of capital and how rollout of different technologies can impact investment decisions. Relative impact of fuel price on adoption (compared to the factors shown) would be helpful.
- No validation.
- More collaboration with OEMs and energy companies to understand the tradeoffs between fuel station availability and vehicle cost.
- Research project fails to distinguish the major differences between the two types of agents: consumer and investor.
- Research fails to take into account the base price of a fuel-cell vehicle and realize that this is much more important than the learning behavior of the consumer.
- This agent-based modeling is very sensitive to the assumed agent behavior.
- The set of assumptions used appears to be incomplete, at the very least.
- Not enough background information was provided to explain or justify agent behavior and response.
- No discussion of how the model results can be used, and by whom.
- Model as it stands is too subjective. It appears to heavily weighted to bandwagon affects and does not take into account economic inputs such as changes in the price of commodities, an expanding or contracting economy, local hydrogen infrastructure influence on build-out, state and local government incentives, training programs. Model needs to be calibrated against some new technology penetrating the market.
- Please document all assumptions in the model meticulously with extensive documentation.

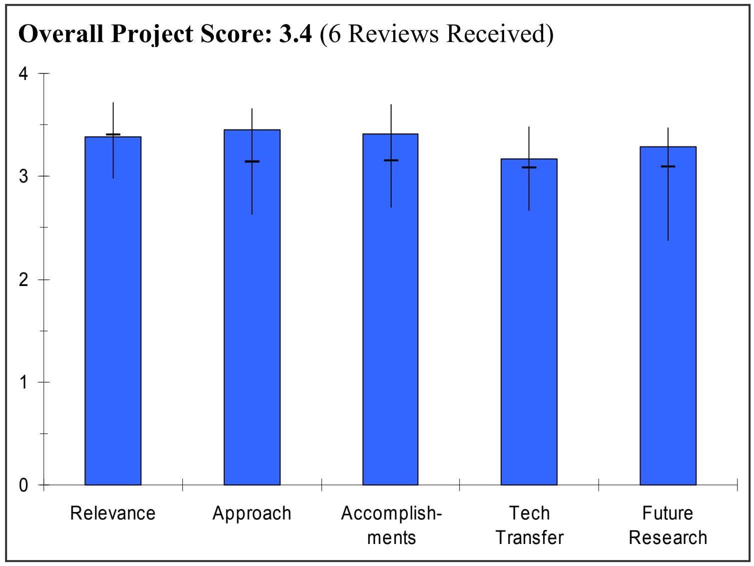
Specific recommendations and additions or deletions to the work scope

- Develop a clear and explicit interaction with other systems analysis teams – DTI, HDSAM, Macro System Model, etc.
- Develop recommendations that can speed private investment in hydrogen infrastructure since that is shown by the results to be important to consumer acceptance. Could the ABM be validated by comparison to the existing gasoline infrastructure?
- I would *not* recommend continuing to work on this model or any model that is consumer-oriented or investor-oriented or any model that examines consumer-investor interaction.
- Profit maximization for a company is a common, useful assumption. Business school literature hypothesizes that companies do not always act to maximize profits but rather employees who work at companies try to maximize their own gains. A simple example is frequent flyer miles – an employee may choose the flight that does not maximize profits for his company but rather gets him the most miles. Have you considered modeling this personal-profit maximization within companies involved with hydrogen which could increase or decrease adoption rates? Is there a frequent flyer equivalent with hydrogen that could increase adoption rates? Expand the model to answer these questions.

Project # AN-04: HyDRA – Resource Analysis
Johanna Levene; NREL

Brief Summary of Project

HyDRA is a web-based geographic information system (GIS) tool to allow analysts, decision makers, and general users to view, download, and analyze hydrogen demand, resource, and infrastructure data spatially and dynamically. Functions of the tool include the following: generate generic viewing maps, resource maps, infrastructure maps, and demand maps; layer control; change underlying assumptions; build hydrogen system; buffer layers; security; import data; export data; select data; and print map. Emissions maps, temporal functionality, and interaction with other applications are also planned.



Question 1: Relevance to overall DOE objectives

This project earned a score of **3.4** for its relevance to DOE objectives.

- Project aligns with the need to understand the potential for H_2 production from renewable resources.
- Interesting model, but it's not clear how much use it would be to actual rollout of infrastructure. There are other un-quantifiable considerations that are likely to take precedence.
- Project is aligned with the Hydrogen vision and when validated will serve as an excellent tool and guide for federal managers.
- Companies and investors may use their own models to make decisions, but it is very likely that they will turn to a model such as this to check/verify their decisions.
- Will be an excellent planning tool for federal managers and decision makers.
- This research project seems to make sense even if the DOE RD&D objectives did not exist.
- The project makes sense because it matches resources (renewable) with hydrogen production and the places of demand.
- This project will make hydrogen demand, resource, and infrastructure data available to users.

Question 2: Approach to performing the research and development

This project was rated **3.5** on its approach.

- Approach benefits from previous software development and GIS experience at NREL.
- It seems more like data presentation than a model, but that data is useful to document in one location.
- Utilizing the ongoing NREL models and providing the link to bring them together for H_2 evaluation is an effective use of resources.
- Effectively looking at the competition for resources, at least on a spatial basis.
- Project makes use of available resource databases – wind, solar, biomass – and geospatial locations of these resources.
- Project results in a tool that will be publicly accessible on the World Wide Web.
- Use existing data resources to perform analyses, subject to multiple constraints and drivers.
- The presentation provided a comprehensive overview of the model's capabilities.

Question 3: Technical accomplishments and progress toward project and DOE goals

This project was rated **3.4** based on accomplishments.

- Project has developed an interesting tool in just one year's effort.
- Progress seems on track to meet objectives.
- One of the better presentations and programs with regard to showing actual work and progress.
- Most functional requirements have been met.
- Case study demonstrates good functionality of the model.
- PI did not identify technical barriers.
- The reviewer does not think there are any major technical barriers to overcome for this project to progress to completion.
- It is primarily a model development activity so far.
- Allows simultaneous view of several parameters.
- The case study example showed how the Minneapolis area satisfies the input parameters.
- It is not clear how well hydrogen-fueled vehicles can be related to the parameters in the model.
- Great progress has been made with this new project.

Question 4: Technology transfer/collaborations with industry, universities and other laboratories

This project was rated **3.2** for technology transfer and collaboration.

- Transfer of this model is obvious, because web-based.
- It seems like a tool that will have use beyond this web application. As the MSM is developed, this tool should be useful.
- Several references were made to interactions with other studies.
- Could benefit from input from industry to evaluate its use.
- Technology transfer considerations are excellent when considering that the model will be a web-based system and will be available to (essentially) everyone.
- Collaborations could be strengthened by pulling in business/industry/investment community and determine what they require.
- The reviewer is of the opinion that no additional coordination or collaboration beyond what has been done is necessary.
- However, the project could benefit from seeking users, such as state hydrogen program managers or fleet managers, to evaluate the application.
- At this early stage of the project, there is little technology transfer or collaboration.
- The PI is seeking beta testers to help improve the model and its user interface.
- Would be useful to work with others in GIS area to expand out capabilities and verify model, troubleshoot.

Question 5: Approach to and relevance of proposed future research

This project was rated **3.3** for proposed future work.

- Future research is just finishing the release and incorporating experience from beta users in the rest of this FY.
- Temporal functionality is questionable, given that this should be incorporated into the MSM, which will provide the temporal integration and variations.
- Good details presented on next steps.
- Looking for H_2-knowledgeable people to do the beta testing and this will provide excellent feedback for improvements to the model.
- Another audience to target for beta testing is the intended user of the model, such as the decision makers. It is recognized that many of their comments may not be easily incorporated in the remaining performance period, but might provide good insight for follow-on activity.
- Future plans discussed in sufficient detail.

- PI identified weaknesses in that NREL does not have a good handle on data concerning non-renewable resources and will seek out sources of such data.
- The proposed future activity is primarily model development.
- It would be helpful to show examples of the effective use of the model, such as for helping to guide related research.

Strengths and weaknesses

Strengths
- Project was a good idea as formulated from existing NREL tools and software experience.
- Inexpensive and short term…to-the-point. Good return for cost.
- Fast paced and seeking real feedback.
- Actual work is being shown and demonstrated.
- If underlying assumptions can be validated, it may be an excellent tool for Federal Managers to use.
- Matching of resources and demand.
- Publicly accessible on World Wide Web.
- Flexible model with an easy-to-use graphical interface.
- GIS mapping of resources and population is a strong planning tool.

Weaknesses
- Data will need to be updated for long-term effectiveness.
- Need better plan for validation of model, actively seek industry input.
- To be of most benefit to federal decision makers, this model must closely match the results of similar private sector models. A validation activity should include a determination of how well it does match business/investor decision models.
- PI needs to be more aggressive in soliciting users to test and evaluate the application.
- Need to show how the results can be used effectively.
- Comment (not weakness): the presentation was very fast, rushed, almost breathless.
- None. Understood it is new project.

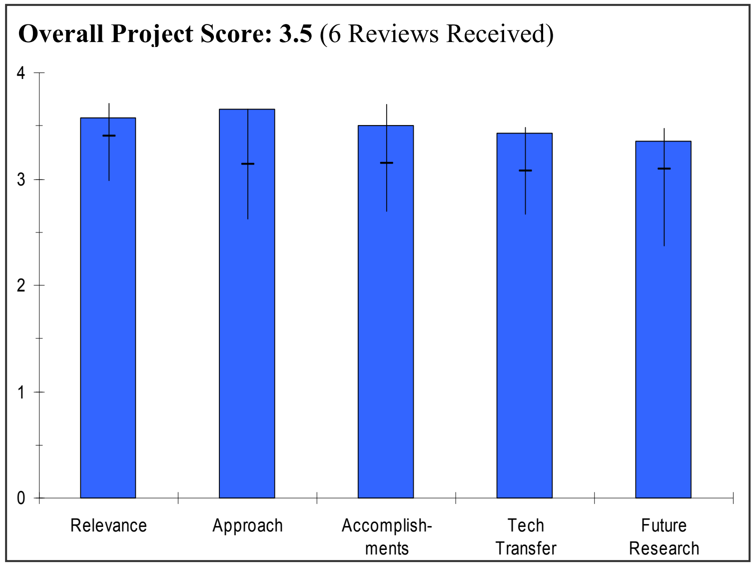
Specific recommendations and additions or deletions to the work scope

- PI mentioned plan for incorporation of this tool into the MSM; this should be the highest priority.
- Bring in business/industrial decision makers and determine their requirements.
- Not within the scope of this activity, but a potential follow-on activity would be the validation of this model.
- Beta test will very likely bring out priority issues that should be addressed within and beyond the scope of this project.
- Reviewer would like to see the inclusion of EPA map of Clean Air Act National Ambient Air Quality Standards non-attainment areas on the demand layer side of the application and FHWA map of corridors of freight movement congestion (these are major generators of diesel particulate and NO_x, and even if the commercial vehicles are not moving, these are major generators of diesel particulate and NO_x during idling) on the demand layer side of the application. The FHWA map does not necessarily duplicate the EPA map but takes into account sensitivity of town and communities to mobile (commercial vehicle) sources of pollution that could be replaced to a certain extent by non-polluting hydrogen energy.
- Consider adding sites for potential geologic storage of Hydrogen as well as hydrogen pipelines.
- Would be useful to add tool to integrate future weather scenarios and their impact on natural resource development.

Project # AN-05: Macro-System Model
Mark Ruth; NREL

Brief Summary of Project

The overall objective of this project is to develop a macro-system model (MSM) aimed at performing rapid cross-cutting analysis within the Hydrogen Program. It uses high-level architecture to link models being developed or used by the Program. The MSM supports decisions regarding programmatic investments and focus of future funding through analyses and sensitivity runs. It also supports estimates of program outputs and outcomes. Currently, the H2A, HDSAM, and GREET models have been linked within the MSM framework.



Question 1: Relevance to overall DOE objectives

This project earned a score of **3.5** for its relevance to DOE objectives.

- The purpose and relevance are clear – there is obviously a need to integrate several "disconnected" models into a combined value chain approach.
- If these models are being developed, it makes sense to make sure they are consistent and can be used together.
- Clearly there is a very serious need to link models together to get a more uniform and consistent output, this model will do that.
- The macro system model (MSM) is a "master" program that can call up and use a library of existing models developed at NREL and elsewhere.
- If successful, this project will be an important tool for System Analysis and the overall program to assess the benefits and costs of a future hydrogen economy.

Question 2: Approach to performing the research and development

This project was rated **3.7** on its approach.

- While the approach towards integration appears strong, MSM heavily relies on H2A, HDSAM and GREET. Perhaps including a feedback loop from MSM to validate/challenge the other models' assumptions and results may also be a beneficial approach as part of the future work.
- The current version of the model is deterministic, which is okay to start with. However, for an emerging technology such as hydrogen, a stochastic approach needs to be taken and I hope MSM considers adopting this approach soon.
- Well laid-out plan.
- Model has a good, simple layout for a complex subject.
- Excellent approach to linking existing models via currently selected simplified architecture.
- Linking existing models via an overarching Federated Object Model, so that the user does not have to call up individual models.
- I would have liked to have seen more presented on the approach in the oral presentation, but the PI covered some of the details during the demo session.
- The current linking approach appears to be suboptimal, but the team is appropriately trying out an alternative solution.
- The team is taking the right approach by starting small and building over time.

Question 3: Technical accomplishments and progress toward project and DOE goals

This project was rated **3.5** based on accomplishments.

- PI demonstrated clear progress and accomplishments in capturing the types and category of information needed. I do see clear value in the model integration efforts of MSM. However, the overarching goal for the systems analysis teams of DOE interfacing with MSM is not completely clear to me because this presentation (and previous presentations in the session) did not clearly outline what the main objective of the systems analysis teams models, i.e., what are we trying to achieve via integration – is it policy planning, is it investor analysis, etc?
- Preliminary sensitivity analysis and tornado charts are good indicators of integration of several models.
- Presentation offered actual results, showing the model is at least functional, if not yet validated.
- Excellent progress from last year.
- Developed and validated interfaces with many separate models.
- Added several more pathways this year.
- Valuable side-effect of the project is vetting current models.
- An important challenge will be de-bugging since it involves data transfer between various models.

Question 4: Technology transfer/collaborations with industry, universities and other laboratories

This project was rated **3.3** for technology transfer and collaboration.

- While collaboration of MSM with H2A, HDSAM and GREET have been well recognized, I encourage the PI to interface more with DTI and RCF in order to include scenario analysis.
- Good input from other labs, but need more input from hydrogen producers/users.
- The collaborations are mostly with the developers of the other models that are being interfaced with the MSM.
- There appears to be sufficient collaboration so far with the necessary model developers.

Question 5: Approach to and relevance of proposed future research

This project was rated **3.3** for proposed future work.

- Next steps are clear and concise.
- Well laid-out future steps and plan in presentation.
- Good plan forward, validation is key as is providing a more user friendly GUI.
- Future work is primarily an extension of the model.
- Ambitious, but reasonable plan for future work.

Strengths and weaknesses

Strengths
- Integration of several models in a single location – production, delivery, emissions.
- Well organized, good plan, and good progress.
- Allowing for one top-level layer to interface with other models to provide consistent assumptions to be used throughout will help to compare model results more easily.
- Makes several different models available simultaneously in a "one stop shop".
- If successful, this project will be an important tool for DOE to make the right R&D and planning decisions. However, the project will only be as good as the models it interfaces with.
- Broad-based modeling linking emissions to production and delivery scenarios.

Weaknesses
- No major weakness as such; however, the project is heavily reliant on the accuracy of the other models. Therefore, I am concerned with the error propagation from the other models. Does MSM test or challenge the assumptions of other models?

- This project has similar issues as other models in how to account for intangibles and unquantifiables.
- User interface at this point is not so great.
- Would have been helpful if the different models used in the case studies were listed.
- Did not explain what we were looking at in slides 13-17, each of which had the same title.
- How do we use this information?
- It was not clear how this is an advance over using GREET or H2A, for example, by themselves.
- Is MSM interfaced with H2A?
- It isn't clear yet how the analysis community will be able to utilize the model to answer questions, but I assume this will worked out in the future work (i.e., beta testing).
- Very ambitious, perhaps too ambitious, end goals (i.e., individual models still need to be developed and utilized).
- Model needs some control to be calibrated to determine degree of error in calculation. Can this be applied to actual plant operation to determine accuracy?

Specific recommendations and additions or deletions to the work scope

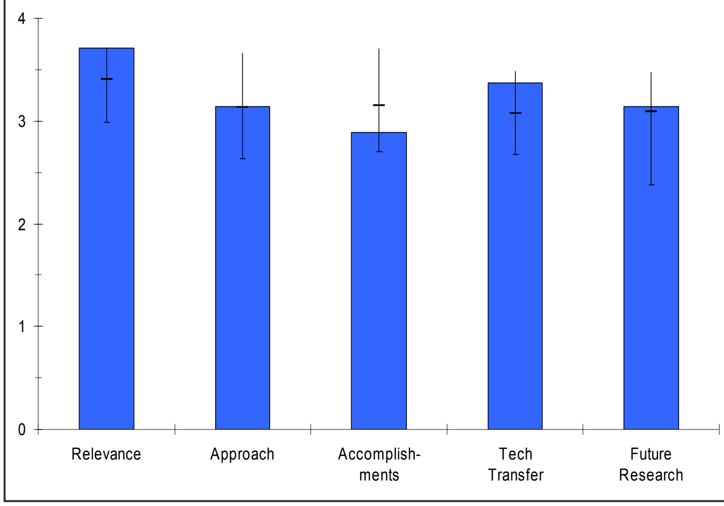
- Develop a clear and concise plan to handle various revisions of H2A, HDSAM, GREET, etc. into MSM.
- Include a methodology to challenge/validate assumptions and results from the above models (which are inputs to MSM).
- Add H_2 quality/cost tradeoffs into MSM.
- Add stochastic modeling capability to capture uncertainties.
- Need to make assumptions clear and adjustable to user.
- Transition scenarios (in future work) should be thoroughly vetted by industry (e.g., auto OEMs and energy companies).

Project # AN-06: Hydrogen Quality Analysis: Production to Fuel Cell
Romesh Kumar; ANL

Brief Summary of Project

The DOE Hydrogen Quality Working Group (HQWG) is tasked with developing a process to determine hydrogen quality requirements for fuel cell vehicles, based on life-cycle costs. This project will identify how fuel quality influences the life-cycle costs of the various components of the overall "hydrogen system" and will develop models to evaluate the effects of fuel quality on the costs of the hydrogen system components. The HQWG will also identify information gaps and the research and development (R&D) needed to fill those gaps.

Overall Project Score: 3.2 (7 Reviews Received)



Question 1: Relevance to overall DOE objectives

This project earned a score of **3.7** for its relevance to DOE objectives.

- Understanding cost effect of impurities on FC vehicles is relevant.
- Hydrogen purity is a very important parameter to rolling out hydrogen as a fuel. It is currently a very controversial topic that needs to be resolved and is potentially a roadblock unless resolved.
- Very, very important topic!
- Very high relevance.
- The project complements other efforts in fuel quality, determining the consequences (mostly monetary) of impurity tolerance specifications.
- Tighter tolerances add to the cost of fuel, and analysis is necessary in order to prevent these added costs from exceeding the costs of damage that the impurities might cause, or the costs of remediation methods that might make the system tolerant of such impurities.
- The project is necessary to bring together the future hydrogen producers (e.g. energy companies), developers (e.g. fuel cell and hydrogen systems) and end users (e.g. auto OEMs) to help establish the least-cost approach to hydrogen quality.

Question 2: Approach to performing the research and development

This project was rated **3.1** on its approach.

- Approach includes a physical model of PSA systems to understand cost of impurity concentration.
- The approach of using the lowest $/mile is a good one, but the focus of the presentation (and work performed to date?) seems to focus on hydrogen cost rather than fuel cell life.
- We have two very competent and experienced PI here, why are there no experiments to validate some of these numbers presented in the findings.
- Integrated approach is very good.
- Gap identification for resource allocation is a key element.
- The project utilizes a team approach to gather, critically assess, and integrate relevant data.
- The approach includes data gathering, model development, a good degree of communication among team members, and ultimately development of a roadmap to steer the community towards the least-cost architecture for dealing with fuel impurities.

- Important outcomes of this work are the identification of (1) information gaps as to the actual costs caused by fuel impurities or measures taken to remove them, and (2) areas of useful R&D that could lead to reduced system costs.
- Balancing cost of FCV and H_2 is a great idea, one that has not yet been fully studied.
- It is not clear how this project is coordinating with industry representatives outside of the FreedomCAR Tech Teams.
- Why consider an ATR for natural gas reforming? Are any developers still considering ATR over SR?
- Modeling PSA may be a waste of time as the industry should already understand the performance trade-offs.

Question 3: Technical accomplishments and progress toward project and DOE goals

This project was rated **2.9** based on accomplishments.

- A model is started, but initial results look simplistic.
- There was little or no data presented that discussed the impact of purity on fuel cell as opposed to cost of hydrogen. It was mentioned, but could be discussed further.
- Summary items match well with reality, which is a good sign.
- The level of confidence in the data is not presented. Too bad there are no field work or lab experiments to support the information presented. It would be great if the PI can conduct some sort of sanity check on the information gathered.
- The project is beginning to bear fruit in such areas as analysis of the costs and effectiveness of steam methane reforming (SMR) and pressure swing adsorption (PSA).
- The PI reports that a "comprehensive draft Roadmap" is out for comment.
- The PI did not make clear whether or not they consider the data gathering phase of the project substantially done, that is, whether all the data (or sufficient data) actually exists within the project in order to make the draft Roadmap truly "comprehensive."
- The project seems to have spent a lot of money with no real results to date.
- It is not clear what has actually been accomplished besides a literature review and getting up to speed on H2A.
- Cost curves presented appear to be based on previous work (i.e. lit review).

Question 4: Technology transfer/collaborations with industry, universities and other laboratories

This project was rated **3.4** for technology transfer and collaboration.

- Excellent collaborations with industry partners on supply and vehicle sides.
- Good number of partners in oil and automotive industries. The group could use representatives from hydrogen and analytical industries as actual participants.
- Keep up the good work.
- Accessible library database of focused content will be important in focusing needed research.
- Very good cross-functional collaboration.
- Performance degradation models will be helpful in the development of a hydrogen quality standard.
- The presentation indicated many proactive efforts to gather detailed data from various sectors and to report findings in a timely manner.
- The questions at the end of the talk indicated a high level of interest in the community on this activity.
- The consensus standards bodies currently working on fuel-quality standards (principally SAE, ASTM, and ISO TC 197) are "open" – meaning that all interested and affected parties may participate. While the H2QWG seeks participation from all sectors, it should be more "open" in the same sense – allowing, soliciting, and welcoming participation by any and all interested and affected parties.
- Not enough fuel cell and hydrogen component developers have been engaged (e.g. on the fuel cell side, only UTC and Ford to date – Ballard has provided some info).
- Need more review and input from industry outside of the Tech Teams.
- There has been no information shared with the public on this project until this Merit Review.

Question 5: Approach to and relevance of proposed future research

This project was rated **3.1** for proposed future work.

- Plans to update model with data.
- Good list of future action items.
- Access to good data on fuel cell performance was not listed as a barrier. If available, this data could be included as well.
- PI needs to propose some sort of field or experimentation to check on the information. The information gathered so far does not have a high level of confidence or buy in from all industry members. How do you plan to validate the model?
- Future research and model development should be more closely focused on DOE goals for catalyst loadings
- The PIs propose to further polish their model (build and validate), publish an initial roadmap, publish a roadmap, and otherwise continue with their well-laid plans.
- It would be good to not rely entirely on model results, but rather have a healthy combination of model results and OEM validation.
- There is no end date for this project?
- It is not clear what final outcome is desired/expected.

Strengths and weaknesses

Strengths

- Collaborations in the working group should provide insight into the question of what H_2 quality is necessary and cost-effective.
- This project is addressing a critical issue and has a reasonable approach.
- Very good PI focused on a major issue at hand.
- Project Strength lies in its cross-functional depth.
- The project complements other efforts to determine the effects of fuel contaminants on fuel cell components, and to set standards for fuel purity.
- In the presentation, the PI well articulated a sensible scope and course of action for this activity, providing value without overreaching into areas already covered by others.
- This project seems well coordinated with other efforts concerning fuel quality.

Weaknesses

- I'm not sure how this project fits in with the other analysis projects. Unless the PSA model will have utility elsewhere, it appears that this project might fit better in the FC program.
- It will be difficult to drive to a consensus.
- It's not clear why the focus is on production (in short term to 2015) when delivery of liquid/gas is likely to be the biggest supply mode in this short term.
- Validation of models will be critical.
- The working groups should be open to all interested and affected members of the community.
- Additional clarity should be given on the extent to which the first roadmap will be "comprehensive," or to the extent that subsequent roadmaps will build on data not yet in hand.
- This is the first time the public has seen anything from this project, and even now, there are no substantial results to speak of.
- Not much progress given the level of funding.

Specific recommendations and additions or deletions to the work scope

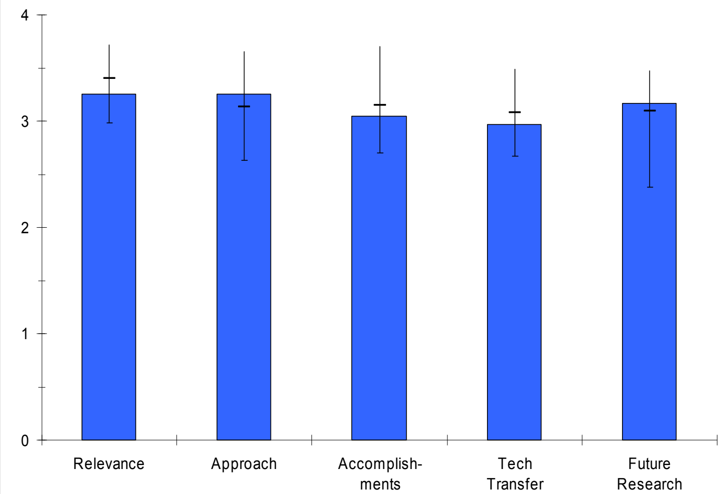
- Consider cost of cleanup on vehicle vs. at a station or at production.
- Include particulates as a contaminant for discussion.
- Should consider conducting some sort of field work or lab experiments to support findings.
- Direct future work to verify current models with DOE targets.

- ANL should focus on the fuel cell performance modeling and work with fuel cell cost analysis teams and hydrogen production and delivery teams for the cost trade-off assessment.
- Need more collaboration/coordination with industry outside of Tech Teams (e.g., fuel cell and hydrogen system developers as well as other analysis teams).
- Need to get more results soon and have an end date.

Project # AN-07: Well-to-Wheel Analysis of Hydrogen Pathways with GREET Model
Michael Wang; ANL

Brief Summary of Project

Overall Project Score: 3.1 (6 Reviews Received)



The objectives of this project are to 1) expand and update the GREET model for hydrogen production pathways and for fuel cell vehicle improvements; 2) conduct well-to-wheels analysis of hydrogen fuel cell vehicles with various hydrogen production pathways; 3) provide well-to-wheels results to assist in DOE planning and evaluation activities; and 4) engage in discussions and dissimilation of energy and environmental benefits of hydrogen fuel cell vehicles. Major efforts in the last year included well-to-wheels analysis of energy use and greenhouse emissions for selected hydrogen production pathways (distributed production from natural gas via steam methane reforming, central production from cellulosic biomass via gasification, central production from coal via gasification with CO2 sequestration, distributed and central production from wind/grid electricity via electrolysis, and central production from nuclear via thermo-chemical water cracking), and analysis of potential energy and greenhouse gas emissions effects of hydrogen production from coke oven gas in U.S. steel mills.

Question 1: Relevance to overall DOE objectives

This project earned a score of **3.3** for its relevance to DOE objectives.

- Well-to-wheel analysis is important to understanding emissions and benefits of H_2.
- The analysis is helpful to compare different roll-out strategies for the hydrogen economy.
- It is absolutely essential that this (and other) activity maintain awareness of greenhouse gas and emissions impacts that are likely to result from the future deployed technologies.
- It is not clear why this project is focused on hydrogen end-use as fuel cell vehicles.
- It is not clear what the practical application of the results of this research project are when the choices for hydrogen production methods may be constrained, such as by geographic proximity to renewable resources.

Question 2: Approach to performing the research and development

This project was rated **3.3** on its approach.

- GREET is a well documented tool in W-T-W analysis; it makes sense to adopt H_2 pathways for comparison with other alternative fuel options.
- The original choice of a spreadsheet as the choice of platform limits the potential future uses somewhat.
- The project is continuing to refine an existing model.
- Expanding credible model. This approach is outstanding and takes full advantage of more than a decade of prior research and model development.
- Looking at all of the right sources for data. The data sources being used are all of the reasonable sources that could be suggested. The fact that they are getting anything from industry is commendable.
- The PI needs to interface with energy providers too; they deal with quite a bit of hydrogen daily. What about obtaining the data on the FCVs from the Technology Validation Program?
- Project makes use of available resource data bases.
- Project results in a tool that will be released to users.

Question 3: Technical accomplishments and progress toward project and DOE goals

This project was rated **3.0** based on accomplishments.

- The results presented here are skewed by the overly optimistic assumptions regarding FC vehicle mileage, in comparison to the overly pessimistic assumptions for the mileage of a hybrid gasoline vehicle. The authors chose a range of 35-39 mpg for a gasoline hybrid, when the Prius is EPA rated at 55 mpg (composite mileage) and on-road is about 45 mpg; the authors adjusted down from a Prius for vehicle size. In contrast however, the FC vehicle is assumed to get 55 to 65 mpg, which is extremely optimistic compared to the values measured as part of the Technology Validation vehicle learning program (see Wipke, TV5). The author mentioned Honda FCX, which has EPA rating similar to Prius (within 1 mpg), yet somehow the FC vehicle's mileage is adjusted upwards under the argument that these prototype vehicles are not representative. These optimistic assumptions dominate the comparisons to follow.
- Another example of overly optimistic input assumption is the >80% efficiency in NG reforming assumed for 2015; this maybe related to a DOE target, or come from assumptions built into H2A, but there is no evidence that the technology will get there.
- The authors do not consider sensitivity studies on any of these parameters to evaluate how critical the assumed values are to the outcome and conclusions.
- The GREET project continues to be a common platform used extensively for analysis.
- Fabulous list of H2 production pathways already included in the model. This could not have been accomplished without the prior research that had gone into GREET.
- PI needs to show levels of uncertainty in the numbers presented so it will be easy to understand the levels of accuracy. These numbers cannot be absolute.
- PI identified technical barriers as inconsistent data, assumptions, and guidelines. However, PI did not explain the details of these inconsistencies.
- PI should show the variation (upper bound and lower bound) or uncertainty in outcome(s) of the GREET model as a result of these inconsistencies.

Question 4: Technology transfer/collaborations with industry, universities and other laboratories

This project was rated **3.0** for technology transfer and collaboration.

- Author makes GREET tool available.
- The GREET project has gotten input from various sources, but it has not been discussed how consensus is reached on the assumptions.
- This is the right team for development of this model.
- Inputs are being collected from the right organizations and sources.
- GREET's credibility has lead to a user list that total 3500. As the H_2 pathways are added, they are available to these and additional users.
- PI needs to interface with the Fuel Cell Tech Team, Hydrogen Production and Delivery Tech Team, along with energy providers.
- Though your current partners are full partners and apparently are full participants, it would be useful for the future development of the model to work with industry to get real validation/comment on your model results.
- The reviewer is of the opinion that no additional coordination or collaboration beyond what has been done is necessary.
- However, the project could benefit from seeking feedback from users,

Question 5: Approach to and relevance of proposed future research

This project was rated **3.2** for proposed future work.

- Several next steps are laid out.
- Agree with current plans for expansion of the model. Would recommend that plug-in hybrid fuel cell vehicle be added to the mix.

- PI needs to collaborate with companies like Air Gas to get decent numbers on trucking of hydrogen costs and other tech team to get accepted numbers in his proposal.
- The implementation of a full lifecycle analysis would be very useful to help understand the GHG emission for different scenarios.
- Future plans discussed in sufficient detail.

Strengths and weaknesses

Strengths
- The GREET tool is a useful contribution to the analysis community.
- GREET is a large multi-faceted model that is developing consistency for this type of analysis.
- Building on one of the most credible and used models in the DOE system.
- Good overview of simulation.
- Excellent program – really helps me understand well to wheels and well to pump results.
- GREET model has become a standard Wells-to-Wheels analysis tool.
- GREET model used for DOE Hydrogen Posture Plan.

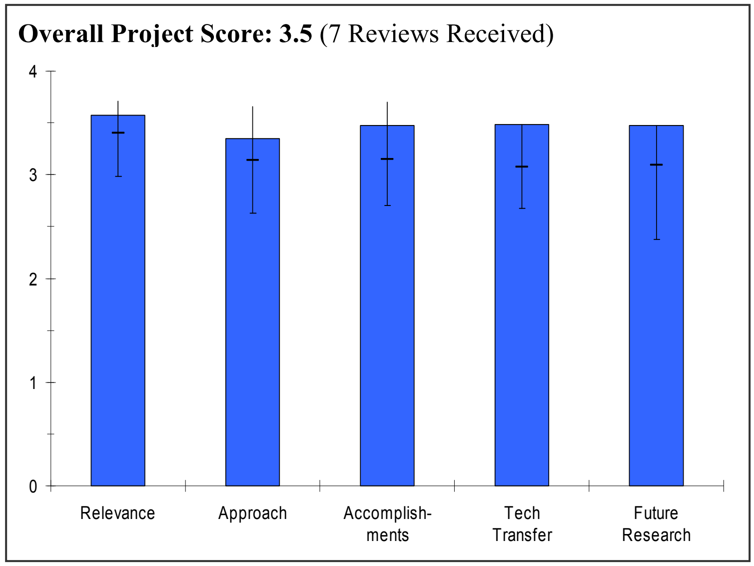
Weaknesses
- The model is only as good as its assumptions. It's important to continually update those assumptions and provide visibility on the process of how they are determined.
- Need to consider current consumption of the hydrogen and how will the increase in demand affect the overall cost of hydrogen. PI needs to show standard deviation to show accuracy of numbers.
- In future it would be great to have more of a life cycle analysis incorporated into the model, to allow for GHG analysis.
- PI needs to solicit feedback from users on improvement and enhancements.

Specific recommendations and additions or deletions to the work scope

- The author needs to provide a parameter study using the critical assumptions.
- Provide more detailed objectives each FY as model is continuously refined and improved.
- Add the plug-in hybrid fuel cell vehicle to the technology options that are modeled.
- PI needs to interface with all the stake holders of this simulation work (FCTT, H_2 Production and Delivery, Energy Providers, etc).
- Implement a means for soliciting feedback from users.
- Take into account (in terms of impact on hydrogen production efficiency, energy use, greenhouse gas emissions, etc.) the estimated energy needed to sequester carbon that may result from hydrogen production methods that rely on fossil fuels, such as hydrogen from coke-oven gas.

Project # AN-08: HyTrans Model
David Greene; ORNL

Brief Summary of Project



Oak Ridge National Laboratory has created a working version of an integrated model of the market's transition to hydrogen as a transportation fuel using non-linear optimization methods. The model includes representation of 1) hydrogen production and delivery; 2) vehicle production, including technological progress, scale economies and learning-by-doing; and 3) demand for vehicles and fuels, including the effects of fuel availability and diversity of vehicle choice. The objectives of this project in FY 2007 were to complete development of an integrated market model of the hydrogen transition (incorporate reduced form representations of the H2A production and delivery models, develop new fuel cell vehicle cost model, add regional detail) and to use the HyTrans model to describe and analyze DOE's early transition scenarios (2012 to 2025) and publish a report on their costs, benefits in greenhouse gas (GHG) and oil reduction, and sustainability beyond 2025.

Question 1: Relevance to overall DOE objectives

This project earned a score of **3.6** for its relevance to DOE objectives.

- The analysis uses program targets and evaluates the proposed FCV sales scenarios using a model of market effects on driver choice and H_2 supply.
- Successful transition and evaluation of how to get there is important to understand if a hydrogen economy is possible.
- This project is highly relevant and focused on the overall DOE objectives. It is less about creating a model, and more about actually using the model to address the key questions and key sensitivities.
- This is one of several models that are addressing the issue of transition to a hydrogen transportation system and infrastructure.
- This is a relevant issue but virtually impossible to execute in a meaningful (relevant) manner.
- It isn't clear that the results of this study, as conducted, will have any effect on the program regardless of the results.
- This type of model is important for developing well-to-wheel estimates of energy and emissions.
- The future of this model should be enabling users to have more control over input parameters (such as efficiencies, emission factors, etc).

Question 2: Approach to performing the research and development

This project was rated **3.3** on its approach.

- The approach of using market, even with the efficient market assumption, is valuable to understand how the transition to hydrogen might occur.
- The fact that the "no scenario" run of the model predicts no market for FCV is reassuring, in that it reflects the realistic fact that there is a hurdle to public purchase of these vehicles.
- One of the barriers has to be the quality of the cost data, but this was not addressed specifically.

- The model is well-designed and adaptable to DOE program needs. It draws information from a wide variety of sources, and doesn't try to duplicate existing models.
- Excellent approach.
- Uses/incorporates various existing models.
- Incorporates new vehicle cost data from OEMs.
- The approach is generally good given the real limitations on such broad modeling. But, the approach is generally assumption driven (as it must be) but too many of the assumptions are unrealistic. A better approach would probably be one emphasizing a sensitivity analysis for the more critical (and questionable) assumptions.
- Too many of the important components of the models used in the approach were either glossed over or neglected completely, thus making an assessment very difficult. It is recognized that there are time limitations, but additional information could have been included in the slides even if there was not time to discuss everything in detail.
- Please try to enable the models to H2A and other models to be able to talk to each other, such that the GREET model is not updated by hand, as shown in the presentation.
- Please delineate all assumptions and methods in documentation attending the model, especially significant assumptions regarding vehicle efficiency.
- Because researchers disagree about the relative efficiency of fuel cell vehicles and internal combustion engine vehicles (and their hybrids), please very carefully outline all assumptions and literature sources and modeling methods behind slide 10.

Question 3: Technical accomplishments and progress toward project and DOE goals

This project was rated **3.5** based on accomplishments.

- The results this year are instructive, relating to the importance of government forcing (incentive) to start the vehicle fleet that allows manufacturers to bring down FCV costs.
- The most interesting result to me – though it was only mentioned briefly in the presentation – is the unstable equilibrium that can occur in the transition; if vehicle costs don't meet targets, then even a government kick-start of an initial fleet cannot produce a sustainable market for the vehicles. We have witnessed this phenomenon in other alternative vehicle programs (natural gas, battery-electric).
- Significant progress has been demonstrated in using the model to examine a broad range of scenarios and sensitivities to highlight key issues and results.
- Main barrier is to get validation of the results. I don't see where you address this.
- One interesting results is shown in Slide 12, which is that even if all the technical and cost goals for fuel cell vehicles are met, their market penetration would be essentially non-existent to 2050.
- Another interesting result is that a $25/ton of CO_2 carbon tax results in CO_2 emissions being reduced by more than half, whereas without the carbon tax, even with fuel cell vehicles, there is no reduction in carbon emissions.
- What is the degree of confidence in these results? If high, the entire DOE hydrogen program needs to revisit its assumptions and targets, at the very least.
- Combining the various existing models and codes along with collecting much new information to yield numerous additional inputs and arrive at coherent (if not completely believable) results represents an impressive accomplishment.
- Please add greater Monte Carlo capability – a distribution of inputs (such as fuel cell vehicle efficiency) that result in a distribution of results (not single values).
- Please enable users to change parameters, such as natural gas reforming efficiency, because the technology performance changes and this has implications for the results.
- Please enable the model to be changed according to an individual company's technical progress. For example, a developer of a new wind turbine design should be able to plug their design parameters (such as capacity factor) into the model to gauge the difference between their technology and the baseline technology assumed in the model.

Question 4: Technology transfer/collaborations with industry, universities and other laboratories

This project was rated **3.5** for technology transfer and collaboration.

- The authors transfer their results to the community, but there does not seem to be a clear path to sharing the model, or implementing it into other efforts, such as the MSM.
- The project has appropriate partners.
- Peer review step is important and a good step.
- Excellent use of existing models and databases. The project team works well with other model developers and analysts.
- The project has good collaborations with other national laboratories, universities, and industry.
- Collaboration among the participating partners seems to be excellent, but for this type project, open information to the groups who could actually use it is very important.
- Please publicize GREET workshops more widely.
- Please actively work with other DOE model developers to reconcile inconsistent assumptions and methods between GREET and other DOE models.
- Please use the model to make at least one very high impact publication that is very visible (such as Science or Nature). This will also help advertise the model.

Question 5: Approach to and relevance of proposed future research

This project was rated **3.5** for proposed future work.

- The project as described seems to be nearing a completion, except to follow other model updates and participate in international studies.
- Specific objectives are defined for FY 08.
- Future work is based on updating the model with H2A changes and other data source improvements. Vehicle technology characterization will be expanded to include plug-in hybrids and plug-in fuel cell vehicles.
- Will publish model documentation and results from analyses.
- Will develop rigorous representation of uncertainties.
- Will update and incorporate additional technology options.
- Will participate in transition analyses by the IPHE (International Partnership for the Hydrogen Economy).
- The proposed activities to the completion of this project seem appropriate.
- There was no mention of any type of follow-on or project extension.
- The future of this model should be enabling users to have more control over input parameters (such as efficiencies, emission factors etc).

Strengths and weaknesses

Strengths
- The model's approach is unique, and its ability to provide intuition into transition questions is very interesting.
- Looking at some realistic transition strategies to enable the rollout of hydrogen. HYTRANS presents some realistic challenges and provides some realistic approaches to foster the rollout.
- Shows the role of policy factors above and beyond simply meeting the technical performance and cost targets.
- A collaboration effort involving combining many models and computer codes to get common results.
- It appears to be a well-organized and well-executed project.
- The PI has done a tremendous job gathering tons of controversial technical, environmental, and other data to build this model and update it.
- The PI deserves recognition for making the GREET model in such detail and making it an industry standard.

Weaknesses
- The output is only as good as the assumptions that are input. It appears as if small changes to input assumptions can make for large result variations. The result is that there is substantial risk for early adopters who rely on the underlying assumptions.
- The conclusion that FCV introduction drive oil use to zero (Slide 14) does not appear realistic.
- The approach leads to results which may have little importance, as presented.
- Some important elements of the effort appear to be unavailable to non- team members.

- Greater user control over input parameters is needed.
- Greater automation among GREET and other models is needed.

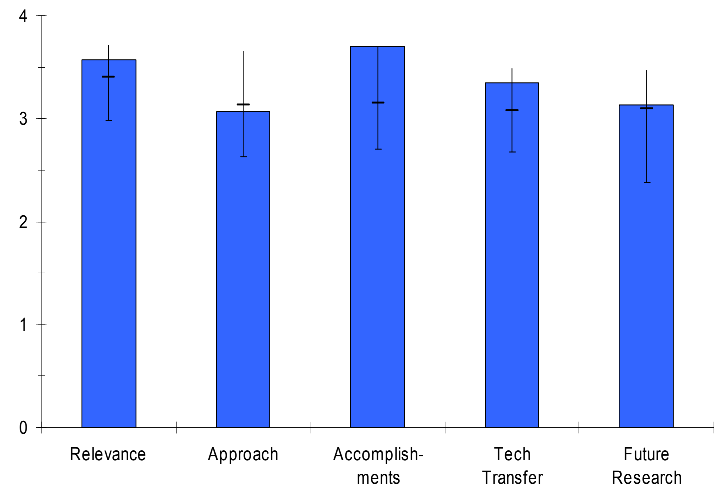
Specific recommendations and additions or deletions to the work scope

- Compare assumptions going forward with assumptions in previous years to consider how realistic they might be.
- Validate progress annually.
- Make sensitivity analyses a bigger part of the current study or have a follow-on study emphasizing sensitivity.
- The DOE should fund some external researchers from ANL to carefully review, critique, and possibly debug GREET, and to identify areas where the GREET model is not consistent in its assumptions and methods compared with other DOE models.

Project # ANP-01: Impact of Renewables on Hydrogen Transition Analysis
Stephen Lasher; TIAX

Brief Summary of Project

Overall Project Score: 3.4 (3 Reviews Received)



The overall objective of this project is to predict the most economically attractive renewable resources for producing hydrogen for future light-duty vehicles in the U.S. Objectives for 2006 and 2007 included 1) identify and down-select the most attractive renewable resources available in the U.S. (Lower 48); 2) establish future H_2 light-duty vehicle demand scenarios; 3) develop logistics model to minimize the delivered cost of H2 by selecting the most economical resources; 4) determine how competitive renewable-based H_2 options could be compared to fossil fuel-based (i.e. natural gas) production; 5) find what technical or cost improvements are needed to make renewable-based H_2 more competitive using sensitivity analysis; and 6) investigate H_2 delivery cost reductions by creating a pipeline network from the output of the logistics model.

Question 1: Relevance to overall DOE objectives

This project earned a score of **3.6** for its relevance to DOE objectives.

- Very valuable study to assist in understanding where priorities should be placed to enable hydrogen production from renewable resources.
- The need to understand how renewable fuels can support our overall effort is very important.
- The project is highly relevant to understanding the cost of producing hydrogen from renewable resources.

Question 2: Approach to performing the research and development

This project was rated **3.1** on its approach.

- This model does not include realistic market forces, such as competition for resources.
- Approach appears to be constrained by limited funding.
- The approach is based on realistic GIS information on hydrogen demand and renewable resource distributions.

Question 3: Technical accomplishments and progress toward project and DOE goals

This project was rated **3.7** based on accomplishments.

- Excellent results (within the limits of the study) showing quasi-optimal solutions.
- Finished on time, what more can you say.
- A tremendous amount of technical results and insights, considering the minimal project time (5 months) and funding ($100K).

Question 4: Technology transfer/collaborations with industry, universities and other laboratories

This project was rated **3.4** for technology transfer and collaboration.

- TIAX has done an excellent job of utilizing prior studies as input for this study.
- Although there has been interaction with NREL, it would have been good to have more interaction directly with the EERE offices of Wind, Solar and Biomass.
- PI should consider having direct industrial partner to get better technical inputs than the NHA working group.
- Good interaction and review of results with NREL and NHA.

Question 5: Approach to and relevance of proposed future research

This project was rated **3.1** for proposed future work.

- If this project is continued, the proposed list of future activities is good and represents many of the things that must be done.
- If this is continued, competition for biomass resources, electricity for the grid rather than electrolysis of H_2, etc. should be included.
- It would be good to put more emphasis on identifying the barriers to achieving low cost hydrogen from renewable resources.
- Program ended but future research is very good.
- Although the project is 100% complete, the work should be extended further. A good set of further model enhancements and further sensitivity studies have been proposed.

Strengths and weaknesses

Strengths
- Excellent analysis on probable cost of producing and distributing renewable hydrogen.

Weaknesses
- Could have done a better job on identifying and prioritizing specific barriers that would lead to economical renewable hydrogen.
- Does not factor in competition for biomass resources and the option/competition to sell electricity to the grid.
- Does not include an economic trade off analysis of pumping hydrogen through a pipeline vs. sending electrons through the grid and performing distributed electrolysis.
- PI needs to have more direct industry collaboration. Cost per kg seemed optimistic, where are the taxes? For a prediction in 2030 or 2050 timeline, there will be taxes on these fuels.

Specific recommendations and additions or deletions to the work scope

- Project is completed; however, if it is continued, the list of recommended extensions plus the addition of competing market forces should be considered.
- The model should be validated.
- PI needs to consider real world factors when you are projecting out to 2030 or 2050, cost of natural gas, cost of resources, investment cost, etc.

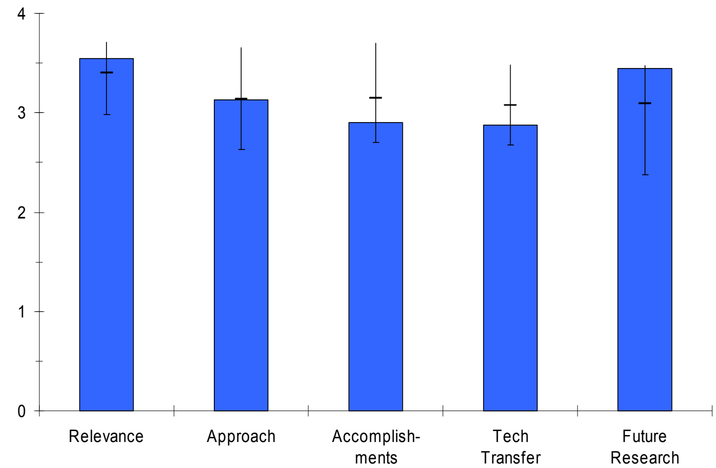
Project # ANP-02: Hydrogen Analysis: H2A Update 2007

Todd Ramsden; NREL

Brief Summary of Project

The H2A model aims to make analyses consistent, transparent, and comparable. Phase II goals are to reflect current DOE program direction, reflect best understanding of available technologies (including cost assumptions and performance assumptions), simplify the model structure and the user interface, improve transparency, and provide new features. New features include plant size scaling, automated sensitivity analyses and graphing, carbon sequestration costs and amounts, well-to-wheel and well-to-pump emissions calculations, and a toggle for using Annual Energy Outlook 2007 prices. The model is meant to be a means of reporting assumptions as well as calculating minimum hydrogen selling price.

Overall Project Score: 3.2 (4 Reviews Received)



Question 1: Relevance to overall DOE objectives

This project earned a score of **3.6** for its relevance to DOE objectives.

- Understanding the cost for producing hydrogen through each pathway is absolutely essential.
- No question hydrogen infrastructure is critical to the overall market of fuel cell products, especially automotive.
- Since many of the other analysis models use outputs from H2A production, getting H2A production costs right is highly relevant.
- The project is worthwhile in that it could inform corporate and DOE decision making. My sense, through, is that this is not a model that is widely needed since it leaves out a few key issues, both political and economic.

Question 2: Approach to performing the research and development

This project was rated **3.1** on its approach.

- Financial parameters are very realistic for our economy today, but should be reconsidered annually to assure they remain realistic.
- The planned approach of taking GREET WTW/WTP results and placing them in the model as lookup tables could lead to potential errors if the tables are not rerun regularly.
- In this development, did PI leverage existing/previous work done in this field (i.e. IHIG)?
- This is a generally effective route to decision making in a flat world – one where every kg of hydrogen is worth the same.

Question 3: Technical accomplishments and progress toward project and DOE goals

This project was rated **2.9** based on accomplishments.

- Progress made considering funding and time constraints is very good.
- Some assumptions cannot be correct such as 100% equity and $5000/acre. This is not realistic of the market across the nation.
- Progress looks good, but there is no benchmark or relevant measure of the extent to which some goal is being achieved.

Question 4: Technology transfer/collaborations with industry, universities and other laboratories

This project was rated **2.9** for technology transfer and collaboration.

- Solid team developing the model.
- Availability of the model needs to be more widely disseminated.
- The project needs collaborators (Air Gas, Air Liquide, etc) who are in this business to give credibility to the model.
- Available on the internet – could be better advertised.

Question 5: Approach to and relevance of proposed future research

This project was rated **3.5** for proposed future work.

- Expanding the model to include the cost impact of hydrogen quality should draw on the ANL project, "Hydrogen Quality Issues for Fuel Cell Vehicles".
- Water use and water quality must be added to the model and should be given very high priority.
- Proposed future work sounds good and is quite relevant. However, without some sort of industrial partner in the business, it is uncertain how this work will be valued to the community.
- Adding the impact of hydrogen fuel purity on production costs is important, and could alter the relative costs for different pathways.
- Proposals seem reasonable – add in transport costs review other fuels and signs. More could be added in – see recommendations.

Strengths and weaknesses

Strengths
- Excellent start on an economic model of the production of hydrogen.
- Did not cost much – potentially quite useful.
- Transparent. Available world wide via the web.

Weaknesses
- There seems to be a tendency to make this a stand alone model, rather than one that incorporates other models (i.e. GREET) and draws on them to make appropriate calculations.
- Not clear how this model is better than previous model developed by other groups. Lack of gas supply industrial partners.
- The world is not flat – the customer has been left out of the picture to an extreme degree. Units are not readily understandable. Outputs are far too large. I don't believe that advanced nuclear should be directly compared to electrolysis – the risks are far different.

Specific recommendations and additions or deletions to the work scope

- Validation of the model must be added to the future plans.
- Incorporate GREET, H2 Quality model, etc. into this one, rather than try to duplicate their function.
- Incorporate the cost of safety when realistic information becomes available.
- PI need to gather the support of a large gas supply partner who knows the business.
- Include some estimate of transport and compression costs, include storage
- Include a basic treatment of scalability – today's fueling stations need 100 kg/day if that much. Include realistic equipment life and decommissioning. Use units people are familiar with – \$/MM BTU, \$/gal, \$/ton of steel.

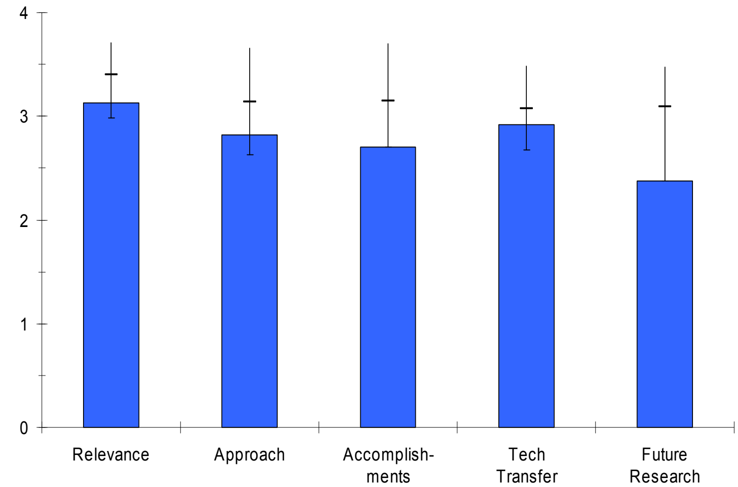
Project # ANP-03: System Dynamics: HyDIVE – Hydrogen Dynamic Infrastructure and Vehicle Evolution Model

Cory Welch; NREL

Brief Summary of Project

The objectives of this project are to 1) quantify and better characterize the nature of the "chicken-and-egg" barrier of hydrogen stations and hydrogen vehicle demand, and 2) identify high leverage strategies and policies for the development of the hydrogen transportation market through spatial, temporal simulation. HyDIVE is a dynamic, spatial, and behavioral market simulation model. System behavior results from decision-making processes of individuals. Vehicle choice model parameters are quantified via discrete choice analysis.

Overall Project Score: 2.8 (4 Reviews Received)



Question 1: Relevance to overall DOE objectives

This project earned a score of **3.1** for its relevance to DOE objectives.

- Understanding the market penetration rate of these technologies is relevant to the initiative and extremely important.
- Consumer acceptance should NOT be a DOE RD&D objective.
- Government has no role or responsibility for marketing when that is best done by the private sector.

Question 2: Approach to performing the research and development

This project was rated **2.8** on its approach.

- Appears to have significant overlap with project AN-3, by George Tolley.
- Surveying consumers regarding "alternative fuels" may not result in accurate information regarding their attitude toward hydrogen.
- Excellent approach to evaluation of the introduction of generic alternative fuels.
- Not clear what the technical barriers were.
- The PI did not identify the chicken/egg situation of whether hydrogen infrastructure/fuel cell vehicle, but this is NOT a technical barrier. It is an economic barrier, thus, out of scope.

Question 3: Technical accomplishments and progress toward project and DOE goals

This project was rated **2.7** based on accomplishments.

- Analysis of consumer response to refueling station density is very good.
- Detailed assessment of 400 and 750 station cases is very good, providing useful views within two slices of time.
- Tornado chart is very good for providing quick look at where the high sensitivities are.
- While the PI seems to be touting progress and meeting milestone schedule, the accomplishments are inconsequential.
- The PI said that the research concluded that we really have a chicken/egg problem. This conclusion does not solve the problem.

Question 4: Technology transfer/collaborations with industry, universities and other laboratories

This project was rated **2.9** for technology transfer and collaboration.

- Long list of partners, but their contributions appear to be very limited.
- The research fails to consider lessons learned from the introduction of other alternative fuel vehicles.
- The research fails to examine how the chicken/egg situation was addressed with the introduction of the automobile.
- Did we have gas stations first or automobiles first?
- The research also failed to collaborate with the PI for AN-3, which is a similar research project.
- Great broad collaboration.

Question 5: Approach to and relevance of proposed future research

This project was rated **2.4** for proposed future work.

- The proposed addition of a more vigorous modeling of the vehicle availability dynamics is very good, but there is much more that needs to be added and some things, such as perceived safety may be more important.
- No plans for future research.
- Should integrate results with RCF behavioral model to see how they correlate.

Strengths and weaknesses

Strengths
- Within the limits of the accuracy of the assumptions, this project will help understand the number of refueling sites required for sustainable growth.
- This model may already be used by the Biomass Program, but if it is not it should be.
- Sound behavior analysis based on evidence – not empirical.

Weaknesses
- Actual projections may not be realistic for hydrogen due to consumer safety perceptions and other concerns beyond station location convenience.
- Research project did not solve the problem it started out to solve; it merely went through a series of analyses only to confirm that there is a real chicken/egg problem with hydrogen infrastructure/fuel cell vehicles.

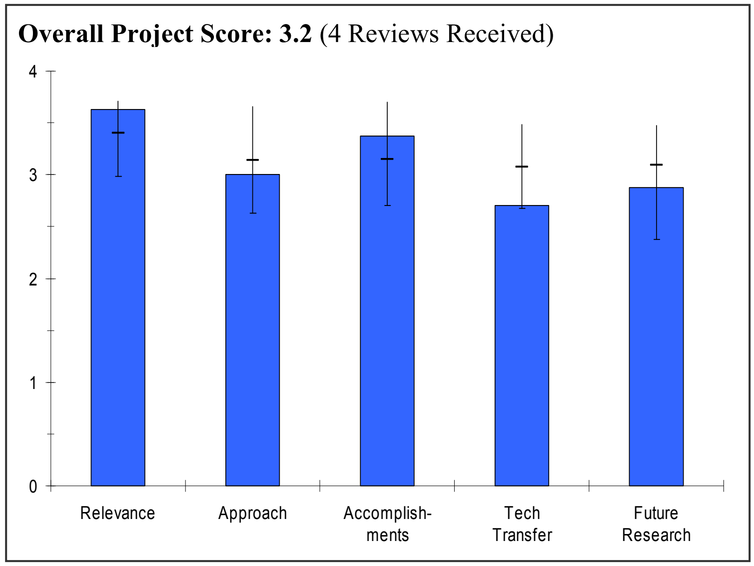
Specific recommendations and additions or deletions to the work scope

- Consumer concerns regarding safety, including safety perceptions, refueling concerns, etc. should be included to get a more accurate assessment of what will be required to achieve sustainable growth.
- Information regarding the plans for validation should be included in any future activity.
- Consideration should be given to combining this activity with the Agent Based Modeling activity to establish complimentary tasking rather than what appears to be overlapping tasking.
- No further funding of market research is recommended.
- DOE should NOT fund any research projects involving analytical models in which the model cannot be validated or collaborated.
- Need to line experimental-based behavioral models to non experimental-based.

Project # ANP-05: Analysis Repository
Melissa Lott; ATS

Brief Summary of Project

The objectives of this project are to 1) create a searchable online database of hydrogen-related analyses; 2) populate the database with as many hydrogen-related analyses as practical, both DOE- and non-DOE-funded; and 3) develop a user-friendly interface that provides the needed functionality, particularly regarding search capabilities. A library-card index approach is employed: each entry in the repository will contain enough information on the analysis or model to identify its general purpose and scope and enable the user to locate further information.



Question 1: Relevance to overall DOE objectives

This project earned a score of **3.6** for its relevance to DOE objectives.

- A single source for relevant H_2 analysis results will be very beneficial for the initiative and when reasonably populated, will save researchers time.
- Project promises to provide a "one-stop shop" or clearing house (by means of a web site) for H_2 analyses and models. This objective makes sense, and is probably long overdue.
- A central clearinghouse or repository of data on analysis and analytical models would be needed even if it were not listed explicitly as a DOE RD&D objective.

Question 2: Approach to performing the research and development

This project was rated **3.0** on its approach.

- Voluntary submission of information is frustratingly slow and frequently incomplete.
- The technology and approach used (web sites) is well understood and relatively low risk.
- The biggest risk to this project is lack of response from model & analysis owners and authors, which the project performers will try to mitigate by personally adding entries for projects for which there is no responding POC.
- Not clear how data on non-DOE sponsored analysis and analytical models will be captured.

Question 3: Technical accomplishments and progress toward project and DOE goals

This project was rated **3.4** based on accomplishments.

- The repository gives ready access to 75 analyses.
- The web site is up and running and already has 75 entries. Response rate from model developers and analysts is good, per presenter.
- The repository is up and running with 75 analyses or analytical models already included and accessible to the public.

Question 4: Technology transfer/collaborations with industry, universities and other laboratories

This project was rated **2.7** for technology transfer and collaboration.

- Data is available to all – outstanding technology transfer.
- Collaboration within the Program is also outstanding and this team is getting great input, considering it is all voluntary.
- The project is all about technology transfer & collaboration, in particular with making researchers and analysts aware of model development & analyses that has already been done.
- PI did not evince collaboration with industry, universities, or other organization that have similar repositories.

Question 5: Approach to and relevance of proposed future research

This project was rated **2.9** for proposed future work.

- Expanding the database and asking other analysts for feedback on its functionality are natural next steps.
- Plans are straightforward – advertise web site to model owners and analysts, fill out entries for more projects, add search capabilities (keyword) to allow users to more quickly navigate through the project entries/descriptions on the web site.
- See recommendations below.

Strengths and weaknesses

Strengths
- Single location for researchers to quickly search on prior work to reduce/avoid duplication.
- Low cost.
- Low risk.
- If researchers/analysts/model owners use the web site, will potentially save time.
- The repository collects data on analysis and analytical models even if not funded by DOE.
- Much needed central database for all HFCIT related projects.

Weaknesses
- Strictly dependent on voluntary submission of information; therefore, very likely to remain incomplete.
- Will not result in breakthroughs in technology or analysis. Payoff will be in time savings of other researchers, which may not be easy to measure.
- Not clear how the repository endeavors to collect data on analysis and analytical models NOT funded by DOE.

Specific recommendations and additions or deletions to the work scope

- Brainstorming session on how to create incentives for analysts to supply information.
- Has a request for analysis project information been submitted through IPHE? If not, might be worth a short presentation at the next IPHE meeting.
- Consider coordinating with other hydrogen research programs, e.g. those led by EU, to save on duplication of effort in cataloguing projects.
- Need a strategy for collecting data on analysis and analytical models NOT funded by DOE.
- Engage NE, FE, and BES early to get their buy-in and participation.