Hydrogen Technical Advisory Panel

Survey Report

May 4, 1998

HTAP SURVEY REPORT{PRIVATE }

5/4/98

1. Summary

As part of its information gathering for its report to Congress, the Hydrogen Technical Advisory Panel (HTAP) has conducted a survey of people involved in or interested in hydrogen energy. Using an HTAP-prepared questionnaire and telephone interviews, HTAP members contacted 52 people in research, industry, and government. About 60% of respondents felt that they are very familiar with the DOE Hydrogen Program, while 40% have either some or little familiarity. Respondents were queried on the following topics:

- project execution (confined to respondents involved in Hydrogen Program RD&D projects)
- DOE program management (including the Hydrogen Program, DOE overall, the national labs, and HTAP)
- balance of elements within the Hydrogen Program (e.g. R&D vs. validation/demonstration, renewables vs. fossil, short vs long-term)
- commercialization
- coordination and partnering
- outreach and communication
- budgets and legislation
- major hydrogen energy issues

Respondents were asked both for ratings such as Good, Acceptable, and Poor (which could be scored), and for comments.

An important dichotomy in viewpoints is reflected throughout these question areas. One viewpoint favors long-term, renewable-based R&D, with little attention at this time to validation/demonstration/commercialization projects or to a significant role for industry. The other viewpoint favors a thrust towards commercialization of hydrogen energy now or in the near future. They support R&D in shorter-term, fossil-based technologies; more emphasis on validation/demonstration projects; and more industry participation. (The second group, nevertheless, still favors a continuing long-term R&D effort as part of the program.)

Key findings in each of the question areas are summarized below, including quotes or paraphrasing of some of the comments received.

Project Execution

Poor continuity of project funding was the main concern expressed in this question area -- e.g. "Funding continuity is difficult. Funds are advanced in February and have to be spent by October, and then there is a gap in funding."

DOE Program Management

Respondents were more positive about the management of hydrogen-related activities by the Hydrogen Program and within the Office of Energy Efficiency and Renewable Energy (EERE) than they were for such activities in DOE as a whole. Many felt that the Hydrogen Program lacked a strong strategic framework for its individual projects. While the national labs and HTAP received satisfactory scores, there were criticisms. Even though the quality of work from the national labs is considered high, so are the costs. "Could siphon off too much of the hydrogen budget" said one respondent. Another commented that the "national labs' strategic plans bear little relevance to DOE hydrogen

strategies." Some felt that HTAP should provide more direction on strategies and dollar allocations to DOE, and be more independent of DOE.

Balance of Elements within the Hydrogen Program
Low scores reflected a general dissatisfaction with the issue of balance, in part due to the dichotomy of viewpoints discussed above. Non-industry respondents tended to support the longer-term, renewable energy view, while the industry respondents favored the opposite position. With regard to validation/demonstration projects, however, there was a clear consensus on both sides -- to proceed cautiously. "Don't launch into high visibility projects that are not well thought out. They can kill the program in the long run."

Commercialization
As expected, responses in this area showed the same long-term/short-term difference of opinion. The Hydrogen Program received satisfactory ratings for its efforts to encourage commercialization. The ratings showed more optimism for the prospects of commercialization of hydrogen for vehicles than for utilities. Lack of attractive low-cost storage technologies and competition from non-hydrogen technologies and fuels were seen as major barriers to commercialization of hydrogen energy systems. With regard to vehicles one respondent stated: "The outcome of the debate on onboard versus stationary reformers will determine the future of the hydrogen vehicle."

Coordination and Partnering
While recent improvement was seen within EERE, low scores were given to coordination and partnering with other parts of DOE (e.g. Fossil Energy and Energy Research), with other Federal agencies, and with state/local authorities. Viewpoints were mixed on international coordination and partnering. Non-industry respondents tended to be positive, largely due to the Hydrogen Program's International Energy Agency (IEA) activities. Industry respondents were more critical, seeing more activity than results -- e.g. "International coordination seems to be an exchange of paper and travel. But don't see any meaningful results." The differing viewpoints about industry participation in the Hydrogen Program were reflected in the comments: "The relationship with industry is strong." "The relationship with industry is too good!"

Outreach and Communication
This area included questions on safety and codes & standards and well as on outreach/communications to the public, industry, and high government levels. Respondents were generally satisfied with DOE's efforts in safety and codes & standards given ongoing work by DOE, the National Hydrogen Association, and the International Standards Organization (ISO) - but, with some cautions, especially that the Hydrogen Program needs a policy to require comprehensive safety reviews on all validation/demonstration projects. The other aspects of outreach all scored lower. Opinions were divided on the need for public outreach now: "if you believe it, educate the children." "if you don't have hardware to sell, why advocate?" Feelings about reaching high government levels were reflected in the comments: "Hydrogen is the most compelling technology at DOE, yet its promotion is the worst at DOE." "DOE does not have a vision of which to explain the program to Congress."

Budgets and Legislation
The split on whether requested and authorized DOE hydrogen budget levels are adequate was about 40% yes and 60% no -- although there was a strong consensus that they should be at least at the levels authorized by the Hydrogen Future Act. The

following comments typify the feelings of both sides of the budget issue: "The budget should not be increased until specific focus and thrusts are clearly delineated." "Need more like a $100 million." Respondents also expressed concerns over lack of funding stability for hydrogen activities, lack of full disclosure regarding the use of funds by the Hydrogen Program, and the earmarking of funds. A note of caution was sounded over additional hydrogen legislation: "Guidelines for developing legislative strategies should be developed first." "Dangerous to have hydrogen-specific legislation. HTAP should recommend legislation encouraging alternative fuel development, including hydrogen, based on energy and environmental performance."

Major Hydrogen Energy Issues

Respondents were asked to rate the importance of 12 hydrogen issues: 1)production cost from fossil fuels, 2) production cost from renewable energy, 3) hydrogen storage, 4) market readiness of vehicles, 5) market readiness of stationary power, 6) industry participation, 7) infrastructure, 8) codes & standards/insurance, 9) competing technologies and fuels, 10) Federal RD&D budgets, 11) visibility, and 12) public perception. The top three issues were seen as production cost from renewable energy, storage, and competing technologies and fuels. Compared to the total population of respondents, industry respondents rated the importance of production cost from fossil fuels much higher, and RD&D budgets much lower.

II. **Introduction**

The Hydrogen Future Act of 1996 requires that the Hydrogen Technical Advisory Panel (HTAP) prepare a report to Congress consisting of an analysis of the effectiveness of the DOE Hydrogen Program and recommendations for improvements in the Program, including recommendations for additional legislation. As part of HTAP's information gathering for its report to Congress, HTAP decided to survey individuals in the industrial, research, and government communities who are currently involved in hydrogen energy, or are involved in areas that could be impacted by hydrogen energy in the future. **HTAP** members conducted the survey by means of an HTAP-prepared questionnaire and telephone interviews.

52 responses were received: 49 filled-in questionnaires and 3 replies from respondents stating that they knew nothing about the DOE Hydrogen Program and thus that they could not respond. Most of the questionnaires were filled in by HTAP members during telephone interviews; in some cases HTAP members sent blank questionnaires to respondents who then completed and sent them in. Based on the original contact list of approximately 77, the response rate was 71 %, which is quite good.

The breakdown of respondents is as follows:

- Industry: 36%
- Government: 23%
- Non-profit: 14%
- University: 9%
- Other: 18% (Most of the national lab respondents chose this category rather than government.)

59% of respondents indicated that they are very familiar with the DOE Hydrogen Program, 32% that they are somewhat familiar, and 9% that they are not familiar - roughly a 60-40 split between people who know the Program very well and people who have less familiarity.

The questionnaire consisted of 10 question areas:

1. Personal data
2. Project execution (Generally confined to respondents who are or have been engaged in RD&D projects in the Hydrogen Program)
3. DOE program management
4. Balance of elements within the Hydrogen Program
5. Commercialization of hydrogen energy systems
6. Coordination and partnering
7. Outreach and communication
8. Hydrogen budgets and legislation
9. Major hydrogen energy issues
10. Additional comments

Question areas 2-9 posed multiple choice questions (that could be statistically tabulated), and also asked for any additional comments. Question areas 2-7 asked respondents to provide ratings among the choices of Good (no significant improvement needed), Acceptable (OK, but could stand some improvement), and Poor (substantial improvement needed). Each question also allowed for a No Response. Question 8 asked a Yes or No question regarding the adequacy of the DOE Hydrogen budget, and asked for any suggestions on additional hydrogen legislation (which will be part of the HTAP Report to Congress). Question 9 asked for a ranking of the importance of issues by High, Medium, and Low.

The sections below present the statistical results by percentages, excluding any No Responses (i.e. the results have been normalized to consider responses only). Each multiple choice response has further been assigned a numerical value — 5 for Good, Yes, or High; 3 for Acceptable, or Medium; and 1 for Poor, No, or Low. The numerical scores are tabulated for each multiple choice item, and then averaged for each question area. In addition to statistically analyzing the total population of questionnaires, sorts were made by industry respondents and by respondents who are very familiar with the Hydrogen Program, to see if there were any significant differences.

Also in each section below, particularly noteworthy comments are quoted or paraphrased. Comments are arranged to progress from opinions on one side of an issue to the other — from positive to negative for example.

A copy of the blank questionnaire is attached. Eileen Kalim has on file the filled in questionnaires and the full statistical analysis prepared by NREL on Excel[. The identity of the respondents is being kept confidential.

This report is longer than anticipated, largely as a result of the effort to capture many of the comments. To have generalized, rather than quoted or paraphrased, comments would have produced a shorter report. It would also have lost much of the tone and nuisances that reflect the real feelings of the respondents.

HTAP SURVEY RIEPORT

I. Project Execution

A. Statistical Results

5/4/98

This question was confined to the 19 respondents who have participated in Hydrogen Program RD&D projects. The statistical results are tabulated below (with No Response entries, and omitted individual question entries, normalized out). Wording of the individual questions have been shortened. See the attached blank questionnaire for the full wording.

Question / Rating	Good	Accep	Poor	Score
Quality of DOE program management?	28%	39%	33%	2.90
Continuity of project funding?	21	47	32	2.78
Understanding of project fit in big picture?	84	5	11	4.46
Adequacy of pursuit of commercialization?	46	38	15	3.59
Adequacy of collaboration on project?	46	38	15	3.59
Average score				3.46

The scores for project execution are generally acceptable. There is fairly good satisfaction among most of the principal investigators/project managers queried regarding their understanding of the big picture, commercialization efforts for their projects, and opportunities for collaboration. Continuity of funding received the lowest score, a concern reflected in several of the comments received.

B. Comments

- Listed below are a sampling of comments regarding project execution:
- "Program managers in DC are available; can talk to them."
- "I have made many calls to our project manager in Washington and have never had my calls returned."
- (These comments suggest that the responsiveness of the headquarters Hydrogen Program office is at best uneven.)
- "There is a disconnect between DOE Headquarters and NREL. Too many management layers."
- Several comments were critical of funding continuity. Here is just one. "Funding continuity is difficult. Funds are advanced in February and have to be spent by October, and then there is a gap in funding."
- "Rationale for projects is uneven. In many cases there is no vision, purpose, strategy or methodology."
- "Projects are judged by economics and not on scientific content."

- "Good pursuit of commercialization on my projects. Clear message from DOE to work with industry."

  (The above two comments suggest that there are mixed feeling about pursuing commercialization, probably as a function of how long-term a particular technology is.)

- "With more resources collaboration on projects would be better." "Pity that researchers cannot devote more time to the infrastructure of researchers and industry, due to limited funding."

II. DOE Program Management

A. Statistical Results

Question / Rating	Good	Accep	Poor	'Score
The Hydrogen Program?	20%	60%	20%	3.00
H2-related activities within EERE?	24	50	26	2.96
H2-related activities throughout DOE?	17	44	39	2.56
The national labs?	39	37	24	3.30
HTAP?	36	50	14	3.44
Average score				3.05

Hydrogen-related activities throughout DOE as a whole received a lower score than the Hydrogen Program or EERE (the Office of Energy Efficiency and Renewable Energy). Both the national labs and HTAP received pretty good scores — although the comments pointed out numerous shortcomings. A sort by respondents very familiar with the Hydrogen Program provided a much lower score for the quality of Hydrogen Program management — 2.10 versus 3.00 for the entire population.

B. Comments

A sampling of comments on DOE program management is listed below under the categories of the Hydrogen Program, EERE and DOE as a whole, the national labs, and HTAP.

The Hydrogen Program

- "Overall the Hydrogen Program's research is conducted successfully."

- "Program has excessive micromanagement. It is a program by committee.

- "2-headed management is detrimental to the program."

- "The Hydrogen Program tries to do too much with too little. One would think that they were addressing all the problems with a tiny program. In fact very little gets done."

- "The Hydrogen Program is missing having a good overall integrated program. See a lot of loose, disjointed efforts without a strategic framework moving toward goals."
- "Too little focus -- e.g. the Alaska project."
- "The problem I have with the Hydrogen Program is not its day-to-day management of specific projects and contracts, but its lack of overall direction and vision."
- "Funding for individual projects within the Hydrogen Program will be most effective if the entire budget is contractually committed at the beginning of the fiscal year. Avoid practice of incremental funding."
- "During the demonstration phase hydrogen safety must become an important part of the project management. At present there does not seem to be any oversight or review of safety aspects of demo projects."
- "A key issue is safety training of hydrogen users before the operation of equipment/ vehicles."

(The above two comments reflect the viewpoints of three safety specialists with extensive hydrogen experience who responded to the questionnaire. They feel that Hydrogen Program management should be doing more to ensure the safety of validation/demonstration projects.)

Within EERE and DOE as a Whole

- "Hydrogen doesn't seem to play a strategic role in DOE's overall thinking."
- "DOE should be doing more as a whole with hydrogen energy.
- "Awareness of others in EERE and DOE as a whole and appetite for hydrogen is low."
- "Within OTT not clear that hydrogen is high enough on the list."
- "Other offices have not contributed to the hydrogen mission. Efforts in the area of fuel cells seek to avoid hydrogen."
- "Need more involvement with Fossil Energy's Vision 21."
- "Energy Research is sponsoring little hydrogen research."

National Labs

- "National labs have high quality, but have high costs. Could siphon off too much of the hydrogen budget."
- "National labs' work is high quality, but lacks focus -- e.g. H2 ICE work.
- "National labs have internal focus. Not interested in RD&D partnerships."

- "National labs' strategic plans bear little relevance to DOE hydrogen strategies. Labs are extremely slow to align with hydrogen plans (NREL excepted)."
- "Need more industry input to programs led by national labs
- "National labs are not willing to collaborate with industry on their work."

HTAP

- "HTAP is in an outstanding position worldwide. To my recollection, in no other country does such an institution exist."
- "HTAP needs to be more proactive."
- "HTAP should be more independent of DOE.
- "The Secretary ignores HTAP."
- "HTAP should be more like OTA/GAO - watchdog on whole program. More clout. Play devil's advocate."
- HTAP needs to look at a much higher level. HTAP is part of the existing micromanagement problem."
- "HTAP should have a significant say in $ allocations."
- "HTAP should set up what is definition of success for demonstration projects -- goals definition, not the means by which they will be achieved."
- "HTAP should have all its meetings in Washington DC, unless there is a charter related reason for conducting a meeting elsewhere (such as a public hearing).

III. Balance of Elements within the Hydrogen Program

A. Statistical Results

Question / Rating	Good	Accep	Poor	Score
Among R&D/validation/systems analysis?	3%	47%	50%	2.06
Among production/storage/utilization?	14	57	30	2.71
Between long-term and short-term?	3	72	25	2.56
Between renewables and non-renewables?	12	45	42	2.37
Average score				2.42

The relatively low overall score reflects general dissatisfaction with the area of program balance as a whole. Each question scored below 3, and the Good rating had low percentages. The Industry sort showed slightly higher scores: 2.60 overall, and 2.40 and 2.68 for questions 1 and 4 respectively — while the Very Familiar sort had a significantly lower score for question 4: 2.09.

From an interpretation of individual comments, especially non-industry versus industry, it seems that the non-industry respondents are generally dissatisfied with perceived trends toward greater emphasis on validation, shorter term, and fossil fuels.

Comments

Validation/R&D/Systems Analysis

(Many expressed concern over emphasis on technology validation over core R&D, but some where more supportive.)

- "Too much emphasis on technology validation."
- "Validation too early. Technology not adequate."
- "Concerned that validation will come to swamp out other work, especially premature demonstration (e.g. Atlanta bus demo)."
- "Too much emphasis on technology validation prematurely, which could lead to a squandering of resources. Don't launch into high visibility projects that are not well thought out. They can kill the program in the long run."
- "Avoid excessive validation projects which are not really demonstrating any new technology."
- "Some technology validation should occur, but emphasis should be on long term research."
- "Should be 50:50 validation/research."
- "Increase in validation budget is logical. But shouldn't be too diffuse. Needs more focus in key areas."
- "More success on demos may trigger more funding."
- "More on engineering development/validation versus core R&D, unless there are no suitable candidates which qualify for such support."
- "Need more thrust on shorter-term, pre-commercialization (validation) categories."

(Less was said about systems analysis although some felt that there was too much of it going on.)

- "Systems analysis expenditures are too high."
- "Amount of work validating models (i.e. computer-based mathematical models) has to be increased. Need to build models before the validation phase which is expensive."
- "Systems analysis served its purpose early in the program. Not clear that the program's current direction is in accord with the analyses."

- "Systems analysis has good intent, but the database is suspect, especially capital costs and efficiency values — e.g. for biomass gasification."

Production/Storage/Utilization

(Many respondents expressed strong support for storage R&D, although it was not unanimous. Opinions differed widely about production and were a strong function of individual background. Likewise, opinions differed on utilization.)

- "Expand storage R&D."
- "More on storage since it is the technology barrier to overcome."
- "Storage needs higher priority at the expense of utilization."
- "Storage needs high priority -- at expense of utilization, if utilization is picked up by other programs."
- "Appears to be slanted more to production. Need more emphasis on storage and utilization."
- "Balance between production and storage research is good."
- "Too much emphasis on storage R&D."
- "Production is not sufficiently funded."
- "Production is key. If can't produce, it's a mute point to develop a hydrogen economy."
- "Less focus on use and more on sources and generation."
- "Current production projects do not have a good rationale. Less fossil, less conventional projects."
- "Question role of government in reformer work."
- "ICE should not be developed with Hydrogen Program funds. Industry knows how to do it."

Long/Short Term and Renewable/Non-Renewable

(Since these questions are closely related, they are considered together. A split in opinion between renewable/long-term and non-renewable/short-term seems to follow non-industry versus industry lines, respectively. These competing interests are perhaps reflected in one of the comments: "2/3 of the Hydrogen Program is corporate welfare.")

- "Long range research is short changed."

- "More emphasis is needed on longer term and renewables."
- "Too near term focus — may not allow truly innovative systems to be discovered."
- "Some short-term tasks should not be funded."
- "Should be renewable hydrogen. That's the rationale that distinguishes this program, unless carbon sequestration is possible."
- "Focus on renewable hydrogen. Shortsighted to go to fossil."
- "Seems to be very little emphasis on renewable production of hydrogen with the Hydrogen Program, in spite of the fact that it's the Program's avowed goal."
- "Since hydrogen ultimately requires renewables to make economic sense and industry can make many near-term gains in non-renewables, DOE should increase emphasis on renewable production and industry should bear a greater burden for non-renewable production."
- "Clearly, the focus of core R&D is renewable, while non-renewable leads in pre commercial demonstrations."
- "More emphasis on shorter-term, focused programs."
- "Much too long term. Should shift to shorter term."
- "Appears too one-sided to renewable energy."

IV. **Commercialization of Hydrogen Energy Systems**

A. Statistical Results

Question / Rating	*Good*	*Accep*	Poor	Score
H_2Prog's encouragement of commercialization	27%	41%	32%	2.90
Utility commercialization prospects?	33	28	38	2.87
H2vehicle commercialization prospects?	51	28	21	3.60
Average scare				*3.12*

The ratings suggest that the Hydrogen Program is doing a reasonably acceptable job of encouraging commercialization. The ratings show more optimism for the prospects of commercialization of hydrogen for vehicles than for utilities.

B. Comments

The comments below are organized by 1) the Hydrogen Program's efforts to encourage commercialization, 2) utility and vehicle commercialization prospects, and 3) responses to the question: "What other areas might be good commercialization prospects?"

The Hydrogen Program's Efforts to Encourage Commercialization

(Some comments continue to reflect differing opinions on validation/demonstration, since it is closely associated with commercialization. Many of the comments are by way of offering advice to the Hydrogen Program.)

- "The Hydrogen Program is doing as much as funding will allow. Making a lot of progress."
- "The Hydrogen Program's efforts to encourage commercialization are good for the amount of money the program has to work with. But need more money for a stronger commercialization push."
- "Some good things going on, but not on a strategic level that will actually make commercialization happen."
- "Suggest focused, prioritized effort to bring hydrogen into service. Near-term needs are for effective low-cost hydrogen storage.
- "Need to support program with defined commercialization path. Use $ to accelerate the programs."
- "This is a difficult area. I sense that, in general, industry does not take hydrogen very seriously or very near term. However, recent interest in fuel cell vehicles may help.
- "Cost share drives people away from government projects."
- "Niches could be penetrated, but will take a long time to implement on a massive scale. Should avoid the perversity of niche applications that might distort markets and delay the real massive use of hydrogen systems."
- "I question the cluster/corridor concept. Has any other technology been introduced into society by a similar approach — i.e. forcing demand-supply match at government cost?"
- "For both stationary and transportation applications, the creation of infrastructure will naturally, economically, and logically follow from good program planning and development of production, storage, and utilization technologies."
- "Focus is wrong. Should not be doing natural gas."
- "It is premature to commercialize."
- "Demonstration and commercialization is premature. The research should be done first. DOE makes this mistake over and over again."
- "DOE is emphasizing commercialization at the expense of R&D. Poor commercialization projects will cause more problems than they will solve."

- "Commercialization by the Hydrogen Program is like putting the cart before the horse. Jumping the gun. Don't know what hydrogen technology will be used. Therefore the Hydrogen Program is doing too much."
- "Need more emphasis on R&D to get past the barriers."
- "Commercialization should be done by industry."
- "NHA's commercialization plan is unique. Nothing comparable in other countries

Commercialization Prospects for Vehicles and Distributed Utility Systems

- "Good prospects for hydrogen fleet vehicles. Poor for personal vehicles."
- "The outcome of the debate on onboard versus stationary reformers will determine the future of the hydrogen vehicle."
- "Prospects for hydrogen vehicles are poor because of inadequate storage onboard."
- "Prospects for commercialization of vehicles and distributed utility hydrogen systems are poor because competition will beat hydrogen to the market — e.g. microturbines, battery electric vehicles, clean diesel."
- "Distributed utility systems prospects are poor because there are no distributed supply systems for hydrogen."
- "Prospects for distributed utility systems are poor because hydrogen is unable to compete with natural gas for the foreseeable future."
- "Commercialization of hydrogen has a long-term future, not short-term niches — e.g. mining vehicle are not compelling enough."

Other Areas for Commercialization Prospects

- "Remote village power systems. Off-grid renewables."
- "Hydrogen gen sets and export markets. (PEM fuel cells still need to become more effective.)"
- "Mining vehicles. Locomotives."
- "Marine portable power. Low power."
- "Small portable power for fuel cells using hydrogen."
- "Nice fuel cell program in military sectors — e.g. Ball Aerospace for stationary and portable power. Could have synergism with the Hydrogen Program."
- "Hydrogen for aviation."

- "Biomass to electricity via electro-farming."
- "Hydrogen combustion-based consumer projects — e.g. lawn mowers, barbecues, etc."
- "Integration with large energy-plex plants — power/chemical co-production."
- "Vision 21 will have a distributed generator module that could encompass hydrogen-related R&D."
- "The chemical and refinery market."
- "Hydrogen as a reducing agent for iron/steel making."
- "Methanol is another fuel that could be explored as a carrier for hydrogen."

V. Coordination and Partnering

A. Statistical Results

Question / Rating	Good	Accep	Poor	Score
Within EERE?	21%	42%	36%	2.67
With other DOE offices?	9	30	61	1.96
With other Federal agencies?	5	42	53	2.04
With foreign governments?	29	43	29	3.03
With state and local governments?	8	54	38	2.40
With industry?	36	39	24	3.21
With industry through the NHA?	50	44	6	3.88
Average score				2.74

The low overall score in this area suggests that, as with the area of program balance, the respondents are generally dissatisfied with the quality of coordination efforts. Coordination with other DOE offices outside EERE, with other Federal agencies, and with state entities received particularly low scores. Higher scores went to coordination with foreign governments (probably as a result of IEA activities) and to coordination with industry. Most positive was the response regarding coordination with industry through the NHA.

The sort by industry respondents had an even lower overall score of 2.40. The industry respondent score for coordination with foreign governments was much lower than for the general population — 2.00 vs. 3.03 — suggesting that industry sees less value in the IEA activities (as reflected in some individual comments below). Industry respondents also scored industry coordination lower — 2.25 versus 3.21 — indicating that from industry's perspective industry coordination is not so good.

The sort by respondents very familiar with the Hydrogen Program showed even lower scores than the general population for the other DOE and other Federal agencies questions.

B. Comments

Coordination/Partnering within DOE and with Other Federal Agencies

- "OUT and OTT are collaborating more and moving in the right direction."
- "Coordination within EERE is now good. Was poor before."
- "Good coordination within EERE. But no strategy for coordination with other parts of DOE and other parts of government -- just optics."
- "Current program suffers from lack of real cooperative development between OTT fuel cells and OUT."
- "Give higher priority to interdepartmental and interoffice cooperative programs. Without such interaction the program appears to lack focus."
- "Establish stronger linkages between the Hydrogen Program and Fossil Energy."
- "Current coordination between FE and EERE is so weak that for FE to become aware of the Hydrogen Program it would have to be via a personal avocation."
- "Need a program with FE to focus on generation of hydrogen from coal. FE has the required core competencies in process design and chemical transformations."
- "Coordination within DOE not done in a way all programs benefit. Done in an adversarial way."
- "Coordination is poor because chemistry isn't good between groups, although they do attempt to coordinate."
- I do not see much fruitful interaction between the Hydrogen Program and other parts of the Federal government."
- "Could have synergies with DOD stationary and portable power fuel cell program."
- "Leverage opportunities with DOD, NIST. Coordinate with, and inspire and compel, NSF."
- "Not enough cross-fertilization between DOE and NASA."
- "Need better coordination between the Hydrogen Program and the national labs."

International Coordination and Partnering

- "Excellent support of lEA should continue."
- IEA implementation agreement working very well to keep up communication and international cooperative R&D."

- "Do not know what IEA activities leads do. Do not know how effective IEA activities are."
- "Don't see anything collaborative coming out of the Hydrogen Program's IEA activities."
- "International coordination seems to be an exchange of paper and travel. But don't see any meaningful programs."
- "There seems to be very little interconnection between national programs
- "Need more partnering efforts with foreign governments. Opportunities in emerging markets to advocate new technologies before they invest in fossil energy."
- "Technology validation could partner with other money from other governments."
- "Industry is setting the example of partnering — e.g. Ballard/Daimler Benz/Ford — but don't see similar results with governments. For example, the Euro Quebec Hydro Hydrogen project is fading out as an indication of lack of international cooperation."

Coordination and Partnering with State and Local Governments

- "The DOE-Nevada collaboration seems a hopeful example of DOE-state collaboration. Are there others?"
- "Did well in Palm Desert."
- "Could have more state government interaction.'
- "SCAQMD's programs are not related to DOE programs. Need greater collaboration in the future. Should be part of DOE's planning process a year ahead of time."
- "Many state energy offices are capable of forming coalitions to perform tasks currently performed within DOE and national labs in a more cost effective manner."
- "HTAP should be used to help in facilitating coordination, especially with local institutions."

Coordination and Partnering with Industry/NH

- "The relationship with industry is strong."
- "Industry is interested, but they are not beating down the doors to get the product, since they have alternative sources/means."
- "Don't see many industry people at the Hydrogen Program meetings. except for companies like Air Products and Praxair."

- "Need the involvement of the petroleum companies, car companies, stationary power companies."
- "The relationship with industry is too good!"
- "Caring too much about industry. Big company-small R&D funding may not be helpful in the long run."
- "Would like to see the NHA not depend so much on government. Would be stronger advocate and be more effective."

VI. Outreach and Communication

A. Statistical Results

Question / Rating	*Good*	*Accept*	*Poor*	*Score*
In safety and codes & standards?	*68%*	*29%*	*3%*	*4.30*
In public outreach?	32	29	38	2.85
With industry?	33	52	15	3.36
At high government levels (DOE, Congress)?	14	45	41	2.46
Average score				*3.24*

The question of safety and codes & standards (which some may argue doesn't really fit under outreach and communications) received a high score — the feeling being that this issue is getting addressed. Industry, however, is somewhat less sanguine, with an industry sort score of *3.92.*

The other three questions scored lower, especially the public and high-government level questions. The total population showed higher satisfaction with industry outreach than did the industry respondents — *3.36* versus *2.84.*

Comments

Safety and Codes & Standards

- "Good job working on codes & standards with the NHA."
- "Without US presence other countries would not take ISO seriously. US participation in ISO is important."
- "DOE Hydrogen Program management and HTAP have very appropriately characterized and treated safety."
- "There are no Federal regulations addressing hydrogen as a fuel. Thus the safety issues are not addressed."

Public and Industrv Outreach

- "Not much headway made in industry and schools from what I can see."
- "More effort should be made to reach public school and university students — especially science and engineering students, the hydrogen technologists of tomorrow.
- "Haven't seen any results from the CD ROM package."
- "DOE not effective in public outreach. If believe it, educate children."
- "The Renaissance Project is a good example of public outreach. Need more."
- "Public outreach is not critical at this stage."
- "If you don't have hardware to sell, why advocate? To get public acceptance, public needs to want to have 'neat new system'."
- "Need creative outreach to environmental organizations to show how hydrogen can achieve becoming a non-polluting energy source — e.g. facilitating dissemination of R&D results, face-to-face meetings with environmental groups."
- "The Word Wide Web Hydrogen Infonet site should be an excellent outreach/communication method. However, it is seldom up-to-date."
- "Improve web page (disappointed). Establish a chat room."
- "The past industry outreach project was well conducted, but don't see any obvious results from that effort."
- "After extensive search with friends at Chevron, we have all concluded that no one is aware at Chevron of the DOE Hydrogen Program."
- "Aware [at Shell] that DOE is doing something in the area, but don't know what. Would like to be more aware."
- "Should hire a powerful, influential public relations agency. A bunch of press releases, CD ROMS and web sites won't do it."

Outreach Communications at High Levels in the Federal Government

- "People at high government level are not generally aware of the Hydrogen Program. Doesn't have same visibility as other programs."
- "The $C0_2$ awareness had helped hydrogen."
- "Communications at high levels of DOE could be better."

- "Hydrogen is the most compelling technology at DOE, yet its promotion is the worst at DOE!"
- "Situation at high DOE levels has improved with the involvement of the new Assistant Secretary of EERE."
- "Congress is not as much a supporter as in the past."
- "DOE does not have a vision of which to explain the program to Congress.
- "Priority for Administration and Congress is clarifying near-term strategy for hydrogen that is economically viable. Make hydrogen seem like a near-term prospect, not merely a long-term hope."
- "Need better coordination with the Appropriation Committee."
- "Reach political people — Senate and House."

VII. Hydrogen Budgets and Legislation

A. Statistical Results

Question	*Yes*	*No*
Are requested and authorized H_2Program and other DOE H_2expenditures adequate?	41%	59%

The sorts by industry and by Very Familiar showed no significant from this approximately *40:60* split in opinion on adequacy of expenditures. Based on numerous comments, it is virtually unanimous among the respondents that budget requests at least be made at the authorized level. No one suggested that expenditures should be lower than they have been.

B. Comments

- "The *1999* request is acceptable. Past appropriations were poor."
- "Budget is adequate for current project portfolio. Need better projects to justify increase."
- "The budget should not be increased until specific focus and thrusts are clearly delineated."
- "Budget is adequate, but must be spent well in order to justify any increases. Must answer critical question — a well planned and thought out success plan for commercialization."
- "The budget should grow slowly and consistently. Budget should not grow too fast."

- "The need for large $, commercial programs, is not yet upon us. At the current stage the level is adequate for the technology program — if spent correctly."
- "The absolute number is low but the gradient is reasonable."
- "in general, budgets for hydrogen and fuel cells are nowhere near the benefits to society compared with other programs in DOE."
- "Too much is being spent in coal and nuclear areas."
- "The national commitments being made off-shore indicate the US needs to aggressively increase its funding for hydrogen, to remain a primary player in this most probable universal fuel."
- "It's an immense job to prepare the country for hydrogen. Yet hydrogen gets a pittance compared to other energy technologies."
- "Need more like $100 million. Money to hydrogen economy will solve 80-90% of air quality problems, and reduce national dependence on foreign fuel sources."
- "There needs to be stable adequate funding for hydrogen activities, and full disclosure on how program funds are used."
- "I suggest a full dollar-by-dollar public accounting of how program funds are spent. Not categories. Names and dollars."
- "Remove earmarked funds from the Hydrogen Program budget."
- "Some increase in funds should go to hire more DOE personnel. Also would require more oversight and peer review to ensure monies are spent effectively."
- "If had larger budget could do real hardware programs."
- "Outcomes of more $: 1) Better balance among core R&D/validation/assessment, and 2) Attract serious attention from industry."
- "Outcomes of more $: 1) Accelerate high quality RD&D, 2) Early commercialization of hydrogen technologies, and 3) Impact on global climate change."
- "All of us in the hydrogen community should go to bat with members of Congress for larger budgets — but we need department support for our efforts."

Suggestions for Additional Legislation

- "The Hydrogen Future Act is enough for now. Follow it and the market will develop without the need for new legislation."
- "Reauthorize the Hydrogen Future Act beyond 2001."
- "Guidelines for developing legislative strategies should be developed first."

"Recommend technology legislation in remote village and biomass areas."

"Dangerous to have hydrogen-specific legislation. HTAP should recommend legislation encouraging alternative fuel development, including hydrogen, based on energy and environmental performance."

"Legislation focused on hydrogen competitiveness — incentives, tax breaks, rebates."

"Exempt hydrogen from fuel taxes in early years."

"California ZEV legislation has driven good products to market."

"Legislation should forbid money to be spent on gasoline fuel cell vehicle program."

"Create a separate Office of Hydrogen Energy."

"A national initiative to eliminate the infrastructure problem. Hydrogen is a choice, not an inevitability."

"Form and interagency board with funds to put resources into hydrogen to educate and force cooperation among the various Federal agencies."

VIII. Major Hydrogen Energy Issues

A. Statistical Results

Issue	High	Med	Low	Score	Rank	Indus	VF
Production cost --fossil	28%	35%	37%	2.82	11	4	11
Production cost -- renew.	74	21	5	4.38	1	3	1
Storage	70	23	7	4.26	2	1	3
Mkt. readiness --vehicles	44	37	19	3.50	6	10	5
Mkt. readiness -- stationary	28	56	16	3.24	10	8	6
Industry participation	38	40	21	3.31	9	6	9
Infrastructure	53	26	21	3.64	4	5	10
Codes & stds./insurance	38	40	21	3.31	9	9	8
Competing tech./fuels	63	33	5	4.19	3	2	2
Federal RD&D budgets	47	35	19	3.59	5	10	2
Low visibility	40	37	23	3.34	8	11	4
Public perception	44	30	26	3.36	7	7	7

Respondents were asked to rate 12 issues affecting hydrogen by High, Medium or Low. The table presents the ratings by percentages and scores for the entire respondent population. The issues are then numerically ranked, with the most important first — again for the entire population. For comparison, the final two columns list the rankings for the sorts by industry and Very Familiar (VF).

The issues of highest importance to the general population were, in order of ranking, cost of producing hydrogen from renewable energy, hydrogen storage, competing non-hydrogen technologies and fuels, hydrogen supply infrastructure, and low Federal RD&D budgets. Ranked lowest (and the only issue to score below 3) was the cost of producing hydrogen from fossil fuels.

Industry respondents agreed with the general population that the issues of hydrogen cost from renewable energy, storage, and competing technologies/fuels are the top three issues. However, they ranked the cost of producing hydrogen from fossil fuels much higher — 4 versus 11 for both the total and Very Familiar populations. The industry respondents ranked the importance of industry participation somewhat higher than did the total and Very Familiar populations — 6 versus 9. They ranked the issue of low Federal RD&D budgets much lower — 10 versus 5 for total, and 2 for Very Familiar populations, respectively.

The Very Familiar population rated the importance of visibility higher and infrastructure lower than did both the general and industry populations.

B. Comments

Most of the comments made in the Major Issues section reflect the statistical results, and are therefore not stated here. Comments that expressed additional thoughts included:

- "Societal costs are not included in the cost of conventional fuels."
- "The cost of hydrogen production from renewable energy is of low importance because the time frame when its needed is very far into the future. There is time to develop renewable hydrogen."
- "Hydrogen has no advantage in vehicular and stationary power applications."
- "Visibility is getting better due to fuel cells."
- "Visibility is improving, but it's not as high as other renewable energy sources.
- "An additional issue is government and industry bureaucracy."
- "An additional issue is lobbying for oil against renewables."

ix. Additional Comments

Finally, some additional comments made by respondents are as follows:

- "Hydrogen is a simple molecule, but a hydrogen-based economy is a very complex system... that needs to be installed."
- "Need more dedication among the R&D implementers. Too many feel it's just a job. Needs 'messianic fever'."

- "If we don't do it soon, other countries will. US will be a follower, not a leader."
- "Prove first that hydrogen works safely and economically, and then public will buy into it."
- "Air pollution rationale is no longer valid. Natural gas cars can reach same low emissions. Single justifying rationale is global warming."
- "Hydrogen should set up its own race, like Sunrayce, for hydrogen cars."
- "Previous technology exists that could be improved upon — e.g. liquid hydrogen.
- "The program needs to focus on development of low-cost hydrogen compressors stationary and vehicle applications."
- "'Taxation' and political diversion of funds for irrelevant projects must be fully disclosed so that actions can be taken to minimize the damage."
- I am grateful to HTAP for instituting this survey and for its efforts to improve the Hydrogen Program."

"Survey is a good effort."

HTAP TELEPHONE QUESTIONNAIRE

HTAP Interviewer:
Person Contacted:
Date of Contact:

Introduction

The new Hydrogen Future Act requires the DOE Hydrogen Technology Advisory Panel (HTAP) to report to Congress on the effectiveness of the DOE hydrogen program and to recommend any improvements.

As part of HTAP's effort to gather information and viewpoints for our report to Congress, we are conducting telephone interviews with individuals in industry, research, and government who are either: 1) currently involved in hydrogen energy, or 2) currently involved in areas that could be impacted by hydrogen energy in the future.

We plan to compile and analyze the interview results so that responses are aggregated, and the names of the individual respondents are not disclosed.

We hope you can take some time to express your opinions and ideas on DOE's hydrogen program -- by responding to the following questions. Your input will be very valuable. Is this a convenient time for you to be interviewed?

(The interview may require 30-45 minutes for those respondents who are very familiar with the hydrogen program.)

1. Personal Data

Organization and position title:

- Affiliation: Industry University Government Non-profit Other (Specify)
- How are you personally involved in hydrogen energy?
- How familiar are you with the DOE hydrogen program? Very Somewhat Not Much

(The questionnaire is designed to be answered completel by respondents who are fairly familiar with the hydrogen program. Forthose who are less familiar, HTAP interviewers can confine theirinterviews torelevant parts of the questionnaire. Interviewers should also feel free to expand on question areas that closely relate to a respondent's area of expertise — e.g. safety, environmental).

HTAP TELEPHONE QUESTIONNAIRE

2. Project Execution (For principal- investigators and technical managers currently engaged in execubbn
of DOE hydrogen program projects. Otherwise, skip to Question 3.)

Please rate the quality of each item below in terms of Good (No significant improvement needed), ?~cceptable
(OK, but could use some improvement), or Poor (Substantial improvement needed), or No response.

0

Quality of DOE program management with respect to your project(s)
(support, responsiveness, contract administration, etc.)? **(Circle One)**
Continuity of project funding?
Extent of your understanding of how your project(s) fits into the big picture in terms of the overall vision, missions, and goals of the hydrogen program?
Adequacy to which commercialization is being pursued on your project(s) and technology area?
Adequacy of collaboration on your project(s)?

G A P N

G A P N
G A P N

G A P N

G A P N

Would you care to elaborate upon any of your ratings, or comment further on project execution? (Elaboration is especially desirable for Good and Poor ratings.)

3.

DOE Program Management
Hydrogen energy-related activities are taking place throughout DOE: 1) in the hydrogen program within
the Office of Utility Technologies, 2) in the Office of Energy Efficiency and Renewable Energy which
includes the Offices of Utility, Transportation, Building, and Industrial Technologies, and 3) in other parts
of DOE such as the Offices of Fossil Energy and Energy Research.

Please rate the quality of each item below in terms of Good (No significant improvement needed),
Acceptable (OK, but could use some improvement), or Poor (Substantial improvement needed), or No
response.

The hydrogen program within the Office of Utility Technologies? **(Circle One)**
Hydrogen-related activities within other offices of the Office of Energy Efficiency and Renewable Energy (e.g. PEM fuel cells)?
DOE as a whole (i.e. hydrogen energy-related activities throughout DOE)?
The national labs?
The Hydrogen Technology Advisory Panel (HTAP)?
Other DOE entities?

G A P N
G A P N

G A P N
G A P N
G A P N
G A P N

Would you care to elaborate upon any of your ratings, or comment further on DOE program management? (Elaboration is especially desirable for Good and Poor ratings.)

4. Balance of Elements within the Hydrogen Program

The hydrogen program within the Office of Utility Technologies can be divided up into several categories:
1) Core R&D/Validation/Systems Analysis, 2) The Core R&D category is further divided into Prod uction/Storage/Util ization, 3) Long-term/Short-term, and 4) Renewable/Non-renewable. To the extent
that you are familiar with these categories, we ask you to rate the degree of proper balance among these
categories, and suggest how any imbalances can be rectified.

Please rate program balance, again using the ratings of Good, Acceptable, or Poor.

Balance among Core R&D/Validation/Systems Analysis?
("Validation" refers to pre-commercial demonstrations.)
Balance within Core R&D among Prod uction/Storage/Util ization ?
Balance between long-term and short-term?
Balance between renewables and non-renewables?

Would you care to elaborate upon any of your ratings, or comment further on program balance?

5. Commercialization of Hydrogen Energy Systems

G A P N

G A P N
G A P N
G A P N

The stated goal of the hydrogen program's validation effort is to "Support industry in the development and
demonstration of hydrogen systems in the utility and transportation sectors." Primarily through solicitations
to industry for cost-shared projects, the hydrogen program is pursuing validation projects in: 1 distributed/renewable energy-based utility systems, 2) development of a hydrogen infrastructure for
vehicle refueling (the clean cluster and corridor program), and 3) through other early commercialization
opportunities identified by industry.

How do you rate the hydrogen program's efforts to encourage
commercialization of hydrogen energy systems by industry?
In your opinion, what are the prospects for successful commercialization
of hydrogen energy for distributed utility systems?
For hydrogen-fueled vehicles?
What other areas might be good commercialization prospects?
Would you care to elaborate upon any of your ratings, or comment further on demonstration and commercialization?

G A P N

G A P N

G A P N

6. Coordination and Partnering

The hydrogen program is responsible for coordinating hydrogen-energy related activities within DOE, between DOE and other federal agencies (e.g. EPA, DOD, NASA, Commerce-NIST), and with other governments (foreign, state, local). It is further encouraged to develop partnerships with these government entities, as well as partnerships with industry.

Please rate the quality of the hydrogen program's coordination and partnering efforts.

Within the Office of Energy Efficiency and Renewable Energy (i.e. Transportation, Buildings, Biomass, Industrial Technologies)? G A P N
With other DOE offices (e.g. Fossil Energy, Energy Research)? G A P N
With other federal agencies? G A P N
With foreign governments? G A P N
With state and local governments? G A P N
With industry in general? G A P N
With industry through the National Hydrogen Association? G A P N

Would you care to elaborate upon any of your ratings, or comment further on coordination and partnering?

7. Outreach and Communication

The hydrogen program strives to raise the visibility of hydrogen energy through its outreach and communication, which consists of several components; For example: 1) Support for hydrogen codes and standards development, 2) Development of educational materials, 3) Technical, promotional, and planning publications, 4) the World Wide Web, 5) HTAP public meetings and 6) participation of outside experts from industry and academia in annual peer reviews of core R&D projects.

Please rate the quality of the hydrogen program's outreach and communications efforts.

- In safety and codes & standards? G A P N
- In public outreach (including the public schools)? G A P N
- With industry? G A P N
- At high levels in the federal government (DOE, the Administration, Congress)? G A P N

Would you care to elaborate upon any of your ratings, or comment further on outreach and communication?

HTAP TELEPHONE QUESTIONNAIRE

8. Hydrogen Budgets and Legislation

DOE's 1999 budget request of $24 million for the hydrogen program is a substantial percentage increase over the $16 million for 1998 -- although it still falls short of the $30 million authorized by the Hydrogen Future Act. (The Hydrogen Future Act calls for $105 million for the hydrogen program over fiscal years 1999, 2000, and 2001.) Hydrogen-related activities in other parts of DOE account for additional FY 99 requests of over $80 million.

Are requested and authorized hydrogen program and other DOE hydrogen expenditures adequate? (Yes or No?)

Y N

If not, what budget changes do you suggest? And what outcomes might result from the budget changes?

The Hydrogen Future Act requests that HTAP, in its recommendations to Congress, include recommendations for additional legislation.
What, if any, additional legislation for hydrogen energy would you suggest?

Major Hydrogen Energy Issues

Numerous needs and barriers confront the successful implementation of hydrogen energy systems.
Several are listed below. Please rank the importance of each in terms of High, Medium, and Low. Feel free to add issues not on the list.

Cost of production from fossil energy sources?
Cost of production from renewable energy sources?
Lack of low-cost, attractive storage technologies?
Market readiness of potential applications vehicles?
Market readiness of potential applications stationary power?
Industry participation?
Inadequate hydrogen supply infrastructure?
Inadequate codes and standards/Lack of reasonable insurance coverage?
Competing non-hydrogen technologies and/or fuels?
Inadequate federal RD&D budgets?
Low visibility?
Negative public perception of hydrogen?
Other?
Other?

Further comments on major issues? For example, what do you feel are the most important one or two issues
that need to be addressed?

10. Other Comments and Suggestions?

(Use separate page or back of this page.)