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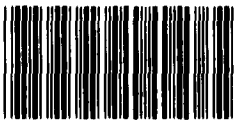

The Honorable Harley O. Staggers
Chairman, Committee on Interstate and Foreign Commerce
House of Representatives

HSE02300

Dear Mr. Chairman:

Subject: Views on the proposed "Hydrogen Fuel Development and Use Act of 1979" (EMD-80-B3)

In a letter dated October 10, 1979, you requested the General Accounting Office (GAO) to report on H.R. 5399--"The Hydrogen Fuel Development and Use Act of 1979." As you know, the bill would create a comprehensive goal-oriented hydrogen research, development, and demonstration program managed by Department of Energy (DOE), and also amend the Internal Revenue Code to provide financial incentives to encourage the production and use of hydrogen fuel. In response to your request and discussions with your office, we reviewed the bill from the standpoint of our past work, hydrogen's potential for greater use, and current federally funded hydrogen research and development activities.

In general, although we believe research and development on hydrogen fuels and associated energy systems should be pursued, we have some reservations that passage of this bill, at this time, may place undue emphasis on developing hydrogen fuels as a major source of energy. In view of hydrogen's uncertain potential as a fuel, we are particularly concerned that the bill mandates a number of specific commercial demonstrations by January 1, 1985, and provides widespread financial incentives for encouraging the production and use of hydrogen. Mandating such demonstrations, in our view, would tend to set them apart from the normal budgetary review procedures and lock DOE into specific commercial demonstrations. Some of these may not be very appropriate in the 1985 time frame.

Our concern in regard to the incentives, as proposed in the bill, is that little or no restrictions are placed on (1) the type of primary energy source used to produce hydrogen and/or (2) what systems or facilities would qualify for

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Government support. Such incentives could conceivably be used by industries that produce hydrogen from natural gas or oil and/or encourage the use of technologies which are not technically sound.

Finally, if the Congress decides such legislation is warranted, we have included in this letter suggested language authorizing GAO access to records.

PERSPECTIVE ON HYDROGEN'S POTENTIAL FOR GREATER USE

Hydrogen is the most abundant element on Earth and is envisioned by some as the fuel of the future. Presently, hydrogen is already being used, although to a very limited extent, as an energy source. It is much more commonly used, however, as a chemical in a variety of industrial processes.

An important aspect about hydrogen is that it is practically nonexistent in its free state and must be produced using some primary energy source such as coal or natural gas. Thus, hydrogen is similar to electricity or synthetic fuels, which also must be produced from a primary energy source. This is important because, in the long run, the pros and cons of using hydrogen as a fuel must be weighed not only against energy sources such as electricity or synthetic fuels but also against using the primary energy source directly as opposed to using it to produce hydrogen. Such comparisons could significantly lower hydrogen's overall potential as a fuel.

Hydrogen's use as a fuel

Over the last decade, as the Nation's energy problems have grown increasingly worse, the concept of using hydrogen as a fuel has been explored and reported on in a number of studies. These studies have examined the near-term energy applications of hydrogen as well as the hypothetical "all hydrogen economy." From this work the advantages of, and constraints to, achieving greater use of hydrogen fuel have become fairly well understood. 1/

1/Additional information on hydrogen can be found in "The Hydrogen Economy: A Preliminary Technology Assessment," by Stanford Research Institute, dated February 1976, and a GAO staff study entitled "The Potential For Hydrogen As An Energy Source" (EMD-79-58, Apr. 20, 1979).

Hydrogen, as a fuel, has a number of attractive features. Although practically nonexistent in its free state, hydrogen is quite abundant in chemical compounds such as water and can be produced from almost any primary energy source by known processes. 1/ Once produced, it is clean burning and has a wide variety of possible end uses. For example, it can be burned by utilities to generate electricity or piped directly to industries and homes to meet their heating needs. Studies and experiments have also shown hydrogen to be an attractive transportation fuel for trains, ships, aircraft, and automobiles.

As appealing as hydrogen fuel might seem, it also has some constraints which severely limit its widespread use. One of the foremost constraints is economics. Presently, most hydrogen is produced from natural gas (the cheapest source of hydrogen). Because of the production cost and loss of energy involved in such production, the resulting hydrogen, on a dollar per unit of energy basis, is about two to five times more expensive than natural gas. These costs have greatly limited hydrogen's use as a fuel. Small amounts of hydrogen are also being produced from electricity (electrolysis). However, the resultant hydrogen produced by this process is more expensive than the cost of hydrogen produced from natural gas.

Another significant constraint facing hydrogen's greater use is the changes that would be necessary to handle and distribute large quantities of hydrogen nationwide. Small quantities of hydrogen are now transported in insulated high-pressure cylinders and in pipelines mixed with natural gas. If serious attention is given to using hydrogen to any great extent as a fuel, new and improved ways of handling and distributing hydrogen must be developed. This could be expensive and time consuming to implement. Furthermore, some changes would be necessary in the way this energy is used. For example, in the transportation sector significant modifications to automobiles and aircraft would be necessary to accommodate hydrogen fuel.

Finally, as with any new emerging technology, socio-political and institutional constraints could hinder the use

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1/These processes include steam-reformation using natural gas, producing hydrogen from coal, and electrolysis, which uses electricity to separate water into hydrogen and oxygen.

of hydrogen fuel. Some of the constraints that would need to be addressed relate to potential safety problems with hydrogen, relocating industries near hydrogen-production facilities, and new building codes for those buildings which use hydrogen fuel.

Hydrogen's use as a chemical

Although hydrogen's use as a fuel is very limited, hydrogen is widely used already as a chemical in a variety of industrial applications. About 5 million tons of hydrogen are being domestically produced annually. 1/ Most of this is used to produce ammonia or methanol, and to refine petroleum. Over the next 10 years, the use of hydrogen in industrial processes is expected to increase significantly. Hydrogen's use as a chemical, therefore, will probably, to some extent, be competing with any efforts to use hydrogen as a fuel.

Future role of hydrogen

To what extent hydrogen can be used as an energy source in the future is very uncertain. Not only will the future role of hydrogen as a fuel depend on how attractive it is versus conventional fuels but also on how it competes against other new alternative fuels. These new alternative fuels include a wide variety of gaseous and liquid fuels that can be produced from coal, oil shale, tar sands, peat, biomass, and solid wastes. At the present time, hydrogen might be less attractive than some of these alternative fuels not necessarily because of economics but because some of these fuels may be more compatible with present energy distribution methods and end-use applications. In the long run, the eventual adoption of hydrogen as a major energy source will most likely depend on the development of renewable-type technologies, such as solar, and advances in ways of producing hydrogen, such as by advanced electrolysis.

In any event, hydrogen will probably continue to be used extensively as a chemical and, in its production, consume large quantities of natural gas. It will also be used to some extent as a fuel. Most likely, over the next decade or so its use as a fuel will be limited to special situations. For example, hydrogen could be used as a transportation fuel in places with severe pollution problems.

1/Most of this hydrogen is produced from natural gas and oil.

FEDERALLY FUNDED HYDROGEN RESEARCH AND DEVELOPMENT ACTIVITIES

In order to understand more about the practical use of hydrogen as a possible fuel as well as explore ways of lessening the Nation's dependence on natural gas as a feedstock for hydrogen, the Federal Government has, for a number of years, funded research on hydrogen under various energy program areas. For example, ways of producing hydrogen from coal are being considered in DOE's fossil programs, while using hydrogen to store energy is being examined within DOE's energy storage program.

To coordinate all hydrogen research activities and ensure the optimum use of existing expertise in the field, a Hydrogen Coordinating Committee was established in June 1975 within the former Energy Research and Development Administration. This Committee has continued under DOE.

According to information supplied by the Committee, hydrogen research activities within DOE are being carried out in 10 different program areas which, over the last 3 years, averaged about $27 million. The following table shows the Committee's estimate, as of January 1980, for DOE funding of hydrogen research and development.

ESTIMATES OF DOE FUNDING FOR
HYDROGEN RESEARCH BY PROGRAM AREA

Program Area	Amount (millions) FY 77	FY 78	FY 79
Fossil energy programs	$ 9.4	$ 1.5	$ 1.5
Basic energy sciences	7.2	9.3	10.7
Military applications	1.7	1.8	1.7
Energy storage systems	4.5	6.3	6.3
Laser fusion	0.6	1.0	0.6
Magnetic fusion	0.0	0.7	0.7
Solar energy	0.4	0.3	1.1
Transportation programs	0.2	0.2	0.2
Environmental control technology	0.1	0.1	0.0
Nuclear power development (note a)	0.0	5.3	8.2
	$24.1	$26.5	$31.0

a/Reflects funding for process heat applications of high temperature gas reactors which include producing hydrogen as an option.

These funds are being used on developing ways of producing hydrogen such as advanced electrolysis, exploring ways of storing hydrogen, basic research, examining hydrogen's potential use in the transportation sector, studying various safety aspects of hydrogen, and examining effective ways of transporting hydrogen.

In addition, other research and development programs funded by DOE indirectly relate to hydrogen's development. For example, DOE is spending hundreds of millions of dollars each year on developing renewable energy resources which, if successful, could provide an economical source of energy to produce hydrogen.

COMMENTS ON H.R. 5399

The bill H.R. 5399--"Hydrogen Fuel Development and Use Act of 1979"--would create a research, development, and demonstration program within DOE, and also amend the Internal Revenue Code to provide financial incentives to encourage the production and use of hydrogen fuel. Such a program and associated incentives would represent a major commitment by the Nation to develop hydrogen as a major energy source.

Considering our past work, DOE's current efforts, and hydrogen's uncertain potential as an energy source, we are concerned that such a program with associated incentives may place undue emphasis on developing hydrogen fuel as a major source of energy.

Mandated commercial demonstrations of hydrogen-related technologies may be inappropriate

Title I of H.R. 5399 sets forth a comprehensive goal-oriented hydrogen fuel research, development, and demonstration program. The program would be established by the Secretary of Energy no later than 60 days after the bill's enactment.

One of the most significant and costly features of the bill is that it mandates demonstrations of commercial uses of hydrogen-related technologies. In this regard, the bill would mandate, by January 1, 1985, the commercial-scale demonstration of hydrogen production from gasification of coal or residual oils, an ocean thermal energy conversion vessel, electrolysis, and low-head hydroelectric power sources. In addition, the bill would require, by January 1, 1985, the commercial application of hydrogen: (1) mixed with natural gas and distributed in natural gas pipeline systems; (2) as a fuel in rail transportation systems, special vehicles such as fork lifts, and in multipassenger vehicles such as buses; and (3) in fuel cells for vehicular power and power generation. The bill further states a number of other goals for January 1, 1990, such as the conversion of natural gas pipelines for hydrogen distribution.

Although none of the demonstrations set forth in the bill are beyond the Nation's technological capabilities, mandating them would tend to set them apart from the normal congressional budgetary review procedures and lock DOE into specific commercial demonstrations. Some of these may not be appropriate in the 1985 time frame. For example, ocean thermal power systems, once developed, could be used for

many different purposes. Such systems could produce electricity directly to a utility grid, be used in ammonia and/or hydrogen production, and even be used at sea in connection with an industrial plant (e.g., in making aluminum). Current DOE plans only call for a pilot plant by 1985. Only after sufficient data is gathered on the working characteristics of this pilot plant, will a decision be made as how best to use the plant. If feasible, a commercial-scale demonstration will then be built. Mandating, at this time, that a commercial plant be built to produce hydrogen may not be the most useful application of an ocean thermal conversion system. Furthermore, since Federal dollars are limited, such a decision now may foreclose other possibly more worthwhile applications of an ocean thermal conversion plant. The same case could be made against many of the other commercial-scale demonstrations mandated by the bill.

Although not mandated, much of DOE's current work on hydrogen production and use already addresses many of the objectives stated in H.R. 5399. In regard to hydrogen production from coal, although DOE does not have plans to build a commercial-scale hydrogen demonstration plant, DOE is working on a number of coal conversion technologies which can provide useful information concerning the economic and technical feasibility of producing hydrogen from coal. For example, in DOE's coal-gasification program, DOE is completing plans for construction of two large gasification demonstration plants. These plants, according to DOE officials, will among other things, resolve some technical uncertainties and give them a better understanding about the possibilities of producing hydrogen from coal.

Similarly, DOE is sponsoring other work which relates to electrolysis and producing hydrogen from a low-head hydroelectric facility. Within DOE's energy storage program, several technologies for producing hydrogen from water are being explored. One of the program's high priority projects is an advanced electrolyzer. DOE's present plans call for the operation of a 500-kilowatt electrolyzer in fiscal year 1982 and a 5-megawatt version in fiscal year 1984. In addition, a project is being cost-shared with New York State to build a small-scale hydroelectric facility that will produce hydrogen for a nearby industry. The project, according to DOE officials, is scheduled for completion in 1983.

Although not on a priority basis, DOE is supporting research on ways of distributing hydrogen, using it in the transportation sector, and in powering fuel cells. For example, a laboratory test apparatus has been constructed and is being tested with hydrogen and natural gas mixtures to

determine the compatibility of existing pipeline materials with hydrogen.

Overall, DOE's efforts in regard to hydrogen production and use appear to be aimed at formulating a better understanding of hydrogen's usefulness, its technical feasibility, and economic practicality rather than making a definite commitment to make hydrogen a major source of energy. Although it is difficult to judge how much attention hydrogen should receive in the Federal energy budget, the present scope of DOE's ongoing activities appear to be more appropriate in view of hydrogen's uncertain potential as a major source of energy. If the prospects for using hydrogen as a fuel increases significantly over the next few years, DOE could reorder its priorities and give hydrogen more attention in the Federal budget.

Incentives as specified in H.R. 5399 for hydrogen production and use may be too flexible

Title II of H.R. 5399 provides for tax incentives for hydrogen production and for certain equipment which uses hydrogen. These incentives include a 60-month amortization for facilities producing hydrogen, and business and residential tax credits for hydrogen equipment. In applying these incentives, there would appear to be no restrictions regarding the type of primary energy source to be used in producing hydrogen and little if any restrictions on what type of hydrogen technologies would qualify for Government support. Such incentives could conceivably be used by industries that produce hydrogen from natural gas or oil and/or encourage the use of technologies which are not technically sound.

As stated previously, hydrogen can be produced from natural gas, coal, or renewable energy resources. Most hydrogen produced today comes from natural gas. This will probably continue over the next few years, according to DOE officials, because hydrogen production from coal or renewable resources, while technically feasible, is generally more expensive. In addition, since working data on commercial-size facilities for producing hydrogen from coal or renewable energy resources has not yet been demonstrated, industries may be reluctant to invest in such facilities even with substantial Government support. Incentives, therefore, as proposed in H.R. 5399 will probably, to some extent, be used by those industries which produce hydrogen from natural gas.

In our view, any financial incentives for hydrogen production should be aimed at saving relatively scarce fossil fuels--oil and natural gas. Accordingly, we would prefer to see widespread financial incentives withheld until such time that hydrogen can be produced from facilities which are technically sound and do not use oil or natural gas.

Although we believe, in general, that widespread incentives for hydrogen production and use might be premature at this time, we recognize that some hydrogen energy projects may be beneficial in helping solve the Nation's energy problems and enhance DOE's overall energy research and development program. Such projects should be examined on a case-by-case basis. If such projects are determined to be worthwhile, DOE could provide financial support via cost-sharing arrangements, contracts, or grants. Such action would appear more appropriate in light of hydrogen's potential and current DOE energy programs.

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If the Congress decides that this legislation is warranted, we would prefer it contain language, different from that under title I, sec. 107, authorizing the General Accounting Office access to records. Specifically, we prefer to see language such as the following included in the bill.

> "(a) Each recipient of Federal assistance under this Act, pursuant to grants, subgrants, contracts, subcontracts, loans or other arrangements, entered into under other than by formal advertising and which are otherwise authorized by this Act, shall keep such records as the Secretary shall prescribe, including records which fully disclose the amount and disposition by such recipient of the proceeds of such assistance, the total cost of the project or undertaking in connection with which such assistance is given or used, the amount of that portion of the cost of the project or undertaking supplied by other sources, and such other records as will facilitate an effective audit.
>
> "(b) The Secretary and the Comptroller General of the United States, or any of their duly authorized representatives, shall, until the expiration of 3 years after completion of the project or undertaking referred to in subsection (a) of this section, have access for the purpose of audit and examination to any books, documents, papers and records of"

"such recipients which in the opinion of the Secretary or the Comptroller General may be related or pertinent to the grants, contracts, subcontracts, subgrants, loans, or other arrangements referred to in subsection (a)."

Sincerely yours,

Signed Elmer B. Staats

Comptroller General
of the United States