

Critical Needs for the Emergence of a Hydrogen Economy

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On January 28, 2003, President Bush announced a new \$1.2 billion hydrogen fuel initiative to develop hydrogen-based technologies for fuel cells to power cars, truck, homes and businesses. Combined with the FreedomCAR initiative, these programs will put \$1.7 billion into hydrogen technologies and infrastructure development during the next five years. Achieving economical development of hydrogen powered vehicles, and making a hydrogen-based economy feasible, will require that advances be made in key technology areas. In addition, the public must be integrated into the planning and development process to allay potential fears regarding on board storage of hydrogen in automobiles and new refueling technologies. Hydrogen powered cars and buses already exist, but these technologies must be promoted and demonstrated to the public to gain acceptance. At the same time, fuel cell and hydrogen-based technologies must continue to advance and become more economical.

It is recommended that federal agencies work together to create and fund at a high level one or more Hydrogen and Fuel Cell Centers located around the nation. These centers should be partnerships between academic institutions, industry, and federal laboratories that will improve and demonstrate hydrogen energy technologies. A Hydrogen Center must advance both hydrogen energy technologies, as well make strong contributions to hydrogen demonstration projects, education, and outreach. The technical areas that must be addressed are:

- **Hydrogen Production technologies:** Our national security relies upon the development of hydrogen from existing resources that gain our country's independence from foreign sources of fossil fuels. These technologies must include as part of the long term vision hydrogen generation from renewal sources such as biomass (crops) and water. In the near term, substantial efforts shall be made to use transition fuels such as methanol, natural gas, and coal.
- **Catalysts and Membranes.** Advances are needed in catalysts used for both hydrogen fuel cells, as well as reforming fuel cells that use methanol or natural gas. Platinum reserves for catalysts are insufficient to meet projected demands, and therefore more economical and efficient catalysts are needed to lower the cost of fuel cells. Of the different types of fuel cells, the most useful for vehicle transportation will be PEMs (proton exchange membranes) because they operate at relatively low temperatures. Improvements are needed to lower the cost of these membranes.
- **Fuel Cell Structure and Operation.** The two main advantages of fuel cells over combustion technologies are its high efficiency and avoidance of combustion gaseous by products. Fuel cell efficiency can be improved by better monitoring of fuel delivery and temperatures in the cells, and for reforming fuel cells, developing methods to clean gas streams to prolong catalyst life.
- **Hydrogen Storage and Safety.** One of the greatest obstacles to extending the range of hydrogen powered vehicles is an efficient hydrogen storage technology. Fundamental breakthroughs in new storage technologies are needed. Carbon-based technologies have

received great attention as the only feasible method of safely storing high concentrations of hydrogen, but techniques to capture and release hydrogen from storage container materials, and manufacturing methods to produce those materials at low cost, have not been developed. All storage systems must include hydrogen monitoring systems to guarantee public safety.

As these technical advances are made, hydrogen based fuel cells will become more economical for home power generation and for use in automobiles. A hydrogen distribution infrastructure will begin to emerge, but its acceptance and use by society will depend on enhancing the accessibility, comfort, and ease of use for these new technologies. There also remain challenges in the most efficient and user friendly methods for refueling automobiles. Therefore, key challenges will be in the area of development and demonstration of refueling systems, combined with outreach efforts. Hydrogen Centers should therefore have as an integral part of their mission the following two areas:

- **Demonstration of Technologies.** Refueling stations exist at several locations in the country. Centers need to be built around such refueling stations so as to demonstrate the feasibility and ease of vehicle fueling. Buses are available that can be inserted into community systems that will showcase the technologies to a wide audience. Cars are available that should also be used as a part of the activities of the center in order to test and demonstrate refueling stations. Costs for these demonstration vehicles is large, due in large part to the small number of such vehicles produced. Center support will be critical in providing the economic assistance needed to demonstrate these vehicle technologies.
- **Education and Outreach.** Universities can play a particularly important role in enhancing the visibility of hydrogen technologies, through demonstration of technologies and inclusion of technologies into classes. Through coursework and outreach programs, and discussions of hydrogen and energy policy, the university can help to train a new and diversified workforce that can help to develop and engineer systems needed for the hydrogen economy.

The development of a new hydrogen economy will require the efforts of not just individuals, but teams working on the above tasks. The emergence of Hydrogen Centers around the nation will provide the focus for these team efforts and help to catalyze and advance the development of hydrogen technologies, creating new businesses and strengthening the nation's economy. Through the coordination provided by Hydrogen Centers, and the cutting edge research at universities and national laboratories, these centers will lead will move us forward towards a global hydrogen-based fuel economy.