CHRYSLER Ford GM

USCAR

UNITED STATES COUNCIL FOR AUTOMOTIVE RESEARCH LLC

Hydrogen Research for Transportation: The USCAR Perspective

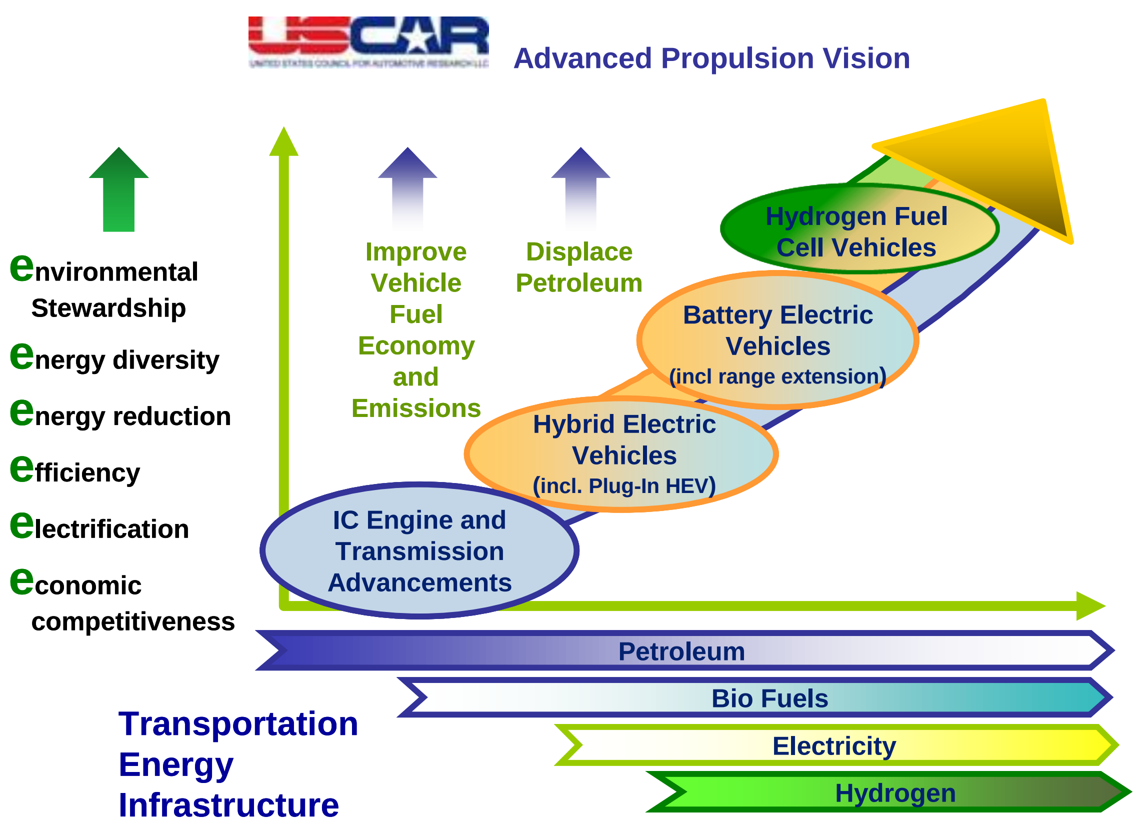
July 2009

Hydrogen Research for Transportation
The USCAR Perspective

The only known forms of energy that offer truly zero emissions from motor vehicles are electricity and hydrogen. Use of electricity as an environmentally-friendly transportation 'fuel' is dependent on progress in on board energy storage (batteries and ultracapacitors) and improved electrical generation and distribution infrastructure. Even with complete success in meeting the USABC long-term goals for battery energy capacity, electric vehicles cannot compete with hydrogen-fueled vehicles for general usage in terms of range and 'refill' time. Use of hydrogen as a transportation fuel as on-board storage for useful range and refill time is already available (if not optimal), for use in both highly-efficient, dedicated internal combustion engines or Fuel Cells Vehicles (FCVs). However, it is well recognized that the H2-ICE is not a truly zero-emission solution as oxides of nitrogen must be controlled. Furthermore, in a future world of precious renewable fuels, its significant efficiency advantage over the ICE makes the fuel cell the better solution in the long-term.

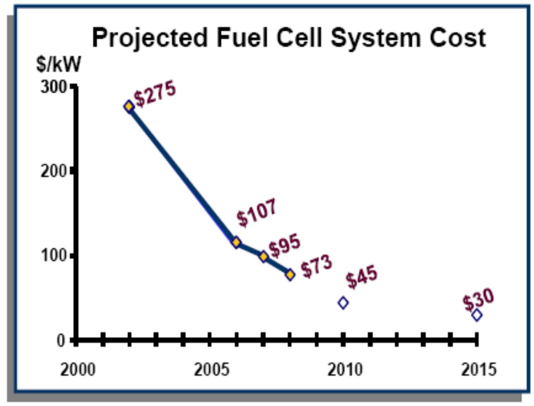
Because profitable high-volume deployment of FCVs depends on significant progress in multiple technologies both on and off the vehicle, the USCAR OEMs have made deployment of hybrid, plug-in hybrid and various forms of electric vehicles a near term focus. Most of the core technologies (battery, electric-drive systems, system controls) of these 'electrified' products will flow directly to fuel cell vehicles. Similarly, the DOE support for 'grid-connected' vehicles will indirectly support the ultimate commercialization of FCVs.

Only hydrogen fuel cell electric vehicle technology offers the promise of true-zero emissions, superior efficiency and uncompromised functionality. Regardless of their individual strategies, the USCAR members are firm in their belief that hydrogen-FCVs will be an important powertrain option in our future of sustainable transportation. Given the long-term nature of this investment and the many uncertainties surrounding the rebuilding of our national energy infrastructure, it is not prudent to pick de facto winning technologies by ending all support for research and development of FCVs. The OEMs and their competitors are continuing their internal work on hydrogen storage and fuel cell propulsion systems, despite the unprecedented downturn in the industry. We encourage the restoration of an appropriate level of funding and continued collaboration for mobile fuel cell applications.



Fuel Cell

Recent technology progress illustrates that fuel cells are the most efficient known way to convert hydrogen to vehicle propulsion energy. Performance and cost of fuel cell systems have improved remarkably in the last 5 years. While progress has tracked DOE and industry research projections for efficiency, cost reduction and durability improvement, there are still gaps to levels that would make fuel cell technology competitive with advanced combustion engines.

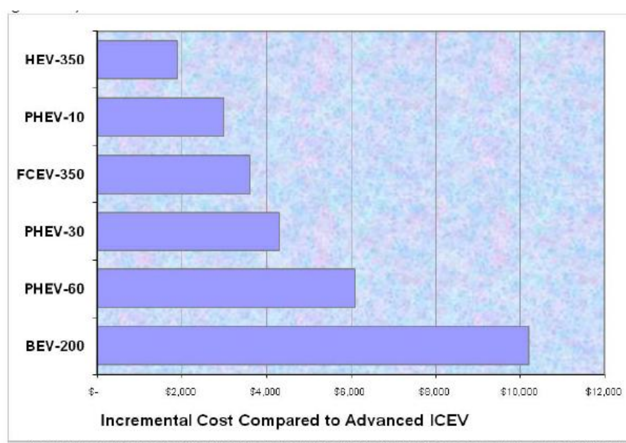


Based on DTI DFMA 2008 cost analysis
•Projected to a manufacturing volume of 500,000 units/year

- DOE's Technology Validation program has demonstrated 58% fuel cell efficiency, nearly meeting the 60% target.
- Current estimates of $60-$80/kW for fuel cell systems are still too high to meet cost targets of ~$30/KW by evolutionary design and development.
- The durability of vehicular fuel cell systems have improved dramatically. According to DOE's own assessment, projections of on-road durability has improved from 950 hours in 2006 to 1900 hours in 2008.The DOE hydrogen program's 2015 target is 5000-hour durability, equivalent to approximately 150,000 miles of driving.
- USCAR members, working with DoE continue core transportation fuel cell materials technologies research in order close these gaps and achieve the 2015 targets.

Hydrogen Storage

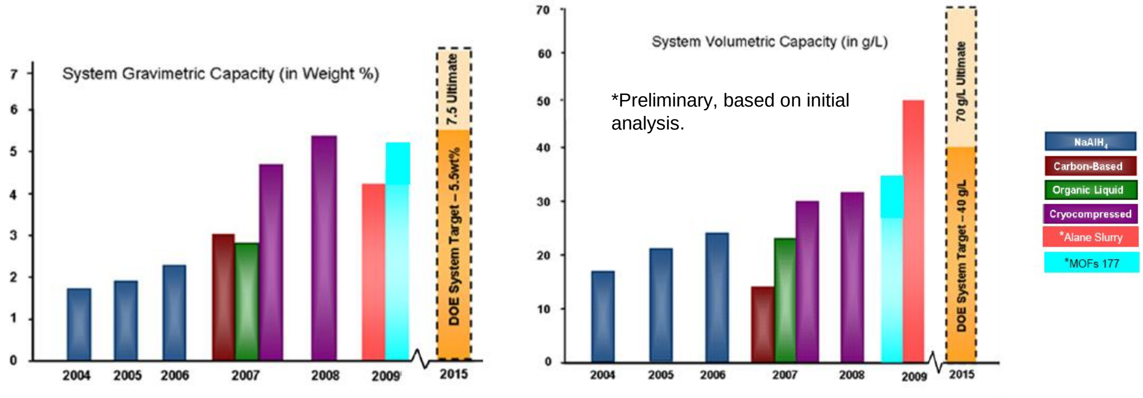
Compressed hydrogen is adequate for many near and mid-term applications, though energy density and cost are still issues. Considerable progress has been made in the last 5 years for onboard H_2 storage methods to improve the storage density of H_2 in vehicles. DOE and industry research has achieved roughly a doubling of stored capacity in advanced systems over the last 7 years



Ref: Kromer & Heywood, "Electric Powertrains: Opportunities & Challenges in the U.S. Light-Duty Vehicle Fleet Report # LFEE 2007-03RP, MIT, May, 2007, Table 53

- Concept vehicles have demonstrated ranges >400km with compressed H_2 storage tanks, without compromising customer requirements.
- Even at present levels, onboard H2 storage system costs are significantly less than that of the batteries used in EVs and plug-in hybrids.
- The range of vehicles with compressed hydrogen tanks vastly exceeds the range capability of equivalent size battery powered vehicles of the same energy storage volume.

The members recognize that continued research on material based storage systems is required in order to achieve performance and cost targets for the full range of U.S fleet model mix. The OEMs support the DOE approach to maintaining a research budget balanced across multiple material groups (metal hydrides, chemical hydrides and sorbents). A sustained effort utilizing DOE's key technical resources such as the National Labs is required to ensure these new technologies reach commercial viability.



Hydrogen Storage -2009 DOE Hydrogen Program & Vehicle Technologies Program Merit Review and Peer Evaluation Meeting 05/19, 2009, Sara Dillich

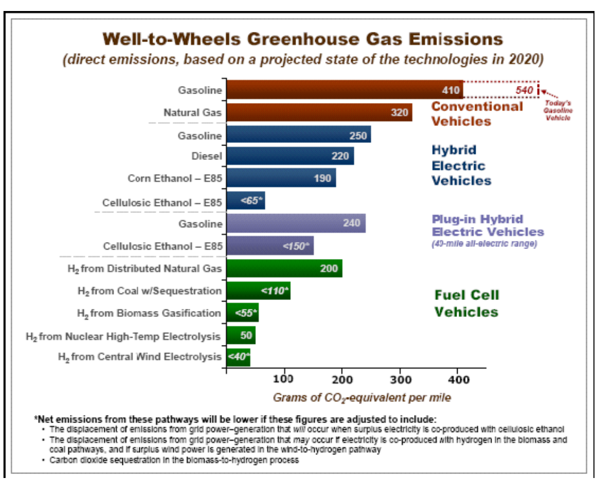
Hydrogen Source Pathways

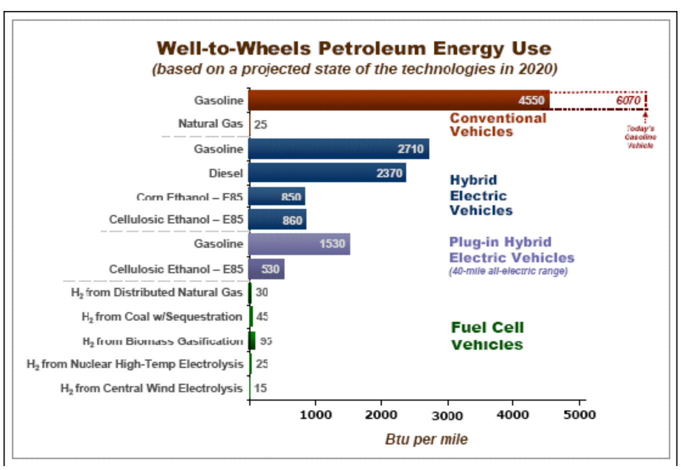
While not the ultimate solution, steam reformation of natural gas can serve as the first of many future hydrogen production pathways. Given that the carbon footprint of and advanced SRNG-fueled FCV is certainly no greater than that of an EV or HEV, use of SRNG during the pre-commercialization phase of FCV technology will not be a significant impediment to progress on GHG reduction. Other pathways for producing hydrogen will exploit increasing availability of clean electricity, renewable feedstocks and carbon sequestration to drive down the carbon footprint of road transportation even as mass deployment of fuel cell vehicles begins. Just as for core fuel cell technologies, the research foundation for large-scale availability of clean hydrogen must be laid today, and DOE plays a central role in driving that research.

DOE Well-to-Wheels studies clearly characterize the GHG and petroleum reduction impacts that natural gas derived hydrogen would provide during initial stages of fuel cell vehicle deployment(see charts below) :

- Commercial hydrogen production from natural gas is a mature technology already operating at a large scale for industrial use.

Ample capacity is available for pre-commercialization development. Natural gas, electricity, and water are widely distributed in the U.S, making virtually any location a potential site for hydrogen production.





http://www.hydrogen.energy.gov/pdfs/9002_well-to-wheels_greenhouse_gas_emissions_petroleum_use.pdf;

Infrastructure

In the context of OEM recognition of the long-term nature of fuel cell vehicle commercialization, the OEMS do not consider a large, immediate investment in fueling infrastructure a high priority at this time. That said, a number of analyses strongly suggest the investment required to keep fuel availability well ahead of vehicle deployment so as to foster rapid adoption is surprisingly modest. For example:

- A network of just 12,000 hydrogen stations would put hydrogen within two miles of 70 percent of the U.S. population (those living in the 100 largest metropolitan areas) and connect the major U.S. metro areas with a hydrogen refueling station every 25 miles.
- An initial investment of just $200 million can provide 40 high-capacity stations in a large metropolitan area such as Los Angeles to provide refueling for more than 40,000 FCEVs.
- Barriers to infrastructure development have now been lowered. National Fire Protection Association (NFPA) and International Code Council (ICC) codes for fueling stations are ready for insertion into State Codes.

Summary

In summary, USCAR and its members support DOE’s goal of investigating multiple propulsion options that would deliver meaningful results in improving US energy security, reducing fossil carbon emissions, and producing a sustainable transportation system in the near term. Continued government support of development over the next few years is very important to maintain stability of critical capabilities, maintain momentum and assure constant evolution of transportation fuel-cell technologies. Furthermore, due to the stricter performance requirements of vehicle technologies vs. stationary technologies, vehicle level H_2 research is relevant to both stationary and mobile applications. On the other hand, developments relevant to stationary applications alone are far less likely to be applicable to vehicles. Since it takes decades to "turn over" the light duty vehicle fleet, critical technologies must approach the point of commercialization in the next ten to fifteen years if they are to play a role in meeting our 2050 greenhouse gas reduction goals. DOE's removal of support for transportation fuel-cell programs will dramatically diminish the U.S. development of one of the truly zero-emission alternatives. Therefore, DOE should be encouraged to balance technology development priorities to include fuel cell vehicle technologies to assure that the current pace of development continues. Should hydrogen emerge as an important transportation fuel, failure to have done so may lead to the US becoming uncomfortably dependent on foreign powers for this important technology.