**BRIEF SUMMARY OF THE US DEPARTMENT OF ENERGY HYDROGEN ENERGY PROGRAM.**

NPRE 470A

Homework Problem 1-2

Where possible, source material has been cited with a numeric-alphabetic code. The references page, at the end of this paper, lists the codes with their bibliographic citation.

In general, the DOE has a clear set of goals with definite but changing deadlines to achieve a hydrogen economy by 2050, if not sooner. The DOE **vision** covers storage, delivery, utilization, regulation, and education regarding the hydrogen economy. They are supporting basic and applied research in storage, delivery, and utilization (most fuel cells), they advocate and propose private sector incentives for adopting hydrogen technology, they advocate and propose regulations for the safe use of hydrogen, and, I assume that they have a limited public awareness campaign (such as their web-site and publications) regarding the hydrogen economy.

Ohi (2001OHI) identifies the Hydrogen Genie as being closest to the HTAP (Hydrogen Task and Advisory Panel) vision. That is, Ohi sees an accelerated (relative to market forces and the status quo) rate of development and penetration of hydrogen technology into consumer, commercial, and industrial use with a modest element of public awareness. I see the DOE **vision** entering the Brave, Clean World quadrant. DOE clearly favors accelerated hydrogen technology development, but I think that its vision also involves heightened public awareness and concern regarding the potential of the hydrogen economy and the necessity for research into this area. Continued and consistent public support of DOE’s vision requires it. This is best illustrated on pages 35-38 of the DOE’s “National Hydrogen Energy Roadmap” (2002NHER) where they outline public outreach to several audiences (energy consumers, students, educators, officeholders, policy makers, NGOs, scientists, engineers, industry groups, trade associations, tv and movie producers) using miscellaneous outreach and media tools (networks, coalition building, public education, exhibits, web-sites, “branding”, product placement, fellowships, scholarships, a “hydrogen village”).

One could also view the DOE program as somewhere just northeast of origin in Ohi’s grid. Government research into energy has been the status quo since mid-1970’s, public interest, though shallow and often ill-informed is present. In functional terms, the status quo on rate of development is probably not far from origin on his grid.

The DOE goals and time-frames for the hydrogen economy are best defined by this chart from its “National Vision of America’s Transition to a Hydrogen Economy” (2002NVA):



They (in 2002) saw the transition as essentially complete by 2040. For production, they saw starting with the existing technology of natural gas reformation with gasification of coal around 2020 and electrolysis of water using nuclear and renewable energy starting around the same time. By 2040 they envision direct splitting of water by sunlight as a major player in hydrogen production. For delivery, they start with the existing technology of a small pipeline network plus tank trucks, railroad tank cars, and barges. In 2010 through 2030 they envision an enlarging network of “distributed” facilities, where hydrogen is either produced on-site or shipped in by pipeline. By 2030-2040 they envision a complete integration of the hydrogen distribution system of both distributed and centralized production facilities.

For storage, they again start with an existing technology (pressurized tanks), then moving to hydrides between 2010-2020, with solid state storage taking hold by 2030. For conversion, they start with combustion, which currently exists only in niche applications. In 2010 to 2020 they envision increased use of combustion plus the introduction of fuel cells (which are already in niche uses). Beyond 2020, they envision widespread adaption of hydrogen conversion using more advanced fuel-cell and combustion technology.

For end-use (closely related to conversion) they again start with the existing technologies of fuel refining and petrochemicals, space applications, and portable power (fuel-cells in specialized applications). In 2010-2020 they envision use in stationary distributed power (fuel cells and combustion in peak-load and small power plants) and also use in centrally fueled applications like fleet vehicles. In 2020 to 2030 they see wider use of hydrogen in fleet vehicles, the introduction of personal hydrogen fuel-cell vehicles, and distributed CHP (Combined heat and power). It is not until the final decade of their plan that one sees fuel-cells and hydrogen moving into utility systems. This may be because in utility systems, hydrogen may be viewed more as an energy carrier and back-up for solar, wind, and geothermal systems; as opposed to the primary means of providing electricity.

One might want to move this time frame up about a decade, given what has happened from 2000-2010 and what is happening now.

The DOE’s 2003 “Fuel Cell Report to Congress” (2003FCRTC) posted these origin goals for stationary fuel cell systems, with no target date given:



The 2003FCRTC also reported the following 2010 goals for the “Freedom Car” fuel-cell vehicle:



The 2009 “DOE hydrogen program, 2009 annual progress report” (2009HPAPR) lists the following goals for its fuel-cell applications:



The PEMFC (Polymer Electrolyte Membrane) fuel-cell probably refers to a stationary power plant application, such as a peak load generation facility. The fuel cell for consumer electronics is referring to a fuel cell for general portable applications (laptops, etc.). APUs (Auxiliary power units) refers to unit akin to today’s portable generators, for items like emergency backup, camping and RV use, and possibly equipment like forklifts. The final category of a fuel cell for transportation refers to trucks, automobiles, locomotives, and possibly smaller watercraft. The given costs refer to capital costs. The DOE considers fuel cost separately under a category of hydrogen production.

Notice that by 2009, the acceptable capital costs for a stationary fuel system have risen from $400 /kWto $750/kW, but the capital costs for transportation (engine powertrain system) remain at $30/kw.

The 2009 progress report went on to identify these additional technical goals, to be achieved by 2010 unless otherwise indicated:



The 2009 Hydrogen Fuel Cell Activities, Progress, and Plans; Report to Congress (2009HFCAPP-RTC) further defines the following targets for a fuel cell vehicle (FCV):



REFERENCES

**2001OHI**: Ohi, Jim, “Enhancing Strategic Management of the Hydrogen Option: Scenario planning by the DOE Hydrogen Technical Advisory Panel”, Proceedings of the 2001 DOE Hydrogen Program Review, NREL/CP-570-30535, 2001.

**2002NVA**: United States Department of Energy, “A national vision of America’s transition to a hydrogen economy – to 2030 and beyond”, National Hydrogen Vision Meeting, Washington DC, November 15-16, February 2002.

**2002NHER:** United States Department of Energy, “National hydrogen energy roadmap”, National Hydrogen Energy Roadmap Workshop, Washington, DC, April 2-3, 2002; November 2002.

**2006HPP:** United States Department of Energy/ United States Department of Transportation, “Hydrogen posture plan: an integrated research, development, and demonstration plan.” December 2006.

**2005FCFP-HDTR**: Freedom Car and Fuel Partnership, “Hydrogen Delivery Technology Roadmap”, November 2005.

**2009HPAPR:** United States Department of Energy, “DOE hydrogen program, 2009 annual progress report”, November 2009.

**2001PNHVM:** United States Department of Energy, “Proceedings of the national hydrogen vision meeting”, Washington, DC; November 15-16, 2001.

**2003FCRTC:** United States Department of Energy, “Fuel cell report to congress”, ESECS EE-1973, February, 2003.

**2009HFCAPP-RTC:** United States Department of Energy, “Hydrogen and fuel cell activities, Progress, and Plans: Report to congress”, January, 2009.