Bay Area Air Quality Management District
939 Ellis Street
San Francisco, California 94109

APPROVED MINUTES

Air Quality Planning Committee Meeting
9:30 a.m., Wednesday, February 9, 2005

1. **Call to Order – Roll Call.** 9:40 a.m. Present: John Holtzclaw, Ph.D., Chairperson; Harold Brazil, Irvin Dawid, Emily Drennen, Fred Glueck. Absent: Kraig Kurucz, Kevin Shanahan.

2. **Public Comment Period.** There were no public comments.

3. **Approval of Minutes of joint Air Quality Planning & Technical Committee Meeting of December 16, 2004.** Mr. Dawid stated that "Joint Policy Committee" instead of "Regional Agency Coordinating Committee" should be listed under "Committee Member Comments on the last page. Mr. Glueck moved approval of the minutes as corrected; seconded by Chairperson Holtzclaw; carried unanimously.

4. **The Current Status of Hydrogen Production and Fuel Cell Technologies and Recent California and U.S. Government Initiatives.** Dr. Tim Lipman, U.C. Berkeley, stated that fuel cell technology has progressed over the last decade, but there remain some obstacles in terms of hydrogen production and distribution. He opined that at this time what may be needed is a broad, clean energy strategy of which the hydrogen fuel cell technology is an increasing part. Also, given the state's legislative concern over greenhouse gas (GHG) emissions with the Pavley bill, it is important to assess the fuel economy of fuel cell vehicles (FCVs) and hybrids of various types.

   Dr. Lipman reviewed the various fuel cell types, noting that the ion exchange membrane cell is intended for vehicle use, entails low temperature transfer and uses platinum as the catalyst material. Phosphoric acid cells have to date proven to be the most useful for stationary source applications, with such other technologies as molten carbonate and solid oxide becoming increasingly feasible for stationary application. At high temperature nickel can be used as the catalyst and is cheaper.

   Displaying a diagram of how a fuel cell works, Dr. Lipman explained that hydrogen enters the cell and makes contact with the catalyst, splits into two protons and electrons, and as the protons go through the membrane, the electrons travel around the external circuit to meet oxygen and the protons to form water, generating electricity. Fuel cells can be stacked, and these assemblies can produce a high voltage system of many cells. The power density of fuel cells has increased dramatically in the last decade: in 1994 a cell generated 200 watts per liter and recently General Motors generated 2 kilowatts per liter from a fuel cell.

   Displaying a series of photographs of early and mid-1990s Daimler Prototype FCVs, Dr. Lipman identified where the fuel cells were installed. He noted that considerable efficiencies have been obtained in the vehicle design of the Daimler/Chrysler Necar 4 FCV, which represents the "next generation" of FCVs. The Air District will receive two of these vehicles in the near future. While the vehicle is production ready, there are cost issues, and concerns over the unavailability of hydrogen fueling stations in the state at this point.

FCVs presently cost $3,000 - $4,000 per kilowatt, compared with $40-$50 per kilowatt for gasoline fueled vehicles. However, FCVs are not mass produced at this time. Under some mass production scenarios, the cost of an FCV would be $200 per kilowatt. This is strictly in terms of the capital cost of the fuel cell system. When durability is factored in, it should be noted that platinum is fairly fragile and susceptible to being poisoned by sulfur or physically damaged from vibration and wear and tear. Fuel cells tend to last upwards of a couple of thousand hours, but in order to be competitive with gasoline engines performance of up to 4,000 hours would be needed.

With regard to hydrogen production infrastructure, centralized strategies such as coal, nuclear and biomass entail low production costs but high transportation costs. It may be possible to sequester the CO_2 emissions although this technology is not fully proven. Distributed hydrogen production, using natural gas or electricity as a source and electrolysis for production entail higher production costs but much less distribution and transportation costs. Oil refineries with hydrocrackers generate a considerable amount of hydrogen, which could support mobile refueling station options.

Dr. Lipman displayed a map of the USA showing the potential for hydrogen production from various types of power, including renewable energy, biomass, solar and wind. He also described options for hydrogen production and distribution within the context of on-site production at larger centralized plants and subsequent distribution. He displayed the latest models for mobile hydrogen refueling technology, with a trailer fueled at a central hydrogen facility and towed to a fueling area. This is reasonably economical if the trailer operates within 100 miles of a hydrogen facility. The Governor has spoken of developing an infrastructure of a hydrogen station every 20 miles.

Cost and emission estimates vary with different means of hydrogen production and whether they are near- or long-term. He noted that in general where there are lower production costs there are higher transportation costs. With regard to renewable energy in wind and solar power, costs are high, but over the future these are projected to decrease. The National Academy of Scientists commissioned a study of centralized, medium production scale and distributed options, taking into account production, distribution and dispensing costs, CO_2 sequestration and a carbon tax. Centralized production was the least expensive, with medium production scale ranking next costly, and the distributed option in some ways being comparable with the centralized approach.

FCVs do not emit GHGs, but some hydrogen production processes do. Therefore, the entire fuel cycle is at issue. Using natural gas to generate hydrogen, a 20-40% reduction in GHGs can be achieved. Using an electrolyzer increases GHG emissions due to the use of coal. With GHGs it is not important where emissions occur, but with regard to air pollutants it is important to know the location of where the emissions occur, particularly if there are hot spots within a region. The type of hydrogen production will determine the type of pollutants emitted upstream in the fuel cycle, and the District requires clear advice on the implications of a given production technology.

Dr. Lipman displayed a map of the location of 15 hydrogen stations in California, noting that there are six more planned for construction. He also displayed a diagram of a distributed hydrogen system using natural gas for hydrogen production and identifying the process for transfer to a reformer, compression, storage and dispensing to a vehicle. In reply to questions he noted that home refueling using natural gas supplied to a residence is under consideration, and that some advocate simply using compressed natural gas for natural gas vehicles in such cases. There are also economies of scale to be considered, because the installation of reformers in homes, in order to be economical, would have to be mass produced in order to drive the cost down.

The challenge that faces the hydrogen fuel cell technology today is akin to the "chicken or the egg" syndrome. Energy stations could combine reformer and production technology in a stationary place to produce power, and an offshoot would be the production of hydrogen to refuel vehicles. However, the infrastructure overall (production, delivery, trucks, gas trucks, pipelines) will not be developed unless there are vehicles purchased, and people won't purchase vehicles unless there is infrastructure to support them. Small energy production stations are a possible solution, and could support business and agency fleets to begin with, and expand into key corridors. Such facilities could be made available to the public and the process could begin in that manner. To date, there have been only a few minor accidents associated with the hydrogen production technology.

There are some major government initiatives under way regarding hydrogen, with the US Department of Energy's FreedomCar program beginning in 2003. In April of last year, the allocation of $350 million was announced regarding a hydrogen storage program, learning demonstrations, fuel cell research and hydrogen education. California Governor Schwarzenegger has issued an Executive Order designating 21 Interstate Highways as the California Hydrogen Highway network, with projected infrastructure development by 2010 with production of hydrogen from renewable energy sources. The blueprint for this plan is due to be issued very shortly. It will identify a rapid transition to a hydrogen economy in the state, institute negotiations with automobile manufacturers to ensure the availability of cars on the market, the development of safety standards, emergency response procedures, incentives for vehicle purchase and advocacy of renewable energy sources for producing hydrogen. The website is www.hydrogenhighway.ca.gov.

In summary, Dr. Lipman stated that while FCVs are coming on strong there are still technical and economic challenges. Hydrogen production can be approached from a variety of ways with varying environmental impacts and economic implications. There is considerable governmental activity at the state and federal level, but budgets across the board are tight. Overall, a broad clean energy strategy is appropriate at the present time, with clean sources of electrical power and other clean fuels that provide a basis for transition to hydrogen power. Public expectations as to the availability and implementation of FCV technology must be responsibly managed.

In response to questions from Committee members, Dr. Lipman replied:

- From an air quality perspective, clean fuel vehicles can be distinguished from clean vehicles in that the latter can be achieved running on conventional fuels. In such instances, durability over time becomes a key factor in comparing the two approaches to vehicular motive power.
- Platinum fuel cells could be poisoned over time in an urban area where there is enough CO_2 in the air and potentially in the fuel stream to poison the membrane.
- Durability issues in comparison with electric battery powered vehicles require further operational experience in order to provide a good baseline of data. If battery powered vehicles had batteries that lasted the life of the vehicle they would be economically attractive.
- Platinum is recyclable as a fuel cell component. The cost has reduced dramatically in the last decade.
- The target date of 2010 for the hydrogen highway is rather early; it appears more realistic to see this as a stepping stone of sorts.
- There are opportunities for an international partnership on the hydrogen fuel cell technology, particularly given that many automobile companies are global in scope.

- The use of natural gas as a hydrogen production source does not entail a shortage as estimates are that there are one million cubic feet of natural gas on the planet for every person.
- Distributed power generation through use of a power plant in a building would eliminate the need for a back-up diesel generator and provide for production of hydrogen as well

Michael Murphy, Advanced Projects Advisor, stated that with regard to incentives in the hydrogen highway blueprint, it is noteworthy that air districts have been major underwriters of clean fuels projects. The blueprinters will look at the District as a major funding source. Perhaps the Council could opine on where to place incentive funds under mobile source programs to a hydrogen fuel cell program, particularly in the overall context of the District's support of other clean vehicle and clean fuels programs.

The Committee thanked Dr. Lipman for his presentation. Chairperson Holtzclaw indicated that the next Committee meeting will be held jointly with the Technical Committee to discuss the CARE program and GHG emission issues. After further discussion, the Committee agreed to hold an interim meeting in March to receive a presentation on the state's hydrogen highway blueprint.

5. **Committee Member Comments/Other Business.** Ms. Drennen apprised the Committee that tomorrow the Board of Directors Mobile Source Committee will discuss revising the criteria governing the Transportation Fund for Clean Air and adopting criteria for the extra two dollars that will be allocated for the Carl Moyer Program. Mr. Dawid stated that in December of 1995 the late Air Pollution Control Officer of the district, Milton Feldstein, wrote an outstanding letter to the Marin Independent Journal entitled "Smog Tax is the Answer". It concerns providing incentives for and implementing programs regarding the use of clean fuel and vehicle technologies.

6. **Time and Place of Next Meeting.** 9:30 a.m., Tuesday, March 8, 2005, 939 Ellis Street, San Francisco, California 94109.

7. **Adjournment.** 11:45 a.m.

James N. Corazza

James N. Corazza
Deputy Clerk of the Boards

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