County of Santa Clara
Board of Supervisors
Supervisorial District Four
Supervisor James T. Beall, Jr.

bosD4−9−14−04fcini

DATE: September 14, 2004

TO: Board of Supervisors

FROM: James T. Beall Jr.

James T. Beall, Jr.
Supervisor, District 4

SUBJECT:
Santa Clara County Fuel Cell Advancement Initiative

RECOMMENDED ACTION

a. Direct County Executive to consider stationary fuel cell applications when planning for building projects and energy−system upgrades. Build public/private partnerships to leverage resources to support R&D of fuel cells and clean hydrogen production efforts in Santa Clara County. Possible demonstration sites could include: county buildings, Fair Oaks Senior Housing Project, sewage treatment plants, and Office of Emergency Services (OES) center. Apply for grants to support stationary fuel cell demonstration projects.

b. Direct County Executive to identify a fuel cell vehicle (FCV) demonstration project. Work with California Fuel Cell Partnership to develop an interest among FCV manufacturers to lease demonstration vehicles to the county. Identify clean and efficient hydrogen refueling infrastructure. Apply for grants to support a fuel cell fleet vehicle demonstration project.

c. Direct administration to contract with a consultant specializing in energy and transportation engineering to assist the county with implementation of the above recommendations. Apply for planning grants to fund consultant services.

d. Direct the Legislative Committee to consider sponsoring legislation related to: hydrogen and fuel cell technology expansion and advancement; and consumer incentives for low– and zero–emissions vehicles, photovoltaic and other clean, distributed generation applications.

e. Direct County Executive to participate in local and regional information–exchange forums of public and private stakeholders to educate, and leverage resources to support the advancement of a local hydrogen economy. Work with California Hydrogen Highway Network to include county fuel cell and hydrogen efforts as a model in the Governor's Hydrogen Highways Blueprint Plan.

FISCAL IMPLICATIONS

No General Fund Impact.

Numerous grant and funding sources are available for fuel cell vehicle demonstration and stationary fuel cell infrastructure planning and capital projects. Some of which include:

- BAAQMD Transportation for Clean Air Grant
- U.S. Department of Energy
- Caltrans Transportation Planning Grants
- California Energy Commission Buy–down Program
- California Public Utilities Commission Self–Generation Program
- The Energy Foundation
- Steven and Michele Kirsch Foundation
- CSAC Bond Programs

REASONS FOR RECOMMENDATION

As the country is moving forward on the road to a hydrogen economy, it is important that the County of Santa Clara position itself for the future – as one of the leading regions supporting emerging clean energy and transportation technologies.

Hydrogen is often characterized as the "ultimate fuel of the future" being both clean and available without the need for energy imports. It has an unmatched potential to bring about economic stability, energy reliability, environmental, and public health benefits. Promising technological breakthroughs are occurring every day throughout the world and within our own backyard.

There is substantial action that governments and other stakeholders can and must take if a transition is to be made in a timely manner to a cleaner and more sustainable energy system. A key step in this process is to conduct demonstration projects, which are essential for identifying and resolving real–world operating issues. They also provide valuable lessons in siting and permitting infrastructure and serve as pilot projects for introducing new technologies and fuels into early markets.

BACKGROUND

Economic Development

Using hydrogen as an energy carrier will require a variety of new technologies, products and services, such as stationary fuel cells for co–generation distributed energy systems, fuel cells for transportation applications, and hydrogen refueling stations. This means economic development opportunities for local companies and new high–technology jobs. This will lead to the creation of high–tech jobs to build and maintain these systems. Although the transition to a hydrogen economy will take decades, faster transitions can occur in particularly progressive regions (Dr. Dan Sperling, UC Davis Institute of Transportation Studies. Hydrogen Conference, August 2004).

Health Implications

Production, sales and use of petroleum–derived fuels in the U.S. emit thousands of tons of chemical pollutants into the air each day. Widespread use of fuel cell vehicles could have a measurable effect on air quality by reducing nitrogen oxides, volatile organic compounds, and particulate matter produced by vehicles. Petroleum pollutants can cause or aggravate a wide range of serious health problems including cancer, birth defects, asthma, and chronic obstructive pulmonary disease. Both nationally and at the county level, we have seen the impact of air pollution on health.

As the attached chart illustrates, asthma deaths have been increasing over the past 25 years. I believe initiatives that seek to improve air quality are important and a first step towards reducing the incidence of asthma in our region. Clearly, adoption of a few zero–emissions fleet vehicles and a handful of stationary fuel cell projects are not going to address the health concerns in isolation, but leadership and building public awareness is critical to advancement towards this goal (Attachment A).

Economic Risks Associated with Petroleum Dependency and Availability

The support of non–petroleum fuels, such as hydrogen, offers an opportunity for County citizens to be able to seek alternatives to gasoline and diesel. This opportunity is important due to the economic risks of petroleum fuel price spikes and potential fuel supply shortfalls.

Hydrogen Production Pathways

Hydrogen – the most plentiful gas in the universe – can be produced from a wide variety of resources including coal, oil, natural gas, bio mass, and water. Several methods of producing hydrogen are currently in use or being explored. Most of the hydrogen used today comes from reforming natural gas offsite, then transported in pressurized tubes and stored in carefully controlled settings.

A small amount of hydrogen used today is produced onsite through electrolysis. Some fuel cells can run in reverse and produce hydrogen as needed via electrolysis. In electrolysis, electricity is used to separate water (H20) into hydrogen (H2) and oxygen (O2). The electricity can come from fossil fuels such as coal, or from renewable sources such as solar, hydroelectric or wind power.

Manufacturers throughout the U.S. and Canada are developing more efficient and cost–effective fuel cell and hydrogen production technologies every day. One manufacturer in Santa Clara County is developing an efficient, secure and cost–effective stationary fuel cell technology that produces electricity or hydrogen as needed, and will be available for demonstration projects within the next year.

Statewide Initiative

Governor Schwarzenegger's Executive Order S–7–05 California Hydrogen Highways Network calls for a blueprint plan to implement a network of hydrogen refueling stations along California s major highways by 2010. In the Executive Order, the governor states: "hydrogen powered vehicles and infrastructure can lead to energy independence, offer zero or near–zero emissions, reduce health problems due to motor vehicle related air pollution, reduce water pollution from oil and gasoline leaks, lower global warming pollution, improve fuel economy, provide smoother and quieter operation, as well as providing economic and workforce benefits to help California meet current and future energy needs".

Local Initiatives

The Santa Clara Valley Transportation Authority (VTA), in partnership with the San Mateo County Transit (SamTrans), is conducting a demonstration program to test hydrogen–powered fuel cell buses. Starting in January, VTA will operate three zero–emissions buses on selected routes within Santa Clara County. The liquid hydrogen fueling station is located at VTA's Cerone Station.

Santa Clara County has demonstrated leadership in early adoption of clean–fuel technology in our fleet program and should continue to do so as new technologies emerge. In County policy 7.11 Vehicle Procurement – Low Emission Vehicles, the Board of Supervisors adopted a policy to encourage low emission vehicles. I believe that we should aggressively extend our program to zero emissions hydrogen vehicles. Board Policy 7.11 states, "The County will identify and give preference in its vehicle procurement to the acquisition of the lowest emission vehicles available, practical, and reasonably cost effective for a given application, or where funding is available to assure that such vehicles are reasonably cost competitive. Public safety and emergency vehicles are exempt from this policy".

It is anticipated that the next round of FCV fleet customers will be identified in Spring 2005. Collectively, auto manufacturers are estimating that by 2007 approximately 200–300 demonstration FCVs will be spread between major metropolitan areas of the State. Each carefully selected customer will receive between one and five vehicles.

There are opportunities to collaborate with one of our affordable housing partners – Charities Housing – to build a stationary fuel cell demonstration project at the Fair Oaks Senior Housing site. This demonstration project could potentially include a fuel cell shuttle vehicle for the residents' transportation needs. The potential combination of both a stationary fuel cell system providing electricity, water, heating, cooling and fuel for a zero–emissions shuttle would set a nationwide precedent.

The Governor's California Hydrogen Highways Team is looking for a county model to include within the Blueprint Plan. I believe that we have the opportunity to do what we do best here in Santa Clara County – establish innovative public–private partnerships that deliver quality services to the public. Furthermore, I believe that we can lead the nation with such an initiative, supporting the diffusion of a clean, reliable and sustainable energy technology that will eventually create jobs, improve air quality, and hence improve public health.

CONSEQUENCES OF NEGATIVE ACTION

Recommendations will not be adopted and county will not be in a position to compete for state and federal grant funding for fuel cell projects.

ATTACHMENTS

- (Transmittal submitted on Sep 8, 2004 9:40:28 AM – PDF Version)
- Attachment A – An Integrated Hydrogen Vision for California (Miscellaneous)
- Attachment B – An Integrated Hydrogen Vision for California (Miscellaneous)

Santa Clara County Fuel Cell Advancement Initiative

Approved by Board of Supervisors on September 14, 2004

1. Directed County Executive to consider stationary fuel cell applications when planning for building projects and energy-system upgrades, to build public and private partnerships to support Research and Development of fuel cells and clean hydrogen production efforts in Santa Clara County, and to apply for grants to support stationary fuel cell demonstration projects.

2. Directed County Executive to identify a fuel cell vehicle (FCV) demonstration project, to work with California Fuel Cell Partnership to develop interest among FCV manufacturers to lease demonstration vehicles to County, to identify a clean and efficient hydrogen refueling infrastructure, and to apply for grants for grants to support Fuel Cell Fleet Vehicle Demonstration Project.

3. Directed Administration to contract with a consultant specializing in energy and transportation engineering to assist County with implementation of recommendations for fuel cell and FCV technology, and to apply for planning grants to fund consultant services.

4. Directed Legislative Committee to consider sponsoring legislation relating to hydrogen and fuel cell technology expansion and advancement, consumer incentives for low- and zero-emissions vehicles, photovoltaic and other clean, distributed generation applications.

5. Directed County Executive to participate in local and regional information-exchange forums of public and private stakeholders to educate and leverage resources to support advancement of local hydrogen economy, and to work with California Hydrogen Highway Network to include County's fuel cell and hydrogen efforts as a model in Governor's Hydrogen Highways Blueprint.

An Integrated Hydrogen Vision for California

White Paper/Guidance Document

Prepared with Support from the Steven and Michele Kirsch Foundation

July 9, 2004

Lead Authors:

Dr. Timothy Lipman
Energy and Resources Group
Inst. of Transportation Studies
University of California – Berkeley and Davis

Prof. Daniel Kammen
Energy and Resources Group
Goldman School of Public Policy
University of California - Berkeley

Assoc. Prof. Joan Ogden
Environmental Science and Policy
Inst. of Transportation Studies
University of California - Davis

Prof. Daniel Sperling
Civil and Environmental Engineering
Environmental Science and Policy
Inst. of Transportation Studies
University of California - Davis

Additional Authors:

Anthony Eggert, Institute of Transportation Studies, UC Davis
Prof. Peter Lehman, Schatz Energy Research Center, Humboldt State University
Dr. Susan Shaheen, Institute of Transportation Studies, UC Berkeley and UC Davis
Dr. David Shearer, California Environmental Associates

Acknowledgments

This project was funded by the Steven and Michele Kirsch Foundation with additional support from the UC Davis Hydrogen Pathways Program and the Energy Foundation. We are appreciative of the Kirsch Foundation's timely support for this project.

We thank (in alphabetical order) Mary Jean Burer, Dr. Charles Chamberlain, Gustavo Collantes, Rachel Finson, Roland Hwang, Jim Lee, Dr. Amory Lovins, Jason Mark, and Stefan Unnasch, and Jonathan Weinert for their insights and assistance as we conducted this project. We thank Hon. Mark DeSaulnier for his support and assistance, and more generally for championing clean air and mobility solutions for California. We further would like to specially acknowledge and thank Dr. Geoffrey Ballard for his visionary leadership in the field of hydrogen and fuel cells, and for his commitment to graduate education and thoughtful debate in this fascinating field.

Of course, the authors alone are responsible for the contents of this paper.

Abbreviations and Acronyms

ARB = California Air Resources Board
ATR = auto-thermal reforming
CAEATFA = California Alt. Energy and Adv. Transportation Financing Authority
CAFCP = California Fuel Cell Partnership
CAISO = California Independent System Operator
CASFCC = California Stationary Fuel Cell Collaborative
CEC = California Energy Commission
CHP = combined heat and power
COP = Conference of the Parties
CPUC = California Public Utilities Commission
DG = distributed power generation
DGS = Department of General Services
DOE = United States Department of Energy
EV = electric vehicle
FCV = fuel cell vehicle
GDP = gross domestic product
GHG = greenhouse gas
HEV = hybrid electric vehicle
INTI = Integrated Network of Transportation Information
ITS = Intelligent Transportation Systems
IOU = investor-owned utility
LEV = low emission vehicle
NAS = National Academy of Sciences
NOx = oxides of nitrogen
NRC = National Research Council
NUMMI = New United Motor Manufacturing Inc.
PG&E = Pacific Gas and Electric
PIER = Public Interest Energy Research
POx = partial oxidation
psi = pounds per square inch
R&D = research and development
RPS = renewable portfolio standard
SCAQMD = South Coast Air Quality Management District
SCE = Southern California Edison
SMR = steam methane reforming
UC = University of California
UNFCCC = United Nations Framework Convention on Climate Change
U.S. = United States
V2G = vehicle-to-grid power
ZEV = zero emission vehicle

Executive Summary

This paper concerns the economic and environmental challenges confronting California and the potential role for clean energy systems and hydrogen as an energy carrier in helping to address these challenges. Hydrogen in particular has recently gained great attention as part of a set of solutions to a variety of energy and environmental problems -- and based on this potential the current high level of interest is understandable. In our view, however, full realization of the benefits that hydrogen can offer will not be possible without a clear strategy for producing hydrogen from clean and sustainable sources and in a cost-effective manner. One of hydrogen's greatest benefits – having a wide range of potential feedstocks for its production – also complicates the issue of how hydrogen use may be expanded and necessitates careful forethought as key technology paths unfold. We must remember that the additional cost and complexity of building a hydrogen infrastructure is only justified if significant benefits to society are in fact likely to accrue.

This paper has been written for two primary purposes. First, we argue that the time is ripe for an expanded science and technology initiative in California for clean energy development and greater end-use energy efficiency. This initiative should span transportation systems, electrical power generation, and natural gas and other fuel use, and should place the potential for expanded use of hydrogen within this broader context. Second, we specifically discuss potential concepts and strategies that California might employ as it continues to explore the use of hydrogen in transportation and stationary settings. The authors believe that at this stage the question is not *if* California should continue with efforts to expand hydrogen use, because these efforts are already underway, but *how* these efforts should be structured given the level of effort that ultimately emerges through various political and corporate strategy processes. However, we feel that it is critical that these efforts take place in the context of a broader "no regrets" clean energy strategy for California.

Opportunities and Obstacles for Hydrogen

We also feel that it is important to point out that the potential use of hydrogen confronts serious remaining obstacles. These obstacles and barriers have recently been well articulated as part of a major review effort on behalf of the National Academy of Sciences / National Research Council. However, we note that hydrogen is one of very few options for significantly reducing oil use and greenhouse gas emissions in the transport sector. Hydrogen has an unmatched potential (based on present knowledge) as part of a set of solutions to a variety of energy and environmental problems. Hydrogen can be produced from a wide range of potential feedstocks within the U.S. and most other countries, potentially improving the balance of trade and geopolitical concerns associated with heavy oil dependence in the transportation sector. In fact, we suggest that it is *the* most compelling option for a low-carbon, post-petroleum future at this time.

A principal attraction of hydrogen is the ability to produce it from a variety of sources, including renewable sources. Hydrogen can be produced from wind and solar power and various biomass and waste resources – as well as from coal, natural gas, and nuclear power. With regard to fossil sources, carbon sequestration offers a potential future (but for the most part presently unproven) concept for production with low greenhouse gases (GHG) emissions to the atmosphere. Hydrogen technologies such as fuel cells, along with other small-scale power generating systems, are also promising for "distributed power generation" (DG). DG can allow production of electricity for commercial and residential buildings and industrial facilities with reduced needs for electricity transmission and distribution. Total energy efficiency levels from

DG can exceed those of central power plants, especially when waste heat is used for "cogeneration" or "combined heat and power" (CHP). Most importantly, hydrogen can be produced and used in ways that significantly reduce or even eliminate emissions of GHGs and air pollutants.

In light of this potential promise, there is a need to prepare for the potential transition to hydrogen since the process will be slow and initially difficult. There is much to learn about the use of hydrogen, the adoption of appropriate codes and standards, and the issues and obstacles associated with public acceptance of its use. Our concern here is different, however, and we believe more urgent and compelling. It is the need to rapidly advance the science and engineering of renewable energy and hydrogen technologies. We believe that the "hydrogen economy" is ultimately likely to come about, but we also conclude, along with the National Research Council and many others, that significant scientific and engineering advances are needed for the transition to advance in a meaningful and sustainable fashion.

Principles and Strategies for Clean Energy Policy

Furthermore, a major science and technology effort is needed more broadly to spur clean energy system development. This is necessary both in order for the potential hydrogen economy to deliver the benefits that are possible, and also in case the "great hydrogen experiment" is not successful. With its strong energy science and technology foundation, California is uniquely positioned to take a leadership role in this regard both within the U.S. and globally. We recommend a strategy that:

1) Advances the production of renewable electricity based on wind power, solar PV, and biomass;
2) Emphasizes *more efficient use of energy* with development and deployment of more efficient heating, ventilating, and air conditioning systems, lighting systems, appliances, and commercial/industrial equipment, and with introduction of higher fuel economy light and heavy-duty vehicles;
3) Expands clean and efficient distributed power generation (DG) through the use of combined heat and power (CHP) systems and "smart grids" -- and explores the use of stationary fuel cells and other hydrogen-based DG technologies in this context;
4) Continues and expands partnerships among U.S. DOE, industry, and the universities and labs to address key renewable energy, fuel cell, and hydrogen storage and delivery technology research and development (R&D); and
5) Explores renewable hydrogen production along with additional means of clean hydrogen production based on "transition fuels" such as natural gas and coal (including efforts to experiment with carbon sequestration), but that "holds the bar high" with regard to their full fuel-cycle environmental performance.

We further recommend that this strategy be pursued by efforts to coordinate and align various State energy R&D and financing mechanisms for clean energy system development, to aggressively pursue federal clean energy R&D funds, and to explore additional funding mechanisms. The major State mechanisms include the $64 million per year California Energy Commission (CEC) Public Interest Energy Research program, financing available under the California Alternative Energy and Advanced Transportation Financing Authority, the $200 million "Green Wave" clean energy investment program developed by State Treasurer Angelides, a re-aligned and expanded natural gas system public purpose R&D program, continued efforts to

garner federal energy and transportation R&D and demonstration project funds, and a new $16 million clean technology incubator sponsored by Pacific Gas and Electric, among other mechanisms.

The California Policy Setting and Energy and Environmental Conditions

The fact is that many U.S. states and nations around the world are aggressively positioning themselves to compete with California's role in this regard. The issues involved are therefore not only related to environmental and energy concerns, but also to local and regional economic development and to which states and countries will develop the most effective clusters for clean energy and transportation industrial activity.

California is a unique setting for clean energy technology development for several reasons. If considered a nation-state of its own, California would represent the fifth largest economy in the world. It is home to some 34 million people who drive 23 million automobiles. The State has historically experienced significant air quality problems and has special status under the Clean Air Act to enact its own particular air quality control measures. California is a global leader in high technology research and development, environmental policy and regulation, and agricultural and forestry production. It also is a major entertainment center and "style leader" for the U.S. and the world.

With regard to clean energy and alternative fuels for transportation, California has also taken a leading role. The State derives approximately 11 percent of its electricity from renewable sources, with plans to increase the percentage to 20 percent by no later than 2017. California has experimented with various alternative transportation fuels over the years and has aggressive plans to curb air pollution and greenhouse gases under the "zero emission vehicle mandate" and the "Pavley Law." California has more than one-fourth of the hybrid electric vehicles in the U.S. (over 11,000 at the end of 2003), and it is home to the California Fuel Cell Partnership – a public/private consortium that has tested 55 fuel cell powered vehicles in California over more than 145,000 accumulated miles – and the California Stationary Fuel Cell Collaborative that is promoting the commercialization of stationary fuel cell technologies.

More recently, California Gov. Schwarzenegger announced his intent to create a "California Hydrogen Highway Network" by signing executive order S-7-04 on April 20th, 2004. This initiative is intended to stimulate development of hydrogen infrastructure in California to remove a key barrier to the introduction of hydrogen-powered vehicles. Among other measures, this order designates the 21 interstate highways as part of that network and calls for a "California Hydrogen Economy Blueprint Plan" to be developed by January 1, 2005 for the "rapid transition to a hydrogen economy in California."

Key Elements of a California Hydrogen Strategy

As California expands hydrogen R&D, demonstration and experimentation projects, and infrastructure planning activities, we advocate a strategy that integrates the potential use of hydrogen into additional energy sectors beyond transportation systems. Future use of hydrogen in the transportation sector appears to have the greatest potential among known options for large reductions in GHGs, air pollutants, and petroleum use, but the barriers to hydrogen and fuel cell use for transportation remain significant. The use of hydrogen technologies for DG may become commercially attractive well before transportation, and there are also interesting potential synergies between the two. Furthermore, the combination of hydrogen systems with other advanced transportation technologies and concepts may also yield important synergies and efficiencies.

We recommend a strategy that includes the following key elements:

1) Build on existing projects, programs, and energy and transportation infrastructure and pursue aggressive but incremental steps as the vehicle market develops;
2) Use public/private partnerships to leverage resources and combine expertise;
3) Explore the integration of hydrogen infrastructure development with distributed electrical power generation (e.g. hydrogen "energy stations") and innovative mobility systems (e.g., shared-use vehicle services facilitated by electronic and wireless reservation and communication technologies);
4) Focus initial hydrogen infrastructure developments on prioritized "key corridors" and in a coordinated fashion, and include experimentation with innovative low-cost hydrogen distribution options (e.g. mobile dispensing platforms and integration with activities with large fleet and retail companies);
5) Emphasize and lay out a clear plan for using California's domestic resources to produce hydrogen cleanly, and increasingly from renewable sources, and prioritize R&D on electrolyzer and biomass-to-hydrogen systems;
6) Experiment with hydrogen for off-road uses including forklifts and other vehicles operating inside buildings, construction site applications, and in maritime and agricultural settings;
7) Demonstrate hydrogen safety and reliability through development of codes and standards and documentation of safety performance for hydrogen energy systems;
8) Use State action to encourage all hydrogen refueling stations, including those owned by public and private fleets, to be available to the public (wherever practical); and
9) Employ existing and new mechanisms, such as the partnership among Caltrans, the Air Resources Board, and CEC, to coordinate State agency activities as appropriate.

These measures among others can help to maximize the effectiveness of efforts to pursue the expanded use of hydrogen, reduce the risks of misplaced investments and stranded assets, and help to advance broader economic, environmental performance, and mobility goals.

Conclusions

We make the above recommendations for California hydrogen policy in the context of a major science and technology initiative aimed at making California a global leader in clean energy. We also more generally recommend greater R&D and clean technology market development support for the energy sector due to its seemingly ever greater importance in geopolitics, environmental health and justice, and social health and well being.

Hydrogen investments should constitute one part of a balanced energy R&D and development portfolio that also emphasizes more "tried and true" energy efficiency and clean fuel solutions. This will require strengthened and coordinated policies for development of renewable and other clean energy sources, continued and enhanced policies for cleaner and more efficient light and heavy-duty vehicles, greater attention to improving energy end-use efficiency, and leveraged and coordinated financing and R&D funding strategies.

In conclusion, continued development and deployment of clean energy technologies is critical to California's future economic growth, human health and welfare, and environmental quality. Hydrogen technologies represent one important part of this future, but *it is essential that efforts to promote hydrogen as an energy carrier occur in the context of a broader clean energy and energy efficiency strategy for the State*. This strategy would enhance the benefits that hydrogen can offer if the "hydrogen economy" does in fact develop rapidly, but it also would provide clear benefits to the State even if it does not.