Hawaii Renewable Hydrogen Program
Policy Evaluation & Recommendations
Final Report

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Prepared by:

Kolohala Holdings, LLP and Hawaii Natural Energy Institute
University of Hawaii-Manoa

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Working Partners:

Co-Author: Mitch Ewan – University at Manoa - School of Ocean and Earth Science and Technology – Hawaii Natural Energy Institute – Hydrogen Systems Program Manager

Co-Author: Joelle Simonpietri - University at Manoa - School of Ocean and Earth Science and Technology – Hawaii Natural Energy Institute – Senior Energy Analyst

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1.0 Objective of this Policy Recommendations Document

The objective of this document is to support implementation of the State of Hawaii's 2010 - 2020 Hawaii Hydrogen Plan for pathways to renewable hydrogen adoption, while aligning the policy recommendations for that plan with the Hawaii Clean Energy Initiative's (HCEI) goal to achieve 70% clean energy by 2030 as well as other State of Hawaii master plans and policy goals. The recommendations are designed to optimize policy effectiveness, in keeping with the recommendations of the National Renewable Energy Laboratory's "State of the States 2010" statistical analysis report, which showed that a suite of policies are more effective than single policies, and that policies are more connected with clean energy development the longer they are in place[1], indicating that policy longevity (and resulting market certainty for investors) is an important aspect of policy effectiveness.

1.1 Implementation Process

To facilitate implementation of pathways to renewable hydrogen, this document addresses the first of the following policy development steps:

1. Identify gaps and barriers within existing system which can be addressed effectively by policy changes.
2. Introduce legislation to fill policy gaps and reduce barriers at the state level.
3. Identify advocacy objectives and advocates to address policy gaps at federal or local level.
4. Conduct stakeholder and public outreach.
5. Measure progress.
6. Adjust policies based upon results.

1.2 Methodology

The authors of this report researched the U.S. Department of Energy-funded Database of State Incentives for Renewables and Efficiency (DSIRE USA) website's glossary of policy types[2] (archived in this document in Appendix D: List of Energy Policy Tools Available to Governments), the policies in place in Hawaii and other states as catalogued in the U.S. Department of Energy's Alternative Fuels and Advanced Vehicles Data Center[3], then reviewed the National Renewable Energy Laboratory's Center for Policy Analysis 2010 "State of the States" statistical review of renewable energy policies across the 50 U.S. states[4], reviewed the "Obstacles in Hawai`i Laws to Implementation of Energy Efficiency and Renewable Resources" policy analysis for the Hawaii Energy Policy Forum (HEPF)[5], then

[1] "State of the States 2010: The Role of Policy in Clean Energy Market Transformation," published by the National Renewable Energy Laboratory, 1617 Cole Boulevard Golden, Colorado 80401, Jan 2011, Contract No. DE-AC36-08GO28308, authored by Elizabeth Doris and Rachel Gelman. http://www.nrel.gov/applying_technologies/state_local_activities/pdfs/49193.pdf

[2] http://www.dsireusa.org/glossary/

[3] http://www.afdc.energy.gov/afdc/laws/laws/HI/tech/3270

[4] "State of the States 2010: The Role of Policy in Clean Energy Market Transformation," published by the National Renewable Energy Laboratory, 1617 Cole Boulevard Golden, Colorado 80401, Jan 2011, Contract No. DE-AC36-08GO28308, authored by Elizabeth Doris and Rachel Gelman. http://www.nrel.gov/applying_technologies/state_local_activities/pdfs/49193.pdf

[5] "Obstacles in Hawai`i Laws to Implementation of Energy Efficiency and Renewable Resources: A Review of Hawai`i's State and County Laws," Prepared for the Hawaii Energy Policy Forum by Carl Freedman, Haiku Design & Analysis, Dec 28 2007.

reviewed sample policies in use in other states (See Appendix B: Policies that all U.S. States havein Place), the U.S. Department of Energy's policy priorities as published in the Quadrennial Technology Review[6], the U.S. Fuel Cell Council's "Agenda for Action" policy document[7], considered some basic market trends as outlined in Appendix E: Market Context section, and finally reviewed each of the current Hawaii Revised Statutes as pertained to hydrogen, clean energy, bioenergy, land use, transportation, disaster response, and environmental regulation as well as recently published master plans and road maps, and outlined them in Appendix A: Policies Hawaii has in Place Today.

[6] U.S. Department of Energy, "Report on the First Quadrennial Technology Review" Sep 2011.
[7] U.S. Fuel Cell Council, "Fuel Cells and Hydrogen: An Agenda For Action: Public Investment in Fuel Cell Technology and Fuel Infrastructure," undated, 1100 H St NW, Suite 800, Washington DC 20005; posted on www.usfcc.com or www.usfc.com.

2.0 State of Hawaii Policy Goals and Context

Since there are several over-arching policy interests of the State of Hawaii codified in different laws, road maps, and master plans, this document takes an inclusive and holistic approach that allows rather than rules out future changes, and takes into account policies and objectives of existing plans, such as the directives of current law in the Hawaii Revised Statutes, the HCEI Road Map, Hydrogen Program Plans, and the Bioenergy Master Plan.

The State of Hawaii's over-arching policy interests can be grouped into three categories:

- Environmental Stewardship:
  - Carbon reduction;
  - Clean air and water and reduction of pollution;
  - Non-fossil energy use;
  - Fresh water use reduction and wastewater re-use increase;
  - Beneficial land use;
  - Develop clean energy resources;
  - Prioritize important agricultural lands for local energy and food production vice urbanization; and
  - Displace use of overused/overfished natural resources with sustainable substitutes.

- Economic Development:
  - Reduce impact of petroleum price volatility on the state economy by reducing the export of 10% of the Gross State Product (GSP) for fossil fuel imports;
  - Stabilize visitor industry by reducing petroleum price impacts on airfares;
  - Generate/maintain local living wage jobs;
  - Invest in local infrastructure and assets;
  - Develop local industries exporting goods, know-how, or research and development achievements;
  - Revitalize agriculture to reduce food and energy dependence on imports; and
  - Exercise leadership relative to other states on clean energy in order to continue to attract priorities, resources, and talent to Hawaii.

- Energy Security:
  - Maintain availability, reliability, and price stability of food and energy through natural disasters, economic disruption, or wartime;
  - Sustain emergency and critical operations for longer durations before resupplies are needed; and
  - Increase the resiliency of state emergency and backup systems to extended or extensive power outages.

2.1 Guiding Principles for Hydrogen Policy Recommendations

These guiding principles are the frameworks in which the specific policy recommendations and priorities in the next section are made:

- Accelerate adoption and reduce switching cost for renewable hydrogen technologies and systems;
- Minimize impact to state/county revenues/budgets;
- Capture underutilized resources and alleviate existing problems;
- Leverage existing economic, commercial market, military, technology, and energy resources and trends where renewable hydrogen already competes effectively; and

- Consistency and predictability of the policy and regulatory environment.

3.0 Policy Recommendations at the State Level

This section addresses the principles, master plans, and guidelines discussed above, factors in the policy already in place at the federal, state, and county levels as shown in the Appendices, identifies barriers that remain which can effectively be addressed by policy changes, and recommends provisions to address those policy gaps. Where feasible and appropriate, the provisions may also recommend implementing procedures, assignment of duties, and relevant funding sources. The new policy recommendations below do not attempt to address gaps that cannot be effectively addressed by policy, such as market trends and physical or technological limitations.

Table 1: Matrix of Recommended Policies and Guiding Principles

Recommended State of Hawaii Policy	Fitness with Guiding Principles				Recommended Year to Introduce New Policy
	Revenue Neutral	Address Other Problems	Work with Market Trends	Synchronize Existing Policy	
Alignment of Guiding Policies					
Integrate Clean Energy and Hydrogen Policies and Objectives	√			√	2012
Integrate Clean Energy and Emergency Power Investments Via Hydrogen	√	√	√	√	2013
Integrate Hydrogen Into State Goals and Master Plans	√			√	2014
Education and Facilitation					
Centralized Hydrogen Information Repository and Education	√	√	√	√	2012
Adopt a State Code for Hydrogen Production and Handling	√		√	√	2012
Adopt a Code for Vehicles	√		√	√	2014
Adopt Hydrogen Fuel Standards	√		√	√	2014
Facilitate Permitting	√	√		√	2013
Ease Implementation by Private Sector					
Include Fuel Cell Electric Vehicles Under the Definition of Electric Vehicles			√	√	2015
Continual funding of the Hawaii State Hydrogen Fund			√	√	2013
Metrics and Reporting					
Vehicle and Fuel Reporting Requirements	√			√	2015
Mandates					
None recommended at this time					

3.1 Alignment of Guiding Policies

3.1.1 Integrate Clean Energy and Hydrogen Policies and Objectives

Barrier:
There are several areas where clean energy and hydrogen initiatives overlap and where their working groups and implementation plans offer areas of alignment and also of competition. Examples include the State of Hawaii's Renewable Hydrogen Program and Objectives and Investment Capital Special Fund [HRS 196-10]; the public-private Hawaii Hydrogen Initiative (H2I); and the Hawaii Clean Energy Initiative led by the State of Hawaii Energy Office and the U.S. Department of Energy's Office of Electricity.

Recommendations:
HCEI should be primary, as the broader initiative in scope and stakeholder size and also one reflected in statute. However, the many benefits provided by hydrogen are un- or under-represented and should be more consistently incorporated into the HCEI work:

- H2I representatives should join and participate in HCEI, for example on the Transportation working group;
- The HCEI Road Map as finalized in 2010 does mention hydrogen vehicles alongside electric vehicles in some of its policy goals and metrics, however it did not anticipate the acceleration by General Motors, via H2I's launch in 2010, to develop a market and fueling infrastructure for hydrogen passenger cars by 2016. The Road Map as finalized in 2010 does not consistently mention hydrogen vehicles alongside electrical vehicles, leaving the priority between the two systems unclear. Recommend that the next revision of the HCEI road map add hydrogen vehicles and fueling infrastructure more consistently in strategy #4 of all phases in the short-term goals 2011-2015; and
- Reference H2I in representative accomplishments to date and important actions in future editions of the HCEI Road Map.

Recommended year to introduce this change: 2012, because many of these changes can be made within the HCEI working groups and road maps, and do not require legislative action.

3.1.2 Integrate Clean Energy and Emergency Power Investments Via Hydrogen

Barrier:
The State of Hawaii has both clean energy policies and also a long-standing practice of preparing for natural disasters.[89] However, "*standard practice*" prevents the common integration of these two areas, i.e. using onsite and distributed renewable energy to provide or extend backup or grid power in the event of disasters.[10] Moreover, federal and state studies after security and manmade disasters in 2001, 2006, and 2011 recently repeatedly

[8] State of Hawaii Emergency Alert System Plan as posted on Hawaii State Civil Defense website (http://www.scd.hawaii.gov/documents/EAS_Plan.pdf)
[9] National Infrastructure Protection Plan as published by the Department of Homeland Security (http://www.scd.hawaii.gov/documents/NationalInfrastructureProtectionPlan.pdf)
[10] http://gov.ca.gov/docs/ec/CalFIRE_Solar_PV_guideline.pdf

found the backup power supplies to critical infrastructure to be inadequate[11] and that standard assumptions on the ability to get timely re-supply do not cover actual outage periods.[12][13][14] Renewable hydrogen can be used to integrate the two and solve the inadequate backup power problem, by being made on site by electrolyzers using curtailed or excess renewable energy, and be stored between disaster events and then used as onsite backup power fuel via fuel cells. Recent trends have made this technical approach more cost-effective as well: photovoltaic prices have dropped by half since 2008[15] and the Federal Communications Commission's move after Hurricane Katrina in 2007 to mandate that cellular telephone towers all have backup power systems in place[16] led to rapid commercialization of backup power systems. Hydrogen fuel cell systems can now be purchased "off the shelf" that compete cost-effectively against diesel generators and conventional chemical battery backup uninterrupted power supply (UPS) systems for longer power outages.[17] There is a precedent for combining renewable energy and backup power systems in the State of Montana, which uses ratepayer public benefit funds to install photovoltaic backup power systems at a handful of fire stations each year.[18]

Recommendations:

- Encourage civil defense, public safety, broadcast, private communications, and first responder stakeholders to emplace or integrate onsite renewable generation and hydrogen backup power systems;
- Expand the availability of Special Purpose Revenue Bonds as governed by HRS 39A to investments that integrate clean energy, energy efficiency, and clean energy storage with hydrogen backup power systems;
- Prioritize contracting, funding, and placement of onsite renewable energy systems with hydrogen backup power systems to first responders and disaster response entities;
- Allow procurement agencies to include disaster response operability sustainment along with clean energy objectives and life-cycle costs in bid evaluation criteria and revise the Hawaii Administrative Rules accordingly;
- Encourage the city/county governments to convert buses to fuel cells buses to run on renewable hydrogen, for long-run cost savings in normal times and to be able to use the buses as portable backup power systems after disasters;
- Encourage city/county governments to expand the use of renewable hydrogen backup power systems for water/sewer pumping systems, and consider expanding their capacity to use renewable energy to electrolyze hydrogen onsite, thereby being able to use the water supply itself as an energy storage medium;
- Encourage contracting agencies for public safety facilities with hot water needs, such as fire stations, to consider hydrogen fuel cell systems for cost-effective heat and power for

[11] 2007 Governor's Comprehensive Communications Review Committee Fina Report (http://www.thebreakingnews.com/files/articles/hawaii-comprehensive-communications-review-report-1.05)
[12] http://the.honoluluadvertiser.com/article/2007/Oct/14/ln/hawaii710140358.html
[13] United States Government Accountability Office, "Report to the Chairman, Subcommittee on Communications, Technology, and the Internet, Committee on Commerce, Science & Transportation, United States Senate on EMERGENCY COMMUNICATIONS: Vulnerabilities Remain and Limited Collaboration and Monitoring Hamper Federal Efforts, delivered 2009. See http://www.gao.gov/new.items/d09604.pdf
[14] http://www.nhc.noaa.gov/sshws_table.shtml?large
[15] Plenary speech at the American Council on Renewable Energy's Renewable Energy Finance Forum, June 2011.
[16] http://www.pcworld.com/article/154835/white_house_rejects_celltower_backup_power_plan.html
[17] City and county of Honolulu Board of Water Supply decision to purchase hydrogen backup power system.
[18] http://www.renewableenergyfocus.com/view/3681/montana-firefighters-use-photovoltaics-pv-technology-for-emergency-response/

every day use and put the connections in place to be able to tap into those fuel cell systems for emergency use;
- Allow governing specifications and procurements to allow additional up-front costs necessary to augment onsite renewable energy generation to integrate with emergency systems and related energy storage systems. Revise the Hawaii Administrative Rules for procurements accordingly;
- Upgrade those schools that are designated evacuation shelters for natural disasters and also have or are getting photovoltaic or similar onsite renewable energy installations with hydrogen backup power systems capable of supporting critical loads, such as refrigerators for medication, water pumps for sanitation, and power for communications;
- Direct the Public Utilities Commission to expand allowable uses of ratepayer funds, like the Public Benefits Fund, to defray the cost of renewable hydrogen backup power systems for emergency and disaster response applications; and
- Adopt the National Fire Protection Association (NFPA) 110 Standard for Standby Power Systems.

Recommended year to introduce this change: 2013, because integrating these two policy sectors is complicated so will require more time to get stakeholder input before introducing legislation, but should not be put off for longer in order to capitalize on the millions of dollars in investment being put into place each year at this time.

3.1.3 Integration of Hydrogen into State Goals and Master Plans

Barrier:

State, county, and city planning and permitting functions may not have the scope or authority to align their departmental functions and regulations to meet the priorities and recommendations established by the state in other Hawaii Revised Statutes and applicable master plans and road maps that overlap but are not directly applicable to the guiding law for their particular function.

Recommendation:

- Modify the methodology for Environmental Impact Studies or Environmental Assessments to include mitigation of existing problems and not just presentation of new ones. The current system only allows negative marks in categories such as land, water, air and cultural impact. The best a project can do is get a finding of “no significant impact.” Projects that go an extra step to address existing problems such as petroleum/fossil energy dependence, wastewater treatment capacity limits, waste generation and handling, freshwater availability reduction, unsustainable sourcing, or conversion of Class A and B agricultural land to non-agricultural purposes, should be able to get credit for those efforts they make above and beyond the normal/neutral “no impact” projects.
- Charge planning and permitting agencies as well as the Public Utilities Commission (PUC) with evaluating fitness of applicant plans against the state’s related road maps and stated priorities. Sample plans to consider include the Hawaii Clean Energy Initiative statutory authority and road map, renewable hydrogen program plan, bioenergy master plan, and transportation master plans.
- Consider requiring that urban renewal plans [HRS 53-52] specifically address private transportation, to include alternative transportation options like hydrogen fueling and electric vehicle charging, in addition to the current requirement to consider public transportation access.

- Consider amending the state law creating county planning commissions [HRS 46-5] to allow the commissions to include electric and hydrogen vehicle charging needs and infrastructure in their scope of authority.
- Support the U.S. Department of Interior's National Park Service's plan to demonstrate hydrogen-fueled buses at Volcano National Park on the island of Hawaii in order to transport visitors safely to and from lava sites and also reduce operational fuel cost relative for petroleum-based diesel fuel by utilizing low-cost hydrogen produced by electrolysis from electric produced by volcanic/geothermal energy capture.
- Support the County of Hawaii's plan to convert the municipal bus fleet to hydrogen in order to reduce operational fuel costs.

Recommended year to introduce this change: 2013, because integrating these two policy sectors is complicated so will require more time to get stakeholder input before introducing legislation, but should not be put off for longer in order to start realizing some of the benefits of aligned policies in permit applications and PUC dockets currently or soon to be in pipeline.

We also considered but rejected a recommendation that the State mandate its Department of Transportation expand its current highway and transit planning functions to include alternative and alternative-fuel vehicle purchase decisions and fueling/charging placement. Those decisions and placements are traditionally performed by the private sector. For example, for state transportation master plan as maintained by the state of Hawaii Department of Transportation's Highways Division [HRS 279E-7] and the state Tourism Authority's tourism master plan [which is referred to in HRS 198D-2], the state maintains oversight of the system needed to get people from point A to point B and improvements such as road resurfacing, new signage, road widening, road lighting, and traffic signals. The plan and planning functions leave decisions about what types of vehicles travel over those roads, and how and where those vehicles are fueled, to the private sector. Private companies decide where to put retail stations in order to most profitably serve customer demand and traffic patterns.

3.2 Education and Facilitation

3.2.1 Centralized Hydrogen Information Repository and Education

Barrier:

The State of Hawaii has many hydrogen-related activities in infrastructure, research, and development, however even industry practitioners lack a clear overall picture. The general public may not have the information it needs to understand the safe use of hydrogen. This can cause concerns about safety and slow the acceptance of hydrogen and hydrogen technologies in the marketplace. Technicians, first responders, and the public should also have the information they need to handle hydrogen safely. Training, certification, and targeted communications should be continually funded through the Energy Systems Development Special Fund (aka "Barrel Tax"), the Hydrogen Investment Capital Special Fund and/or the Environmental Management Special Fund. See Appendix A: Policies Hawaii has in Place Today for references to those funds and applicable uses. Prioritized uses for those funds are in the following recommendations.

Recommendations:

- Maintain a state hydrogen website under the Department of Business, Economic Development, and Tourism charged with maintaining and updating a central repository of hydrogen-related activity in the state;
- Provide first responder training on hydrogen storage, dispensing, and vehicles;
- Provide training for code enforcement officials;
- Provide training for agency staff in hydrogen technology, codes, analysis, and life cycle costing. Consider modifying HRS 103D-110 accordingly;
- Implement contractor licensing and training in hydrogen storage, dispensing, transportation, backup power, and other applicable hydrogen systems;
- Ensure mid-career education is available for specify-build-install-repair professions and trades. Consider modifying HRS 464 accordingly;
- Provide outreach media information;
- Calculate and communicate benefit to potential Fuel Cell Electric Vehicle owners, similar to the outreach that has been done for prospective plug-in electric vehicle owners;
- Encourage development of decision-making tools. Include modules for retail vehicle buyers, auto dealers, grid stability, fueling stations; and
- Science Technology Engineering and Math (STEM) education integration by providing renewable hydrogen energy systems education in K-12 as a component of the science curriculum.

Recommended year to introduce this change: 2012, because establishing such a communications hub is called for in HRS 196-10 and funds from the "barrel tax" are now available to start designing and implementing a dedicated communication portal.

3.2.2 Adopt a State Code for Hydrogen Production and Handling

Barrier:

The state currently does not have an agreed set of hydrogen codes and standards. A lack of accepted codes and standards makes it difficult for relevant experts to implement the policies and meet many of the objectives laid out in the Hawaii Revised Statutes: for design engineers to design against, for permitting authorities the ability to evaluate the safety of projects and issue permits, and for developers to develop accurate cost estimates and acquire effective insurance policies. The current system is ad hoc. This makes each project a unique and time-consuming effort, and expense must be invested in ensuring that adequate safety is being accomplished in the development and execution of a design.

Recommendation:

The State of Hawaii shall promulgate the National Fire Protection Association's Hydrogen Technologies Code (NFPA 2) as the set of codes and standards for all aspects of hydrogen production, storage, use, and handling in the State for stationary and portable applications. NFPA 2 is structured to work seamlessly with other NFPA codes the State already has licensed for compressed and cryogenic gases, building codes, and fire codes.

- Hawaii State Department of Health shall be designated as the state Hydrogen Permitting Authority (HPA) to align with existing regulatory authority for compressed gases and cryogenic gases, hazardous materials, etc.;
- The state HPA shall have the technical expertise on staff to evaluate compliance of projects with NFPA 2;
- The HPA shall provide technical support to other state departments and to county permitting departments;

- The HPA shall ensure that the state is using the most current version of NFPA 2 and will ensure that all departments with a need to know are kept up-to-date on the most current standards;
- The HPA shall become a member of the NFPA working group; and
- The HPA shall report any issues to the NFPA WG for evaluation and make recommendations for changes to NFPA 2 that are appropriate to Hawaii.

In addition, the state could consider enacting environmental and energy standards for hydrogen production to encourage renewable hydrogen production, rather than fossil-derived hydrogen, similar to legislation in place in the state of California.

Recommended year to introduce this change: 2012, because code and standard uncertainty is delaying existing projects called for by HRS 196-10 and paid for through the Hydrogen Investment Capital Special Fund.

3.2.3 Adopt a Code for Vehicles

Barrier:
There is general uncertainty about the safety, reliability, and performance of new alternative-fueled vehicles that are not yet in mass production and proven reliable over time on public roads.

Recommendation:
ANSI/CSA America FC1-2004 (formerly ANSI Z21.83) is an American National Standard for Fuel Cell Power Systems. This standard provides design, construction, operating and quality requirements for fuel cell power systems operating on:

- Natural gas, methane gas mixtures;
- Liquid petroleum gases;
- Methane, ethane, kerosene, diesel, gasoline; and
- Hydrogen gas and/or Zinc particulates conveyed in a non-flammable liquid medium:
  - At an output voltage not exceeding nominal 600 VAC or 600 VDC; and
  - At a power output not exceeding 10 MW.

While hydrogen and fuel cell systems in vehicles pertain directly to the propulsion and drive train and not the balance of the vehicle, having an agreed-upon set of codes and standards can help to reduce uncertainty.

Recommended year to introduce this change: 2014, because having an agreed-upon set of codes should facilitate the planned introduction of mass-produced hydrogen vehicles in 2016 but research on the codes and standards still needs to be completed and accepted.

3.2.4 Adopt Hydrogen Fuel Standards

Barrier:
Automobile suppliers and dealers would like to sell fuel cell electric vehicles in Hawaii and are working with private sector suppliers to develop the fueling infrastructure for hydrogen vehicles, however there is uncertainty about how to standardize the fuel itself in order to have a fungible refueling system that all parties can rely upon. Certification standards of

qualifying hydrogen and plug-in electric vehicles are needed to ensure minimum quality standards are met. This is especially important for consumer protection and retrofit kits.

Recommendation:
If a voluntary industry consensus cannot be arrived at, adopt the following American Society for Testing and Materials International (ASTM) testing standards for hydrogen fuel, as may be amended from time to time by ASTM or replace with the rules used by the fuels purity test program. These include:

1. ASTM D7606-11 Standard Practice for Sampling of High Pressure Hydrogen and Related Fuel Cell Feed Gases ;
2. ASTM D7650-10 Standard Test Method for Test Method for Sampling of Particulate Matter in High Pressure Hydrogen used as a Gaseous Fuel with an In-Stream Filter ;
3. ASTM D7652-11 Standard Test Method for Determination of Trace Hydrogen Sulfide, Carbonyl Sulfide, Methyl Mercaptan, Carbon Disulfide and Total Sulfur in Hydrogen Fuel by Gas Chromatography and Sulfur Chemiluminescence Detection ;
4. ASTM D7649-10 Standard Test Method for Determination of Trace Carbon Dioxide, Argon, Nitrogen, Oxygen and Water in Hydrogen Fuel by Jet Pulse Injection and Gas Chromatography/Mass Spectrometer Analysis ASTM D7653-10 Standard Test Method for Determination of Trace Gaseous Contaminants in Hydrogen Fuel by Fourier Transform Infrared (FTIR) Spectroscopy ;
5. ASTM D7651-10 Standard Test Method for Gravimetric Measurement of Particulate Concentration of Hydrogen Fuel ;
6. ASTM D7675-11 Standard Test Method for Test Method for the Determination of Total Hydrocarbons in Hydrogen by FID Based Total Hydrocarbon (THC) Analyzer ; and
7. ASTM D7634-10 Standard Test Method for Visualizing Particulate Sizes and Morphology of Particles Contained in Hydrogen Fuel by Microscopy ASTM D7265-06 Standard Specification for Hydrogen Thermophysical Property Tables .

Recommended year to introduce this change: 2015, in order to have more certainty for industry at least a year prior to the planned introduction of mass-produced hydrogen vehicles in 2016.

3.2.5 Permit Facilitation

Barrier:
In some states, such as Illinois, state law had to be amended to allow the state department of health/clean air regulation to be able to issue permits to facilities designed primarily to produce hydrogen from biomass. It is out of the scope of this document to determine whether similar a amendment would be required in Hawaii Law or regulation for the Hawaii State Department of Health's air permit issuance. The State of Hawaii does have several permit facilitation laws and a funded position already in place within the Department of Business, Economic Development and Tourism (DBEDT) for renewable energy in general, so additional legislation for permit facilitation for a subset of that, for renewable hydrogen production, does not appear to be necessary at this time.

Recommendation:
Require that the DBEDT review with the State Department of Health whether there might be an unnecessary level of air regulation levied upon renewable hydrogen production, such as production from biomass, over and above the necessary and reasonable level of regulation

required of other hydrogen production methods, like those used in Hawaii today to extract hydrogen from fossil fuels.

Recommended year to introduce this change: 2013, since whether or not this policy change will be needed depends upon some baseline research.

3.3 Ease Implementation by Private Sector

3.3.1 Include Fuel Cell Electric Vehicles Under the Definition of Electric Vehicles

Barrier:
Much like for electric vehicles, there is a barrier for consumers to switch from traditional petroleum-fueled vehicles to alternative vehicles.

Recommendation:
Amend the statutory definition of qualifying electric vehicles to include fuel cell electric vehicles with the same status as battery or plug-in and plug-in hybrid electric vehicles, particularly for the vehicle purchase tax credit and the rental vehicle surcharge exemption [for an example, see HB 444]. Including fuel cell electric vehicles under the definition of electric vehicles for the purpose of access to reserved electric vehicle parking/charging spaces [HRS 291-71 and 291-72] is not necessary.

Recommended year to introduce this change: 2015, in order to have more certainty for industry at least a year prior to the planned introduction of mass-produced hydrogen vehicles in 2016.

3.3.2 Continual Funding of the Hawaii State Hydrogen Fund

Background:
The US Department of Energy manages an aggressive and highly successful hydrogen program – *Hydrogen, Fuel Cells & Infrastructure Technologies Program – Multi-Year Research, Development, and Demonstration Plan*. Planned program activities span the period 2005-2015. The Program works with industry, national laboratories, universities, government agencies, and other partners to overcome the challenges to commercialization of hydrogen and fuel cell technologies. The Program integrates R&D activities in hydrogen production, delivery, storage, and fuel cells within DOE's Offices of Energy Efficiency and Renewable Energy (EERE); Nuclear Energy, Science and technology: Fossil Energy: and Science.

Developing hydrogen as a major energy carrier will require a combination of technological breakthroughs, market acceptance, and large investments in infrastructure. Success will be incremental over decades; and will require an evolutionary process that phases hydrogen in, assisted by government policies, as the technologies and their markets mature.

The successful development of hydrogen energy from diverse domestic resources will ensure that Hawaii has an abundant, reliable, and affordable supply of clean energy to maintain the State's prosperity throughout the 21st Century.

Hawaii has been very successful in winning competitive bids from the US DOE for multi-million dollar hydrogen infrastructure projects. These have included hydrogen production stations from geothermal power, hydrogen fueling stations on the Big Island and Oahu,

hydrogen production technologies from biomass and sewage waste, hydrogen-fueled buses, and the deployment of the first fleet of General Motors Fuel Cell Electric Vehicles (FCEVs). All US DOE projects require "skin in the game" in the form of cost share and depending on the degree of technological risk, can be from 20% to 50% of the total project budget. The participation of the State in supporting the cost share requirement sends a strong signal to the US DOE that Hawaii is committed to the project provides a competitive edge.

The FY2012 US DOE hydrogen budget totals $104 million as follows:

- Fuel Cell Systems R&D $45.5M*
- Hydrogen Fuel R&D $35.0M*
- Systems Analysis $3.0M
- Manufacturing R&D $2.0M
- Technology Validation $8.0M*
- Safety, Codes, and Standards $7.0M*

* Projects that have Hawaii participation

The Hawaii Hydrogen Fund was established by the legislature to support the development of a hydrogen economy in Hawaii. This multi-faceted program includes installing the infrastructure necessary to produce, store, and distribute hydrogen. The fund was initially funded with an $8.7 million appropriation and was directed to provide:

- Investments to support projects that developed the renewable energy sources that could be used to produce hydrogen;
- Hydrogen infrastructure such as hydrogen production and dispensing systems;
- Supporting local entrepreneurs to develop hydrogen technologies.
- Cost share required to capture federally funded projects.

The Fund has been highly successful in attracting hydrogen related projects to Hawaii:

- State funding has been leveraged 30x - the original goal was 10x;
- Approximately $120 million in funding has been co-invested or granted to companies supported by the Hydrogen Fund;
- Cost share in private companies has been converted to equity;
- The State Hydrogen Plan has been developed and integrated into HCEI;
- The State has gained recognition for leadership in hydrogen;
- General Motors launched its Equinox Fuel Cell Electric Vehicle in Hawaii;
- A Geothermal-to-Hydrogen project has been established on the Big Island; and
- Hydrogen buses are being demonstrated at Volcanoes National Park and the County of Hawaii Hele-on bus system.

Barriers

All US DOE projects require "skin in the game" in the form of cost share and depending on the degree of technological risk, can be from 20% to 50% of the total project budget The original Hydrogen Fund appropriation has been expended and there are no funds available for cost share support. To continue our momentum a consistent level of funding is required to exploit the successes that have been accomplished. The Federal government has ongoing hydrogen projects and Hawaii is strategically placed to win new projects. However, these projects will require cost share support from the state.

Recommendations

1. Provide Continued Funding for the Hydrogen Fund
   The Hydrogen Fund continue to be appropriated funding to continue its operations. Sources of funds could be:
   - An appropriation from the general fund;
   - An annual allocation from the Barrel Tax fund;
   - An annual allocation from Hawaii Energy.

2. Broaden the Focus of the Fund
   Broaden the focus of the fund to support renewable energy sources development. The production of hydrogen requires the input of some form of energy – electricity from solar, wind and geothermal sources; Municipal Solid Waste; and biomass feedstock from energy crops or food crop residues. These renewable energy sources need to be developed and the Hydrogen Fund may be a good vehicle to accomplish that.

Recommended year to introduce this change: 2013, after an assessment of the performance of the first five years of the first Hydrogen Investment Capital Special Fund.

3.4 Metrics and Reporting

3.4.1 Vehicle and Fuel Reporting Requirements

Barrier:
The State of Hawaii has established goals for clean energy adoption and has generally tasked the Department of Business, Economic Development, and Tourism (DBEDT) with tracking progress towards meeting those goals, however the data needed to measure progress is not consistently reported to the state or by electronic means that allow for rapid aggregation and analysis.

Recommendation:
Require reporting to ensure HCEI metrics can be measured and tracked:

- Require fuel distributors to report the amount and types of non-fossil fuel sold into the state's fuel supply, whether liquid or gaseous. Apply/modify the definitions of fuel entities in HRS §196-2; and
- Require city and county motor vehicle departments to track and report registrations of motor vehicles capable of utilizing hydrogen fuel, whether liquid or gaseous, to DBEDT at least annually. Retrofitted vehicles should be tracked and reported in the same manner as original equipment vehicles.

Recommended year to introduce this change: 2015, in order to have some lead time to review and revise forms and databases prior to the planned introduction of mass-produced hydrogen vehicles in 2016.

3.5 Mandates

We do not recommend any hydrogen-related mandates be enacted in State of Hawaii policy at this time. Existing mandates, such as the "barrel tax" [HRS §243-3.5] and Act 234 "greenhouse gas law" enacted in 2007 have either recently been enacted or rules are still

being developed, and effects have not yet been determined. Another recently enacted mandate, the electric vehicle charging spot mandate [HRS 291-71] has received negative feedback from city and county administrators, as reported in the Hawaii Energy Policy Forum meeting Oct 2011. Feedback has been negative for three reasons: 1) the requirement that charging stations be placed in 1% of all parking lots with over 100 spaces did not allow the counties any discretion to place stations where they would best be utilized by projected customer analysis, driving patterns, or charging needs. As an example, the law did not facilitate the placement of charging stations in small lots where the county vehicles themselves would have been parked and charged; 2) The mandate was not accompanied by any funds to defray the cost of installing charging systems; and 3) since there are so few electric vehicles in circulation, the majority of the reserved electric vehicle spots are empty and therefore represent lost revenue for the city/county.

If the state were to consider a mandate pertaining to hydrogen for the long term, we would recommend a limited transitional period for fossil-derived hydrogen such as that reformed from liquefied natural gas, after which eligibility for state incentives/mandates would be limited to hydrogen produced from renewable sources. To prevent being too prescriptive and "picking winners" in a field undergoing a lot of technical development, we recommend qualifying pathways include electrolysis of water by electricity produced from renewable energy sources as well as direct production of hydrogen from biomass or waste. Qualifying hydrogen fuel could be gaseous, compressed, or liquefied.

4.0 Incentives and Requirements at the City & County Level

Barrier:
There is a switching cost to all systematic change, and these costs can be especially hard to overcome at the retail level where individual consumers need to make choices. In some of these areas, policy changes at the state level have less impact than those imposed at the local or city and county level.

Recommendations:

- Expand High-Occupancy Vehicle (HOV) Lane eligibility to include fuel cell electric vehicles (FCEV), like that currently in place for PHEV and EV, for up to 5 years after enactment;
- Expand free municipal parking to include fuel cell electric vehicles (FCEV), like that currently in place for PHEV and EV, for up to 5 years after enactment;
- Consider emplacing vehicle traffic congestion pricing, like that used in the Cities of Washington DC, London, and Singapore, to have a toll for entering congested districts at peak hours. An equivalent system for the most heavily trafficked areas, such as the Pearl Harbor to Punahou area in Honolulu, would help to meet the HCEI ground transportation goal of encouraging the reduction of vehicle miles traveled (VMT) and support use of the rail system and work-at-home policies;
- Require vehicle owners to report ownership of plug-in electric/hydrogen vehicles or conversion of vehicles to the City/County Department of Motor Vehicles with their initial and annual vehicle registrations;
- Review whether the state code adoptions discussed above would require changes to related codes at the City and County level; and
- Require C&C/utility to track and report electric/hydrogen vehicle registrations to DBEDT.

Appendix A: Policies Hawaii has in Place Today

Except areas identified above for alignment and clarification, we support retaining the policies the State of Hawaii already has in place, which include:

1. **Guiding principles: [**HRS § 196-1**]**
   Lists findings and declaration of necessity with regards to energy sources and use in the State of Hawaii and the need for more use of indigenous renewable resources.

2. **Gases:**
   Included in the statutory definition of 'Fuel" [HRS § 196-2].

3. **The Hawaii Clean Energy Initiative (HCEI) Program:**
   Established within DBEDT [HRS § 196-10.5] to develop a plan to transition the state to a clean energy economy by 2030. The state law implements a 2008 Memorandum of Understanding (MOU) with the U.S. Department of Energy to collaborate to produce 70% of the state's energy needs from energy-efficient and renewable sources by 2030. This effort is part of the Hawaii Clean Energy Initiative. The goals of the partnership include defining the structural transformation required to transition the state to a clean energy-dominated economy; demonstrating and fostering innovation in the use of clean energy, including alternative fuels; creating opportunities for the widespread distribution of clean energy benefits; establishing an open learning model for other states and entities to adopt; and building a workforce with cross-cutting skills to support a clean energy economy in the state.[19]

4. **Hawaii** Bioenergy Master Plan **(established under Act 253, SLH 2007)**

5. **Renewable Hydrogen Program Plan [**HRS §196-10**]**

6. **Integrated Solid Waste Management Plan:**
   To include a requirement for Hawaii's counties to characterize waste flows and estimate the output energy that could be recaptured through combustion, conversion to fuel, and other forms to include hydrogen. [HRS § 342G-26]

7. **Metropolitan Planning Organization:**
   Responsible for transportation master plan for the state and that the counties have at least short-term (6 year) transportation master plans in place. [HRS § 79E-7]

8. **Renewable portfolio Standard (RPS):**
   Mandates that the privately-held electric utilities in the state achieve at least 40% renewable energy by 2030 [196-41]. Electricity derived from hydrogen produced from renewable energy sources is among the qualifying clean electricity sources listed in the RPS that could be used by a utility to meet the RPS mandate. [HRS § 269-91].

[19] http://www.afdc.energy.gov/afdc/laws/laws/HI/tech/3270

9. **Energy Efficient Portfolio Standard (EEPS):**
   Mandates State achieve four thousand three hundred gigawatt hours of electricity use reductions statewide by 2030, equivalent to a 30% reduction in statewide electricity use from 2005 levels. [HRS § 269-96]

10. **Feed-In Tariff (FIT) [235-12.5]**
    Requires standard rates to be set for renewable energy systems to connect to the grid, based on the system size and percentage penetration of the grid. For more information, see Hawaiian Electric Company's website.

11. **Net Metering law [HRS§ 269-101]:**
    Allows small producers of electricity produced from biomass as well as solar and wind to connect to the grid and be paid at retail rates for the power supplied, and that the net metered customers do not have to pay any additional standby or interconnection charge. [HRS§ 269-102].

12. **HRS§ 196-42 State support for achieving alternative fuels standards:**
    The state of Hawaii is responsible for facilitating the development of alternative fuels and supporting the attainment of a statewide alternative fuels standard. The alternative fuels standard will be as follows: alternative fuels will provide 10% of highway fuel use by 2010, 15% by 2015, 20% by 2020, and 30% by 2030. For the purposes of the alternative fuels standard, ethanol produced from cellulosic materials is equivalent to 2.5 gallons of non-cellulosic ethanol. [HRS § 196-42]

13. **State Energy Office:**
    Hawaii has a state energy office, where HRS§ 196-3 designates the DBEDT Director as the state energy resources coordinator and HRS HRS§ 196-4 establishes the duties. In addition, the state has a permit facilitation requirement within DBEDT for large-scale renewable energy projects. Existing permitting legislation includes the following:

    a) [HRS§ 196-1.5] All state agencies shall have Priority permitting process for renewable energy projects.

    b) A state-funded renewable energy permit facilitator as a full-time exempt position from collective bargaining (HRS§ 201-12.5).

    c) Streamlined permitting process for geothermal energy and inter-island energy cable development. [HRS § 196 D]

14. **"Barrel Tax":**
    Formally known as the Environmental Response, Energy, and Food Security Tax [HRS§ 243-3.5], places a $1.05 tax on each barrel of petroleum product sold for non-aviation purposes. 25 cents of each barrel's tax revenues are placed into two funds which could be resources for hydrogen-related energy security and energy development programs: 15 cents of the tax on each barrel shall be deposited into the energy security special fund established under section 201-12.8; and 10 cents of the tax on each barrel shall be deposited into the energy systems development special fund established under section HRS§ 04A-2169. The tax also has the secondary effect of creating a modest price advantage for renewable fuels and hydrogen.

15. **Hydrogen Investment Capital Special Fund [**HRS§ 211F-5.7**]:**
    Administered by the Hawaii Strategic Development Corporation [HRS§ 211F] for investments to create job opportunities and further economic development within the state.

16. **Environmental Management Special Fund [**HRS§ 342G-63**]:**
    Created for solid waste management and container recycling, where fee income is directed to be used for program costs, statewide education, and annual training for solid waste handlers. Includes a provision to use the funds for statewide and education and training on desirable uses of solid waste such as green waste, sewage sludge, etc. Education and training on how to use those waste resources for hydrogen production could be considered a permitted use of those funds. The fund was drawn down by $750,000 by the Hawaii legislature in 2010 to help close a general fund deficit. It is not clear what the remaining balance was after that withdrawal and what the rate of refill/drawn down for Integrated Solid Waste Management program costs has historically been.

17. **Investment tax credits for renewable energy generation:**
    Individuals or corporations can claim a state income tax credit equal to 35% of the system's cost [HRS § 235-12(b)(1) and HRS § 235-12(b)(4)] or elect to take a 27.5% refundable credit in lieu of the 35% tax credit.

18. **Ethanol blending**
    10% (E10) mandate (HRS§ 486J-10).

19. **Enterprise zones [**HRS Chapter 209E**]:**
    Offer a seven-year holiday against the state business tax of up to 80% of the eligible tax due, and a 100% credit against general excise tax that would otherwise be owed for construction in an enterprise zone or gross revenues of eligible products. These incentives are available to eligible businesses located in the zone, which includes manufacturers, service businesses, research and development, and utility-scale wind energy production. Manufacture of renewable hydrogen would probably qualify, but it appears that utility-scale backup power using any renewable energy other than wind, or electricity storage medium of any kind, would not qualify under current city and county enterprise zone designations.

20. **Important Agricultural Lands:**
    Designation and incentives [HRS § 205-4.5], to include listing the permitted uses for master productivity Class A and B land, in which is included growing and processing biomass into liquid or gaseous fuel.

21. **Lease of State Lands:**
    [HRS § 171-95] allows Board of Land and Natural Resources to lease state land for public utilities and renewable energy developers for purposes that include hydrogen production, without having to go to public auction.

22. **Solar energy [HRS § 196-7] and electric vehicle charger [HRS § 196-7.5] placement access law:**
    Homeowner's association mandates that homeowner's associations shall not impose conditions or restrictions upon single-family home or townhome owners that render the device more than twenty-five per cent less efficient or increase the cost of installation, maintenance, and removal of the device by more than fifteen per cent.

23. **Solar Hot Water Heater Mandate:**
    All new construction after Jan 1, 2010, which can be substituted by other suitable renewable system, as defined in section HRS § 235-12.5.

24. **Energy efficiency and environmental standards for state facilities, motor vehicles, and transportation fuel:**
    HRS HRS § 196-9 requires state buildings meet LEED silver. [HRS § 196-19] requires life cycle and other tracking and reporting of state vehicles and fleets. HRS § 196-11 defines life cycle costs in support of HRS § 196-19.

25. **State vehicle fleet procurement policy [HRS § 103D-412]:**
    Mandates and prioritizes hydrogen vehicles in state procurement after electric vehicles and before all others, specifically prioritizing: 1) electric vehicles and plug-in hybrid electric vehicles (EV/PHEV), 2) hydrogen vehicles, 3) other alternative-fueled vehicles, 4) hybrid vehicles and then 5) fuel economy leaders.

26. **The Act 234 greenhouse gas law**
    Enacted in 2007 aims to reduce carbon emissions in Hawai`i to 1990 levels by the year 2020. Rules are due out from the state Department of Health (DoH) in December 2011. It is not clear yet what standards the state will adopt, for example the ASTM E2725-10 Standard Guide for Basic Assessment and Management of Greenhouse Gases .

27. **Refundable General Excise Tax Credits:**
    For clean energy equipment such as PV panels and inverters.

28. **Public Benefit Fund: HRS § 269-121:**
    Provides authority to the Public Utilities Commission to establish a ratepayer-funded Public Benefits Fund and to appoint a third-party administrator. The PUC did so with docket No 05-0069 to appoint an administrator for the investor-owned utilities on the major islands of Oahu, Maui, Hawaii, Molokai and Lanai but not the ratepayer-owned utility on Kauai. These funds can be applied to electric grid aspects of hydrogen, but not vehicles.

29. **Contractor Licensing**
    For solar hot water and photovoltaic installers to ensure codes and standards are met.

30. **Petroleum Industry Reporting:**
    Monthly reporting by petroleum industry to DBEDT of the barrels of product imported, refined, and exported to/from the State of Hawaii. [HRS § 486J-3]

31. **State and city and county adoption of electrical codes and standards:**
    For solar, wind, biomass, and hydroelectric electricity generators from the National Electrical Code, the Institute of Electrical and Electronics Engineers, and accredited testing laboratories such as the Underwriters Laboratories. Systems under 10kW in size are exempt from requirements by the electric utility or Public Utilities Commission to provide

additional testing and certification, such as interconnection studies. [HRS § 269-111] The City and County of Honolulu has updated the Honolulu Electrical Code (ROH Chapter 17) – to reference the 2008 National Electrical Code per Ordinance 09-029 and the Building Energy Conservation Code (ROH Chapter 32) – to reference the 2006 International Energy Efficiency Code.

32. Disaster Response:
In disaster response situations where the Governor has declared a state of emergency, agricultural irrigation water providers can contract with independent power producers to provide backup power for irrigation systems and not trigger Public Utilities Commission oversight for either the irrigation system or the independent power producer, for the duration of the emergency. [HRS § 209-10].

33. Electric Vehicle (EV) High Occupancy Vehicle (HOV) Lane and Parking Fee Exemptions:
Qualified EVs affixed with special state-issued EV license plates may use HOV lanes regardless of the number of passengers and are also exempt from parking fees charged by any non-federal governmental authority. (Reference Hawaii Act 290, 1997).

34. Plug-in Electric Vehicle (EV) Parking Requirement:
All public, private, and government parking facilities that are available for use by the general public and that include at least one hundred parking spaces must designate at least 1% of the spaces specifically for EVs by December 31, 2011. At least one of the parking spaces must be located near the building entrance, and spaces must be clearly marked and equipped with an EV charging unit that meets recognized standards. Owners of multiple parking lots may designate and install an EV charging unit in fewer parking spaces than required in one parking lot, as long as the total number of aggregate spaces for all parking lots is met. The spaces designated for EVs will continue to increase by 1% for each additional 5,000 registered EVs until the percentage reaches 10%. Penalties apply for non-EVs that park in parking spots designated for EVs. [HRS § 291-71 and HRS § 291-72].

35. "Right-to Plug-in" Electric Vehicle (EV) Charging System Requirements for multi-unit structures:
A multi-family residential dwelling or townhouse owner may install an EV charging system at a parking stall at the dwelling as long as the system is in compliance with applicable rules and specifications; the system is registered within thirty days of installation; and the homeowner receives consent from the private entity if the system is placed in a common area. Private entities may adopt rules that restrict the placement and use of charging systems, but many not charge a fee for the installation of a vehicle charging system. The owner of a charging system is responsible for any damages resulting from the installation, maintenance, repair, removal, or replacement of the system. A private entity includes any association of homeowners, community association, condominium association, or cooperative. (Reference Hawaii Revised Statutes 196-7.5)

36. Utility/Private Incentives

- Plug-In Electric Vehicle Charging Rate Incentive - Hawaiian Electric Company. The Hawaiian Electric Company offers Electric Vehicle (EV) Pilot Rates for both residential and commercial customers. The pilot EV rates are available to 1,000 customers on Oahu, 300 in Maui County, and 300 on the Island of Hawaii for

charging highway-capable, four-wheeled battery electric and plug-in hybrid electric vehicles. The pilot will remain in effect until October 1, 2013;[20]
- Utility rate tiers for residential ratepayers, where more efficient households pay a lower rate; and
- Utility generation disclosure.

Municipal policies

- Rebates for electricity efficiency;
- City and County of Honolulu HOV lane open to electric and plug-in hybrid vehicles;
- City and County of Honolulu County development of alternative energy resources, see HRS§46-19;
- City and County of Honolulu free street and municipal parking for electric and plug-in hybrid vehicles; and
- City and County of Honolulu property tax exemption for renewable energy improvements.

Policies previously in Hawaii law that have expired

- 20% State of Hawaii Research and Development tax credit (Act 221 of 2001, and Act 215 of 2004), expired 2010);
- 100% High technology business investment tax credit (Act 221 of 2001, and Act 215 of 2004), sunset 2010) and
- 5% tax credit for commercial buildings to put backup power systems into place (expired 2010). [HRS § 235-110.51]

[20] Information copied from the US Department of Energy's Alternative Fuels and Advanced Vehicles Data Center, http://www.afdc.energy.gov/afdc/laws/laws/HI/tech/3270

Appendix B: Policies that Other U.S. States have in Place

Synopsis of NREL studies
NREL summarizes its research on individual state clean energy policies and their impacts driven by goals related to the environment, economic development, renewable energy deployment, and energy security. Policies include renewable portfolio standards, feed-in tariffs, renewable fuel standards, renewable energy rebates.
http://www.nrel.gov/applying_technologies/state_local_activities/state_policy_effectiveness.html?print

- Policies are more connected with clean energy development the longer they are in place, indicating that policy longevity (and resulting market certainty for investors) may be an important aspect of effectiveness;

- Higher electricity prices, population size, longer longevity of policies increased correlation between policy and effectiveness in terms of actual new renewable energy generation;

- Suite (aka campaign) of policies more effective than single policies;

- FIT highly effective in NREL study – FIT for grid storage complements fueling infrastructure;

- For residential energy use, price signal, i.e. electricity rates was only meaningful factor to explain…rebates, tax credits etc had no significant effect… 2007-2009 data so during economic downturn building codes and EEPS had effect but only codes significant at the 5% level.

- For PV, the length of time an RPS is in place was a significant factor, along with Contractor licensing, production incentives, rebates, access laws, and personal tax incentives are all positively associated with PV capacity;

- Compares to geothermal and biomass because PV is "off the shelf" and repeatable rather than project specific, so policies that make PV more repeatable are more effective;

- But for wind, only industry support, RPS duration, and population explained increases in wind capacity. Other incentives, like Contractor licensing, state production incentives, and having a grade of "C" or better from the "Freeing the Grid…" report (NNEC 2009) are negatively associated with wind resource build-out.[21]

Hydrogen or clean energy incentives that states have in place:

- State fleet procurement policies (AL, AK, CT, DE, HI, IL). Generally for all alternatives, including other fuels and electric; lifecycle environmental and cost projections may be considered. HI also prioritizes the type of vehicles – EV/PHEV first, followed by hydrogen. IN provides grants to public fleets;

[21] "State of the States 2010: The Role of Policy in Clean Energy Market Transformation," published by the National Renewable Energy Laboratory, 1617 Cole Boulevard Golden, Colorado 80401, Jan 2011, Contract No. DE-AC36-08GO28308, authored by Elizabeth Doris and Rachel Gelman.
http://www.nrel.gov/applying_technologies/state_local_activities/pdfs/49193.pdf

- Fleet requirements including private fleets (DC) – air quality related;
- Program to educate and facilitate information flow (AL, FL, IL) – a proposal for 2012 legislature from Fuels HCEI WG to implement a decision support tool;
- Research and development/investments fund (AL, CA, FL, IN, HI);
- Boards/working groups (AL, AK, CA, CT, FL);
- Congestion pricing/HOV lane exemption (AZ, CA, GA), usually with a state-issued sticker and FastTrac system; exemption from time of day restrictions (DC);
- Parking incentive (AZ, Honolulu);
- Reduced vehicle licensing fee/weight tax/road tax (AZ, CO, DC);
- Tax credit for fueling infrastructure (OK);
- Joint use of government fueling infrastructure (AZ);
- Mandates applied to municipal/local fleets (AZ);
- Grants applied to municipal/local fleets (CT);
- Dealer information dissemination requirement (AZ);
- Vehicle conversion reporting requirement/standardization requirement (AR, CA);
- Clean Vehicle rebate/income tax credit (CA, CO, FL, GA, IL, OK). Credit is capped, phased out over time, or first-come, first-served. 75% in FL. 10% in GA, capped at $2500. $4000 per vehicle in IL, also covers incremental cost of alt fuel. Rollovers of unused credit often limited;
- Motor vehicle registration fund reinvests vehicle registration fees into clean vehicles through “feebates,” grants, or loans (CA);
- School bus grants (CA, CT, IL);
- Cash for clunkers (CA SCAMD);
- Technical training for mechanics, fueling operators (CA);
- RFS (CA, HI);
- State transportation master plan/greenhouse gas reduction plan (CA, CT, FL) updated every 5 years to include station locations;
- Fleet average greenhouse gas requirements/CAFÉ (CA) with preference for zero-emission vehicles;

- Environment and energy standards for hydrogen production (CA);
- Hydrogen fuel specification (CA) until ANSI/ASTM standard is published. (CA);
- Fuel infrastructure tax credit (CO, FL) 75% in FL but capped at $3m/year from state coffers. Tax exemption in OH;
- Bonds for production, transportation, storage of clean energy (CO);
- Define qualifying alternative fuels (CO);
- Define gallon gasoline equivalent (gge) (CO);
- Alt fuel tax exemption (for state and federal vehicles) (DE, FL, ID) or reduction for all vehicles set at a specific % of the tax for diesel fuel (HI). ID has carve-out for idling;
- Sales and use tax exemptions for all qualifying vehicles (CA);
- Fuel excise tax applied on gallon gasoline equivalent (gge) basis (AR, ID);
- Registration/licensing for alt fuel sellers (DE, FL, GA);
- Registration/licensing for alt fuel vehicle owners and conversions (CA, ID);
- Landowners can apply to amend master plans to include bioenergy in agricultural zones (FL);
- Expedited permits for production facilities and amendments to plans to allow production facilities (FL);
- Standardized siting and permitting. NREL's statistical study showed standardized siting and permitting practices correlated with increased wind development;[22]
- R&D/high technology business investment tax credit (HI);
- Air permits can be issued for hydrogen production from biomass (IL);
- Vehicle manufacturer investment tax credit (IN 15%);
- Enterprise zones/ technology parks (IN) Net metering eligible for fuel cell applications (MD);
- Utility/ratepayer-funded programs: California's SGIP many use anaerobic digester gas from wastewater treatment plants and food/beverage processing. Bloom's unit using redirected biogas also counts. Connecticut CEF has two programs -On-Site Distributed Generation(OSDG) Program ($12.86 million) and Alpha Program. CCEF's Project 150

[22] "State of the States 2010: The Role of Policy in Clean Energy Market Transformation," published by the National Renewable Energy Laboratory, 1617 Cole Boulevard Golden, Colorado 80401, Jan 2011, Contract No. DE-AC36-08GO28308, authored by Elizabeth Doris and Rachel Gelman.

program, an initiative aimed at increasing renewable energy supply in CT by at least 150 MWs also funding numerous fuel cell installations in state. New York State (NYSERDA) - $21.6 million was made available to Renewable Portfolio Standard Customer-Sited Tier Fuel Cell Program;[23] and

- Pay-as-you-save (PAYS) systems for renewable energy and energy efficiency systems, like solar hot water heaters. In Hawaii, the Kauai Island Utility Cooperative (KIUC) held a pay-as-you-save on-bill pilot program, but actual adoption was much slower for the same level of effort than setting up pre-agreed loan providers to provide the upfront financing for the systems. Only 3 hot water heaters were installed under the PAYS while 126 were installed under the loan program during the same time period.[24]

[23] Jennifer Gangi, Program Director, Fuel Cells 2000, www.fuelcells.org, "State Of The States: Fuel Cells In America 2011: Hydrogen Learning for Local Leaders Webinar Series," June 21, 2011.
[24] Mr Steven Rymsha, KIUC, briefing to the Hawaii Energy Policy Forum on 29 Oct 2010, http://www.hawaiienergypolicy.hawaii.edu/PDF/2010/10.29.10KIUCPresentation.pdf

Appendix C: Policies at the U.S. Federal Level

Net federal incentives as of Sep 2011 that apply to Hawaii:

- Cost to switch for vehicles - $4,000 federal income tax credit for fuel cell vehicle;
- Cost to switch for fueling infrastructure - 30% credit up to $200K for H2 fueling in place by 31 Dec 2015;
- Fuel excise credit but for liquefied hydrogen only, not gaseous hydrogen.

Issues State of Hawaii may need to try to address at the federal level:
Federal: gaseous hydrogen, renewable diesel are not classified as alternative fuels by the Internal Revenue Service, making some hydrogen applications ineligible for the intended federal tax benefits.

Source for the next section: DSIRE USA
The list below contains summaries of all Federal incentives and laws related to Hydrogen Fuel Cells.

Incentives

- **Alternative Fuel Infrastructure Tax Credit**
  A tax credit is available for the cost of alternative fueling equipment placed into service after December 31, 2005. Qualified alternative fuels are natural gas, liquefied petroleum gas, hydrogen, electricity, E85, or diesel fuel blends containing a minimum of 20% biodiesel. The credit amount is up to 30% of the cost, not to exceed $30,000 for equipment placed into service in 2011. Fueling station owners who install qualified equipment at multiple sites are allowed to use the credit towards each location. Consumers who purchase qualified residential fueling equipment may receive a tax credit of up to $1,000. The maximum credit amount for hydrogen fueling equipment placed into service before January 1, 2015, is $200,000. Under current law, the credit expires December 31, 2011, for all other eligible fuel types. Unused credits that qualify as general business tax credits, as defined by the Internal Revenue Service (IRS), may be carried backward one year and carried forward 20 years. For more information, see IRS Form 8911 and/or Form 3800, which are available via the IRS website. (Reference H.R. 4853, 2010, Section 711; and 26 U.S. Code 30C and 38B);

- **Fuel Cell Motor Vehicle Tax Credit**
  A tax credit of up to $8,000 is available for the purchase of qualified light-duty fuel cell vehicles. After December 31, 2009, the credit is reduced to $4,000. Tax credits are also available for medium- and heavy-duty fuel cell vehicles; credit amounts are based on vehicle weight. Vehicle manufacturers must follow the procedures as published in Notice 2008-33 (PDF 30KB) in order to certify to the Internal Revenue Service that a vehicle meets certain requirements to claim the fuel cell vehicle credit. Notice 2008-33 also provides guidance to taxpayers about claiming the credit. For more information, see IRS Form 8910, which is available via the IRS website. This tax credit expires on December 31, 2014. (Reference 26 U.S. Code 30B);

- **Hydrogen Fuel Excise Tax Credit**

A tax credit of $0.50 per gallon is available for liquefied hydrogen that is sold for use or used as a fuel to operate a motor vehicle. For an entity to be eligible to claim the credit they must be liable for reporting and paying the federal excise tax on the sale or use of the fuel in a motor vehicle. Tax exempt entities such as state and local governments that dispense qualified fuel from an on-site fueling station for use in vehicles qualify for the incentive. Eligible entities must be registered with the Internal Revenue Service (IRS). The incentive must first be taken as a credit against the entity's alternative fuel tax liability; any excess over this fuel tax liability may be claimed as a direct payment from the IRS. Under current law, the credit for liquefied hydrogen expires after September 30, 2014. For more information, see IRS Publication 510 and IRS Forms 637, 720, 4136, and 8849, which are available via the IRS website. (Reference Public Law 110-343, Section 204, and 26 U.S. Code 6426);

Hawaii note: There is currently no supply of liquefied hydrogen in the State of Hawaii

Point of Contact
Excise Tax Branch
U.S. Internal Revenue Service Office of Chief Counsel
Phone: (202) 622-3130
http://www.irs.gov/

- **Hydrogen Fuel Mixture Excise Tax Credit**
  A tax credit of $0.50 per gallon is available for the sale or use of liquefied hydrogen used to produce a mixture containing a taxable fuel. To be eligible, an alternative fuel blender must be registered with the Internal Revenue Service (IRS). The incentive must be taken as a credit against the blender's alternative fuel tax liability. Any excess over this fuel tax liability may be claimed as a direct payment from the IRS. Under current law, the credit for liquefied hydrogen expires after September 30, 2014. For more information, see IRS Publication 510 and IRS Forms 637, 720, 4136, and 8849, which are available via the IRS website. (Reference Public Law 110-343, Section 204, and 26 U.S. Code 6426);

  Hawaii note: There is currently no supply of liquefied hydrogen in the State of Hawaii

  Point of Contact
  Excise Tax Branch
  U.S. Internal Revenue Service Office of Chief Counsel
  Phone: (202) 622-3130
  http://www.irs.gov/

- **Alternative Fuel Tax Exemption**
  Alternative fuels used in a manner that the Internal Revenue Service (IRS) deems as nontaxable are exempt from federal fuel taxes. Common nontaxable uses in a motor vehicle are: on a farm for farming purposes; in certain intercity and local buses; in a school bus; exclusive use by a nonprofit educational organization; and exclusive use by a state, political subdivision of a state, or the District of Columbia. This exemption is not available to tax exempt entities that are not liable for excise taxes on transportation fuel. For more information, see IRS Publication 510, which is available via the IRS website;

Point of Contact
Excise Tax Branch
U.S. Internal Revenue Service Office of Chief Counsel
Phone: (202) 622-3130
http://www.irs.gov/

- **Improved Energy Technology Loans**
  The U.S. Department of Energy (DOE) provides loan guarantees through the Loan Guarantee Program (Program) to eligible projects that reduce air pollution and greenhouse gases, and support early commercial use of advanced technologies, including biofuels and alternative fuel vehicles. The Program is not intended for research and development projects. DOE may issue loan guarantees for up to 100% of the amount of the loan for an eligible project. For loan guarantees of over 80%, the loan must be issued and funded by the Treasury Department's Federal Financing Bank. For additional Program guidelines and solicitation announcements, please visit the Loan Guarantee Program website. (Reference 42 U.S. Code 16513);

  Point of Contact
  U.S. Department of Energy
  Phone: (800) 342-5363
  Fax: (202) 586-4403
  http://www.energy.gov

- **Laws and Regulations**
  Alternative Fuel Definition - Internal Revenue Code
  The Internal Revenue Service (IRS) defines alternative fuels as liquefied petroleum gas, compressed natural gas, liquefied natural gas, liquefied hydrogen, liquid fuel derived from coal through the Fischer-Tropsch process, liquid hydrocarbons derived from biomass, and P-Series fuels. Gaseous hydrogen, biodiesel, ethanol, and renewable diesel are not considered alternative fuels by the IRS. While the term "hydrocarbons" includes liquids that contain oxygen, hydrogen, and carbon and as such "liquid hydrocarbons derived from biomass" includes ethanol, biodiesel, and renewable diesel, the IRS specifically excluded these fuels from the definition. (Reference 26 U.S. Code 6426);

  Point of Contact
  U.S. Internal Revenue Service
  Phone: (800) 829-1040
  http://www.irs.gov/

- **Vehicle Acquisition and Fuel Use Requirements for Federal Fleets**
  Under the Energy Policy Act (EPAct) of 1992, 75% of new light-duty vehicles acquired by certain federal fleets must be alternative fuel vehicles (AFVs). As amended in January 2008, Section 301 of EPAct of 1992 defines AFVs to include hybrid electric vehicles, fuel cell vehicles, and advanced lean burn vehicles. Federal fleets are also required to use alternative fuels in dual-fuel vehicles unless the U.S. Department of Energy (DOE) determines an agency qualifies for a waiver; grounds for a waiver include the lack of alternative fuel availability and cost restrictions. Fleets that use fuel blends containing at least 20% biodiesel (B20) in medium- and heavy-duty vehicle may earn credits toward their annual requirements. Additionally, Executive Order 13423, issued in January 2007, requires federal agencies with 20 vehicles or more in their U.S. fleet to decrease petroleum consumption by 2% per year, relative to their Fiscal Year (FY) 2005 baseline, through FY

2015. Agencies must also continue to increase their alternative fuel use by 10% per year, relative to the previous year.

Executive Order 13514, issued in October 2009, requires each federal agency to develop, implement, and annually update a Strategic Sustainability Performance Plan. Federal agencies must measure, reduce, and report their greenhouse gas (GHG) emissions, with an overall federal government GHG emissions reduction goal of 28% by 2020, relative to a 2008 baseline. Federal fleets of 20 vehicles or more must reduce petroleum consumption by a minimum of 2% per year through the end of FY 2020 as compared to 2005 baseline usage. Each agency must establish a comprehensive inventory of GHG emissions for FY 2010, to be updated on an annual basis thereafter. Reductions may be achieved through a variety of measures including the use of AFVs, and fleet optimization efforts. For more information, visit the Federal Fleet Management website.

Additional requirements for federal fleets were included in the Energy Independence and Security Act of 2007, including low GHG emitting vehicle acquisition requirements and renewable fuel infrastructure installation. These requirements are dependent upon formal rulemaking by DOE.
(Reference 42 U.S. Code 13212, Executive Order 13423 (PDF 105 KB) and Executive Order 13514 (PDF 186 KB). Download Adobe Reader.

Point of Contact
Federal Fleet Requirements
U.S. Department of Energy
fed_fleets@afdc.nrel.gov
http://www1.eere.energy.gov/femp/about/fleet_mgmt.html

- **Vehicle Acquisition and Fuel Use Requirements for State and Alternative Fuel Provider Fleets**
  Under the Energy Policy Act (EPAct) of 1992, certain state government and alternative fuel provider fleets are required to acquire alternative fuel vehicles (AFVs). Compliance is required by fleets that operate, lease, or control 50 or more light-duty vehicles within the U.S. Of those 50 vehicles, at least 20 must be used primarily within a single Metropolitan Statistical Area/Consolidated Metropolitan Statistical Area. Those same 20 vehicles must also be capable of being centrally fueled. Covered fleets earn credits for each vehicle purchased, and credits earned in excess of their requirements can be banked or traded with other fleets. Additionally, fleets that use fuel blends containing at least 20% biodiesel (B20) in medium- and heavy-duty vehicles may earn credits toward their annual AFV acquisition requirements.

  On March 20, 2007, the U.S. Department of Energy (DOE) issued a final rule on Alternative Compliance (PDF 2.5 MB), which allows fleets the option to choose a petroleum reduction path in lieu of acquiring AFVs. Interested fleets must obtain a waiver from DOE by proving that they will achieve petroleum reductions equivalent to that achieved by having AFVs running on alternative fuels 100% of the time.

  For more information, visit the EPAct State and Alternative Fuel Provider Fleets website, or contact the Regulatory Information Line at (202) 586-9171 or regulatory_info@afdc.nrel.gov.
  (Reference 42 U.S. Code 13251 and 13263a, and 10 CFR 490)

Point of Contact
Dana O'Hara
State and Alternative Provider Fleets
U.S. Department of Energy
Phone: (202) 586-8063
dana.o'hara@ee.doe.gov
http://www1.eere.energy.gov/vehiclesandfuels/epact/state_alt_fleets.html

- **Vehicle Acquisition and Fuel Use Requirements for Private and Local Government Fleets**
  Under the Energy Policy Act (EPAct) of 1992, the U.S. Department of Energy (DOE) was directed to determine whether private and local government fleets should be mandated to acquire alternative fuel vehicles (AFVs). In January 2004, DOE published a final rule announcing its decision **not to implement an AFV acquisition mandate** for private and local government fleets. In response to a March 2006 ruling by a U.S. District Court, DOE issued a subsequent final rulemaking on the new Replacement Fuel Goal in March 2007, which extended the EPAct of 1992 goal to 2030. The goal is to achieve a domestic production capacity for replacement fuels sufficient to replace 30% of the U.S. motor fuel consumption. In March 2008, DOE issued its determination **not to implement a fleet compliance mandate** for private and local government fleets, concluding that such a mandate is not necessary to achieve the Replacement Fuel Goal. For more information on the Private and Local Government Fleet Rule compliance, visit the EPAct Private and Local Government Fleet Determination website. (Reference 42 U.S. Code 13257)

- **Alternative Fuel Definition**
  The following fuels are defined as alternative fuels by the Energy Policy Act (EPAct) of 1992: pure methanol, ethanol, and other alcohols; blends of 85% or more of alcohol with gasoline; natural gas and liquid fuels domestically produced from natural gas; liquefied petroleum gas (propane); coal-derived liquid fuels; hydrogen; electricity; pure biodiesel (B100); fuels, other than alcohol, derived from biological materials; and P-Series fuels. In addition, the U.S. Department of Energy (DOE) may designate other fuels as alternative fuels, provided that the fuel is substantially nonpetroleum, yields substantial energy security benefits, and offers substantial environmental benefits. For more information about the alternative fuels defined by EPAct 1992 as well as DOE's alternative fuel designation authority, visit the EPAct website. (Reference 42 U.S. Code 13211)

  Point of Contact
  U.S. Department of Energy
  Phone: (800) 342-5363
  Fax: (202) 586-4403
  http://www.energy.gov

- **Alternative Fuel and Vehicle Labeling Requirements**
  Alternative fuel vehicles (AFVs) and fuel dispensers must be labeled with information to help consumers make informed decisions about buying or fueling a vehicle. All new and used AFVs, including vehicles with an aftermarket conversion system installed, must be clearly labeled with the vehicle's cruising range as estimated by the manufacturer, as well as other descriptive information. The labeling requirements do not apply to hybrid electric vehicles (HEVs). Alternative fuel dispensers must also be clearly labeled with the name of the fuel and fuel rating. This rule applies to, but is not limited to, the following fuel types: methanol, denatured ethanol, and/or other alcohols; mixtures containing 85 percent or more by volume

of methanol, denatured ethanol, and/or other alcohols; natural gas; liquefied petroleum gas; hydrogen; coal derived liquid biofuels; biodiesel blends containing more than 5% biodiesel by volume; and electricity. (Reference 16 CFR 306 and 309)

Point of Contact
Federal Trade Commission
Phone: (202) 326-2222
http://www.ftc.gov/

- **Vehicle Incremental Cost Allocation**
  The U.S. General Services Administration (GSA) must allocate the incremental cost of purchasing alternative fuel vehicles across the entire fleet of vehicles distributed by GSA. This mandate also applies to other federal agencies that procure vehicles for federal fleets. (Reference 42 U.S. Code 13212 (c))
  Hawaii note: This applies to the vehicles placed into use by the Department of Defense and other federal agencies with fleets in Hawaii.

  Point of Contact
  U.S. General Services Administration
  Phone: (703) 605-5630
  AFVteam@gsa.gov
  http://www.gsa.gov/afv

- **Procurement Preference for Electric and Hybrid Electric Vehicles**
  The U.S. Department of Defense (DOD) must exhibit a preference for the lease or procurement of motor vehicles with electric or hybrid electric propulsion systems, including plug-in hybrid systems. Tactical vehicles designed for use in combat are excluded from the requirement. The Secretary of Defense must establish regulations to implement the electric vehicle preference by October 28, 2010. (Reference 10 U.S. Code 2922g, and Public Law 111-84, Section 2844)
  Hawaii note: This applies to the vehicles placed into use by the Department of Defense and other federal agencies with fleets in Hawaii. Most of the military facilities commands have had to buy 85% ethanol-ready (E85) vehicles to meet this requirement even though there is no supply of E85 in the state. The plan for the next few years, starting in 2010, is to meet this requirement but with a preference for electric, plug-in hybrid, and hydrogen vehicles.

  Point of Contact
  U.S. Department of Defense
  Phone: (703) 571-3343
  http://www.defense.gov/

Programs

- **Clean Cities**
  The mission of Clean Cities is to advance the energy, economic, and environmental security of the United States by supporting local initiatives to adopt practices that reduce the use of petroleum in the transportation sector. Clean Cities carries out this mission through a network of more than 80 volunteer coalitions, which develop public/private partnerships to promote alternative fuels and advanced vehicles, fuel blends, fuel economy, hybrid vehicles, and idle reduction. Clean Cities provides information about financial opportunities,

coordinates technical assistance projects; updates and maintains databases and websites, and publishes fact sheets, newsletters, and related technical and informational materials. For more information, visit the Clean Cities website.

Point of Contact
U.S. Department of Energy
Phone: (800) 342-5363
Fax: (202) 586-4403
http://www.energy.gov

- **State Energy Program (SEP) Funding**
  The SEP provides grants to states to assist in designing, developing, and implementing renewable energy and energy efficiency programs. Each state's energy office receives SEP funding and manages all SEP-funded projects. States may also receive project funding from technology programs in the U.S. Department of Energy's Office of Energy Efficiency and Renewable Energy (EERE) for SEP Special Projects. EERE distributes the funding through an annual competitive solicitation to state energy offices. For more information about the SEP, including SEP project descriptions, visit the SEP website.
  Hawaii note: The Hawaii Hydrogen Power Park project was funded out of this program.
  Point of Contact
  U.S. Department of Energy
  Phone: (800) 342-5363
  Fax: (202) 586-4403
  http://www.energy.gov

- **Clean Ports USA**
  Clean Ports USA is an incentive-based program designed to reduce emissions by encouraging port authorities and terminal operators to retrofit and replace older diesel engines with new technologies and use cleaner fuels. The U.S. Environmental Protection Agency's National Clean Diesel Campaign offers funding to port authorities and public entities to help them overcome barriers that impede the adoption of cleaner diesel technologies and strategies.

  Point of Contact
  Trish Koman
  National Clean Diesel Campaign
  U.S. Environmental Protection Agency
  Phone: (734) 214-4955
  Fax: (734) 214-4869
  koman.trish@epa.gov
  http://www.epa.gov/cleandiesel/

- **Clean Construction USA**
  Clean Construction USA is a voluntary program that promotes the reduction of diesel exhaust emissions from construction equipment and vehicles by encouraging proper operations and maintenance, use of emission-reducing technologies, and use of cleaner fuels. Clean Construction USA is part of the U.S. Environmental Protection Agency's National Clean Diesel Campaign, which offers funding for clean diesel construction equipment projects.

Point of Contact
Trish Koman
National Clean Diesel Campaign
U.S. Environmental Protection Agency
Phone: (734) 214-4955
Fax: (734) 214-4869
koman.trish@epa.gov
http://www.epa.gov/cleandiesel/

- **Clean Agriculture USA**
  Clean Agriculture USA is a voluntary program that promotes the reduction of diesel exhaust emissions from agricultural equipment and vehicles by encouraging proper operations and maintenance by farmers, ranchers, and agribusinesses, use of emission-reducing technologies, and use of cleaner fuels. Clean Agriculture USA is part of the U.S. Environmental Protection Agency's National Clean Diesel Campaign, which offers funding for clean diesel agricultural equipment projects.

  Point of Contact
  Trish Koman
  National Clean Diesel Campaign
  U.S. Environmental Protection Agency
  Phone: (734) 214-4955
  Fax: (734) 214-4869
  koman.trish@epa.gov
  http://www.epa.gov/cleandiesel/

- **Air Pollution Control Program**
  The Air Pollution Control Program assists state, local, and tribal agencies in planning, developing, establishing, improving, and maintaining adequate programs for prevention and control of air pollution or implementation of national air quality standards. Plans may emphasize alternative fuels, vehicle maintenance, and transportation choices to reduce vehicle miles traveled. Eligible applicants may receive federal funding for up to 60% of project costs to implement their plans. (Reference 42 U.S. Code 7405)

  Point of Contact
  U.S. Environmental Protection Agency
  Phone: (202) 272-0167
  http://www.epa.gov

- **Alternative Transportation in Parks and Public Lands Program**
  The Alternative Transportation in the Parks and Public Lands Program provides funding to support public transportation projects in parks and on public lands. The goals of the program include conservation of natural, historical, and cultural resources, and reduced congestion and pollution. The Federal Transit Administration administers the program while partnering with the Department of the Interior and the Forest Service to provide for technical assistance in alternative transportation options. Eligible projects include capital and planning expenses for alternative transportation systems such as clean fuel shuttle vehicles. For more information, see the Alternative Transportation in Parks and Public Lands fact sheet. (Reference 49 U.S. Code 5320)

Hawaii Note: The Hawaii Volcanoes National Park is using this funding for its FCEV bus project that HNEI is supporting.

Point of Contact
Federal Transit Administration, Office of Program Management
U.S. Department of Transportation
Phone: (202) 366-4020
http://www.fta.dot.gov

- **National Fuel Cell Bus Program (NFCBP)**
  The goal of the NFCBP is to facilitate the development of commercially viable fuel cell bus technologies and related infrastructure with funding awarded through a competitive grant process. Priority consideration is given to applicants that have successfully managed advanced transportation technology projects, including projects related to hydrogen and fuel cell public transportation operations, for a period of at least five years. A minimum 50% non-federal cost share is required. For more information, see the NFCBP fact sheet. (Reference 49 U.S. Code 5309)

  Point of Contact
  Federal Transit Administration, Office of Program Management
  U.S. Department of Transportation
  Phone: (202) 366-4020
  http://www.fta.dot.gov

- **Congestion Mitigation and Air Quality (CMAQ) Improvement Program**
  The CMAQ Improvement Program provides funding to state departments of transportation (DOTs), municipal planning organizations (MPOs), and transit agencies for projects and programs in air quality nonattainment and maintenance areas that reduce transportation-related emissions. Eligible activities include transit improvements, travel demand management strategies, traffic flow improvements, purchasing idle reduction equipment, development of alternative fueling infrastructure, conversion of public fleet vehicles to operate on cleaner fuels, and outreach activities that provide assistance to diesel equipment and vehicle owners and operators regarding the purchase and installation of diesel retrofits. State DOTs and MPOs must give priority to projects and programs to include diesel retrofits and other cost-effective emissions reduction activities, and cost-effective congestion mitigation activities that provide air quality benefits. For more information, visit the CMAQ website. (Reference 23 U.S. Code 149)

  Hawaii note: Hawaii does not to our knowledge have federally-designated air quality non-attainment districts caused by human emissions. The active volcanoes do reduce air quality.

  Point of Contact
  Federal Highway Administration
  U.S. Department of Transportation
  http://www.fhwa.dot.gov/index.html

- **Clean Fuels Grant Program**
  The Clean Fuels Grant Program assists designated ozone and carbon monoxide air quality nonattainment and maintenance areas in achieving or maintaining the National Ambient Air Quality Standards through grant funding. The program accelerates the deployment of advanced bus technologies by supporting the use of low-emission vehicles in transit fleets. The program assists transit agencies in purchasing low-emission buses and related equipment, constructing alternative fuel stations, modifying garage facilities to accommodate clean fuel vehicles, and assisting with the use of biodiesel. For more information, see the Clean Fuels Grant Program fact sheet. (Reference 49 U.S. Code 5308 and 49 CFR 624)

  Point of Contact
  Federal Transit Administration, Office of Program Management
  U.S. Department of Transportation
  Phone: (202) 366-4020
  http://www.fta.dot.gov

- **Voluntary Airport Low Emission (VALE) Program**
  The goal of the VALE program is to reduce ground level emissions at commercial service airports located in designated ozone and carbon monoxide air quality nonattainment and maintenance areas. The VALE program provides funding through the Airport Improvement Program and the Passenger Facility Charges program for the purchase of low-emission vehicles, development of fueling and recharging stations, implementing gate electrification, and other airport air quality improvements. (Reference 49 U.S. Code 40101)

  Point of Contact
  Jake Plante
  Federal Aviation Administration, Airports Environmental Office
  U.S. Department of Transportation
  Phone: (202) 493-4875
  jake.plante@faa.gov
  http://www.faa.gov/airports/environmental/vale/

- **Transit Emissions and Energy Reduction Assistance**
  The Transit Investments for Greenhouse Gas and Energy Reduction (TIGGER) program works with public transit agencies to implement strategies for reducing greenhouse gas emissions and energy use from transit agency operations. Strategies may be implemented through operational or technological enhancements and electric drive projects are specifically encouraged. Eligible projects include on-board vehicle energy management such as energy storage, regenerative braking, fuel cells, and turbines; accessory electrification; vehicle and locomotive design including lightweight materials; and rail transit energy management such as regenerative braking and solar propulsion engine systems. For information about funding availability and application instructions, refer to the TIGGER Program Web site.

  Point of Contact
  Federal Transit Administration
  U.S. Department of Transportation
  http://www.fta.dot.gov

Appendix D: List of Energy Policy Tools Available to Governments

Source: U.S. Department of Energy-funded Database of State Incentives for Renewables and Efficiency (DSIRE USA) website http://www.dsireusa.org/glossary/

FINANCIAL INCENTIVES and REGULATIONS

Corporate Tax Incentives
Corporate tax incentives include tax credits, deductions and exemptions. These incentives are available in some states to corporations that purchase and install eligible renewable energy or energy efficiency equipment, or to construct green buildings. In a few cases, the incentive is based on the amount of energy produced by an eligible facility. Some states allow the tax credit only if a corporation has invested a minimum amount in an eligible project. Typically, there is a maximum limit on the dollar amount of the credit or deduction. In recent years, the federal government has offered corporate tax incentives for renewables and energy efficiency. (Note that corporate tax incentives designed to support manufacturing and the development of renewable energy systems or equipment, or energy efficiency equipment, are categorized as "Industry Recruitment/Support" in DSIRE.)

Grant Programs
States offer a variety of grant programs to encourage the use and development of renewables and energy efficiency. Most programs offer support for a broad range of technologies, while a few programs focus on promoting a single technology, such as photovoltaic (PV) systems. Grants are available primarily to the commercial, industrial, utility, education and/or government sectors. Most grant programs are designed to pay down the cost of eligible systems or equipment. Others focus on research and development, or support project commercialization. In recent years, the federal government has offered grants for renewables and energy efficiency projects for end-users. Grants are usually competitive.

Green Building Incentives
Green buildings are designed and constructed using practices and materials that minimize the impacts of the building on the environment and human health. Many cities and counties offer financial incentives to promote green building. The most common form of incentive is a reduction or waiver of a building permit fee. The U.S. Green Building Council's Leadership in Energy and Environmental Design (LEED) is a popular point-based certification program for green buildings. The LEED system awards points for site selection and development; material, energy and water efficiency; indoor air quality; innovation; and the application of renewable technologies. (Note that this category includes green building incentives that do not fall under other DSIRE incentive categories, such as tax incentives and grant programs.)

Industry Recruitment/Support
To promote economic development and the creation of jobs, some states offer financial incentives to recruit or cultivate the manufacturing and development of renewable energy systems and equipment. These incentives commonly take the form of tax credits, tax exemptions and grants. In some cases, the amount of the incentive depends on the quantity of eligible equipment that a company manufactures. Most of these incentives apply to several renewable energy technologies, but a few states target specific technologies, such as wind or solar. These incentives are usually designed as temporary measures to support industries in their early years. They commonly include a sunset provision to encourage the industries to become self-sufficient.

Leasing Programs
A handful of programs have been established by government agencies and utilities that allow homeowners, businesses, and other entities to lease energy-efficient equipment or renewable energy systems. In some cases, the customer may choose to purchase the system after a specified period of time. (Note that it is increasingly common for companies to lease energy equipment to customers. However, with the exception of incentives offered by utilities, DSIRE generally does not include incentives offered by businesses.)

Loan Programs
Loan programs provide financing for the purchase of renewable energy or energy efficiency systems or equipment. Low-interest or zero-interest loans for energy efficiency projects are a common demand-side management (DSM) practice for electric utilities. State governments also offer low-interest loans for a broad range of renewable energy and energy efficiency measures. These programs are commonly available to the residential, commercial, industrial, transportation, public and/or non-profit sectors. Loan rates and terms vary by program; in some cases, they are determined on an individual project basis. Loan terms are generally 10 years or less. In recent years, the federal government has offered loans and/or loan guarantees for renewables and energy efficiency projects.

PACE Financing
Property-Assessed Clean Energy (PACE) financing effectively allows property owners to borrow money to pay for renewable energy and/or energy-efficiency improvements. The amount borrowed is typically repaid over a period of years via a special assessment on the owner's property. In general, local governments (such as cities and counties) that choose to offer PACE financing must be authorized to do so by state law.

Performance-Based Incentives
Performance-based incentives (PBIs), also known as production incentives, provide cash payments based on the number of kilowatt-hours (kWh) or BTUs generated by a renewable energy system. A "feed-in tariff" is an example of a PBI. To ensure project quality, payments based on a system's actual performance are generally more effective than payments based on a system's rated capacity. (Note that tax incentives based on the amount of energy produced by an eligible commercial facility are categorized as "Corporate Tax Incentives" in DSIRE.)

Personal Tax Incentives
Personal tax incentives include income tax credits and deductions. Many states offer these incentives to reduce the expense of purchasing and installing renewable energy or energy efficiency systems and equipment. The percentage of the credit or deduction varies by state, and in most cases, there is a maximum limit on the dollar amount of the credit or deduction. An allowable credit may include carryover provisions, or it may be structured so that the credit is spread out over a certain number of years. Eligible technologies vary widely by state. In recent years, the federal government has offered personal tax credits for renewables and energy efficiency.

Property Tax Incentives
Property tax incentives include exemptions, exclusions, abatements and credits. Most property tax incentives provide that the added value of a renewable energy system is excluded from the valuation of the property for taxation purposes. For example, if a new heating system that uses renewable energy costs more than a conventional heating system, the additional cost of the renewable energy system is not included in the property assessment. In a few cases, property tax incentives apply to the additional cost of a green building. Because property taxes are collected

locally, some states have granted local taxing authorities the option of allowing a property tax incentive for renewables.

Rebate Programs
States, utilities and a few local governments offer rebates to promote the installation of renewables and energy efficiency projects. The majority of rebate programs that support renewables are administered by states, municipal utilities and electric cooperatives; these programs commonly provide funding for solar water heating and/or photovoltaic (PV) systems. Most rebate programs that support energy efficiency are administered by utilities. Rebate amounts vary widely by technology and program administrator.

Sales Tax Incentives
Sales tax incentives typically provide an exemption from, or refund of, the state sales tax (or sales and use tax) for the purchase of a renewable energy system, an energy-efficient appliance, or other energy efficiency measures. Several states have established an annual "sales tax holiday" for energy efficiency measures by annually allowing a temporary exemption – usually for one or two days – from the state sales tax.

Utility Rate Discounts
A few utilities offer rate discounts to encourage residential energy efficiency. For homes that meet certain energy efficiency criteria, such as those established by the federal Energy Star program, the owner or tenant is awarded a discount on his or her electric bills.

RULES, REGULATIONS & POLICIES

Appliance/Equipment Efficiency Standards
Many states have established minimum efficiency standards for certain appliances and equipment. In these states, the retail sale of appliances and equipment that do not meet the established standards is prohibited. The federal government has also established efficiency standards for certain appliances and equipment. When both the federal government and a state have adopted efficiency standards for the same type of appliance or equipment, the federal standard overrides the state standard (even if the state standard is stricter).

Building Energy Codes
Building energy codes adopted by states (and some local governments) require commercial and/or residential construction to adhere to certain energy standards. While some government entities have developed their own building energy codes, many use existing codes (sometimes with state-specific amendments), such as the International Energy Conservation Code (IECC), developed and published by the International Code Council (ICC); or ASHRAE 90.1, developed by the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE). A few local building energy codes require certain commercial facilities to meet green building standards.

Contractor Licensing
Some states have adopted a licensing process for renewable energy contractors. Several states have adopted contractor licensing requirements for solar water heating, active and passive solar space heating, solar industrial process heat, solar-thermal electricity, and photovoltaics (PV). These requirements are designed to ensure that contractors have the necessary knowledge and experience to install systems properly. Solar licenses typically take the form of either a separate, specialized solar contractor's license, or of a specialty classification under a general electrical or plumbing license.

Energy Efficiency Resource Standards
Energy efficiency resource standards (EERS) are state policies that require utilities to meet specific targets for energy savings according to a set schedule. EERS policies establish separate reduction targets for electricity sales, peak electric demand and/or natural gas consumption. In most cases, utilities must achieve energy savings by developing demand-side management (DSM) programs, which typically provide financial incentives to customers to install energy-efficient equipment. An EERS policy is sometimes coupled with a state's renewables portfolio standard (RPS). In these cases, energy efficiency is typically included as a lower-tier resource.

Energy Standards for Public Buildings
Many states and local governments, as well as the federal government, have chosen to lead by example by requiring new government buildings to meet strict energy standards. DSIRE includes policies that have established green building standards, energy-reduction goals, equipment-procurement requirements, and/or the use of on-site renewable energy. Many of these policies require that new government buildings (and renovated buildings, in some cases) attain a certain level of certification under the U.S. Green Building Council's Leadership in Energy and Environmental Design (LEED) program. Equipment-procurement policies often mandate the use of the most efficient equipment, including equipment that meets federal Energy Star criteria. Policies designed to encourage the use of on-site renewables generally establish conditional requirements tied to life-cycle cost analysis.

Equipment Certification Requirements
Policies requiring renewable energy equipment to meet certain standards serve to protect consumers from buying inferior equipment. These requirements not only benefit consumers; they also protect the renewable energy industry by keeping substandard systems out of the market.

Generation Disclosure
Some states require electric utilities to provide their customers with specific information about the electricity that the utility supplies. This information, which generally must be shared with customers periodically, usually includes the utility's fuel mix percentages and emissions statistics. In states with restructured electricity markets, generation disclosure policies are designed to help consumers make informed decisions about the electricity and suppliers they choose. A few states that have not fully restructured their electricity markets require generation disclosure by utilities.

Green Power Purchasing Policies
Government entities, businesses, residents, schools, non-profits and others can play a significant role in supporting renewable energy by buying electricity from renewable resources, or by buying renewable energy credits (RECs). Many state and local governments, as well as the federal government, have committed to buying green power to account for a certain percentage of their electricity consumption. Green power purchases are typically executed through contracts with green power marketers or project developers, through utility green power programs, or through community aggregation.

Interconnection Standards
Interconnection standards specify the technical and procedural process by which a customer connects an electricity-generating to the grid. Such standards include the technical and contractual terms that system owners and utilities must abide by. State public utilities commissions typically establish standards for interconnection to the distribution grid, while the Federal Energy Regulatory Commission (FERC) has adopted standards for interconnection to the transmission level. Many states have adopted interconnection standards, but some states' standards apply only to investor-

owned utilities -- not to municipal utilities or electric cooperatives. (Several states have adopted interconnection guidelines, which are weaker than standards and generally apply only to net-metered systems.)

Line Extension Analysis
When a prospective customer requests electric service for a home or facility that is not currently served by the electric grid, the customer usually must pay a distance-based fee for the cost of extending power lines to the home or facility. In some cases, it is cheaper to use an on-site renewable energy system to meet a prospective customer's electricity needs. A few states require utilities to provide information regarding renewable energy options when a line extension is requested.

Mandatory Utility Green Power Option
Several states require electric utilities to offer customers the option to buy electricity generated from renewable resources, commonly known as "green power." Typically, utilities offer green power generated using renewable resources that the utilities own (or for which they contract), or they buy renewable energy credits (RECs) from a provider certified by a state public utilities commission.

Net Metering
For electric customers who generate their own electricity, net metering allows for the flow of electricity both to and from the customer – typically through a single, bi-directional meter. When a customer's generation exceeds the customer's use, electricity from the customer flows back to the grid, offsetting electricity consumed by the customer at a different time during the same billing cycle. In effect, the customer uses excess generation to offset electricity that the customer otherwise would have to purchase at the utility's full retail rate. Net metering is required by law in most U.S. states, but these policies vary widely.

Public Benefit Funds
Most public benefit funds (PBFs) were developed by states during the electric utility restructuring era, in the late 1990s, to ensure continued support for renewable energy, energy efficiency and low-income energy programs. These funds are commonly supported through a very small surcharge on electricity consumption (e.g., $0.002/kWh). This charge is sometimes referred to as a "system benefits charge" (SBC). PBFs commonly support rebate programs, loan programs, research and development, and energy education programs.

Renewables Portfolio Standards
Renewable portfolio standards (RPSs) require utilities to use renewable energy or renewable energy credits (RECs) to account for a certain percentage of their retail electricity sales -- or a certain amount of generating capacity -- according to a specified schedule. (Renewable portfolio goals are similar to RPS policies, but renewable portfolio goals are not legally binding.) Most U.S. states have established an RPS. The term "set-aside" or "carve-out" refers to a provision within an RPS that requires utilities to use a specific renewable resource (usually solar energy) to account for a certain percentage of their retail electricity sales (or a certain amount of generating capacity) according to a set schedule.

Solar and Wind Access Policies

Solar and wind access policies are designed to establish a right to install and operate a solar or wind energy system at a home or other facility. Some solar access laws also ensure a system owner's access to sunlight. These laws may be implemented at both the state and local levels. In some states, access rights prohibit homeowners associations, neighborhood covenants and local ordinances from restricting a homeowner's right to use solar energy. Easements, the most common form of solar access policy, allow for the rights to existing access to a renewable resource on the part of one property owner to be secured from an owner whose property could be developed in such a way as to restrict that resource. An easement is usually transferred with the property title. At the local level, communities use several policies to protect solar access, including solar access ordinances, development guidelines requiring proper street orientation, zoning ordinances that contain building height restrictions, and solar permits.

Solar and Wind Permitting Standards

Permitting standards can facilitate the installation of wind and solar energy systems by specifying the conditions and fees involved in project development. Some local governments have adopted simplified or expedited permitting standards for wind and/or solar. "Top-of-the-stack" permitting (or fast-track permitting) saves system owners and project developers time and money. Some states have capped fees that local governments may charge for a permit for a solar or wind energy system. In addition, some states have developed (or have supported the development of) model wind ordinances for use by local governments.

Appendix E: Market Context

Current State of the Market
National overview of hydrogen uses:

1) Industrial hydrogen: hydrotreating petroleum to create energy-dense hydrocarbons; petrochemicals
2) Fertilizer;
3) Fuel cells;
4) Vehicles

See http://www.fuelcells.org/BusinessCaseforFuelCells.pdf

Industrial Hydrogen
Today, most hydrogen in the United States, and about half of the world's hydrogen supply, is produced through the steam reforming of natural gas.

The U.S. demand for hydrogen currently is about 9 million tons per year. Of this amount, about 1.5 million tons is merchant hydrogen production that is sold to refineries and chemical plants.

In refineries, hydrogen is produced as a by-product of naphtha reforming, and any supplemental hydrogen is produced from steam reforming of natural gas. The chemical industry also uses hydrogen, mostly to manufacture ammonia and other nitrogen-based fertilizers. Hydrogen for the chemical industry is also produced from steam reforming of natural gas, although some chemical plants use coal gasification (i.e., partial oxidation) to produce hydrogen. In total, about 95 percent of U.S. hydrogen production for supplemental refinery needs and the chemical industry is produced from natural gas using steam reforming technology.

Steam Reforming of Natural Gas
Steam reforming is a catalytic process that involves a reaction between natural gas or other light hydrocarbons and steam. The result is a mixture of hydrogen, carbon monoxide, carbon dioxide, and water that is produced in a series of three reactions:

The first reforming step catalytically reacts methane (the chief chemical constituent of natural gas) to form hydrogen and carbon monoxide in an endothermic (heat-absorbing) reaction.

The carbon monoxide is then "shifted" with steam to form additional hydrogen and carbon dioxide in an exothermic (heat-releasing) reaction.

The carbon dioxide and trace amounts of carbon monoxide are removed using one of several adsorption processes, leaving hydrogen separated for its commercial use.

Current Coal-Based Technology
Today, hydrogen is produced from coal by gasification and the subsequent processing of the resulting synthesis gas. This approach is currently used primarily to produce ammonia for fertilizer. At one plant, the Eastman Chemical Complex in Kingsport, Tennessee, the coal-derived synthesis gas is being converted to methanol for use as an intermediate for chemical production, but it could also be used as a hydrogen carrier for subsequent applications.

In its simplest form, coal gasification works by first reacting coal with oxygen and steam under high pressures and temperatures to form a synthesis gas consisting primarily of carbon monoxide and

hydrogen. This synthesis gas is cleaned of virtually all of its impurities and shifted to produce additional hydrogen. The clean gas is sent to a separation system to recover hydrogen.

Cost - The Primary Hurdle
Although natural gas will likely provide the earliest affordable feedstock for hydrogen, today's costs are prohibitively expensive. The cost of producing and delivering hydrogen from a small scale reformer of natural gas for a fuel cell vehicle could be as high as $40 per million BTUs with today's technology. This would make hydrogen about four times as expensive as gasoline at the pump untaxed.

The Energy Department's Office of Fossil Energy, therefore, has begun a new effort to develop new technologies that can dramatically lower the cost of producing hydrogen from coal.[25]

Fuel Cell and Hydrogen Industry:
The fuel cell industry is growing even in the face of a global economic recession, with 2010 revenues exceeding $750 million. Markets such as uninterruptible power supplies (UPS), residential combined heat and power (CHP), power for remote monitoring equipment, auxiliary power units (APUs), and portable power for military applications have all experienced an increase in traction over the last year.

In the midst of the increase in revenue and shipments, a number of meta trends are emerging that will change the shape the industry by the end of 2011. These include long-anticipated trends such as company consolidation but also issues that have sprung out of nowhere in the past year such as concerns over supply of rare earth metals (REMs). The issue of government intervention versus free market will continue to simmer. Finally, new markets for fuel cells are continuing to come to the fore as the economics of adoption, both direct and indirect, continue to be tipped in favor of the technology.[26]

There were 200 stations in the year 2010.

Pike forecasts that annual investment in hydrogen stations will be $1.6bn, and annual demand for hydrogen will increase from 775,000 kg in 2010 to 418m kg in 2020.

“There is no one clear business model for the hydrogen infrastructure market at present,” says senior analyst Lisa Jerram.

“Currently, the major players in hydrogen fuelling are large multinationals: the industrial gas companies, and the energy and gas companies, both those that operate retail gas stations and those that provide fuels for the grid. These companies tend to favor large-scale hydrogen infrastructure options.”

[25] U.S. Department of Energy, Office of Fossil Energy home page, published 23 Jul 2010; http://www.fossil.energy.gov/programs/fuels/hydrogen/currenttechnology.html
[26] Pike Research, "Fuel Cell and Hydrogen Industry: Ten Trends to Watch in 2011 and Beyond," online report; http://www.pikeresearch.com/research/fuel-cell-and-hydrogen-industryten-trends-to-watch-in-2011-and-beyond

Lisa Jerram notes that the smaller or independent hydrogen suppliers "could offer a more modular path to hydrogen infrastructure build out."

A third pathway is vehicles with low hydrogen consumption such as scooters using hydrogen cartridges sold in retail outlets.

The research estimates that forklifts will be the largest driver of hydrogen fuel by 2020, accounting to 36 per cent of the total market. Light duty vehicles will be 33 per cent of the total hydrogen market and uninterruptible power supplies 27 per cent. Buses and scooters will be a small percentage.[27]

US Hydrogen association market report from 2008 data
http://www.netinform.net/h2/Aktuelles_Detail.aspx?ID=3066

How Hawaii ranks relative to other states:
FuelCells.org chose CA, CT, NY, OH and SC as Top 5 Fuel Cell States in the U.S.A. in June 2011. Hawaii is listed with DE, FL, MD and TX as "*Up and Coming states*". Hawaii was included in the list due to the Hawaii Hydrogen Initiative. In addition, Hawaii has one of the few hydrogen fueling stations operated on behalf of Dept of Defense at the Joint Base Pearl Harbor Hickam. The City and County of Honolulu's Board of Water Supply has at least one fuel cell system in place for backup power supply.

Hydrogen Needed for the Production of Liquid Biofuels
Hydrogen is needed for hydro-treating crude oils to produce drop-in replaceable hydrocarbons. It was a previous assumption of Hawaii and the U.S. DOE when HCEI was launched in 2008, that the state cannot do much to affect air and marine transportation energy use. Rapid changes in the fuels sector, such as the formation of CAAFI and completion by ASTM of two new renewable jet fuel certifications have changed that. Major airlines, such as United and American, and now signing deals with suppliers in CONUS for more stable-priced alternative fuels.

Making wins out of losses:
- Dependence on visitor industry/major economic driver on jet fuel prices = opportunity to stabilize seat count with stabilized fuel supply;
- Required upgrades needed for waste removal, wastewater treatment;
- Backup power systems for natural disasters;
- Utilization of fallow agricultural land for agricultural purposes vice urbanization;
- Reduce the proportion of Gross State Product exported for crude oil.

Policy Priority:
Borrow technique from DOE's QTR and establish priorities:

Drop-in fuels higher; opportunity cost of limited biomass and limited land.

Given ton of biomass, priority of transportation over stationary applications, and within transportation aviation, then marine, then ground.

[27] "Pike Research: over 5,200 hydrogen fuelling stations by 2020," *The Hydrogen Journal*, Fuel Cells page, Aug 02 2011; http://www.thehydrogenjournal.com/displaynews.php?NewsID=672

Within stationary applications: combined heat and electrical power, backup power via H2, grid stability,

- **Ground Transport:** buses and fleets before passenger vehicles.

Market Overview of the Hydrogen and Fuel Cell industry:

- More than 50 MW of stationary fuel cells were either installed or purchased, most in CA but also NY and CT;
- Commercial customers for stationary fuel cell systems include Coca-Cola, Cox Communications, Whole Foods, Price Chopper;
- Municipal customers include the Sonoma County Water Agency in California for naturalgas/biogas-powered backup power supply. System estimated to have a 7-year payback period and the County received a loan from Bank of America to finance it.[28]
- The City and County of Honolulu Board of Water Supply has put in at least one fuel cell system running off of synthetic propane/natural gas for backup power;
- 1,500 fuel cell forklifts deployed or ordered, both repeat and new customers. Commercial customers include Coca-Cola (CA, NC), Walmart, Sysco (PA, TX, VA), and Martin-Brower;
- 30 fuel cell or hydrogen-powered buses either on the road or in numerous states, including AL, CA, CT, DE, IL, MA, MI, OH, SC, TN and TX;
- New hydrogen fueling stations announced in CA, DE, NY, SC. Hawaii announced plans for 25 stations by 2015[29].

In the road transportation space, hydrogen-fueled buses are commercially accepted and in use in California and Connecticut. Xx number of hydrogen-powered passenger cars have been in use in the state of California since xx. Generally use natural gas and propane for hydrogen source as opposed to renewable hydrogen derived from biomass or electrolysis, however their multi-year use does demonstrate the reliability and xx. In Hawaii, buses are defined in the law as vehicles carrying ten passengers or more [HRS 291C-1].

Hawaii Hydrogen Initiative

Over time, achieving Hawaii's clean energy goals in transportation will require a variety of different propulsion and fuel types. At the national level, fuel cell electric vehicles (FCEV) are complementary to battery electric vehicles (BEV); the FCEV are a good fit for longer and faster driving patterns and the BEV for shorter and heavier traffic patterns.[30] For passenger cars that may be available in the near term for Hawaii, General Motors has developed and plans to start mass production of a hydrogen fuel cell version of its Equinox sport-utility vehicle by 2016, and roll out that vehicle in select markets, to include Hawaii. The General Motors fuel cell vehicle will have an estimated 200 mile range and under five-minute refueling time. They also have a hybrid electric propulsion system that includes regenerative braking to recapture energy that would otherwise be lost during deceleration, similar to that system used in plug-in electric vehicles and hybrid electric vehicles today. The fuel cell vehicle also does not need to sacrifice as much total space for battery electric storage and weight reduction, and so is able to support an SUV-style number of passenger seats and cargo area. Therefore, within the alternative vehicle options available to the passenger car consumer in Hawaii in the 2016 time frame, the fuel cell vehicle will be of interest to buyers with a large family and/or a highway commute greater than 25 miles, while electric vehicles will be of

[28] Julia Donoho, AIA, Esq., Project Manager of Comprehensive Energy Project, "Comprehensive Energy Projects (CEP) and Innovative Financing" webinar, June 21, 2011.
[29] Jennifer Gangi, Program Director, Fuel Cells 2000, www.fuelcells.org, "State Of The States: Fuel Cells In America 2011: Hydrogen Learning for Local Leaders Webinar Series," June 21, 2011.
[30] Xx Check with Mitch if can reference C.E. Thoas "Summary Comparison of Alternative Vehicles," July 2011

interest to buyers with small families or cargo needs and a driving pattern that includes a lot of stop-and-go travel under 25 miles round trip. Within Hawaii driving patterns, this means the longer driving distances on the island of Hawaii will complement fuel cell cars while the congested roads in and around Honolulu on Oahu will complement electric vehicles.

Relevance to Hawaii:

- Hydrogen shortage for hydrotreating of crude oils and distillates to produce jet fuel and marine diesel.

- Disaster preparation/emergency response/backup power chapter 209 in HRS addresses disaster declaration authority, recovery loans, and unemployment compensation, but only addresses petroleum product supply and backup power for agricultural irrigation systems. Backup power for communications, emergency services, drinking water supply, waste treatment and disposal etc are not addressed in this chapter. Civil defense and federal activities are separate.

Commercial/fleet use: Systems used to refuel forklifts are the same as the ones used to refuel buses