



PROJECT ROADMAP
HAWAII RENEWABLE ENERGY
DEVELOPMENT VENTURE

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Introduction

The Hawaii Renewable Energy Development Venture (HREDV), a program funded by the U.S. Department of Energy (USDOE), was established in July 2008 to accelerate the commercial application of clean energy technologies in the State of Hawaii with intent to apply those lessons learned in the U.S. mainland and other locations. The purpose of this document is to establish a clear pathway for HREDV to achieve the objectives of the program through a project roadmap.

HREDV has established operations at a very opportune time, when interest in the deployment of energy efficiency and renewable energy is very high both in Hawaii and in the nation. Hawaii has a very paradoxical energy economy, highly reliant on imported fossil fuels, while blessed with extraordinary renewable energy resources. Both U.S. and State of Hawaii governments are developing and pursuing strategies to reduce dependence on foreign oil imports and developing a robust, sustainable alternative energy industry.

HREDV can make a significant contribution toward the development and growth of the clean energy sector in Hawaii. There are unique opportunities manifesting themselves in Hawaii through a combination of government interest and leadership, market transformation efforts, and unparalleled access to a natural environment that is blessed with a generous endowment of renewable energy resources.

This roadmap has been developed to guide the efforts of HREDV and to ensure its relevancy to affected constituencies. In doing so the roadmap will help HREDV to provide support to the state's and USDOE's efforts to execute the Hawaii Clean Energy Initiative especially in those areas with identified gaps. HREDV will help grow the clean energy sector by supporting worthy investments in technology development and clean tech companies.

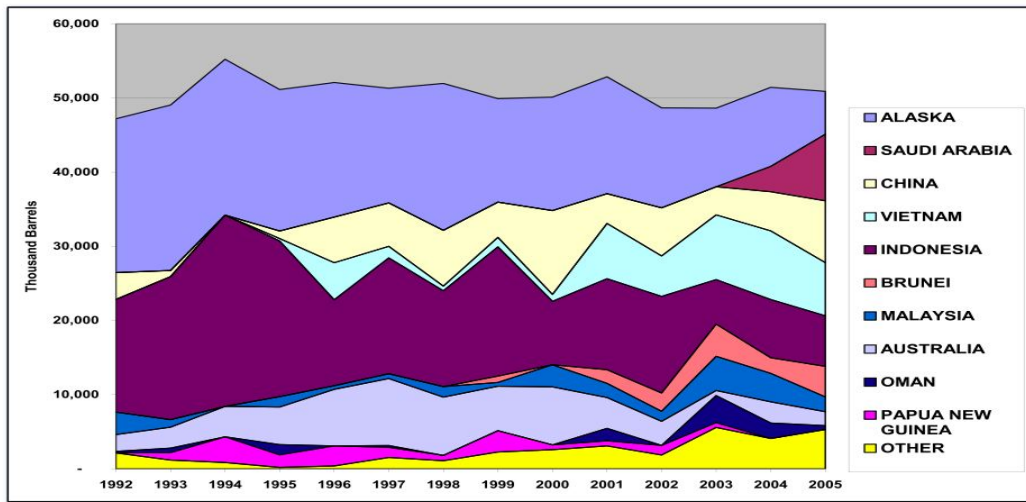
Overview of Energy in Hawaii

The Hawaii economy is still dependent on oil for 90 percent of its energy needs. In the last two decades, this dependence has become increasingly reliant on oil resources from sources outside of the United States. Figure 1 illustrates how this dependence has evolved over the last two decades and has shifted from a balance that included domestic U.S. sources to practically total dependence on foreign imports in 2005. The effect of this oil dependency on the Hawaii economy was dramatically underscored in July of 2008 when oil prices in the world markets exceeded \$147 per barrel.

Oil price volatility remained high in the months after, dropping to below \$40 per barrel in early 2009 as the U.S. and world economies contracted through the effects of a severe recession. This volatility again dramatically illustrates why Hawaii must immediately address energy and economic security by reducing this oil dependence through the development and utilization of energy efficiency and renewable energy resources.

Knowledgeable experts are not predicting a long-term return to low oil prices. As economies recover and demand for limited supplies of oil increases, Hawaii can again expect a disproportionate effect on the state because of its isolation and reliance on imports of both food and fuel. Although Hawaii has two refineries located on the island of Oahu, these refineries are not very advanced by current industry standards and are small and sized to fit Hawaii's market. The refineries therefore must purchase lighter "sweet" crudes, at relatively high cost thus exacerbating economic effects during periods of high-energy prices.

Changes in Origins of Hawaii's Crude Oil



Sources: State of Hawaii – DBEDT, 2006; and U.S. Energy Information Administration (USEIA), 2006.

Figure 1. Hawaii's Oil Sources, 1992 to 2005

These energy security and energy pricing challenges have raised the consciousness of Hawaii's consumers who are looking for answers from government and incumbent energy providers. Hawaii's electric utilities in particular face critical issues with energy delivery with an aging electric generation, transmission and distribution infrastructure. Because of the dominance of oil products used to fuel Hawaii's electric utilities, increases in oil costs are felt severely by all electricity customers. Figure 2 summarizes how electricity prices compare with U.S. averages, and the large fraction of revenue requirements utilized to pay for fuel costs, which are calculated as the fuel cost percent of total bills.

Reducing reliance on imported petroleum has become a stated priority for state, federal and county governments. The current crisis has created ample opportunity for leadership to emerge, ensuring that actions leading to sustainable energy development and management get established.

Figure 2. Electricity Prices, 2005-2008

For several decades the federal government has supported the state's efforts to develop clean energy technologies in Hawaii. Federal programs in the past have funded research and development of geothermal energy and an inter-island transmission cable, wind energy, ocean thermal energy conversion, biomass and energy crops, alternate transportation fuels, solar thermal and solar photovoltaic, and hydrogen and fuel cell development. Much of these previous efforts have been ad hoc, sought by and supported by technology advocates rather than as part of a holistic systematic effort. In recent years, policy-makers have become more aware of the interconnectedness of Hawaii's energy systems, resulting in more integrated policy-making and attempts to minimize unintended consequences. While the opportunity costs from inaction are high in Hawaii's isolated island energy systems, risks from failed policies or technology investments can have greater relative consequences compared to larger, interconnected mainland energy systems. Accordingly the state and federal governments are now engaged in a systematic effort to address local and national energy security issues in the Hawaii environment.

The Challenge of Multiple Organization Interests

Clearly the interest in accelerating Hawaii's transition to a future based largely on maximum energy efficiency and renewable energy is high. As a result a multitude of organizations with a stated interest in helping to overcome Hawaii's energy challenges has emerged. While this interest is welcome, the large number of government, academic, NGO and private sector organizations can result in overlap, confusion, disagreement and discord without adequate coordination and guidance.

Stakeholders include the following.

- Government: Federal – U.S. Department of Energy, U.S. Department of Agriculture, U.S. Department of Defense; State - Department of Business, Economic Development and Tourism, Department of Agriculture, Department of Land and Natural Resources; County - City and County of Honolulu, Hawaii County, Maui County, Kauai County
- Academia: University of Hawaii, Hawaii Natural Energy Institute, College of Tropical Agriculture and Human Resources
- Private Sector: Hawaiian Electric Company, Hawaii Electric Light Company, Maui Electric Company, Kauai Island Utility Cooperative, Chevron, Tesoro, The Gas Company, numerous private energy developers
- NGOs: Enterprise Honolulu, Maui Economic Development Board, Kauai Economic Development Board, Hawaii Island Economic Development Board, Economic Development Alliance of Hawaii, Hawaii Renewable Energy Association, Hawaii Science and Technology Council, Hawaii Agricultural Research Council, Blue Planet Foundation

The above list is not intended to be all-inclusive, but is meant to illustrate the major players in the energy sector across the spectrum of public and private interests. Each organization has a distinct role and agenda, and for HREDV to be most effective, it needs to understand what these organizations are doing, identify common interests and needs, and strive to coordinate HREDV's efforts to be complementary, to offer some direction and coordination, to serve as a clearinghouse for information and insight, and to help fill key gaps for the growth of the clean tech sector in order to address Hawaii's energy problems.

Appendix A characterizes these organizations in summary fashion. Some notable facts emerge from an understanding of these organization interests. It is clear that reducing Hawaii's dependence on imported oil, addressing energy security, and transitioning to renewable energy is a top priority for many of these organizations. All of the county economic development boards, and their collaborating organization, the Economic Development Alliance of Hawaii, have placed addressing Hawaii energy security at the top of their priority lists. Each of the county governments has prepared, or is preparing county-specific sustainable energy plans. Significant institutional efforts have emerged, efforts such as the Hawaii Clean Energy Initiative, state efforts to work with Hawaiian Electric Company and the Public Utilities Commission on regulatory reform, and climate change initiatives like the Green House Gas task force. These will be discussed in greater detail below, since these are the major drivers affecting HREDV program direction. Finally, significant NGO activity has emerged, as illustrated by the work of the Hawaii Energy Policy Forum, Blue Planet Foundation, and Kanu Hawaii.

The Hawaii Clean Energy Initiative

The Hawaii Clean Energy Initiative (HCEI) provides the overall guiding framework for actions being undertaken by the state to address energy security and overdependence on imported oil by maximizing development and utilization of energy efficiency and renewable energy resources. HCEI was formally initiated as a partnership between the Governor of the State of Hawaii and the U.S. Department of Energy through a Memorandum of Understanding signed on January 28, 2008. A copy of this MOU is reproduced in Appendix B.

According to the agreement HCEI is designed to help Hawaii transform its energy system from one predominantly reliant on imports to a system based primarily on indigenous energy resources. According to information provided by the state and USDOE at the inauguration of the program, the partnership was to provide technical assistance and seed funding for a variety of innovative projects including:

- Designing cost-effective approaches to achieve 100 percent reliance on renewable energy at the small island scale
- Designing systems to improve the stability of island electric grids operating with variable generating sources like wind energy on Maui and the Big Island
- Minimizing energy use while maximizing energy produced at new military housing developments, including use of solar and wind systems, and
- Expanding Hawaii's capability to use locally grown crops and by-products for energy sources

Besides support for projects, HCEI is also designed to help the state design comprehensive policy, regulatory and financing frameworks to promote clean energy use. USDOE has provided direct access to management and technical expertise, the most evident of which is the assignment of a senior management official to the Department of Business, Economic Development and Tourism for a three-year period. Technical support has been garnered from the National Renewable Energy Laboratory, USDOE support contractors like Booz, Allen Hamilton and The McKinsey Group, and special experts that have been provided on a contract basis for regulatory initiatives and project development and finance.

HCEI has established an ambitious target for the state to obtain 70 percent of its primary energy from efficiency and renewable energy resources within a generation, or 2030. Four technical working groups were established with joint Chairs from both the State and USDOE. These working groups included: efficiency, generation, transmission and

distribution, and transportation. Cross-cutting issues that transcend the primary focus of the working groups have been handled by a separate Integration Group.

HCEI's several objectives include consideration of directing Hawaii's emerging innovation economy to solve energy security issues using local creativity and talent, to foster economic development by investing Hawaii dollars into companies that are delivering sustainable energy solutions, to train the workforce of the future, and to create opportunities for quality, high-paying jobs for Hawaii's youth.

With success, HCEI's role to transform Hawaii can be used as a model for the US and the rest of the world.

After a little over a year's effort, several conclusions can be drawn from the HCEI experience. Based on the analytical work supported by USDOE, 70 percent renewable energy and efficiency by 2030 is possible, according to the analysis. A financial and investment analysis performed by Booz, Allen, Hamilton has demonstrated that this scale of achievement is possible at an investment break-even price point of \$73 per barrel oil equivalent. In order to technically achieve this transformation, the state would need to maximize energy efficiency in all end use categories.

Customer-sited renewable energy must be developed as a significant new market, while large-scale wind energy projects on the neighbor islands (Maui County) must be developed to address resource limitations on Oahu. An inter-island transmission cable is needed to connect the generation sources to Oahu. Greater (almost complete) saturation of solar water heating systems will be required, as will utilization of distributed generation assets throughout the electrical distribution system. The development and use of smart grid technology will capture increasing benefits for the overall reliability and robustness of the electric grid, and will create new ways to incorporate storage technologies to maximize energy capture from otherwise non-dispatchable renewable energy resources such as wind and solar.

Because of the significant amount of energy used in the transportation sector, development of locally produced biofuels must be pursued. In later years advanced generation technologies like ocean thermal energy conversion and wave energy generation devices will become more common.

Recognizing that much of the transformation to renewable energy and energy efficiency will be funded by the private sector, new approaches to attract investment capital and addressing risk management will be critical. HCEI identified the need to reform the current regulatory structure toward a new business model that is likely to decouple utility profits from electricity sales levels, and instead, offer compensation on the utility's ability to deliver energy services that are reliable, more efficient, more stable in cost compared to oil, and environmentally friendly.

In addition to addressing the technological hurdles, other tough issues must be addressed for HCEI to succeed. With the transformation to a clean energy society, there must be equal attention paid to developing a competent workforce so that Hawaii citizens can be prepared for the jobs that will be created by these green industries. Potential conflicts over water and land use policy must be addressed, particularly if a biofuels industry is to be developed. Public education must be addressed, given that renewable energy resources are capital intensive compared to conventional energy conversion technologies. Greater acceptance of the need to pay more up front to achieve energy, economic and environmental security for the long-term will be required. Tough permitting issues will emerge, especially over potentially controversial proposals like the inter-island cable and export of energy from the neighbor islands to Oahu.



Figure 3. La Ola Solar Farm, Lanai features 7,400 photovoltaic panels that tilt to efficiently track the path of the sun and is remotely controlled by Maui Electric Co.

The State-HECO Agreement

In October of 2008 the Governor of the State of Hawaii, Linda Lingle, announced an unprecedented agreement between the State and Hawaiian Electric Company that publicly committed joint voluntary efforts to an electric energy future based on renewable energy and an ethic of energy efficiency, and a future that moves decisively and deliberately from imported oil. The agreement was unprecedented not only for the boldness of the stated commitments, but because it represented the first public pronouncement of its type by the state's largest electric utility. Parties to the agreement included the Governor, Department of Business, Economic Development and Tourism, Division of Consumer Advocacy, and Hawaiian Electric Company. A copy of this agreement is reproduced in Appendix C.

There are several reasons why this agreement is significant in Hawaii's quest to achieve greater energy independence. It describes the belief that a new business model for Hawaiian Electric Company is essential, one that compensates the company not for electricity sales, but for their ability to successfully deliver energy services that result in greater reliability and energy security, while striving to source and integrate greener and lower cost generation. The delivery of services that capture the benefits of energy efficiency at both the customer as well as the generation and delivery levels is inherent in this new business model.

In an effort to stimulate as well as facilitate the development and use of renewable energy resources, a number of significant new regulatory policies will be pursued. For example, HECO and the State are pursuing the use of feed-in tariffs for renewable energy. These tariffs are intended to establish a firmer basis for compensation for specific renewable energy technologies based on their predicted costs and desirable attributes. When feed-in tariffs are established properly, risk and uncertainty faced by renewable energy developments are better addressed, creating significant market pull for these technologies.

HECO has committed to achieving the target of 70 percent clean energy by 2030 by obtaining 40 percent through renewable energy generation and 30 percent through efficiency resources. Efficiency resources are those measurable gains in reduction of electricity demand or usage such as solar with water heating, efficient lighting and HVAC, combined heat and power, and energy conservation. By decoupling its profits from sales, these commitments are expected to profoundly change the business environment, and stimulate increased private sector activity to deliver green technologies.

Notable elements from this agreement include commitments to:

- Pursue and integrate as much as 1000 MW of renewable energy resources by HECO, MECO and HELCO
- Seek legislative changes to the Hawaii RPS law to require that 40 percent of electricity be obtained from renewable energy sources by 2030
- Integrate up to 400 MW of wind energy from one or more wind farms on Lanai or Molokai, transmitted to Oahu via inter-island undersea cable
- Decouple utility profits from sales by seeking approval from the PUC in 2009 beginning with HECO's current rate case
- Seek approval from the PUC for the establishment of feed-in tariffs for renewable energy technologies to create more certainty for developers by covering their costs of energy production plus a reasonable profit
- Lifting system-wide caps on net metering installations and instead, handling interconnections on a per circuit basis, and
- Pursue a variety of strategies designed to increase renewable energy use through Pay-as-You Save solar programs, utility photovoltaic host programs, advance metering, deploying electric vehicles, and enacting lifeline rates.



Figure 4. The photo above is an aerial view of the Kaheawa Wind Farm on Maui. Wind energy has emerged as a significant resource to propel Hawaii toward energy independence.

In July of 2009, Governor Lingle signed into law, a measure enacted by the Hawaii Legislature to codify the requirement for Hawaii's electric utilities to produce 40 percent of the electricity it sells from renewable energy sources and 30 percent from energy efficient resources by 2030.

Feed-in tariffs, decoupling utility profits from sales, net metering and the above list of commitments represent an unprecedented commitment from Hawaii's major electric company to change the way it does business and more importantly, synchronize its profitability with societal goals for clean energy established by State policymakers. The policy of decoupling will mean that the utility will be profitable not by selling more electricity, but by meeting certain targets established by regulators. A formal proceeding is now before Hawaii regulators and the actual mechanisms must await that proceeding. In total this framework for a new electricity regulatory model is unlike any being pursued elsewhere in the country, is being closely watched, and could very well prove to be a model for others.

HREDV is perfectly positioned to complement the Hawaii Clean Energy Initiative, and support the changes that will result from the market pull created by HECO and its sister utilities in their efforts to transform energy markets to green tech. Because resources are limited, HREDV must design its program to effectively deploy those resources to fill possible gaps that are not being adequately addressed by other public or private institutions. In order to strive for the best possible outcomes, HREDV must utilize tools to address how to sustain the efforts supported by its investments through leverage, training and education, business practices, and creative partnering. Achieving the HCEI targets will require advanced technologies suitable for the Hawaii energy environment. Systems solutions must be pursued. Consumers must understand the need to move aggressively toward greater energy independence, and they must be prepared to make the initial investments in order to obtain the longer-term cost, economic, and environmental benefit of a future that is not tied to oil and its products.

A roadmap to guide HREDV's efforts is an important part of a well-executed plan, and can be used for base-lining efforts, establishing milestones, and monitoring and evaluation.

A Roadmap for HREDV

The Hawaii Renewable Energy Development Venture (HREDV) was initiated with the approval of the U.S. Department of Energy effective July 1, 2008. This Congressionally-directed project was initiated to cover an 18 month period with an initial budget amount of \$1.2 million. Subsequently, a second year of funding totaling \$3.8 million has been appropriated to continue and expand the program.

This project seeks to identify, evaluate and/or demonstrate feasible energy options, including the development and testing of technologies to create viable renewable energy systems and together with the development of policies to support the implementation of those systems in the State of Hawaii. Hawaii, with its isolation, extreme dependence on imported petroleum, high energy costs, and abundant access to a wide variety of renewable energy sources holds significant potential for a major transformation to clean energy technologies, and in doing so, to become an example for the rest of the nation. The project starts with a needs assessment, develops collaborative approaches with other major partners, and supports the development and application of innovative technologies to enable this market transformation.

In order for Hawaii to achieve the desired transition to a clean energy-based economy, the ultimate goal of the project will be to provide project funding to Hawaii-based small businesses to enhance the opportunities for successful testing, evaluation, and sustainable implementation and operations of energy efficiency and renewable energy technologies. HREDV envisions that funding will be needed to support early stage innovation and deployment and demonstration. The project intends to select and award meritorious projects through an independent peer-reviewed process approved by USDOE. HREDV will establish an Advisory Committee to help with project evaluation and selection. Any cost-share required by USDOE for the anticipated funding awards will be passed on to the awardees as a condition of award.

Both HREDV and USDOE agree that a roadmap is needed to help guide the project toward desired successful outcomes. The basis of this roadmap will rely upon an understanding of the contemporary Hawaii energy economy, the vision for the New Hawaii Energy Economy, the major stakeholders involved, and recognition of the value of coordinated efforts and how HREDV can become a valued asset to the state's efforts. The Hawaii energy economy of today and the major stakeholder involvement has been discussed in preceding sections. Below we discuss how HREDV can support the vision for a clean energy future articulated by the Hawaii Clean Energy Initiative, describe the assessment conducted to strategically direct technology development support efforts, and discuss the need for systematic coordination and public education and outreach.

Acknowledging the Vision of the Hawaii Clean Energy Initiative

HREDV, instead of crafting its own vision for the transformation of Hawaii's energy sector to one predominantly based on clean energy technologies, respects the vision already promulgated by the Hawaii Clean Energy Initiative: Hawaii will meet 70 percent of its basic energy needs from a combination of energy efficiency resources and renewable energy within a generation, by the year 2030.

This vision reflects the already adopted statement of principle from the Memorandum of Understanding executed between the Governor of Hawaii and the Assistant Secretary of Energy, Office of Energy Efficiency and Renewable Energy, in January of 2008, which drives the actions derived from the Hawaii Clean Energy Initiative. As such it is already a well-accepted program of the State of Hawaii and the U.S. Department of Energy, and supported by Hawaii's Congressional delegation and especially U.S. Senator Daniel K. Inouye.

More importantly, it allows for the execution of HREDV to be in concert with and to achieve good synergy with the leadership framework established by the state and federal governments. The principals involved with a host of related programs are part of the HCEI leadership team: the Director of the Hawaii Natural Energy Institute, the Deputy Assistant Secretary of the Office of Electricity Delivery and Energy Reliability, and the Technical Director of HREDV.

While key sector recommendations emerging from HCEI are still evolving, it is increasingly apparent that the following outline of strategies makes sense between now and 2030. These strategies are described in phases, but these should be pursued collectively and will overlap to some degree. Phasing is intended to give some sense of relative timing; efficiency resources, for example, can generally be acquired much more quickly than development of renewable electricity projects at utility-scale.

- Phase I—aggressively utilize all reasonable energy efficiency resources. Set aggressive and measurable targets for energy efficiency, like achieving a 30 percent reduction in per capita energy use by 2015. Ramp up penetration of solar water heating systems in residences to 75 percent compared to the present 25 percent. Achieve 30 percent reduction of energy usage in current building stock, and develop an aggressive energy code for Hawaii's sub-tropical climate.
- Phase II—transform Hawaii's electricity sector to one that is predominantly based on renewable energy. Attain a minimum 40 percent reliance on renewable energy resources by 2030, with sub-goals for near-complete conversion of neighbor-island electricity systems to renewable energy. Maximize the cost-effective development and utilization of commercial and near-commercial renewable

energy resources like wind, solar, biomass, geothermal, and run-of-the river hydroelectricity. Pursue the interconnection of the island electricity systems by undersea cable, and increase the saturation of customer-sited renewable energy such as solar photovoltaic, building scale wind energy, and concentrating solar thermal systems.

- Phase III—transform the ground transportation sector to non-fossil fuels. Achieve a 50 percent shift to non-petroleum fuels by developing substitute, bio-based fuels like ethanol, biodiesel, other biofuels, and greater use of battery electric vehicles including plug-in hybrid electric vehicles. Maximize the synergies possible with the integration of technologies for transportation using electricity as a resource as electricity generation is converted to renewable energy.
- Phase IV—consciously develop plans and supportive policies to allow for the introduction and integration of “game changing” technologies. Emerging technologies like wave energy conversion devices, ocean thermal energy conversion, cellulosic biofuels, and hydrogen and fuel cell systems can make the 70 percent clean energy by 2030 target much more achievable.

As plans and programs develop from the Hawaii Clean Energy Initiative, HREDV will adapt its efforts to maintain relevancy and direct its limited financial resources toward the best potential outcome, filling gaps that are identified by the state, USDOE, and its constituent base.

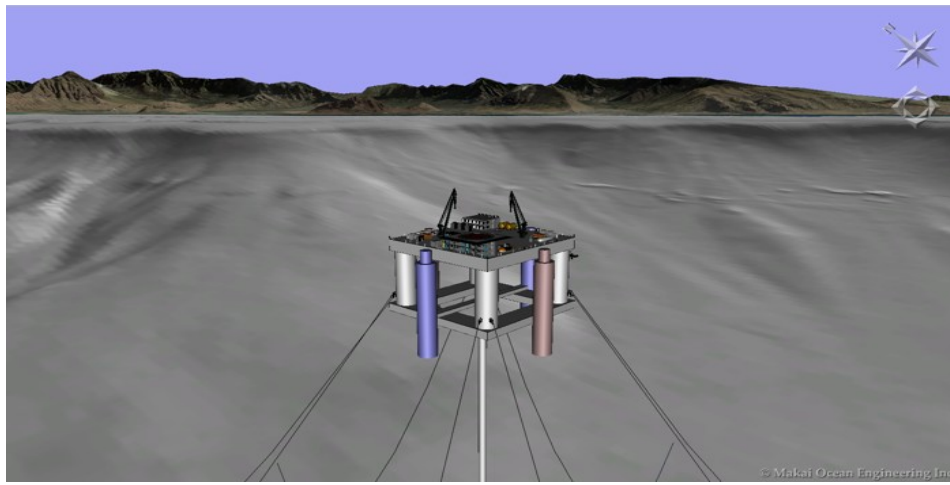


Figure 5. Artist’s rendition of offshore OTEC plant moored off Kahe Point, Oahu (courtesy of Lockheed Martin, 2009)

Assessment of Needs

HREDV has commissioned a needs assessment of renewable energy technologies with potential application to Hawaii and the nation. This needs assessment will be an integral part of the roadmap for this project to offer development funding, and to provide collaborative services to potential stakeholders and partners who are attempting to transform the energy market in Hawaii through the use of energy efficiency and renewable energy, thereby addressing long-term security concerns.

The assessment is intended to identify appropriate strategies for this project to help to achieve significant market transformation to renewable energy for Hawaii. The USDOE has already recognized the potential for Hawaii to serve as a national leader for significant utilization of renewable energy in place of the current 90 percent dependency on imported oil for its energy through HCEI. This major effort will succeed only if key decision-makers in Hawaii's energy markets operate collaboratively. Part of the strategy must include the derivation and support of Hawaii-specific energy technology innovations, which is intended to be the focus of this project. For example, early needs that are being considered include:

- Reduction of cycling of significant available supplies of intermittent renewable resources like wind in the small island grids,
- Increased reliance on distributed renewable energy systems while providing ancillary services to the electric grids
- Potential integration of electric and transportation technologies with significant impact on island grids, e.g. plug-in hybrid electric vehicles, to enhance utilization of renewable resources,
- Development of controls, smart grids, storage technologies, systems engineering, integration and application,
- Significant uptake of island-based biofuels to include non-grain ethanol for transportation and biodiesel as substitute fuel in diesel electric generation units, all to provide significant market pull for these non-petroleum based fuels, and
- Novel approaches for new biofuels, including micro-algae as a platform for the production of bio-oils.



Figure 6. Storage technologies can increase utilization of intermittent resources like wind energy. These sodium sulfide batteries have been integrated into a wind farm in northern Japan.

HREDV relied on the University of Hawaii’s Hawaii Natural Energy Institute (HNEI) to prepare the initial assessment. HNEI is uniquely positioned to offer its counsel to HREDV. The Hawaii Natural Energy Institute is a research unit of the University of Hawaii, and is an international leader in the energy field. Its responsibilities include conducting and supporting basic research, managing research facilities and laboratories, demonstrating the applications of its work, and investigating the social, environmental, and financial impact of energy- and marine-related activities.

Its activities cover a wide variety of clean energy sectors, many of which are important to the success of Hawaii’s strategic energy objectives. HNEI will be an important partner and collaborator with HREDV. Many of HNEI’s program areas are particularly relevant to HREDV, and no other institution in Hawaii, public or private, has a similar portfolio.

HNEI has obtained state, federal, and private sector support for a variety of applied research projects in the clean tech sector. Federal support encompasses not only USDOE programs, but those of DOD, USDA, and the U.S. Department of Interior (DOI). Their relevant project initiatives include the Hawaii Distributed Energy Resources Technologies for Energy Security (USDOE), Biofuels Crop Trials Project (USDA), Hawaii Bioenergy Master Plan (State and USDOE), Hawaii Energy and Environmental Technology Initiative (DOD), Renewable Portfolio Standards (RPS) Analysis for the Hawaii Public Utilities Commission (State), Maui Wind Integration Assessment Project (USDOE), Western Region Carbon Sequestration Project (USDOE), Hawaii Ocean Energy Center (USDOE), and the Hawaii Hydrogen Power Park and Vehicle Fueling Demonstration (USDOE, DOI, and DOD). HNEI’s experiences managing and executing these projects will greatly help to facilitate the completion of the technology assessment for HREDV and the derivation of subsequent project criteria and metrics.

HNEI’s assessment included a technology overview and analysis of readiness for commercialization and appropriateness to Hawaii. These assessments will be used by HREDV and, coupled with the selection metrics and criteria, comprise tools for project evaluation for funding.

HNEI conducted an initial screening of renewable energy and enabling technology categories using the considerable experience of its researchers, on the status of technology commercial readiness and appropriateness for Hawaii. In parallel, HNEI developed the “Technology Selection Criteria and Metrics” report, and utilized this process to down-select technology areas that hold promise for near-term deployment and commercialization in Hawaii. As a result, the following technology areas were selected for assessment:

- Solar energy systems: photovoltaic and solar thermal (two assessments)
- Small scale wind turbines
- Biomass: conversion technologies and energy crops (two assessments)
- Information systems for grid operation and end use efficiency
- Energy storage
- Transportation technologies for electric vehicles
- Geothermal, including engineered systems and low grade geothermal heat
- Water resources: small pumped hydro, water/energy integration, and wastewater

Figure 8 illustrates the process employed by HNEI to select the technology areas for evaluation.

The assessments prepared by HNEI provide HREDV with “snapshots” of each technology area including a brief overview of a technology or family of technologies, as appropriate, the status of its commercial readiness, and its appropriateness to Hawaii. In order to construct a consistent evaluation approach for each technology, the following framework was utilized:

- An overview of the technology
- The status of its commercial readiness
- Assess its appropriateness to Hawaii
- Any consideration specific to the technology or resource



Figure 7. OPT’s Powerbuoy is undergoing development testing at Kaneohe, Oahu. It is one of several wave energy technologies being deployed in Hawaiian waters.

FIGURE 8

While these technology assessments should be helpful in targeting HREDV’s funding efforts in a strategic direction, the characteristics of any specific proposal must also be evaluated. Some of these characteristics might include potential for establishing significant market share in the state, availability of resources, possible impacts on the environment, maturation of the technology or significant components crucial to eventual commercial success. In addition HREDV evaluations must also consider state policies and the overall potential to significantly reduce dependence on imported petroleum, thereby addressing the energy security needs of the state.

Figure 9. General Motors Corporation’s planned production of the Volt plug-in hybrid electric vehicle is a hopeful harbinger of advanced automotive technologies that can revolutionize transportation and electricity systems.



From the above framework, HNEI has completed several letter reports that summarize each of the technology areas. These reports are included in Appendix D. Through the HNEI research and assessments, the following project areas were narrowed down with potential program areas of development and expansion.

The following Table attempts to categorize possible broad interest areas for consideration for support from the numerous technology assessments prepared by HNEI. This tabular arrangement of technology focal area, apparent needs, and potential applications supports the request for proposal development process that is described in a following section.

Technology	Need	Assessment	Potential Applications
Grid Modernization	-Reduce curtailment of as-available energy systems -Reduction of net energy costs	-Provide ancillary services while increasing use of distributed renewable energy systems -Enhance integration of transportation and electricity systems	-Engineered Geothermal System -Smart Grid -Wave Energy
Renewable Energy for Electricity	-Reduction of costs -Increase use over “business as usual”	-Increase Technology	-OTEC -Water Energy Integration -Small Pumped Water Storage -Wave Energy -PV -Solar Thermal
Renewable Energy for Transportation	-Reduce petroleum use -Have measurable impact by 2015	-Integration of agricultural production with transportation fuel energy	-EV & PHEV -Bioenergy Crops -Biomass Conversion -Algae Production and Oil
End-use Efficiency	-Decrease lighting energy requirements -Reduce building loads -Benefit large commercial end user sector	-Accelerate use of energy efficient building materials -Smart Controls	-Small Wind -Water Energy Integration -Demand Response and Demand Side Management

Criteria and Metrics for Project Support

In addition to the technology assessment, the Hawaii Natural Energy Institute has prepared a complementary guide for criteria and recommended metrics to be used for the selection of technology projects. Given that HREDV plans to deploy funds through a competitive solicitation process, a transparent, defensible system for proposal evaluation is needed. The criteria and metrics provide a tangible guide for where priorities are to be placed, in concert with the programmatic direction developed from the assessment. HNEI's Technology Selection Criteria and Metrics analysis is included within Appendix E and reflected in Figure 10.

Projects must initially pass several broad “gates” before they are evaluated against remaining technical and business criteria. These gates include whether or not the technology or project proposal is consistent with the U.S. Department of Energy's technology portfolio, ensuring that proposed technology projects are not duplicative of efforts already underway, ensuring that the project falls within the maximum permissible funding level, and whether the project meets USDOE's minimum cost share requirement.

For projects that meet these minimum criteria, HNEI recommends that proposals be evaluated further to determine their readiness for commercial application, whether they are consistent with and supportive of state policies and regulatory initiatives, superiority of proposer qualifications, amount of leverage and/or defined collaborations, and the project proposal's relevance and ability to address the uniqueness of Hawaii's energy environment.

Through its support, HREDV will concentrate efforts to accelerate commercialization of clean energy technologies. Therefore any set of criteria that addresses commercial readiness of any technology must by necessity address anticipated development timelines, availability of supporting infrastructure for near-term deployment, expected strategic value to customers, whether it is replicable in other markets whether there is sufficient market pull, and that there is sufficient support from end users.

Given that both the State of Hawaii and the U.S. Department of Energy have invested considerable effort toward the creation of policies that drives markets toward energy efficiency and renewable energy, project proposals that are consistent with these policies and regulatory direction should gain the most support. In the discussion above, both the Hawaii Clean Energy Initiative and the unique voluntary agreement for electricity sector transformation between the state and Hawaiian Electric Company continue to be important drivers. Accordingly, project proposals that support state policies and regulatory initiatives, adequately address the timeframe for permitting and regulatory requirements, and are sensitive to the unique cultural and societal environment of Hawaii will be favored.

An essential part of project success and ultimately, commercialization of supported technologies is the capability and strength of the businesses behind the proposals. HREDV has good models to follow in first, screening successful applicants for their potential for business success, and second, to provide assistance with business practice particularly for fledgling enterprises. The models have been developed and utilized by a sister program, the Hawaii Technology Development Venture, which has supported commercialization of technologies for DOD and civilian applications for several years. That experience and infrastructure will be utilized in this USDOE program.

For the evaluation process, HREDV will screen and evaluate applicants on their abilities for project management, will evaluate whether proposers already have acceptable accounting practices, financial strength, and requisite business management skills such as marketing, business planning, and compliance with acceptable personnel and hiring practices.

While the USDOE's minimum cost share requirement will be imposed on qualifying proposers, superior projects will also demonstrate a high degree of leverage and other collaborations with public or private sector entities. Superior projects are those that already have raised significant funding from the proposer team or other sources of capital markets, and HREDV's support is able to push the project toward commercial viability more rapidly.

Finally HREDV wishes to emphasize proposals that clearly demonstrate their relevance and uniqueness to the energy environment in Hawaii, contributing to the state's economic stability and offering competitive advantages to sectors where energy availability, cost, and reliability, are significant challenges for sustainability. For example for Hawaii to succeed in its long-term goal to markedly reduce import dependence, projects that enhance not only energy security, but food security and water availability are of paramount importance. Projects that strengthen our ability to develop a skilled job market and workforce are attractive, as are those that strengthen and enhance Hawaii's economic stability and diversity.

The relationship of energy security and food security deserves amplification. Besides the evident interest in developing biomass resources for Hawaii's energy diversity goals, energy costs have a significant effect on Hawaii's ability to feed itself. Like imported petroleum, Hawaii imports an astounding 90 percent of its food supply from outside of the state. All of this imported food travels here via transportation modes that are currently completely dependent on oil for fuel. Hawaii's farmers have struggled to produce more locally-grown agricultural products because of high labor costs, high energy costs, restricted availability of lands, and at times, restrictions on water supply. Labor and energy represent the greatest cost elements faced by Hawaii agriculture. Fuel for mechanization, cultivation and harvesting, electricity costs for processing, freight and

distribution costs, even fertilizers are all dependent on fossil fuel. When oil costs approached \$150 per barrel in mid-2008, Hawaii's farmers all struggled desperately. Dependency on imported oil poses a grave threat to Hawaii's food security. At the same time, Hawaii needs a vibrant agriculture sector if it is to make a reasonable transition to biofuels for energy diversification. The same farmers are expected to grow potential energy crops. Thus the notion of sustainable agriculture and energy is inseparable. Energy efficiency and renewable energy hold considerable promise to help Hawaii agriculture, so there is a compelling justification to direct support for agriculture.

These selection criteria and metrics will be incorporated by HREDV into any solicitation for funding upon USDOE's acceptance of this roadmap.

FIGURE 10

Proposal Solicitation, Evaluation and Award

HREDV will employ a transparent and objective request for proposal and project award process as it seeks candidate projects for its co-investment portfolio. This process will employ a two-step selection process starting with a call for proposals for funding under a broad agency announcement, seeking project abstracts in Step One, evaluating the quality of the abstracts, and Step Two, inviting full proposals from those projects deemed worthy of further review and possible award. A technical advisory committee whose membership includes knowledgeable representatives from both public and private sector clean energy interests will assist HREDV in its evaluation as described below.

The call for proposals will be issued in the Fall of 2009 for the funds available to PICHTR/HREDV through a combination of both FY08 and FY09 federal appropriations. PICHTR as the fiscal agent for HREDV will be responsible to oversee the solicitation and contracting process under the supervision of HREDV's Project Director, who will also serve as the Selecting Official. We expect that abstracts will be due approximately one month after the date of the broad agency announcement. The Technical Advisory Committee will be convened by HREDV to advise the Selecting Official with recommendations for invitation of full proposals. Short-listed proposers will then be given from four to eight weeks to submit full proposals for final evaluation and award by the Selecting Official. The proposal solicitation and award process will remain open for ninety days after the initial announcement date, in the event PICHTR finds that it is desirable to seek an additional round of full proposals from the originally submitted abstracts.

Abstracts will be limited to five pages including a cover page, with the bulk of the abstract describing the substance of the project's problem, product, process, importance and price. HREDV expects that the majority of the work will be carried out in Hawaii, addressing Hawaii problems and opportunities as described by the call for proposals in the areas of interest and priorities from this roadmap. However HREDV does not plan to limit eligible offerors to Hawaii companies and may instead, express a preference for affiliation of non-Hawaii entities with Hawaii partners in an effort to build and sustain capacity in clean energy technology in Hawaii.

The abstract may also contain other information deemed important to the proposed effort, such as description of leveraged assets, co-funding arrangements, consultant commitments, or technical references and how intellectual property is to be treated. The project duration for subcontracts is expected to range from one to two years, depending on the complexity of the project proposal, and whether the proposal is for test and evaluation, or for pre-commercial demonstration. Both the abstracts and eventually, the full proposals will be evaluated against a set of criteria that include technical quality,

approach and capabilities of the team, anticipated benefits to Hawaii and its clean energy goals and objectives, and cost and budget.

Successful offerors will be required to execute a cost reimbursable sub-agreement with PICHTR and contract payments will be made contingent upon the receipt of federal funds. A draft of the Hawaii Renewable Energy Development Venture Request for Proposals is included in Appendix F.

Full proposals will be expected to contain the level of detail needed by HREDV to confirm the soundness of both the technical approach and the financial and management capabilities of the offeror. The offeror will be required to submit a technical proposal that includes a statement of work that clearly details the scope and objectives of the effort along with the technical approach. HREDV expects to incorporate the proposed statement of work as a part of the eventual award instrument. A project schedule and milestones will be required, as will be a section that addresses proprietary rights to any intellectual property. A detailed description of the results expected and the products to be delivered will be required.

Full proposals will also have to include a detailed cost proposal in two parts. First, HREDV will require a detailed description and breakdown of all costs by cost category by calendar or government fiscal year to include direct labor, indirect costs, travel, subcontract costs if any, consultant costs, materials, and other direct costs. No fee or profit will be allowed since these contracts will be treated as cost reimbursable contracts. Second, HREDV will ask offerors for a cost breakdown by task and sub-task using the same task numbers in the proposed statement of work, including helpful illustrations such as schedule diagrams, charts, pictures, formulas, etc.

Offerors submitting full proposals will also be required to submit a detailed description of the management approach, including brief descriptions of the organization, personnel, subcontractor and consultant relationships, government interfaces, and proposed planning, scheduling and control practice. A suggested full proposal description is included as Appendix G.

To assist with its review, HREDV will establish a technical advisory committee made up of knowledgeable sector individuals and representatives from key stakeholder organizations to ensure fairness and competency in pursuit of its objectives. The primary responsibility of this committee will be to review and evaluate the abstracts received in response to the HREDV RFP, and to offer its insights and recommendations to HREDV and its Project Director who is the Selecting Official. The advisory committee will include the HREDV Technical Director, the HREDV technical consultant, a representative with knowledge of the Hawaii electric utility industry, a representative from the University of Hawaii (possibly the Hawaii Natural Energy Institute), a

representative from the Hawaii venture capital or investment community, a person with wide domain knowledge of the technology sector in Hawaii, and possibly an at-large representative knowledgeable about economic development programs and initiatives in Hawaii. The total number of members of the technical advisory committee will be not greater than 7 but no less than 5.

HREDV will invite a representative of the USDOE or one of its national laboratories active and knowledgeable about the Hawaii Clean Energy Initiative to participate in the review and evaluation process on an ex-officio, non-voting basis to offer technical advice and recommendations to the committee. By participating, both HREDV and USDOE or the National Laboratory representative will be able to get a first hand look at how private sector emerging technology companies are attempting to develop solutions to help achieve Hawaii's clean energy goals.

The technical advisory committee will review and evaluate all abstracts, rank based on criteria set forth in the HREDV Roadmap and consistent with the objectives of the program, and recommend to the Selecting Official, a set of projects for funding consideration. Upon the review and findings from the Selecting Official, HREDV staff will notify both successful and unsuccessful applicants. The successful applicants will be invited to submit full proposals, which should address any open comments or technical issues raised by the technical advisory committee during the review and evaluation process.

Upon receipt of a full proposal, inclusive of all required USDOE and HREDV application forms, HREDV will evaluate the proposals and, as appropriate, forward to subject matter experts for further review and evaluation. These subject matter experts may be drawn from the technical advisory committee, or other impartial experts drawn from HREDV's contacts. If these experts are drawn from outside the technical advisory committee, they will be required to affirm non-disclosure procedures to protect proprietary information contained within the full proposals. Upon completion of the HREDV full proposal review process, and with the approval of the HREDV Project Director and Technical Director, subcontracts for successful awardees will be negotiated, subject to formal approval under the terms and conditions of the prime agreement between PICHTR and the USDOE.

Addressing the Sustainability of Investment Support

HREDV to the maximum extent practicable wants to ensure that its investment in the deployment and commercialization of clean energy technologies is lasting. The assessment and criteria and metrics that will drive project investments are designed to support a superior portfolio of technically sound projects. At the same time our experience has demonstrated that superior technology alone will not result in successful

deployment and commercialization. Sound business management is essential, including the ability to understand and comply with federal contracting procedures that will flow through to awardees as a condition of award.

HREDV must first understand the needs of businesses in relation to the programs being supported in Hawaii through the efforts of the U.S. Department of Energy. HREDV will then be in position to advocate, on behalf of these businesses, the appropriate strategies to support the implementation of renewable energy and energy efficiency systems in Hawaii. HREDV will be able to specifically address company needs through education and training that will be needed to enhance the successful implementation of projects, thereby firming prospects for long-term sustainability of efforts.

It will be essential for HREDV to analyze the gaps not being adequately filled by programs such as HCEI and the HECO-state agreement on transformation of the electricity sector. Again the primary focus will be to determine how any support to be provided by HREDV can meet these needs that enhance the ability of any commercial interests to develop successful projects. Concurrently we envision that we could offer partnering assistance to these complementary programs like the Hawaii Clean Energy Initiative, electric utility integrated resource planning, and clean technology research and development programs emerging within the University of Hawaii's Hawaii Natural Energy Institute. All of these organizations and others have important roles to play in addressing Hawaii's energy security challenges through the development of renewable energy and energy efficiency. HREDV will work with these organizations to identify unmet needs and develop synergies, incorporating appropriate programs and strategies as part of this roadmap.

With gathered intelligence, HREDV will offer assistance to client companies as part of the support to be provided after these companies have been selected for funding assistance. HREDV will be seeking entities to assist in providing support to enable these companies to not only develop their technology ideas and projects, but to assist these client companies by providing business mentoring and training, thereby enabling them to encourage the expansion and/or sale of their companies or technologies for more widespread adoption. The services could include assistance with federal solicitation identification assistance, and encouraging and facilitating partnerships and joint proposals to enhance competitiveness.

Capable business planning is an essential part of any successful company and training on the preparation of business plans will be offered to interested parties as part of HREDV's services. We anticipate offering nationally recognized expertise, funding permitting, on recognizing, developing, and capturing business opportunities through organizations such as Dawnbreaker¹. This training on the preparation of winning business plans offers proven methodologies, and will include the following outline format plus critiques:

- Description of company and technology
- Commercialization system strategy overview
- Industry overview, policies and legislation driving business
- Description of customer, needs, buying behavior, decision makers
- Market assessment
- R&D plan
- Manufacturing and sales plan
- Human resource plan
- Contingencies
- Financial plan, objectives, inventions, or strategic alliances, investor profiles
- Pro forma analysis and timeframe
- Exit scenarios

While individual businesses will have to tailor the above approach to suit their needs, HREDV can work with companies in their planning and challenge them to be creative, yet realistic.

HREDV will take advantage of the capabilities already developed by a sister program administered by PICHTR that is focused on similar technology commercialization support for the U.S. Department of Defense, the Hawaii Technology Development Venture (HTDV). HTDV has successfully developed a program to provide training and business assistance on a variety of subject areas, including preparing winning proposals, federal contracting, accounting procedures and reporting, human resource management, and other essential components for business success.

¹ Servo, Jenny C. "Business Planning for Scientists and Engineers," Dawnbreaker, The Commercialization Company, Fourth Edition (2005)

The outreach and education components of this sustainable business approach are also an important part of the services to be offered by HREDV. However outreach and education needs are part of a much greater and broader subset of HREDV's outreach efforts and will therefore be covered in a succeeding section.

This roadmap recognizes that HREDV itself must formulate its own transition plan for technology commercialization. HREDV is currently funded at a level that can meaningfully initiate a systematic effort to deploy energy efficiency and renewable energy technologies to achieve the broad overall objectives of the Hawaii Clean Energy Initiative. From this start, HREDV can and should define a transition plan as it executes this roadmap and builds support for the program from the identified stakeholders. With the completion of this initial program, and as additional funding is obtained to capitalize on the initial federal investment, HREDV will be better positioned to formalize a transition plan considering an appropriate pathway for technology innovation from research and development, through testing and evaluation, pilot, scale-up, demonstration and commercialization in light of limited State of Hawaii and other funding resources.

The Value of Coordination by HREDV

The high level of interest within the state resulting from the visible and accelerated joint efforts of the Hawaii State Government and the U.S. Department of Energy is welcomed. Hawaii historically has benefited from the plethora of organizations, institutions, and parties who have expressed a willingness to tackle the state's energy challenges. Some of these organizations like the University of Hawaii and state agencies have relied on public funding support to develop and execute programs. Many others have emerged out of enlightened self-interest and are self-supporting.

While this multitude of organizational involvement is tangible evidence of a collective desire to reduce the state's dependence on imported petroleum, and while there is general agreement on long-term goals, the large number of these organizations can at times, make it difficult to coordinate any systematic programs, especially those in the public sector. The challenge of dealing with these multiple organization interests is discussed in a preceding section above. HREDV, along with other statewide programs that may be supported by funding from the federal government, will benefit significant through a coordination of these multiple interests. Accordingly this roadmap for HREDV acknowledges that an effort to invest in coordination that benefits the primary constituency served, parties who are involved directly in accelerating the deployment and commercialization of clean energy technologies, is warranted.

Through the Pacific International Center for High Technology Research, HREDV has acquired significant historical experience in delivering major clean energy programs in renewable energy technologies for geothermal, solar, wind, biomass, and ocean energy technologies. These previous efforts have focused on technology deployment for island-scale systems for the Pacific Region, and have been supported by funding from the U.S. Government, Japan, the State of Hawaii, and private sector interests. PICHTR has worked closely with the University of Hawaii throughout its history. In many cases, the programs have been developed with particular attention to the training needs of served constituencies, and have included public outreach. Thus HREDV can effectively utilize this past experience in administering the degree of multiple organization coordination for this project. HREDV's two principal leads have amassed over 70 years of combined experience in complex project organization, public policy, public-private partnerships in Hawaii and the Pacific Rim. This experience has enabled HREDV to be treated with immediate credibility in the Hawaii community, enhancing our ability to effectively coordinate efforts to succeed with deployment of clean energy technology.

The emphasis for coordinated efforts will be on commercial project development to accelerate the transition away from imported energy sources to indigenous clean energy resources. With government, the state, USDOE, and the counties serving in their primary roles as enablers, HREDV can focus its attention on deployment and commercialization, mobilizing the considerable interest of the private sector and directing capital investment to achieve the broader strategic objectives toward clean energy articulated by public policy.

This coordination can be achieved effectively by HREDV serving as a clearinghouse for credible, unbiased information; by facilitating the development of strategic private sector development partnerships to achieve critical mass in a variety of clean tech sectors; by serving to advise companies on upcoming funding opportunity notices from the federal government; by providing resources to help company management run better businesses and comply with federal contracting requirements; and finally, to offer competitively awarded funding to support clean energy technologies that have high prospect to help the state achieve its energy independence targets.

To be most effective this coordination will be designed to complement the policies and programmatic agenda of the state and USDOE as part of the Hawaii Clean Energy Initiative. HREDV will work closely with the state organizations that have the primary responsibility for the implementation of HCEI, DBEDT and its partners. In addition HREDV recognizes the significant role that incumbent energy companies like Hawaiian Electric Company will play in the transformation of Hawaii's energy economy to one reliant on renewable energy and energy efficiency. HREDV, through its past programs, and from the experience of the senior managers responsible for program execution, has

considerable experience working with HECO and other local energy companies, and will leverage this experience to achieve successful outcomes.

To date we have already demonstrated that HREDV can effectively offer this type of coordination. In January 2009 HREDV organized and held a project kick-off meeting that was attended by some 170 interested parties. HREDV was able to develop a program that featured senior managers from the U.S. Department of Energy, Hawaiian Electric Company, Senator Inouye's office, the University of Hawaii's Hawaii Natural Energy Institute, and the National Renewable Energy Laboratory. Besides the description of the anticipated HREDV project activities and funding possibilities, the program afforded a unique chance for attendees to hear about the outstanding opportunities emerging from key individuals who are shaping the future energy direction for the state. HREDV demonstrated that it could effectively organize such a program and mobilize the interest from individuals, businesses, and other organizations that will be an important part of the transformation process.

Equally significantly HREDV will continue to maintain a listing of stakeholders to facilitate our efforts at coordination. This stakeholder database will be updated throughout the course of this project. It currently contains approximately 500 entries and is expected to grow as more people become aware of this project. Because of USDOE's investment in HREDV, this stakeholder list can be made available to USDOE to supplement its own efforts to deliver programs in Hawaii.

ARRA: Practical Demonstration of the Value of Effective Coordination

In February of 2009, the U.S. Congress passed, and President Obama signed the American Recovery and Reinvestment Act, otherwise known as the economic stimulus legislation, which created unprecedented opportunities for clean energy funding for the entire nation. While the various provisions of that Act offer significant federal funding for health information technology, broadband infrastructure, and research and development, a large portion of the stimulus funding was directed to green energy and jobs. This Act has created a great deal of interest in Hawaii, both because of the funding being directed to state energy programs through formula and block grants, and through opportunities created through competitive solicitations from USDOE. PICHTR and HREDV has used this window of opportunity to help mobilize Hawaii industry to become more competitive in seeking green energy technology from ARRA. We have demonstrated the value of coordination, serving as a clearinghouse for information, helping to facilitate strategic partnerships to increase the quality of potential proposals, and thereby helping to make Hawaii applications more competitive and of higher quality. HREDV is best positioned to offer these types of valuable coordination within and among public and private sector entities because of HREDV's efforts to date with outreach, sector assessments, establishing up-to-date databases of relevant companies and their expertise, and knowledge of both needs and capabilities within the clean tech sector in Hawaii. From these actions, the value of this type of coordination, and respected knowledge base, has been clearly demonstrated in practice, even while this project has been under development.

We expect that this significant investment in coordination of activities by HREDV will result in greater understanding within the larger energy community of the directed efforts of the project, a more systematic and integrated program supported by HREDV investments in clean tech deployment, and therefore a higher probability of achieving the overarching clean energy transformation outcomes sought by the State of Hawaii and the U.S. Department of Energy through the Hawaii Clean Energy Initiative.

USDOE has been very supportive of Hawaii energy initiatives. As expressed by during a presentation at TechEnterprise 2009 by Andrew Trenka, representing USDOE's Golden Office, this support is evidenced not only through the Hawaii Clean Energy Initiative, but also toward the development of a Hawaii Bioenergy Master Plan, the creation of a series of HCEI Working Groups to help implement HCEI, providing support via the National Labs, and through an introduction to the Technology Driven Enterprise and Economic Development (TDEED) Program administered by NREL.

USDOE has a major responsibility in implementing the American Recovery and Reinvestment Act of 2009, and the resources offered through this Act can support and strengthen Hawaii's efforts. HREDV's role in assisting Hawaii companies and organizations to take advantage of this opportunity has been described above, and working with USDOE, we can also help constituencies be aware of other competitive funding available such as contracts, grants and cooperative agreements, the loan guarantee program, and direct formula grant programs administered by state and local governments.

The Technology Driven Enterprise and Development (TDEED) program is administered by NREL's Enterprise Development Program. This program fosters workforce development through its support of entrepreneurship. It facilitates linkages to financing resources through sponsored forums, maintenance of an investor directory, and through a Clean Energy Entrepreneurship Center. TDEED partners with industry to bridge NREL intellectual property and new product development to encourage partnerships for innovation and product development of innovations created in the national laboratories to encourage the development and new markets and investment.

These activities supported by USDOE and NREL are highly aligned with the technology deployment model envisioned by HREDV, and are intended to traverse the gap between technology creation and commercialization, commonly known as "bridging the valley of death" for technologies. Hawaii can play an important role in meeting not only the energy transformation objectives of the state, but also serve as a model for the rest of the nation. The valuable coordination efforts of HREDV will help to access considerable assets of USDOE and the National Labs to develop sound, sustainable, and economically viable clean technology projects.

Education and Outreach

The value of adequate education and outreach cannot be underemphasized. With the lofty goals established by the state and USDOE through the Hawaii Clean Energy Initiative, successful execution to achieve the market transformation that is needed to attain “70 percent clean energy within a generation” requires acceptance and commitment of individual and collective responsibilities. Individual behavior changes will be required, and conscious decisions made to invest, or re-invest in clean energy technologies by consumers, companies, organizations and government institutions.

HREDV can assist the state and USDOE with this education and outreach by investing a portion of its portfolio. A broad, systematic approach to education and outreach would consist of programs to reach a broad spectrum of stakeholders and exceed the resources available to HREDV. However, targeted outreach and education can be effectively employed to enhance the success of HREDV programs.

HREDV is interested in bridging the commercialization gap for attractive clean energy technology applications in Hawaii. These efforts are targeted primarily at industry, to facilitate getting real, high potential projects on the ground. Once the candidate technologies are identified and investments contemplated, education must be directed toward candidate companies to assist them in their ability to sustain their companies’ post-HREDV funding, increasing the probability of successful commercialization. The importance of addressing the sustainability of investments is described above, along with the tools to be employed by HREDV.

Because projects also need to adequately address public policy, including energy independence, environmental safeguards, siting and permitting, public understanding and appreciation is also a critical component of any effective outreach program. Accordingly HREDV must continue to invest in personal interactions with key stakeholder groups such as local government, local economic development boards, environmental groups, community organizations, and academia. This roadmap therefore acknowledges the continuing need to give public talks at invited seminars, workshops, and community meetings, offer papers and presentations and technical meetings organized by academia, national labs, trade organizations, and the state and USDOE.

Finally invitations to utilize mass media, print, audio and video, can be effective means to keep the drive to clean energy in the minds of the public, who ultimately will bear the responsibility of paying for clean energy investments in their utility bills and purchases of fuels. Without the tacit support of the populace, it will be extremely difficult for any large scale transformation of energy markets to take place. HREDV is not resourced to make

significant purchases of media space, but can use its influence and knowledge to secure media time as has already been the case.

HREDV will target its outreach efforts toward a series of activities with stakeholders, interested companies, and a variety of communication channels. These efforts will try to achieve the greatest leverage for project funding by partnering with efforts already underway or planned by these organizations or outlets for the duration of this project.

1) Stakeholder Outreach

HREDV outreach will engage with identified stakeholders in government, academia, private sector and NGOs on a continuing basis. Examples of stakeholder engagement are detailed below:

HREDV can partner with the High Technology Development Corporation (HTDC) on two of their federal programs – SBIR and MEP. HTDC is the state’s point of contact for the federal SBIR program. The SBIR program provides funding opportunities for companies developing technology. The MEP or Manufacturing Extension Partnership is a Department of Commerce NIST program that assists American manufacturing companies. The MEP program for Hawaii is expanded to offer product development services and contacts through MEP’s manufacturing clients in the U.S.

The Technology Showcase is a forum where University of Hawaii faculty presents a brief on their research to the technology and business community. HREDV staff assisted in facilitating the establishment of quarterly Technology Showcases by the named organizations. The event is hosted by BAE Systems at their downtown Honolulu facility and includes participation with the University of Hawaii Office of Technology Transfer and Economic Development the High Technology Development Corporation and Enterprise Honolulu. Showcasing innovations from academic researchers before a business audience can help to interest businesses in commercializing worthy clean energy technologies to meet Hawaii needs.

Hawaii Technology & Entrepreneurs Network or HiTEN is network of the state's service providers who each have a focus on entrepreneurial development. Members include the four economic development boards of each island, U.S. Small Business Administration, SCORE, Hawaii Small Business Development Center Network, Dept. of Business Economic Development & Tourism, High Technology Development Corporation, Hawaii Strategic Development Corporation, CEROS, University of Hawaii OTTED and Shidler School of Business, Hawaii Pacific University, Hawaii Science & Technology Council, Hawaii Venture Capital Association, Hawaii Angels, Hawaii Technology Development Venture and HREDV. Members meet monthly for information sharing, collaboration on events and resource sharing.

2) Company Outreach

HREDV outreach activities will be designed to connect directly with individual companies to learn what they do, to provide information and HREDV assistance and obtain feedback on what clean energy businesses need to support their growth. HREDV will utilize its continually expanding contact list of clean tech companies, derived from existing public databases and attendees at HREDV workshops and conference.

The outreach plan will engage with these companies on an ongoing basis. Information obtained from these interactions will provide valuable data on the capabilities of the companies, their planned projects, and needs. Additional contacts should result from the discussions with individual companies and stakeholders

3) Events

Public events provide an efficient and effective method for disseminating information and/or gaining knowledge of upcoming activities or opportunities. HREDV will utilize its own events, along with those put on by others that are identified as relevant and strategic. On an ongoing basis HREDV will work with stakeholders and collaborators to identify venues for outreach and education, both on Oahu and the Neighbor Islands. HREDV, by working with the county economic development boards and various state agencies, will try to coordinate the events calendar for maximum benefit.

HREDV, besides supporting technology development, is committed to helping its supported companies with sustainable business practices. Toward that end HREDV intends to offer programs to not only make companies more competitive, but to ensure that they have the skills to successfully negotiate government contracting requirements. Accordingly, HREDV will educate the local clean technology community on government contracting and procurement requirements to enhance local capacity and capabilities to position entities for success. This effort will allow early assessment and evaluation of company capabilities and limitations. HREDV will utilize skilled trainers who have a successful track record in supporting companies in this manner. For example, HREDV will plan to contract with a firm like ESI International (ESI), a recognized leader in innovative project management, contract management, business analysis, sourcing management training and business skills training, to deliver training on government contracting, project management, and quality proposal development to enhance improve responsiveness for HREDV solicitations and for USDOE proposals. Training through ESI will allow participants to receive professional continuing education credits as well as the ability to work towards professional certifications (i.e. project management, contracts management).

Any training offered by HREDV will be open to all applicants and interested parties so that this resource is available equitably to all applicants.

The Overview of Government Contracting will cover government contracting fundamentals, the pre-award process, solicitation and award, and contract administration (post-award). Training on Government Cost Accounting will cover legal framework, contract types, cost accounting system requirements, cost allotments and allocations, audits, and financial accounting systems. In an effort to hone managerial skills, a course on Project Management will also be offered, covering the role of the project manager and team, project initiation, project planning, project implementation, and project closeout. Collectively these training sessions are intended to bolster the management capabilities of supported contractors to not only help themselves, but also to facilitate the ability of HREDV and ultimately, the USDOE, to develop high quality projects.

A Summary of the Roadmap for HREDV

In support of the U.S. Department of Energy's efforts to work with the State of Hawaii to accelerate market transformation toward clean energy technologies in Hawaii, HREDV and its host organization, the Pacific International Center for High Technology Research, PICHTR, are committed to direct its efforts in a multi-faceted, but integrated way. The focus of HREDV will be on supporting the growth of the clean technology sector in Hawaii, developing solutions that promise to achieve successful early deployment in the islands, but whose experiences can serve as models for the remainder of the US and the international community.

Co-investments to support technology development will be the primary development strategy employed by HREDV. However, project funding alone is not expected to ensure success. Project funding must be complemented by other support including training and education for Hawaii enterprises to position them for success by being effective managers and stewards of government funds, to establish business practices in accounting, financial management, and human resources. HREDV will supplement its co-investment portfolio with training programs that will be required as a condition of award. Further, because a rising tide lifts all boats, supported companies will be asked to share their progress in clean energy innovations with their peers annually, through participation in PICHTR's Tech Enterprise annual program review.

Besides direct support to technology companies, HREDV will use its resources to support the USDOE and State of Hawaii efforts to achieve the goals and objectives of the Hawaii Clean Energy Initiative. HREDV will serve to catalyze project development and investment, focusing its efforts to facilitate getting "projects in the ground." With the considerable in house experience of principals within PICHTR in government, academia,

and the private sector with decades-long experience within the Hawaii energy sector, HREDV is well-positioned to serve as an “honest broker” to help the private sector develop strategic partnerships to pursue clean tech development opportunities.

HREDV will include in its tool kit, coordination of multiple party efforts to aid clean tech project development. There will be a conscious effort to work with the neighbor island counties, given that renewable energy project development opportunities on the counties of Hawaii, Maui, and Kauai are considerable. Outreach efforts will focus on partnerships with the County governments and the NGO economic development boards on each of the neighbor islands. HREDV will also maintain a strong interface with academia, both to address workforce development needs, and to encourage connection of exciting new inventions emanating from within Hawaii’s universities to entrepreneurs within Hawaii business community.

Through this strategically placed multi-faceted approach, HREDV intends to help develop and grow Hawaii clean technology sector, all in consonance with the state desires of the USDOE and the State of Hawaii as articulated by the Hawaii Clean Energy Initiative. The elements of this roadmap are portrayed in the following illustration, Figure 11.

While the ultimate degree of success achieved by HREDV will depend on a number of factors, including funding, quality of proposals received, eventual commitment from supported companies and support from project sponsors, the State of Hawaii, and the U.S. Department of Energy, HREDV is clearly trying to help renewable energy technology in Hawaii overcome the known “valley of death” in commercialization through the elements described in the roadmap. We will do our best to offer these valued services in light of the limited resources, the unique limitations within Hawaii’s markets, the multitude of organizations interested but not coordinated and the overwhelming sense of urgency faced by the Hawaii economy to address energy security issues.

HREDV ROADMAP FLOWCHART TO PROJECT FUNDING

INPUTS

OUTPUTS

HNEI
-HNEI Technology Assessments
-HREDV Metrics and Evaluation Criteria

HCEI Program
-DBEDT
-USDOE
-National Labs
-Consultant Team

State HECO Plan
-HECo
-HELCo
-MECo

**US DOE
Input/Approval**

**HREDV
Roadmap**

**Community Outreach/EDB's
Ongoing Technology Assessments**

Community Notification
-Website Postings
-E-mail list serves
-HREDV RFP Meeting

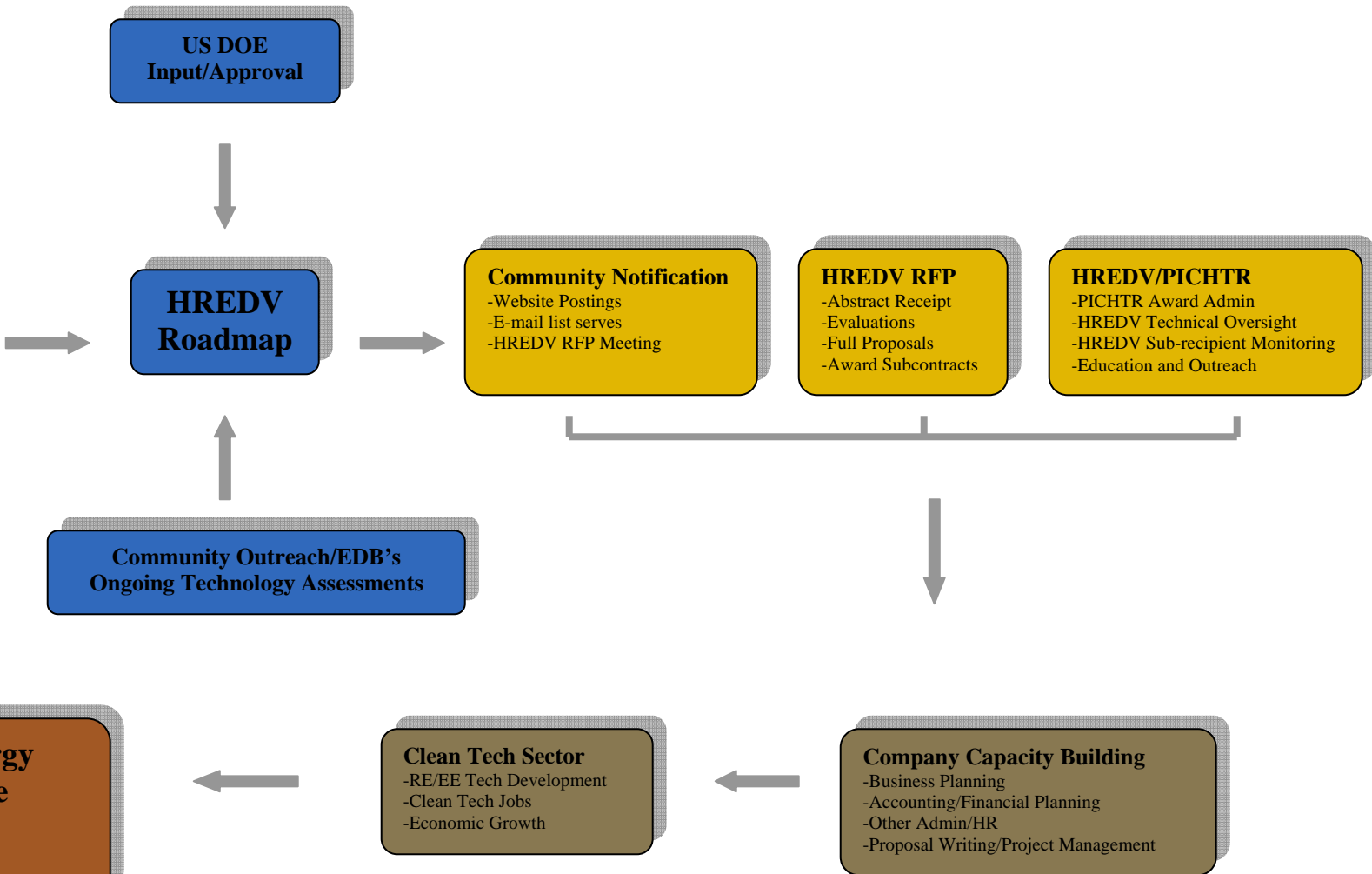
HREDV RFP
-Abstract Receipt
-Evaluations
-Full Proposals
-Award Subcontracts

HREDV/PICHTR
-PICHTR Award Admin
-HREDV Technical Oversight
-HREDV Sub-recipient Monitoring
-Education and Outreach

Increased Energy Independence
-40% RE by 2030
-30% EE by 2030

Clean Tech Sector
-RE/EE Tech Development
-Clean Tech Jobs
-Economic Growth

Company Capacity Building
-Business Planning
-Accounting/Financial Planning
-Other Admin/HR
-Proposal Writing/Project Management



Defining Success for HREDV and Future Efforts

HREDV will fulfill an important role that will help achieve the vision articulated by the State of Hawaii and the U.S. Department of Energy through the Hawaii Clean Energy Initiative. The transformation of Hawaii's energy economy away from imported fossil fuels to one dominated by energy efficiency and renewable energy will require significant private sector project development and investment. The state must continue to send the proper signals to the market through its policy setting function. The U.S. Department of Energy, along with the support from its national laboratories, must continue to provide management expertise, resources, and technical assistance. Dominant energy providers who have large control of energy markets like the electric utilities and conventional energy providers can help through purchase preferences and providing for green energy. Energy consumers can express their desire for green energy through their pocketbooks.

HREDV will focus its efforts to help build a larger, more robust green tech sector in Hawaii, developing Hawaii-grown technology solutions for expected transformation to the green energy market. As described by this roadmap, HREDV's success can be characterized by the following attributes:

- Develop a more robust clean tech sector in Hawaii by offering tangible support to HCEI
- Establish HREDV as a valuable conduit (“honest broker”) for clean energy development for Hawaii

- Increase the success rate for Hawaii companies developing technologies through public-private partnerships
- Improve the ability of Hawaii clean tech companies to compete for and effectively manage federally-funded projects
- Establish clearer, more effective networks among university inventors, business innovators, investors, and technology users
- Serve as a model for effective deployment and diffusion of clean energy technologies for USDOE, the State of Hawaii, and other regions of the U.S.

This systematic approach to address the deployment of technologies within the Hawaii market can serve as a useful model for application elsewhere. Immediate replication can be envisioned in other isolated, insular or island economies such as Alaska and the territorial governments of the U.S. Specific deployment activities may also be readily transferable to other locations or regions within the continental U.S. For example, technologies and methodologies to address high penetrations of intermittent renewable energy assets may be of interest to other regions with large assets of wind or solar energy but where transmission may be constrained.

In terms of specifically measuring HREDV's success using available FY08 and FY09 federal funding, we expect to achieve the following:

1. Direct funding assistance to at least four or five Hawaii-based clean tech projects
2. Create or retain at least twenty to twenty-five clean tech jobs through the initial solicitation from FY08 and FY09 funding
3. Facilitate or assist ten or more companies in competing for and securing non-HREDV federal clean energy project funding under ARRA or other programs
4. Produce a comprehensive database of Hawaii clean tech stakeholders
5. Leverage federal investment in HREDV with equal amount of non-HREDV funds.

Besides replication in domestic markets within the US, there is expected to be significant interest internationally. Through the Pacific International Center for High Technology Research, HREDV is positioned to work with the State of Hawaii, USDOE, and HREDV's stakeholder community to promote international partnerships and demonstrate leadership.