
Local Agriculture for Energy and Economic Security

*Developing a Pacific-based
Coalition for Bioenergy and
Bioproducts Development*

American Samoa Community College

College of Micronesia

Northern Marianas College

University of Alaska at Fairbanks

University of Guam

University of Hawaii at Manoa

March 2004

Executive Summary

Calling for a dynamic vision of energy and economic security for our nation, the Sun Grant Initiative of 2003 encourages the development of biobased technologies that produce energy and other useful products from locally grown crops and other bioresources. In doing so, the Initiative sees the opportunity to reduce our nation's dependence on imported fossil-based energy sources, to provide environmentally friendly plant and crop-based alternative products, and to infuse needed economic development for America's rural communities.

Senator Tom Daschle, cosponsor of the Sun Grant Initiative, has stated that "the best way to harness solar energy for rural America is by harnessing the energy of America's land grant colleges and universities...to develop innovative and commercially viable biobased products and technologies and to make sure that those technologies reach the global marketplace."

Hawaii, Alaska, and the American-affiliated Pacific Island nations of Guam, American Samoa, Micronesia, and the Commonwealth of the Northern Marianas encompass America's most geographically diverse region, as well as the westernmost outreaches of our nation's land grant colleges and universities. Representatives from these institutions have come together to form a Pacific Coalition for Bioenergy and Bioproducts Development, an integrated program partnership that seeks to build a foundation for research, development, and demonstration (RD&D) of advanced biobased technologies for the Pacific region that has applicability nationally and internationally. Training and outreach will be important objectives for our Coalition to extend knowledge and resources among our Pacific colleagues and to build awareness and skills of renewable energy technologies among the youth of our region.

Our Coalition's objectives align well with the intent of the Sun Grant Initiative, which can serve as an important source of funding for cooperative Pacific-based bioenergy and bioproducts RD&D. At the same time, our distinctive region offers this Initiative a diversity of ecosystems, geographic regions, cultures and indigenous peoples, bioresources, and agricultural practices and developments that can enhance the exportability of U.S.-developed new biobased products and technologies to the global marketplace.

Our Coalition and its partners in industry and government already represent a significant body of knowledge in biobased RD&D and stand ready to expand and integrate activities among the institutions in our region with the Sun Grant Initiative as an appropriate potential funding vehicle. The Western Region of the Sun Grant Initiative, to be headquartered at Oregon State University, has stated the need for a subcenter to address the special needs of Hawaii, Alaska and the American-affiliated Pacific Island nations. We believe our Coalition is well suited to serve as this subcenter. The time is now to strengthen our Pacific capacity to join in a nationwide effort to build a sustainable future of energy and economic security.

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Developing a Pacific-based Coalition for Bioenergy and Bioproducts Development

Hawaii, Alaska, and the American-affiliated Pacific Islands of Guam, American Samoa, Micronesia and the Commonwealth of the Northern Marianas are the most geographically isolated regions in the United States. This reality puts these areas at significant and increasing economic vulnerability as traditional fossil resources become depleted. It is important to act now to begin and continue the development of technologies that provide some level of energy self-sufficiency and economic security to our isolated areas. Research and development and deployment funds are required to strengthen our capacity to meet these goals.

The nation's 49th and 50th states and the American-affiliated Pacific nations also represent the westernmost outreaches of our nation's land grant colleges and universities. Representatives from these institutions have come together to establish a Pacific Coalition for Bioenergy and Bioproducts Development (PCBBD), an integrated program partnership among our land grant institutions and stakeholders. (Appendix A lists the participating colleges and universities and their representatives who have contributed to this document.)

Using our collective knowledge and resources, we envision harnessing the untapped biological resources of our distinct region to increase our energy and economic security through locally-based alternative technologies. To this end, we seek to build a solid foundation for research, development and demonstration (RD&D) of advanced bioenergy and bioproduct technologies that use sustainable biological resources for commercial production of energy, feed, fiber, and high-valued products. Establishing local training and outreach in bioenergy and bioproducts is another important objective of the Coalition.

Among our Pacific region institutional partners, the Coalition would encourage creating and sharing new technologies, pooling resources, and developing Asia/Pacific partnerships. Pacific-based bioenergy and bioproducts would promote biobased economic diversification in our rural communities and contribute to energy security by reducing local dependence on imported fossil fuels. The technologies and training developed by the Coalition will benefit not only the local communities within the Coalition; they will also be replicable nationally and internationally.

Why the Need?

In these challenging economic and political times, our nation's heavy dependence on imported foreign oil underscores a need to develop viable, indigenous energy alternatives. Compared to the politically unstable Middle East, which holds two-thirds of proven world oil reserves, the U.S. has just two percent of such reserves.¹ Imports currently supply about 55 percent of our nation's oil needs and an even greater share of the needs of some of our most important allies, including Japan and Great Britain. By 2025, our nation's oil imports are projected to grow to 68 percent.²

Beyond the uncertainties of the current economic and political climate, sustained economic growth for our nation depends on having secure supplies of energy. With projected rapid world growth and continuing changes in consumer demands, much attention has been turned to renewable biobased fuels, power, and products to make important contributions to U.S. energy security, rural economic development, and environmental quality.

With such renewable energy, created in our own backyards, the U.S. Department of Energy estimates that a 10 percent displacement of the petroleum we use for transportation, with biofuels produced from organic materials, could save about \$15 billion over 10 years. A 20 percent displacement could save us about \$50 billion, while decreasing our dependence on foreign oil imports and strengthening our energy, economic and national security.³

Biomass energy, or bioenergy, is derived from the most flexible non-fossil energy alternative available – chemical energy in organic matter harnessed from the sun. Biomass can be burned for heating in various industrial and other applications or for producing steam to generate electricity, and it can be converted into gaseous or liquid fuels, and co-products.

Bioenergy resources, such as forestry and agricultural crops, biomass residues and organic wastes, already provide about 14 percent of the world's primary energy supplies.⁴ In the U.S., approximately 2 percent of the energy demand is supplied by alternative energy sources. During the next century, the International Energy Agency Bioenergy Commission, which promotes international cooperation among nations with bioenergy research, development and deployment programs, has estimated that bioenergy has the potential to meet 50 percent of world energy demands, while meeting the requirement of reducing carbon emissions from fossil fuels. In doing so, it would also strengthen local agriculture and promote rural and sustainable development in industrialized as well as developing countries.

Why the Pacific?

Regional Opportunities. With Hawaii and Alaska the only states in the nation that are not part of the contiguous continental U.S., coupled with our region's geographic isolation, we have unmatched challenges and problem-solving opportunities for biobased RD&D in our own backyards.

Geographic isolation makes the coalition members particularly vulnerable to energy disruptions from imported oil sources, as all members are highly dependent on imported fossil fuels for energy. In Hawaii, about 90 percent of the energy used in the 50th State comes from imported fossil resources.⁵ About two-third is consumed as petroleum transportation fuels (gasoline, diesel, and aviation fuel) and most of the remaining third is consumed in generating electricity. Alaska imports 95 percent of the fossil fuels it needs for energy, despite having untapped oil reserves in its Arctic National Wildlife Refuge (ANWR) and other sites, in addition to natural gas. The Pacific island nations, for example, Micronesia which imports 100 percent of its fossil fuels, share similar or higher energy import dependencies.

With such high import dependency, our isolation has put us at the forefront of research efforts to reduce vulnerability to disruptions in imported supplies of oil and other feedstocks. In the past 20 years, Hawaii has made significant strides in biomass energy RD&D, with particular attention to developing Pacific area competencies in biomass production, conversion processes, and commercial viability. These have market potential in the developing countries of Asia and Latin America.

Geographic "extremes" represented in our region can also work to our advantage, as well as benefit the contiguous 48 states. The icy tundra of Alaska on the one end and the tropical climates of Hawaii and the Pacific island nations on the other define boundaries of the environmental spectrum in the U.S. and establish the widest possible parameters for RD&D data points across this continuum. The U.S. Department of Agriculture's Bioenergy & Energy Alternatives National Program has emphasized the importance of research at many different locations to account for climactic, regional and geographical variations, as well as many different combinations of pests, diseases, and agricultural products, each with unique problems calling for unique research approaches and solutions.⁶ Our aim is to provide not only for local needs, but to develop replicable biobased technologies for both domestic and international use.

Cultural and ecological diversity encompassed in our region also provide opportunities to develop technologies whose commercial value reflect sensitivities to the rights of indigenous and culturally diverse peoples and the impacts to delicate ecosystems. Hawaii and the Pacific island nations in our Coalition were first settled by native peoples of Polynesia, Micronesia, and Melanesia with traditional cultural values and sovereignty rights tied to land, fresh water and ocean use. Alaska is home to indigenous Inuit and other Native American peoples of the arctic, such as the Upik and Inupik. The tropical rainforests of Hawaii and the Pacific island nations are home to many species of flora and fauna not found anywhere else in the U.S. With its lakes, rivers, and islands, Alaska, the nation's largest state, has a spectacular variety of ecosystems from the vast extent of the boreal forest in northern and central Alaska and the southeastern Alaska northern rain forest to mountain ranges and permafrost (permanently frozen land).

Proximity to emerging Asian and Pacific markets position us strategically to develop global partnerships and to provide commercially viable technologies suitable for exportation to the Pacific Rim. Worldwide, the Asia-Pacific region and Latin America are projected to have the greatest need for electric generating capacity in the next decade and, in spite of temporary economic setbacks in Asia, show great potential for economic growth over the next decade, making them attractive markets for biomass power.⁷

Among Asian nations, Japan and the Republic of Korea are the only countries capable of emergency stockpiling of oil reserves; and Asian political leaders recognize the increasing importance of ensuring energy security in the region. Japan's Minister for Foreign Affairs Yoriko Kawaguchi has called for regional energy cooperation, which "is only viable with close collaboration with countries outside the region, since ASEAN+3 countries alone are not able of securing the stable supply of energy."⁸

Among Small Island Developing States (SIDS) including Pacific island nations, energy demand (particularly for electricity) is projected to increase, with energy from biomass, in the form of fuel wood and agricultural residues, as a feasible energy source in many SIDS (for example, about 50 percent of total energy use in the Pacific).⁹

Agricultural Opportunities. Year-round growing seasons in Hawaii and the Pacific island nations and vast acreages in Alaska are just the start of the distinct advantages our region can offer for bioenergy and bioproducts RD&D.

Potential for biomass development in our region offers timely opportunities for strategic planning and cooperative partnerships in RD&D. Hawaii’s agricultural industry has been in transition over the past decades from large-scale production of sugarcane and pineapple commodities to diversified agriculture, which offers a wide variety of potential sources for bioresidues. Since 1997, farm acreage in the islands has dropped 10 percent, with much of the fallow land ready to plant, according to the Hawaii State Department of Agriculture.¹⁰ The 50th State is well suited for the development, production, and utilization of biomass energy – conditions for plant growth are ideal, enabling high yields of biomass feedstocks and a wealth of experience and expertise exists in the Hawaii agricultural industry and the University of Hawaii community to support the development of advanced bioenergy systems.¹¹

Alaska’s late entry into the Union in 1959 translates into its having missed a century of agricultural infrastructure development, particularly the production of raw commodities that was the focus of the U.S. Department of Agriculture.¹² With more than 365 million acres as the nation’s largest state, Alaska has bioresidue potential with over 25 million acres of forest lands and over 100,000 acres in the interior delta cultivated in hay and other crops. As the state with some of the nation’s most isolated landlocked and sea-locked communities, Alaska can offer unique growing conditions for producing high-valued bioproducts. Its emerging organic market is due to its disease-free status and products grown in the state face fewer national and international phytosanitary barriers than more temperate production areas.¹³

Year-round growing seasons offer ideal biomass development potential among the Pacific island nations in our Coalition, many of whom have mostly subsistence level agriculture. Researchers at the University of Hawaii have identified significant bioresidue potential from existing agri-industries in Asia/Pacific, including sugarcane, rice, wheat, maize, coconut, oil palm and roundwood processing.¹⁴ Research programs are now investigating “biopharming” and “biorefining” of tropical plants.

Agricultural and bioenergy benefits to our rural communities would also economically benefit many indigenous and native peoples who reside in these areas. Hawaii’s large, rural communities are located mostly on the Neighbor Island counties of Hawaii (Big Island), Maui, and Kauai. Native Hawaiians, including part-Hawaiians, make up 15 to 19 percent

of the total population of these counties, compared to just 11 percent of urbanized Honolulu County on the island of Oahu.¹⁵ Of the State's 1.3 million acres in cultivated agriculture in 2002, approximately 800,000 acres are located on the Big Island where 19 percent of the county's population, the highest in the State, is of Hawaiian ancestry.¹⁶

Most of Alaska's rural communities are remotely located, with no off-the-road access to the paved roads of Alaska's highway network. Some of these areas are accessible only by air or sea. As a result, the high cost of transportation, coupled with the lower incomes of rural Alaskans, has made imported healthy food products unaffordable to many. While Alaskan farmers can increase production of fresh fruits and vegetables, federal funding assistance is being sought to help the nation's food banks and their 270 organization network of non-profit agencies provide produce to rural Alaska, where between 60 to 90 percent of indigenous tribes and Native peoples reside.¹⁷

Sustainable agriculture and renewable energy sources have promising potential to benefit these isolated rural communities. Rural locations – where fossil-based systems have high energy conversion and distribution costs and where bioresources and agri-processing facilities to support bioenergy production already exist – are where bioenergy systems have been shown to be particularly cost competitive with fossil fuel systems.

The Pacific island members of our Coalition would also benefit from agriculturally-based renewable energy sources, because their islands are largely undeveloped and rural. In Micronesia, for example, 95 percent of the Federated States of Micronesia, the Marshall Islands and Palau are rural and 95 percent of its indigenous peoples live there. About 85 percent of Micronesia's farmers are indigenous people, cultivating only 20 percent of the land mostly on a subsistence level. In American Samoa, small farms of 1 to 2 acres make up the majority of subsistence level farming, with only a handful of 5 to 20 acre commercial farms. As in Alaska, many locations in the Pacific islands would benefit from distributed bioenergy and bio-based manufacturing's inherent advantages over large petroleum-based processing facilities.

RD&D Opportunities. Our Coalition provides a strategically advantageous alliance of technical expertise and broad-based opportunities for RD&D with different climates, agricultural development stages, resource availability, and commercial viability.

Advances in Pacific-based bioenergy/bioproducts RD&D have been going on for more than two decades at the University of Hawaii, with support from the U.S. Department of Energy, Hawaii's Energy Division, and private companies. As a result, significant expertise has amassed in three major areas of biomass energy RD&D: Biomass Production, Biomass Conversion, and Biosystems Integration.

In Biomass Production RD&D, the University of Hawaii has identified the fastest growing, highest yielding biomass species and has been developing their yields through breeding and selection, and field testing. These energy crops include short-rotation woody crops, such as Eucalyptus and Leucaena, herbaceous crops, such as sugarcane, energy cane, and banagrass, and to a lesser extent, aquatic species, in particular microalgae. RD&D in biomass conversion in Hawaii has focused on identifying optimal processes for converting biomass into commercial forms of energy (fuel gases, electric power, and transportation fuels). Considerable commercial progress has also been made in Hawaii to convert non-cellulosic bioresources into useful fuels (e.g., transesterification of vegetable oils into biodiesel).

Using information gleaned from these two research areas, Biosystems Integration RD&D matches energy crops to available and suitable sites, projects yields and economics of producing biofuels, and demonstrates the sustainability of bioenergy systems from the environmental, economic, and resource utilization standpoints. Hawaii has made significant advances in RD&D on maximizing the yield and minimizing the cost of producing tropical plant species, which are abundant among our Pacific island nations. In an effort to establish sustainable energy systems and recognizing the significant economic advantages of using biomass feedstocks with no or even negative cost (e.g., by providing "tipping fees"), considerable RD&D has focused on conversion of bioresidues into commercial forms of energy.¹⁸

Hawaii has several biopower projects being conducted across the state. The Honolulu Project of Waste Energy Recovery (H-POWER) facility's generated electricity sold to Hawaiian Electric Company provides power to 40,000 Honolulu homes and reduces the volume of landfill space on Oahu by about 90 percent. Excess electricity produced by Hawaiian Commercial & Sugar Company on Maui provides power to 10 percent of

Maui's homes and businesses. In May 2002, Pacific Biodiesel opened its second facility on Oahu to rid the State of used restaurant cooking oil while producing a renewable transportation fuel. Its Maui facility prevents about 40 tons of used cooking oil a month from entering landfills by converting it into biodiesel.¹⁹ Anaerobic digestion facilities that convert animal and agricultural wastes into useful forms of energy have been installed in the State.

In the last two decades, Hawaii's State government has recognized the importance of local energy security by taking measures to promote renewable energy in the State. For example, it has adopted a Renewable Portfolio Standard, which requires that a certain percentage of an electric utility's power be generated from renewable resources, including organic materials. Currently under consideration in the Hawaii State Legislature is HB 1692, legislation which would permit the creation of renewable energy cooperatives, joining currently allowable agricultural, consumer, and housing co-ops, to generate, transmit, and sell electricity generated by renewable resources to co-op members.²⁰

As long as fossil energy sources continue to have inherent advantages over renewable sources, including hidden subsidies and energy pricing policies that often favor environmentally harmful but readily available resources, bioenergy will continue to experience difficulty competing with fossil-based energy except in special situations. As already demonstrated in certain Coalition locales, bioenergy is competitive where biomass feedstocks are used that have low or negative cost.

In the long term, the overall energy mix will be significantly boosted by crops grown specifically for energy conversion. Indeed, we are on the way to that end, with much of the RD&D already completed or planned within our Coalition institutions aimed at developing higher yielding fiber and oil crops at lower costs.

Other specialized and complementary bioenergy/bioproducts activities are also ongoing among our Coalition partners. The University of Alaska at Fairbanks has formed a public-private partnership to develop cold weather building technology to sustain crop growth under cover. And our Coalition's Pacific island institutions can offer land demonstration sites, tropical agroforestry systems, and labor resources for research and development. A biogas project attempted in American Samoa in 1989 and 1994 to convert pig manure to methane gas, unsuccessful due to a lack of local technical expertise, underscores the need for pooling resources and sharing new technologies in our region.

Developed capacity in biomass technology has prepared our Coalition for the new technologies, new laws, and new reality that an increasingly environmentally conscious public are ushering in for a new materials base for the 21st century. The “biorefinery” concept is the next big leap, in which bioenergy is only one of a mix of commercial products generated from a single biomass feedstock. Much of the knowledge already developed for biofuels and bio-based electricity will be directly transferable to biorefining RD&D. Coalition members are already researching the production of structural materials, animal feed, bio-based polymers and biodegradable materials, natural pesticides, industrial proteins, nutraceuticals and pharmaceuticals, and other natural products from various plants and agri-residues. Through the manufacturing of multiple bio-based products, significant amounts of electricity or fuels can be produced profitably. The Coalition’s variety of ecosystems, with many plants and organisms unique to the region, hold tremendous potential for the discovery of new biobased products.

These new bioproducts will provide new and expanded markets for rural agri-industries. The “2003 Roadmap for Biomass Technologies in the United States” forecasts that the production of chemicals and materials from biomass will increase substantially in the next several decades, from approximately 12.5 billion pounds, or 5 percent of the current production of targeted U.S. chemical commodities in 2001 to 25 percent in 2030. The Coalition is well poised to contribute to meeting these projections.

Training and outreach in bioenergy and biorefining are high on our agenda to sustain future development in this area. Renewable energy curricula have already been developed and introduced in primary and secondary schools within parts of the Coalition.

In Hawaii, the “Sun Power for Schools” program includes a curriculum component to develop local technological skills and knowledge in alternative energy sources among Hawaii’s K-12 students. Solar energy events and similar activities involving high school and college students helps increase awareness of new technologies, including renewable energy. Training in biological and thermochemical conversion of biomass into energy and other commercial products is being offered at the university level. The current K-12 and university training will be expanded and K-12 educational materials will be developed to guide and inspire teachers and students. As part of the planned program, the Coalition will offer short courses to professionals and field training to technicians. Finally, conferences and workshops and interactive distance learning will be regularly used to facilitate the sharing and transfer of RD&D results.

Funding Opportunities. To advance the Coalition's objectives in a timely manner, we have explored funding possibilities. The new Sun Grant Initiative of 2003 has emerged as a promising significant resource for RD&D funds. Our Coalition's purposes align well with the intent of this Initiative to develop biobased energy technologies to enhance national energy security, promote agricultural and environmental sustainability, boost economic diversification in rural areas, and enhance cooperative activities with the U.S. Department of Agriculture and Department of Energy.

In its 2002 Report, the Western Region of the Sun Grant Initiative, to be headquartered at Oregon State University, has stated that the special needs of Hawaii, Alaska and the Pacific Territories will be the focus of one or two of the western regional subcenters. Being located in key areas of the region and given the extensive knowledge we have accumulated to date and our commitment to work together on RD&D, our Coalition is ideally positioned to meet the Sun Grant's requirement for "culturally sensitive, small-scale, and vertically integrated biobased energy systems"²¹ for the region. We believe our Coalition is well suited to serve as a Sun Grant subcenter.

Toward a Pacific-based Sustainable Future

In summary, moving toward the use of renewable resources and away from limited and imported fossil resources, wherever the technology is available, is a more sustainable and environmentally responsible approach to our local as well as national energy needs. These "clean technologies" are appropriate and sensible for development in our region. Our Coalition has accumulated a significant body of know-how and stands ready to expand and integrate activities among the institutions in our region with the Sun Grant Initiative as a potential vehicle. And the time is right to pursue these new technologies, as they are emerging as a multimillion-dollar growth sector with the potential to create investment opportunities and jobs to help ensure our region's economically dynamic and environmentally sustainable future.

Our Coalition will develop technologies and system packages for the efficient utilization of indigenous biological resources to produce energy and other commercial products. It will be instrumental in training a skilled workforce to support new bioenergy/biorefining industries. These basic goals will be achieved within a cooperative framework in which the private sector works with government and academia to promote economic development while operating in harmony with the environment. In the process, American economic and environmental leadership will be solidified.

APPENDIX A

**Pacific Coalition for Bioenergy/Bioproducts Development
Land Grant Colleges and Universities Member List**

American Samoa Community College
Agriculture, Human and Natural Resources
Pago Pago, American Samoa
Dr. Don Vargo, Dean and Director

College of Micronesia
Land Grant Programs
Kolonia, Pohnpei, Federated States of Micronesia
Dr. Singeru, Singeo, Director

Northern Marianas College
CNMI Cooperative, Research, Extension and Education Service
Saipan, Commonwealth of Northern Marianas Islands
Mr. Anthony Benavente, Interim Director

University of Alaska, Fairbanks
Fairbanks, Alaska
Dr. Anthony Nakazawa, Director, Cooperative Extension Service
Dr. Carol Lewis, Dean, College of Natural Resources and Agriculture

University of Guam
College of Natural and Applied Sciences
Mangilao, Guam
Dr. Lee Yudin, Dean and Director

University of Hawaii
College of Tropical Agriculture and Human Resources
Honolulu, Hawaii
Dr. Andrew Hashimoto, Dean and Director
Dr. Charles Kinoshita, Interim Associate Dean
Mr. James Hollyer, ADAP Program Manager

ENDNOTES

¹ “International Aspects of U.S. Energy Security,” testimony of Alan P. Larson, Undersecretary for Economic, Business and Agricultural Affairs, before the Senate Foreign Relations Committee on International Economic Policy, Export and Trade Promotion, 4/08/03.

² U.S. Department of Energy, Energy Efficiency and Renewable Energy, www.eren.doe.gov, 2/05/03

³ The National Renewable Energy Laboratory, www.nrel.gov, no date.

⁴ International Energy Agency, IEA Bioenergy, www.IEABioenergy.com, no date.

⁵ Charles Kinoshita, Hawaii Energy Resources Coordinator, 2001, cited in “Bioenergy Research, Development, and Demonstration in Hawaii,” University of Hawaii.

⁶ ARS Bioenergy & Energy Alternatives National Program, U.S. Department of Agriculture, www.ars.usda.gov/research/programs, no date.

⁷ Charles M. Kinoshita, et al., “Availability and Suitability of Bioresidues for Electric Power Generation in Asia and Latin America,” presented at the American Power Conference, Chicago, IL, 4/15/98, p.1

⁸ Seminar on Energy Security in Asia: ASEAN+3 Energy Cooperation, Tokyo, Japan, 3/07/02

⁹ Special Ministerial Conference on Agriculture in Small Island Developing States, Rome, Italy, 3/99

¹⁰ 2002 U.S. Census, Honolulu Advertiser, 2/21/04, p. 1

¹¹ Charles M. Kinoshita, “Bioenergy Research, Development, and Demonstration in Hawaii,” p.1

¹² Anthony Nakazawa, “Promoting Agriculture in Alaska,” 1/20/04, p. 2

¹³ *Ibid.* pp. 5, 7

¹⁴ Charles M. Kinoshita, et al., “Availability and Suitability of Bioresidues for Electric Power Generation in Asia and Latin America,” p. 1

¹⁵ Data Report, Policy Analysis System Evaluation Report 2001-02:06, “Census 2000: Hawaiians in the U.S.,” October 2001, p. 4

¹⁶ Hawaii Agricultural Statistics Service

¹⁷ Anthony Nakazawa, “Promoting Agriculture in Alaska,” p. 4

¹⁸ Charles M. Kinoshita, “Bioenergy Research, Development, and Demonstration in Hawaii,” p. 4

¹⁹ Hawaii Biobased Fuels, Power, and Products, The Biomass Research and Development Initiative, 1/03, p.1

²⁰ “Renewable energy co-ops give power to the people,” Honolulu Star-Bulletin, 2/15/04

²¹ Western Region Report, Sun Grant Initiative, 2002, pp.61-62