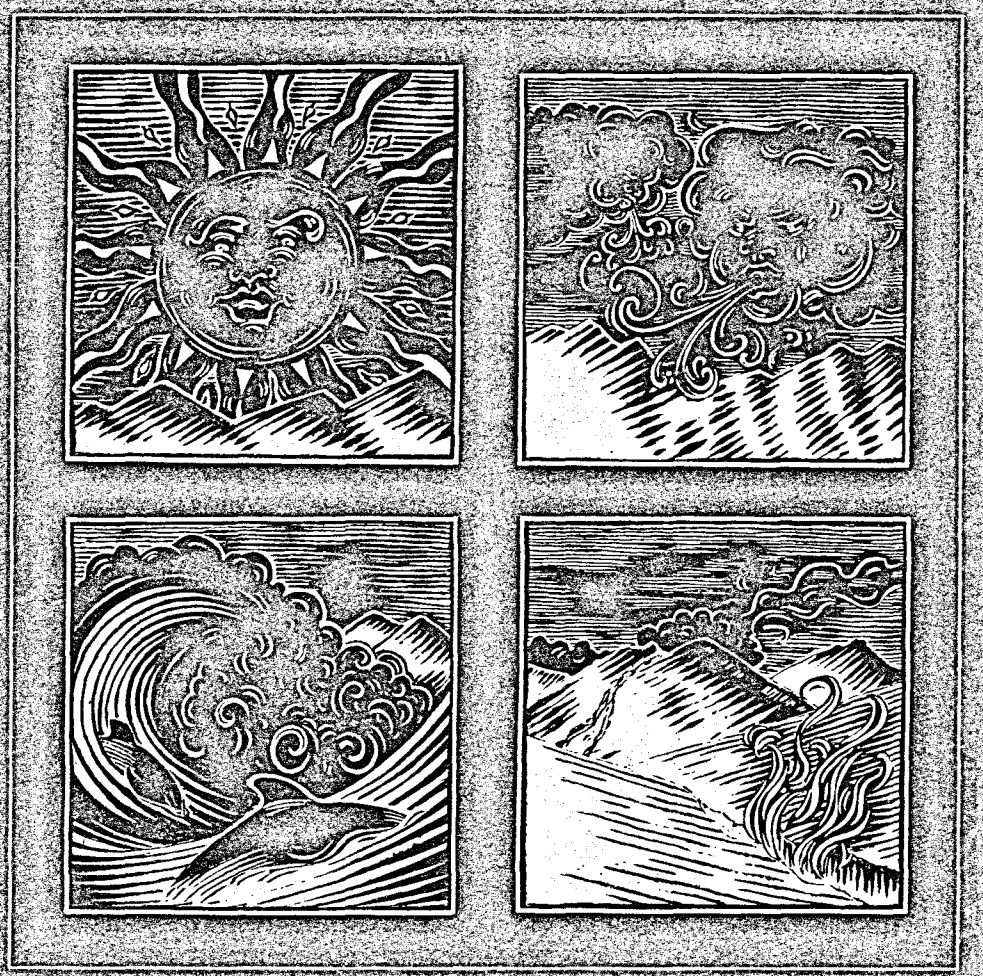
STATE ENERGY RESOURCES COORDINATOR'S ANNUAL REPORT 1994



DEPARTMENT OF BUSINESS, ECONOMIC DEVELOPMENT & TOURISM
STATE OF HAWAII

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ENERGY RESOURCES COORDINATOR'S OUTLOOK

Hawaii is among the world's most geographically isolated areas and strongly dependent on imports for its everyday needs. One of the most basic needs is energy. With Hawaii dependent on imported fossil fuels for about 90 percent of its energy, it is still the most oil dependent state in the nation. Given that vulnerability, our mission has not changed. We are still committed to increasing Hawaii's energy self-sufficiency, while supporting efficient, reliable, economic, and environmentally responsible energy systems capable of meeting Hawaii's requirements.

Many people may not be aware that Hawaii is a leader in the areas of innovative energy conservation and efficiency practices, and sustainable energy technologies. These project areas are instrumental in marketing and showcasing Hawaii's energy efforts to the U.S., the Asia/Pacific region and throughout the world. Continued marketing efforts can lead to the creation of business, employment and income opportunities for the state in such areas as energy technology applications and energy technology transfer.

Energy education continues to be one of our priorities to improve and preserve Hawaii's energy and environmental future. It is designed to improve the public's energy awareness and foster appreciation of efficient energy use and management. The marriage of education and marketing helps build the foundation for a better educated and higher skilled work force and population.

Each resident of our state has a key role to play in helping Hawaii achieve its energy goals. Improving energy efficiency, reducing energy consumption and effectively educating others about our precious energy resources are all practices to enhance our energy self-sufficiency and environmental vitality. For those of you who have taken the challenge and implemented energy and environmental programs in your home and workplace, please know that your efforts do make a difference and will serve as models for others to follow.

We are a leader in developing renewable energy technologies

Seiji F. Naya

The energy program priority for Hawaii is to reduce its extremely high dependency on fossil fuels, balanced with the need to provide adequate and reliable energy supplies at a reasonable cost. Hawaii's energy problem is of greater urgency than in other parts of the country where other energy resources are more readily available.

ENERGY PROGRAM DESCRIPTION

There are three basic components to the State's energy program:

- Energy planning and policy;
- Displacing petroleum fuels with alternate, or renewable forms of energy; and
- Improving energy efficiency.

The first element, energy planning and policy, includes the development of an integrated energy policy and plan designed to facilitate the accomplishment of Hawaii's energy objectives. Also included in the planning and policy component is the Hawaii Energy Strategy (HES) program, a comprehensive strategic energy planning and policy development initiative designed to provide direction for the accomplishment of the Hawaii Department of Business, Economic Development & Tourism's (DBEDT) goals of reducing Hawaii's dependence of imported fossil fuels; influencing the mix of supply-side and demand-side resources to optimize economic and societal costs of reliable energy services; increasing public awareness of energy issues; and providing the State with energy security and emergency preparedness.

DBEDT's mission is set by the statutory energy policy objectives contained in the State Plan, Chapter 226-18, Hawaii Revised Statutes (HRS), which states: "(a) Planning for the state's facility systems with regard to energy shall be directed toward the achievement of the following objectives: (1) Dependable, efficient and economical energy systems capable of supporting Hawaii's needs; (2) Increased energy self-sufficiency where the ratio of indigenous to imported energy use is increased; and (3) Increased energy security in the face of threats to Hawaii's energy supplies and systems." These broad policy objectives are supported by the following energy program goals:

- Reduce Hawaii's dependence on imported fossil fuels;
- Influence the mix of supply-side and demand-side energy resources to optimize economic and societal costs of reliable energy services;
- Increase public awareness of energy issues; and
- Provide the state with energy security and energy emergency preparedness.

Planning is the key to achieving Hawaii's energy goals of a more secure and environmentally safe energy future. This includes continuous review, evaluation and revisions with input from the community. Plans are being developed to meet changing state, national and world conditions, including energy supply and demand, economic fluctuations and technological advances.

ENERGY PLANNING

The Energy Planning and Policy Group provides the following functions in support of energy programs, projects and activities:

- Formulates and recommends plans and programs for the optimum utilization of Hawaii's energy and energy related organizational resources as the State pursues its statutory energy objectives (Hawaii State Plan (revised), Chapter 226, HRS, as amended);
- Provides planning support to ensure coordination and integration of DBEDT activities;
- Provides assistance to DBEDT staff, personnel of other organizations and the general public by compiling, evaluating and disseminating energy information and data;
- Develops, implements and maintains a comprehensive energy modeling and forecasting system to effectively support State energy management activities;
- Assesses impacts of changes in energy supply and demand, and recommends appropriate action;
- In accordance with Chapters 196 and 226, HRS, provides staff assistance in updating the Energy Functional Plan and other energy related planning activities;
- In accordance with Chapter 125C, HRS, develops, maintains and updates energy emergency preparedness plans. Formulates and recommends plans, policies, and procedures for fuel allocation and distribution to be implemented in the event of a declared energy emergency; administers fuel allocation activities; coordinates the State's emergency fuel allocation program with other government and private agencies and organizations;
- Makes recommendations and provides staff assistance for initiatives to obtain a component of the National Strategic Petroleum Reserve to meet Hawaii's emergency fuel needs; and
- Conducts analysis and long-range assessments of energy resources and formulates plans for integrating energy systems.

HAWAII ENERGY STRATEGY PROGRAM.

The HES program emerged from the recommendations of the preceding Hawaii Integrated Energy Policy Development (HEP) program as a set of seven projects intended to implement the goals identified by HEP. These seven projects are also designed to increase understanding of Hawaii's energy situation and transfer skills from supporting consultants to DBEDT staff, as well as to produce recommended strategies to achieve the state's energy objectives.

With support from Senators Inouye and Akaka, DBEDT secured $1.5 million of federal grant funds to match the state's contribution to this unique energy planning initiative. This effort is envisioned to be the first iteration of an integrated biennial state energy planning process.

The Energy Policy Advisory Committee, comprised of the executive leadership of Hawaii's public and private energy community, supported DBEDT's energy planning activities through active participation in the HES. Opportunities for public involvement in the process were scheduled from project inception (March 1992) through the scheduled program completion, the end of 1994. The program's seven projects are now completed or in near final draft form, awaiting technical and public review. The final report will be published in 1995.

The following is a brief summary of the accomplishments of the HES program during 1994.

Seven projects increase understanding of Hawaii's energy situation

Project 1 - Analytical Energy Forecasting Model.

As a basis for further work on the HES program, a Hawaii-specific analytical energy forecasting model capable of analyzing and predicting the state's energy consumption by end use, sector and utility service area under varying economic and technical conditions was developed. This model was fundamental to understanding how energy is used, the potential for changing use patterns and proper planning to ensure a stable and suitable future for Hawaii. A forecasting capability was also an important step in assisting the Energy Resources Coordinator (ERC) in exercising his statutory authorities and responsibilities for energy planning.

This project worked closely with other HES projects and the IRP technical assistance efforts for each utility to ensure that energy forecast assumptions and results were reasonable and consistent. As a result, more useful and informative forecasts were also developed by the utilities. An additional benefit of this project was an independent statewide forecast in addition to utility-produced forecasts to meet the state's needs.

Fossil Fuels = Oil, coal or natural gas. Fuel that was formed in the earth in prehistoric times from remains of living-cell organisms.

ENERGY 2020 was adopted as the state's energy forecasting model from among 30 models evaluated. ENERGY 2020 was designed for planning/scenario analysis with a focus on conservation/load management decisions along with the interactions between the utility, the regulatory commission, and the utility service area. The model allows analysts and planners to resolve issues and sort potential strategies in an efficient and comprehensive manner.

The demand module of ENERGY 2020 was calibrated for each of Hawaii's four counties. Hawaii-specific demographic and energy data were obtained and included. Revised forecasts were presented in January 1994, and training manuals and user guides to accompany the model were also provided. Later in 1994, Project 1 was incorporated into Project 7 as the forecasts provided a basis for policy assessment under the integration project.

Project 2 - Fossil Energy Review and Analysis.

A comprehensive analysis of fossil energy in Hawaii and the Pacific area was conducted, providing a clearer understanding of world fossil energy markets and fossil energy use in Hawaii. The project also examined the possible diversification of Hawaii's fossil energy resources through the possible additional use of coal in Hawaii or the use of liquefied natural gas, summarized the changes needed in infrastructure, the costs of changes, and possible economic and environmental impacts. In addition, a set of scenarios was analyzed as to how petroleum requirements might be reduced and how such reductions would affect Hawaii's refineries. The five volume final report was completed and delivered at the end of 1993 and copies were distributed to the State Library System in early 1994.

The Project 2 report suggested the following: First, the state should improve its basic data reporting and analysis function and give more attention to staff development and training in the technical aspects of the petroleum industry. Second, the state could open an IRP-type of dialogue on the future of oil in the state's energy supply. Third, the state should encourage increased refinery flexibility via installation of additional upgrading facilities which will not only make the refiners more capable of responding to changes in the world market, but will also give much more latitude to state programs in alternative fuels. Fourth, the Asia/Pacific oil market is highly fluid and several key aspects should be watched closely on a continuous basis. Fifth, Hawaii should focus on making improvements in energy conservation and efficiency of energy use, encouraging cost-effective fuel substitution, and moving to develop alternative energy resources. Such measures are the cheapest ways of expanding energy supplies or lowering current levels of dependence.

Project 3 - Renewable Energy Assessment and Development Program.

This study produced a comprehensive assessment of Hawaii's renewable energy resources (wind, solar, biomass, hydroelectric, ocean thermal energy conversion, geothermal and wave energy) and a long-range development strategy. The project consisted of three phases:

- Phase I - Development of a Renewable Energy Resource Assessment Plan which defined the most promising potential renewable energy projects and sites. This phase was completed in 1993.

- Phase II - Development of Renewable Energy Resource Supply Curves which were based on the cost and performance of projects identified in the first phase was completed in 1994.

- Phase III - Collect Additional Wind and Solar Resource Data and Develop a Plan for Integrating Renewable Energy Resources Into the State's Energy Supply Mix. Data collection was completed in late 1994. In early 1995, the data will be integrated into a final report which will include an integrated plan for incorporating renewables into the state's energy mix.

Renewable Energy = Resources that constantly renew themselves or that are regarded as practically inexhaustible.

Project 4 - Demand-Side Management Assessment.

Project 4 developed a comprehensive assessment of Hawaii's demand-side resources. In addition, it supported DBEDT's participation in the Hawaii Public Utilities Commission's (PUC) IRP process for each utility.

The project was divided into two phases. Phase 1, established a framework and data requirements for a demand-side management (DSM) measure database, developed data collection workplans, collected data for a DSM measure database and commercial building prototypes, and characterized 10 commercial building types. A DSM Measures Compendium was developed which identified and described the most appropriate DSM measures for consideration in Hawaii. On-site surveys of 50 commercial buildings produced a set of building prototypes for engineering simulation modeling efforts.

Phase 2 of the project used and expanded upon Phase 1 data to conduct building prototype simulations of DSM measures and technical, economic, market assessments of potential DSM; and recommended DSM programs. The product of the two phases of the project was the DBEDT DSM Forecasting Model. This model provides a comprehensive assessment of DSM potential by DSM measure, building type and county over a 20-year forecast horizon.

The final report for Project 4 consisted of a three volume main report and four reference volumes. The main volumes are an Executive Summary; A Building Prototype Analysis which provides baseline assumptions, simulation results, and a detailed description of the building prototype simulations; and a DSM Opportunities Report which includes detailed descriptions of the DSM Assessment Model and its supporting methodology and results from different scenario runs. Also included are descriptions of DSM programs and characteristics relevant to program design which affect the size and timing of potential DSM resources.

Project 5 - Transportation Energy Strategy.

Project 5 collected and synthesized information on the present and future use of energy in Hawaii's transportation sector; examined the potential of energy conservation to affect future energy demand in the transportation sector; analyzed the possibility of satisfying a portion of the state's future transportation energy demand through alternative fuels; and recommended a program targeting the state's transportation sector to help achieve state energy goals. The final report consists of a comprehensive single volume and emphasizes that a program to achieve meaningful petroleum substitution could begin now. Experience on the mainland and elsewhere has shown the need for successful programs to be integrated, publicly-supported packages of requirements, incentives, research, outreach and public information, governmental actions and monitoring programs. Because of these interrelationships, it may be appropriate to integrate all elements relating to ground sector energy use into one package addressing conservation, alternative fuel supply and demand, and vehicle supply and demand.

Overall, the potential benefits of energy conservation and petroleum substitution in the ground transportation sector are large, the costs of the program appear reasonable in relation to the benefits, and the risks would be relatively small.

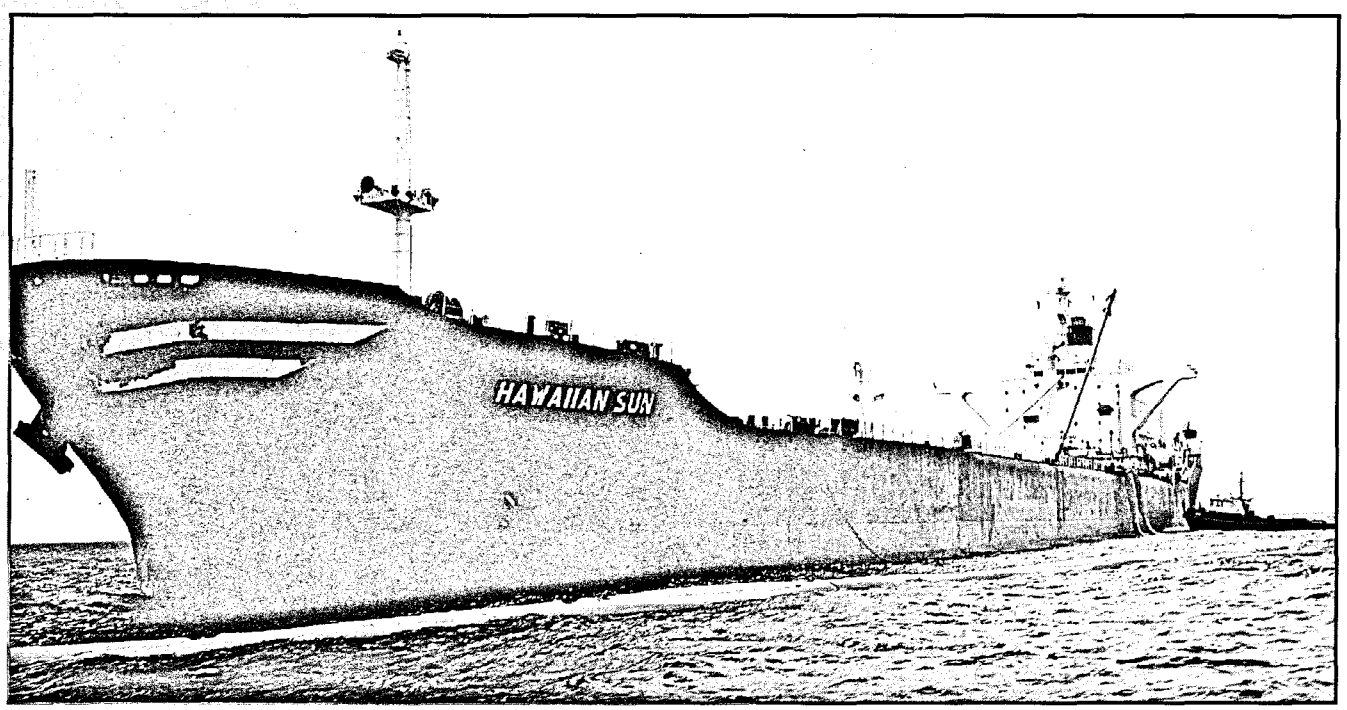
PROJECT 6 - ENERGY VULNERABILITY ASSESSMENT AND CONTINGENCY PLANNING. Project 6 evaluated the vulnerability of Hawaii's energy systems to energy disruptions stemming from natural disasters and measures to reduce that vulnerability. The project assessed the state's capability to effectively contend with an energy supply disruption; and examined hazard mitigation options for minimizing energy system vulnerability, improving energy emergency preparedness (EEP) planning and response.

Hawaii's vulnerability to energy emergencies is a reflection of its extreme dependence on oil; the decline in oil exports by its current sources of supply; probable increased future reliance on politically unstable sources of oil; relative isolation and long distance from its normal sources of supply and the U.S. Strategic Petroleum Reserve; the lack of utility grid interties; and the unpredictability of energy disruptions resulting from political and economic events, or natural disasters. Because of these elements, it is crucial for the state to be prepared to deal with its energy vulnerability and the sudden unpredictable nature of energy disruptions.

In response to Hawaii's vulnerability to energy emergencies, the state has strengthened its EEP program over the past several years. The purpose of the program is to be prepared to effectively manage energy emergencies and threats to Hawaii's energy security. This role is complementary, but subordinate to the State Civil Defense Program in a general emergency, and is consistent with state and federal response plans. DBEDT provides principal EEP staff support to the Governor and ERC by assisting them in fulfilling their statutory responsibilities to ensure effective planning and preparedness for any energy emergency and timely and effective response, irrespective of cause.

The majority of Project 6's policy recommendations will reflect the findings of the energy vulnerability assessment.

Project 6 assessed the capability to contend with energy supply disruptions



OIL TANKER OFFLOADING CRUDE OIL TO ONE OF HAWAII'S REFINERIES.

Project 7 - Hawaii Energy Strategy Program Integration.

Project 7 integrated the findings of the overall HES program into a comprehensive state energy strategy. The work included facilitating the integration of information among the other six projects and inclusion of that information in the final report. The draft final report will be presented to the public in 1995 to obtain feedback for inclusion in the final published report.

Based upon the work of the projects, Project 7 identified, assessed and recommended public policy mechanisms (e.g., legislative, regulatory or both) by which to implement a "least-cost" strategy for energy development in Hawaii. Existing energy policy and planning management frameworks were used for synthesis, integration and evaluation of policy and planning initiatives that emerged from the component projects. The ENERGY 2020 model and the Regional Economic Models, Inc. economic input/output model were used to develop an automated system for use in evaluating the effectiveness of policy options.

Project 7 also developed, evaluated and recommended policy initiatives and plans to formalize an energy planning and policy evaluation system within state government; e.g., institute a statutory requirement to conduct integrated energy planning on a biennial basis. Project 7 also developed an energy planning and policy evaluation capability by providing requisite staff training, strengthening the state's in-house capabilities and reducing dependence on outside consultants.

The HES Program is based on the earlier Hawaii Integrated Energy Policy Development Program. It began in March 1992 and is a set of seven projects intended to produce an integrated energy strategy for the State of Hawaii.

Conclusions.

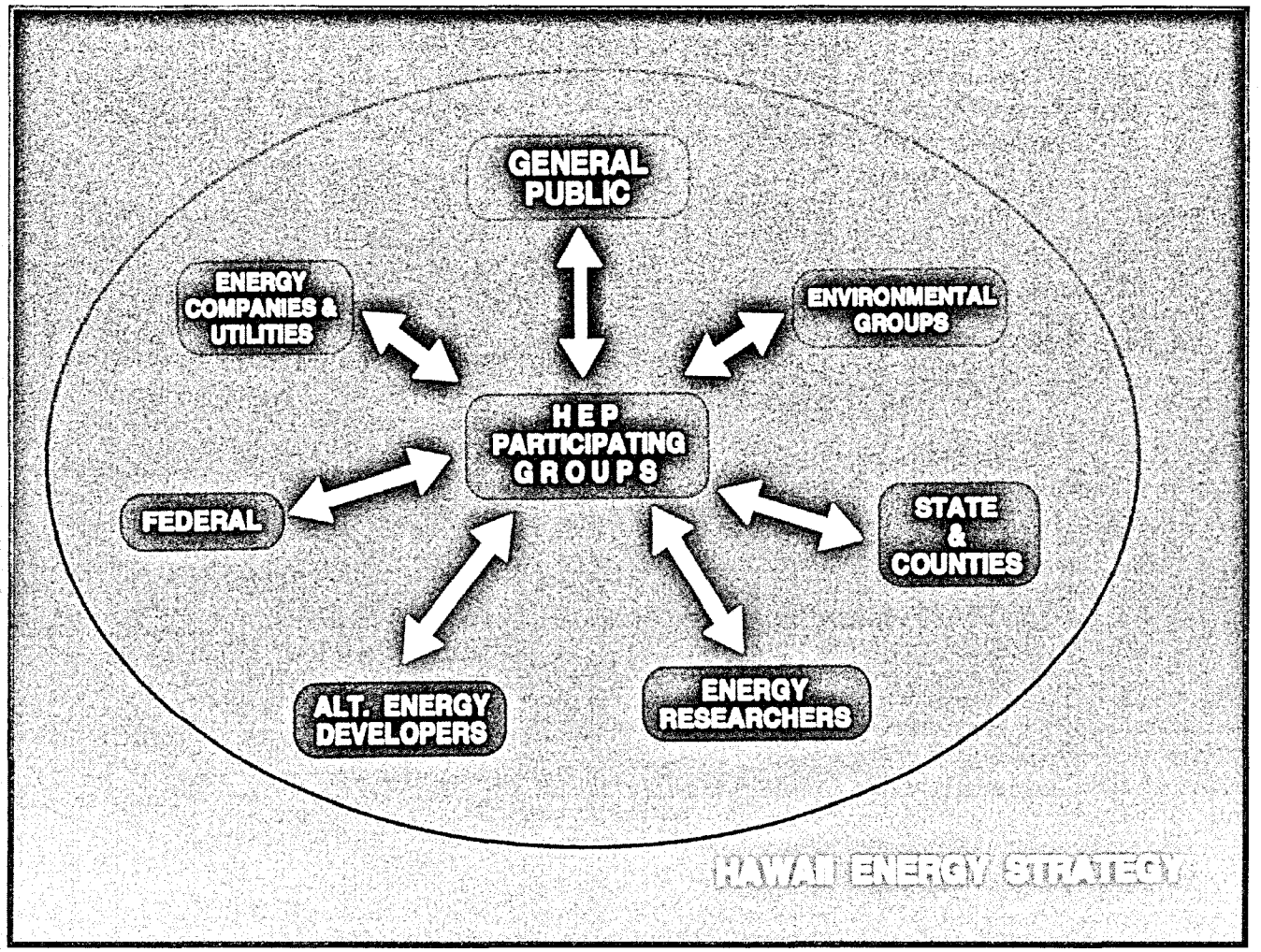
The HES program created a state energy system modeling capability and comprehensive, statewide energy resource assessments. With sufficient resources to maintain these planning and policy tools, they can form the basis of future biennial integrated energy planning, which can lead to much more informed energy policy decision making by first analyzing the policies' impacts on Hawaii's energy system and economy. Most importantly, Project 7 has resulted in an open, public energy planning and policy development process, which can help to ensure that recommended policies are understood and supported by Hawaii's energy community and the general public. The program transferred important skills from the consultants to the DBEDT staff to strengthen in-house energy management expertise.

HES Public Participation.

Public participation was important to the HES program. Direct public participation involved two elements: Technical Advisory Groups under the auspices of the Energy Policy Advisory Committee (EPAC) and formally established opportunities for participation by the general public.

Technical Advisory Groups were based on EPAC and its Integration Group was established during the development of the HEP Program. They are comprised of members of Hawaii's "energy community," including energy companies, utilities, environmental groups, and state and county government organizations. EPAC continues to serve as advisor to the ERC. Subcommittees were formed by HES project groups for periodic review of the progress and results of each project. The technical review of Project 7, the Energy Strategy Integration and Evaluation System, involved the Integration Group as a whole.

Public participation was important to the



A second HES Workshop was held on January 11, 1994. Registrants were provided a copy of the Hawaii Energy Strategy Program Status Report and a questionnaire. About 180 people registered to attend and another 110 who could not attend requested a copy of the Status Report and the questionnaire. Persons attending the Workshop listened to briefings on progress to that point and were given the opportunity to ask questions and offer comments. Participant comments, questionnaire responses, and the results of the Workshop were documented in a volume of Proceedings, which served as a reference for HES project teams in completing their work.

AWARDS FOR HEP PROGRAM.
DBEDT's HEP Program was awarded a Certificate of Environmental Achievement from Renew America and will appear in Renew America's Environmental Success Index, a database of more than 1,600 successful environmental programs.

HEP is also a candidate for Renew America's Fifth Annual National Awards for Environmental Sustainability. Renew America, a resource of environmental solutions for 15 years, identifies, verifies and promotes environmental initiatives.

HES Program

Hawaii is considered one of the country's leading states in the availability and development of renewable, sustainable energy resources and technologies. A major objective of the Alternate Energy Program is to facilitate and expedite the development and commercialization of Hawaii's renewable energy resources to reduce our dependency on imported fossil fuels.

ALTERNATE ENERGY DEVELOPMENT

The program focus included assisting potential developers by providing them information through statewide assessments of renewable energy resource availability, workshops and cost-shared demonstrations of new promising technologies. Such state projects are ongoing in biomass, wind, ocean thermal, hydro, solar and transportation technologies.

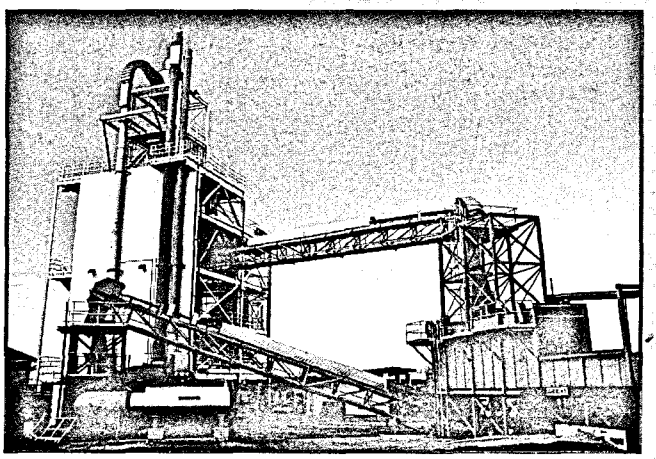
Increased development of these alternate energy resources will not only provide greater energy security for Hawaii and environmental benefits, but will provide economic benefits in the form of new industries with more employment opportunities, and a more favorable balance of trade.

DBEDT continued to work closely with the USDOE, University of Hawaii (UH), Natural Energy Laboratory of Hawaii Authority (NELHA), Pacific International Center for High Technology Research (PICHTR) and private industry to increase research, development, demonstration and commercialization of Hawaii's renewable energy resources and technologies.

BIOMASS.

Biomass is the largest source of renewable fuel in Hawaii. It consists primarily of bagasse, the fibrous waste from sugarcane. Sugar mills burn bagasse to generate electricity for their own operations as well as for sale to local utilities. Hawaii is the only state that processes sugar cane every month of the year. Biomass is also considered a potential source of fuel for ground transportation.

The production of bagasse for electricity was reduced on the Island of Hawaii in 1994 by the closing of two sugar mills due to high costs and the shift of acreage for other uses. Hilo Coast Processing Company closed in September and Hamakua Sugar Company closed in October, leaving only one mill operating on the island. However, the remaining mills on Oahu, Maui and Kauai continued their sugar cane operations.

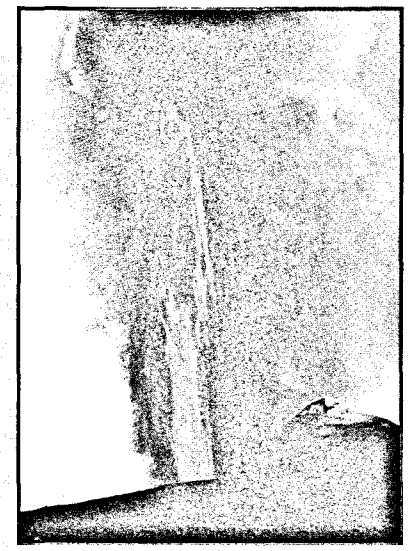


BIOMASS GASIFICATION SCALE-UP FACILITY IN PAIA, MAUI.

BIOMASS GASIFICATION SCALE-UP FACILITY.

The state and USDOE have jointly funded the design, construction and operation of a pre-commercial Biomass Gasification Scale-Up Facility (BGF) in Paia, Maui. Construction of the $9.2 million facility under Phase I of the project was completed in late 1994. The objective of Phase I is to demonstrate the technical feasibility of producing a fuel gas from sugarcane bagasse. Laboratory tests have confirmed that biogasification can double the efficiency of energy production from bagasse.

A hot gas cleanup/gas-turbine system will be incorporated during Phase II of the program for electrical power generation. Successful demonstration of the system will encourage the commercialization of biomass generated electricity. Phase III of the BGF project will investigate the conversion of biogas produced by the facility into methanol



fuel. The technologies developed during the program will enable the widespread use of a cleaner, self-sustaining energy resource, while at the same time preserving or creating jobs in the agricultural sector.

GEOTHERMAL.
The Geothermal Project Office facilitates the utilization of Hawaii's indigenous geothermal resources to provide for the energy needs of the Island of Hawaii and helps ensure that commercial development is accomplished in an environmentally sound and socially acceptable manner.

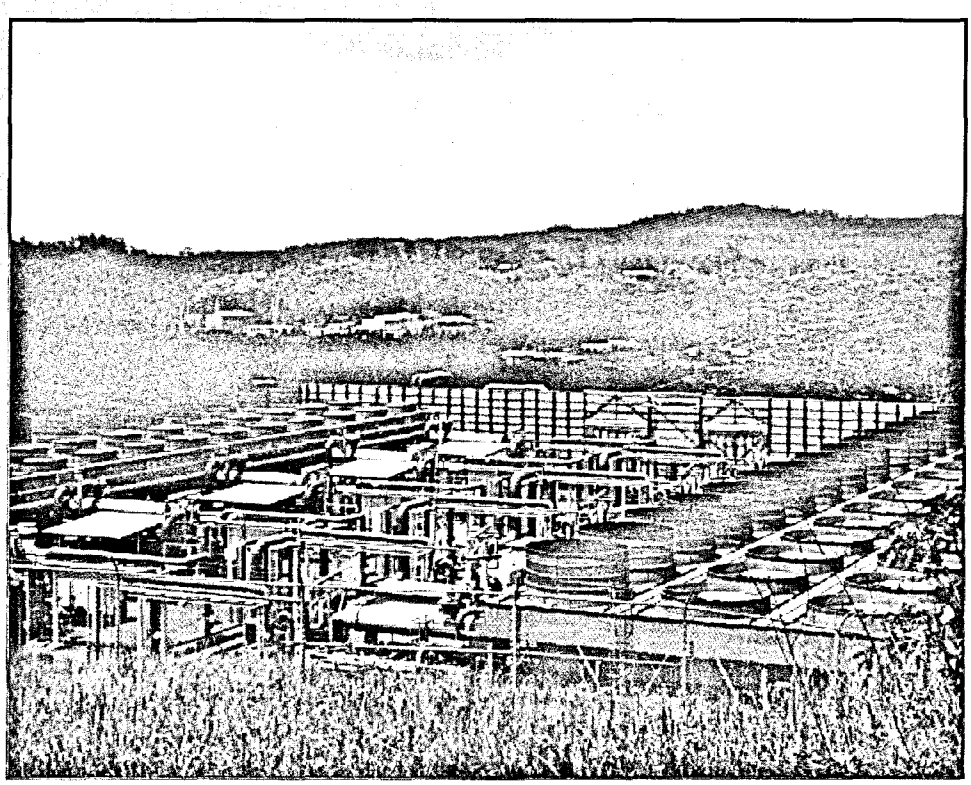
The Geothermal Project Office coordinates geothermal programs and projects, implements policy and formulates plans for the optimum utilization of geothermal energy resources. In developing and administering programs to encourage private and public exploration and research of geothermal energy resources, the Geothermal Project Office maintains close cooperation and coordination with USDOE, UH-Manoa, the utilities and private organizations involved in geothermal energy development.

The Geothermal Project Office also coordinates the preparation of technical studies to facilitate utilization of geothermal energy and administers geothermal energy demonstration and commercialization projects for which DBEDT is designated as the lead agency.

STATE'S GEOTHERMAL POLICY.
Current state policy supports the development of geothermal energy as a potential resource exclusively for the Island of Hawaii. In accordance with this policy, USDOE withdrew its earlier Notice of Intent to prepare an Environmental Impact Statement for a conceptual large-scale geothermal/inter-island cable project. The state continues to facilitate commercial activity toward achieving greater energy diversification for the Island of Hawaii through the safe and prudent utilization of geothermal energy.

PUNA GEOTHERMAL VENTURE.
Puna Geothermal Venture (PGV) has entered into its second year of successful commercial operation generating firm electrical power for delivery to Hawaii Electric Light Company (HELCO). The long-awaited production of geothermal energy, after lengthy legal and technical delays, has contributed toward alleviating some of the Island of Hawaii's energy concerns.

Current assessments indicate that PGV's geothermal wells have tapped a highly productive resource capable of supporting the generation of additional power for the Island of Hawaii. PGV has continued discussions with HELCO for the possible increased production of electrical energy.

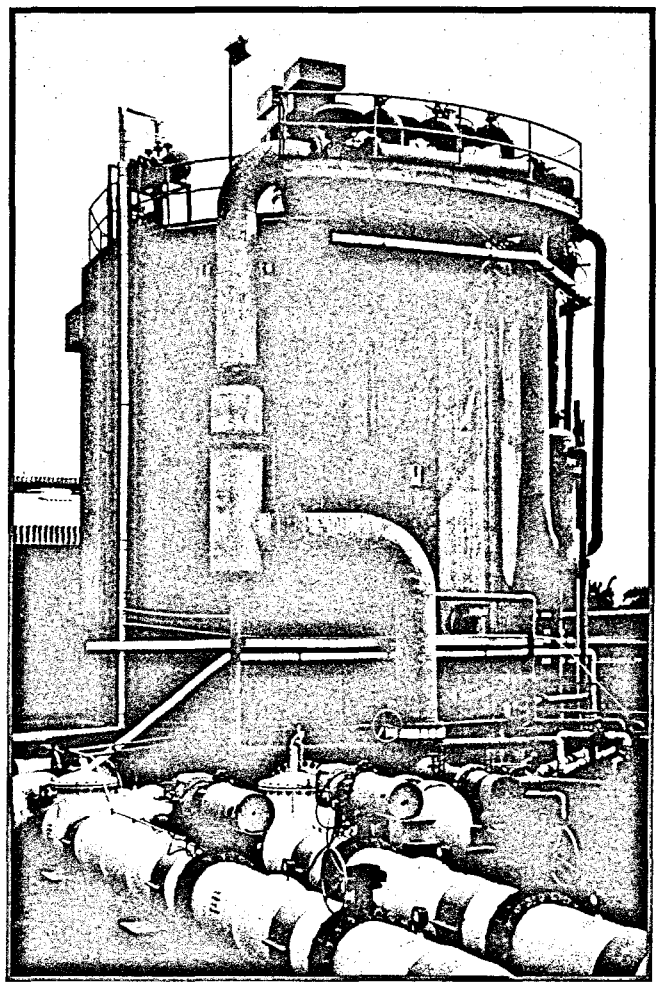


THE PUNA GEOTHERMAL VENTURE FACILITY IS LOCATED WITHIN THE KILAUEA EAST RIFT ZONE ON THE ISLAND OF HAWAII.

TRUE/MID-PACIFIC GEOTHERMAL VENTURE. True/Mid-Pacific Geothermal Venture, citing a re-direction of corporate objectives, decided to pursue other business opportunities outside of Hawaii. Notwithstanding its decision to cease Hawaii geothermal operations, the venture's exploration efforts over the years have contributed greatly to broadening the state's understanding of the resource within the Island of Hawaii's Kilauea East Rift Zone (KERZ).

GEOTHERMAL RESEARCH AND MONITORING. The Scientific Observation Holes (SOH) drilled by the Hawaii Natural Energy Institute (HNEI), under contract to DBEDT, continue to provide valuable information on the geologic characteristics of the KERZ pertinent to research and regulation of geothermal development activities. Transfer of the SOHs from HNEI to the Hawaii Department of Land and Natural Resources (DLNR) has ensured continued data collection and will assist DLNR in its regulation and management of the state's geothermal resource.

The OTEC facility generated a record output of 255 kW

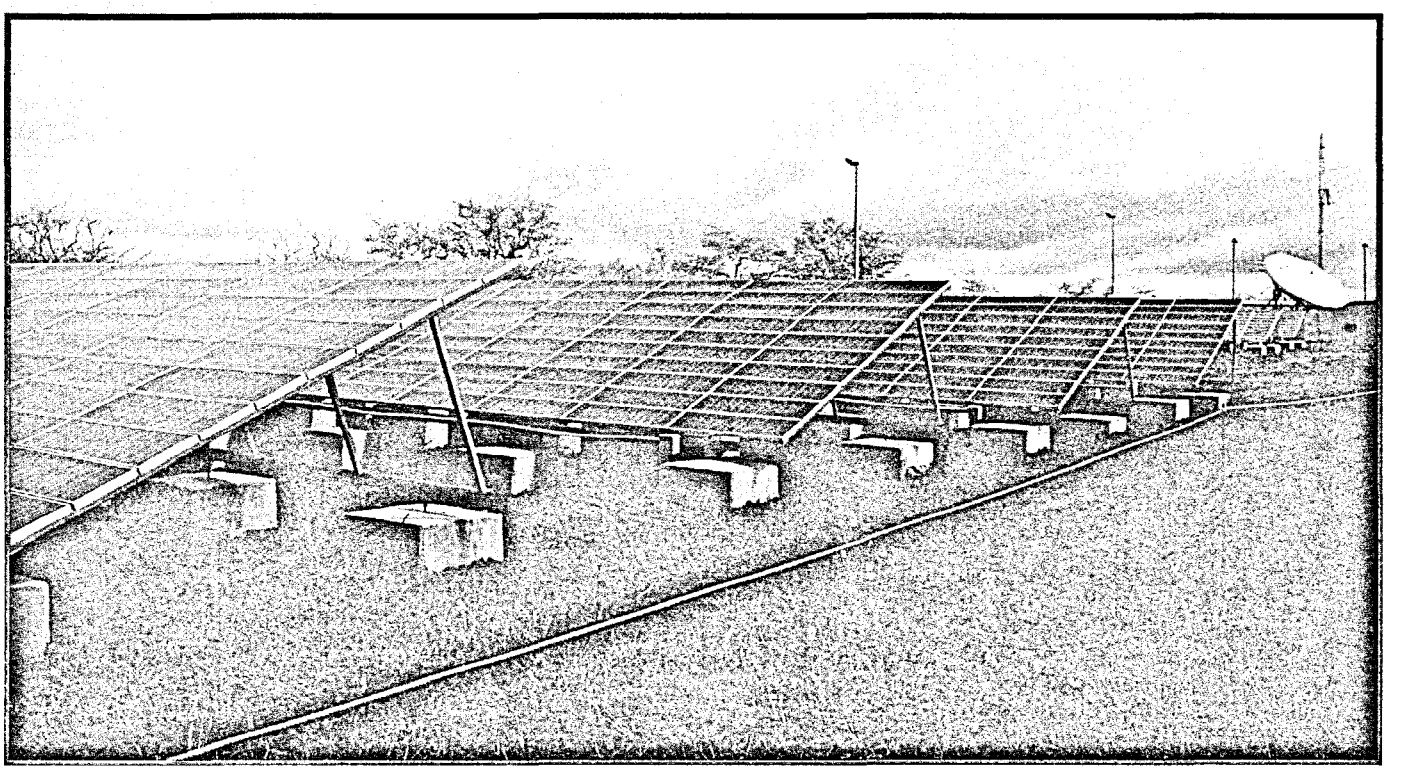


OPEN-CYCLE OTEC DEMONSTRATION PLANT LOCATED IN KONA, HAWAII.

The University of Hawaii's School of Ocean and Earth Science and Technology, through a contract with DBEDT, continues a geothermal research, monitoring and testing program in support of the state's regulatory and geothermal resource management functions. SOH core samples from the KERZ are currently being analyzed by university and independent researchers to study mineralogical and chemical characteristics.

OPEN-CYCLE OCEAN THERMAL ENERGY CONVERSION DEMONSTRATION PLANT. The state and USDOE co-funded the development and construction of an experimental open-cycle Ocean Thermal Energy Conversion (OTEC) plant with a 210-kW (gross) capacity at NELHA in Kona, Hawaii. The OTEC plant uses low-pressure steam produced from surface sea water to drive a turbine-generator to produce electricity.

ALMOST ALL OF THE MAJOR U.S. OTEC EXPERIMENTS IN RECENT YEARS HAVE TAKEN PLACE IN HAWAII. NELHA IS RECOGNIZED AS THE WORLD'S FOREMOST LABORATORY AND TEST FACILITY FOR OTEC AND OTEC-RELATED RESEARCH.

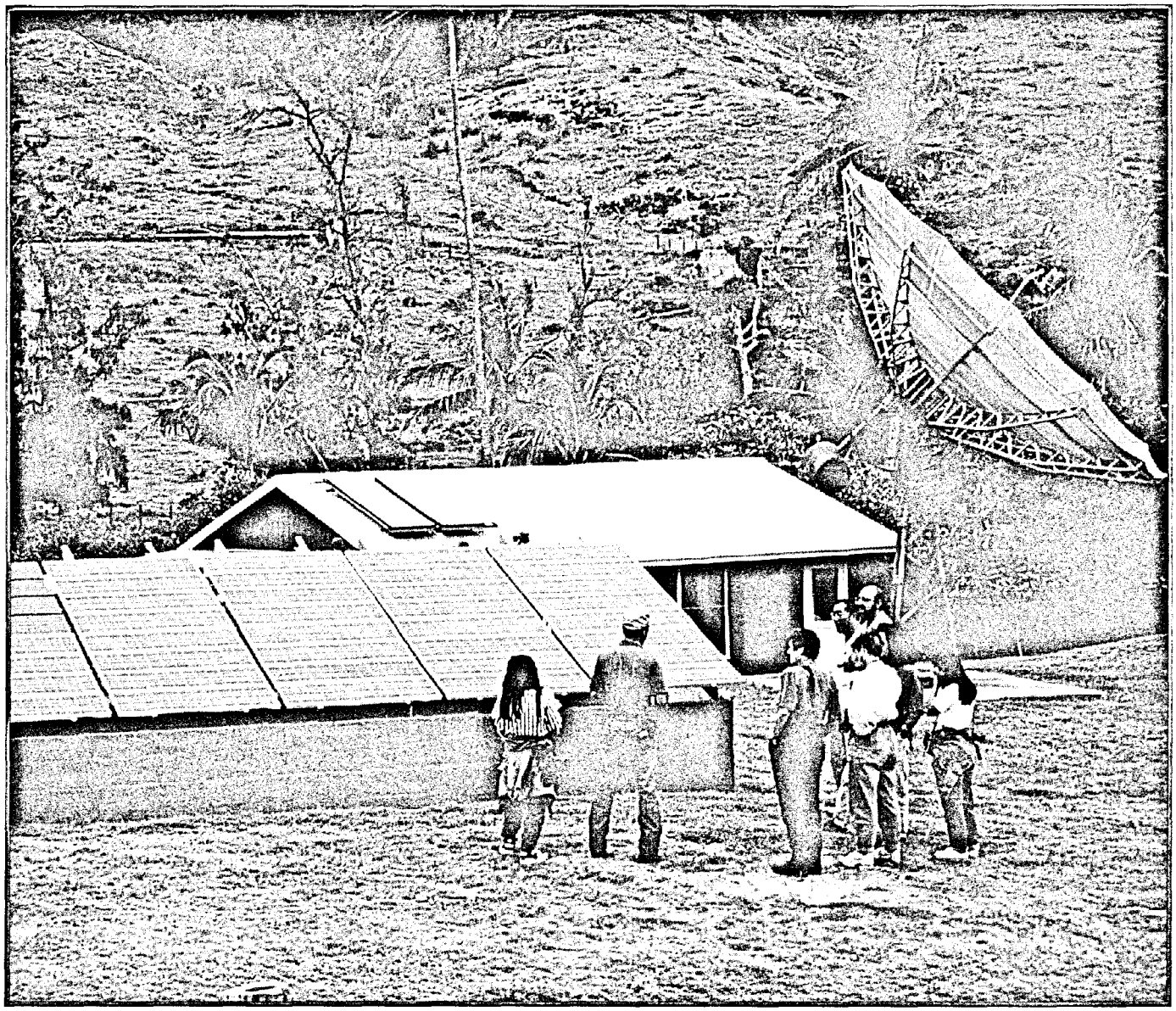


PHOTOVOLTAICS FOR UTILITY SCALE APPLICATIONS - HAWAII SATELLITE PROJECT IN KIHEI, MAUI.

The facility has been operational since December 1992 and has generated a record output of 255 kW (gross). In addition to electricity production, the facility has been configured with a desalinization system to produce potable (or fresh) water, which has been operational since February 1994. Continued evaluation of plant operations will determine system availability and power production over an extended period and will assess the feasibility of large scale commercial applications of the OTEC technology.

PHOTOVOLTAICS FOR UTILITY SCALE APPLICATIONS – HAWAII SATELLITE PROJECT.
Completing its fifth year of operation, the 20-kW photovoltaic project on Maui continued to supply electricity to the Maui Electric Company (MECO). Over this period, the Photovoltaics for Utility Scale Applications–Hawaii Satellite Project has also been able to increase its system availability and reliability.

PV FOR UTILITIES.
Hawaii is one of 12 states that have joined to form a national collaborative to support the Photovoltaics for Utilities (PV4U) program. The major focus of this program is to catalyze the efforts of key players from the utility, regulatory, photovoltaics (PV) industry, government and consumer communities to stimulate greater near-term use of photovoltaics in the utility market for both grid-connected and stand-alone systems. The state coalitions are working to find acceptable approaches to defining, justifying and financing contemplated utility PV projects. Toward this end, the state working groups are focusing on developing utility-driven hardware projects, identifying regulatory, policy and institutional barriers to PV development and deriving strategies to remove the barriers in the process.



LOCATED ON THE ISLAND OF KAUAI, KIPUKAI RANCH IS AN EXAMPLE OF A STAND-ALONE PHOTOVOLTAIC ENERGY SYSTEM.

This program is supported by the USDOE. Hawaii views the removal of institutional barriers to the deployment of photovoltaics through these efforts to be helpful for all renewable technologies as well. The ability to work first-hand with other states facing the same issues is very beneficial and an organized effort such as PV4U is much more effective in influencing national policy.

The Hawaii collaborative meets on a quarterly basis and was instrumental in obtaining a $15,000 grant from Sandia National Laboratory to fund PV startup and educational activities for HELCO. The Hawaii collaborative also obtained technical assistance to support a Pacific Island Photovoltaics Applications workshop held in conjunction with the First World Conference on Photovoltaic Energy Conversion held in December 1994 in Waikoloa, Hawaii.

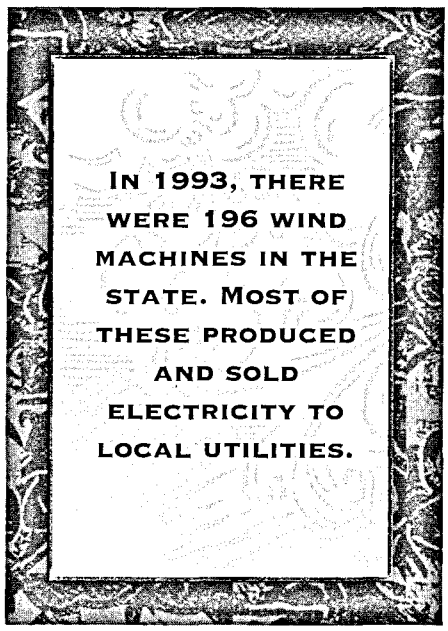
Hawaii Windpower Workshop.

DBEDT and USDOE jointly sponsored a Hawaii Windpower Workshop bringing together participants from the state and federal governments, industry, the utilities, regulatory agencies, environmental groups and the general public. A major objective of the workshop was to develop a comprehensive strategy for increasing utilization of wind energy. The workshop provided a forum for technology transfer and development of recommendations to integrate additional windpower into Hawaii's current mix of energy resources.

Wind/Diesel Electric Hybrid System.

Zond Pacific, Inc. of Hawaii in conjunction with Zond Pacific, Inc. of California has undertaken a project to plan, design, construct and operate a wind/diesel electricity generating hybrid system on Molokai.

The system consists of three 100-Kilowatt (kW) wind turbines in conjunction with a 100-kW diesel engine-powered electricity generator. These components, in addition to a number of other project-related services (such as design, site selection and wind data acquisition), have been provided by Zond Pacific, Inc. An objective of the system was to optimize wind output through controller design and the simulation of this type of system for water pumping applications.



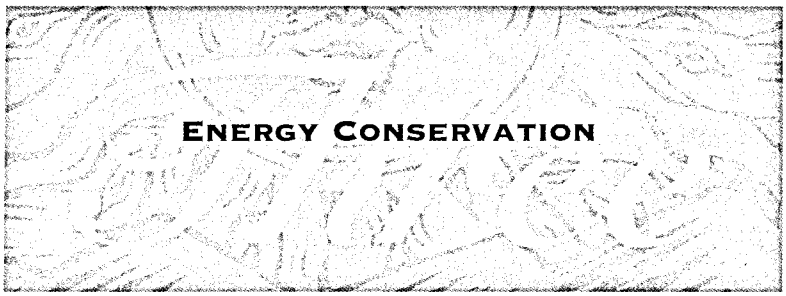
System start-up, testing and evaluation began in February 1992. A final report for this program has been submitted and will be available in early 1995.

Hawaii Zuteck Rotor Project.

Despite the reorganization of Makani Uwila Power Corporation (MUPC), the project was continued and examined the feasibility of modifying the existing rotor design for wind turbines to improve mechanical reliability, increase wind energy production and provide Hawaii with global wind industry prominence in its pursuit of renewable energy technologies. A final Task 2 report has been prepared which describes the design and hardware modification activities for the Westinghouse WWG-0600 Wind Turbines.

The PV4U focus is to stimulate use of PV in the utility market

Energy conservation and energy efficiency are the most cost-effective methods for the state to reduce its nearly total dependence on imported fossil fuels for its power needs. By using energy-efficient appliances, equipment and design for new and existing buildings, following energy-efficiency practices and encouraging utility least-cost planning, the need for new petroleum- or coal-powered power plants may be deferred.



The work of the Conservation Branch is carried out through the administration of two Federal Grants, the State Energy Conservation Program which provides a wide range of programs statewide, and the Institutional Conservation Program which provides technical and funding support to replace inefficient equipment in non-profit schools and hospitals. Working through the two Federal programs administered by DBEDT, the Conservation Branch has targeted three major areas: (l) Integrated Resource Planning and Demand-Side Management, (2) Building Efficiency and (3) Education and Information.

INTEGRATED RESOURCE PLANNING.
Integrated resource planning is an approach to regulated utility planning that evaluates all potential energy options, including production or supply-side (energy production by conventional fuels and renewable energy resources) and consumer or demand-side (energy conservation, efficiency and load management) as well as the social, environmental and economic costs of these options. The goal is to meet consumer's energy needs in an efficient and reliable manner at the lowest reasonable cost.

IRP and the events leading to its implementation have been a strong, positive force in Hawaii. It is already clear that the utilities will have better resource plans as a result of implementing IRP in conformance with Hawaii's IRP Framework, which was issued by the PUC in 1992. In addition, Hawaii's IRP Framework and the collaborative process have fostered greater understanding of utility and intervenor concerns, resulting in better communications among the utilities, the State, interested parties and the public.

Hawaii's IRP Framework calls for the utilities to develop 20-year integrated resource plans, which began in 1993, with the PUC every 3 years. Along with the long-term plans, the utilities have filed five-year action plans. They also filed annual evaluations reporting on progress in implementation of their action plans and any necessary changes.

DBEDT intervened in the five utility IRPs filed in 1993. During 1994 DBEDT testified in evidentiary hearings on MECO, Kauai Electric (KE) and HELCO IRPs. GASCO and Hawaiian Electric Company (HECO) hearings were held in 1993. Throughout its participation in the first cycle of IRP, DBEDT maintained that it is both possible and desirable for the utilities to comport with State energy objectives established in the Hawaii State Planning Act and the Energy Functional Plan. Key statutory objectives are:

- Dependable, efficient and economical statewide energy systems capable of supporting the needs of the people;
- Increased energy self-sufficiency where the ratio of indigenous to imported energy use is increased; and
- Greater energy security in the face of threats to Hawaii's energy supplies and systems.

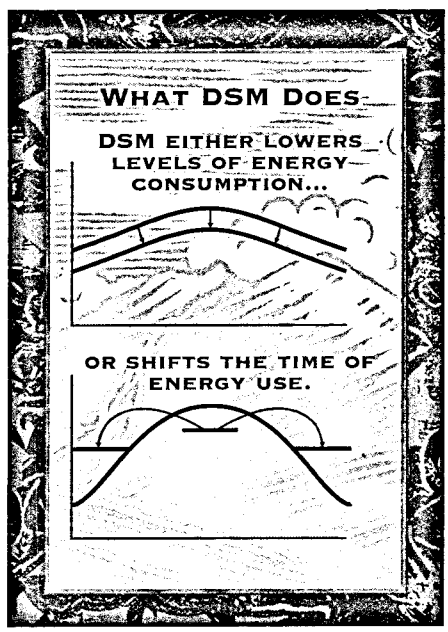
DBEDT staff also participated in all five utility IRP Advisory Groups as well as advisory groups on demand-side management, forecasting, externalities and integration. As part of its participation, DBEDT provided analyses and policy recommendations on various issues. DBEDT will also intervene in the Renewable Energy docket established by the PUC in 1994.

DEMAND-SIDE MANAGEMENT.

The goal of demand-side management is to modify energy use to maximize energy efficiency. In contrast to "supply-side" strategies, which increase energy supplies (e.g., by building new power plants), DSM strives for the efficient use of existing energy resources. DSM involves consumers' changing their energy use habits and using energy-efficient appliances, equipment and buildings. In reviewing the utilities' proposed DSM programs, DBEDT sought to ensure cost-effective and efficient DSM programs of least cost to consumers by determining:

Energy conservation may defer the need for new power plants

a) whether the program represented a reasonable course for meeting the energy needs of customers;
b) whether the program was in the public interest and consistent with the goals and objectives of integrated resource planning;
c) whether the program appropriately considered and analyzed the cost effectiveness and benefits of the energy technologies included;
d) whether the estimated program costs were necessary and reasonable; and
e) whether the evaluation procedures included in the program application were sufficient and reasonable.



Limited funds restricted DBEDT from intervening in each utility DSM program docket, therefore, DBEDT intervened where complex issues were considered. These issues included fuel choice (gas vs. electricity) and cases where the amount of energy savings would be significant (e.g., residential water heating which comprises over 40 percent of residential demand). During the year, DBEDT intervened in HECO's $46.1 million residential water heating DSM docket. This program is expected to save 82,000 Megawatt hours (MWh) in its first 5 years of operation.

DBEDT reviewed utility DSM programs presented to the IRP Advisory Groups and met regularly with utility DSM planning groups to encourage the utilities to become more active in clarifying marketing programs, delivery mechanisms, evaluation, monitoring and verification of DSM programs. As one component of the comprehensive HES program, DBEDT completed a statewide assessment of DSM resource potential. As part of this effort, a DSM Measures Compendium containing descriptions of 2,001 electric and gas DSM technologies was issued. The DSM assessment concluded that there is achievable potential in the State for about 650,000 MWh of electric energy savings, 100 Megawatts (MW) of peak demand reduction and about 1,650 kilotherms (kTherms) of gas savings. This compares with an estimated maximum technical potential of 1,600,000 MWh, 290 MW and 3,600 kTherms of gas.

The assessment forecasted that in the residential sector, solar water heating was the single measure contributing the most savings by providing 21 percent of the residential electric DSM potential and 42 percent of the residential gas potential. Other substantial savings could be achieved from the installation of compact fluorescent lamps. The DSM potential within the commercial sector was not dominated by any one technology; lighting measures provided the bulk of electricity DSM potential and water heating measures all the gas DSM potential.

Energy Efficiency Performance Contracting Initiative.

Performance contracting is an arrangement in which a private company finances and installs energy efficiency building improvements for a payment that is based on future energy savings resulting from the improvements. All the project costs, including up-front engineering and construction as well as operations and maintenance, are financed by the private company. This up front financing by the private company removes lack of funds as a barrier to government agencies for energy efficiency improvements.

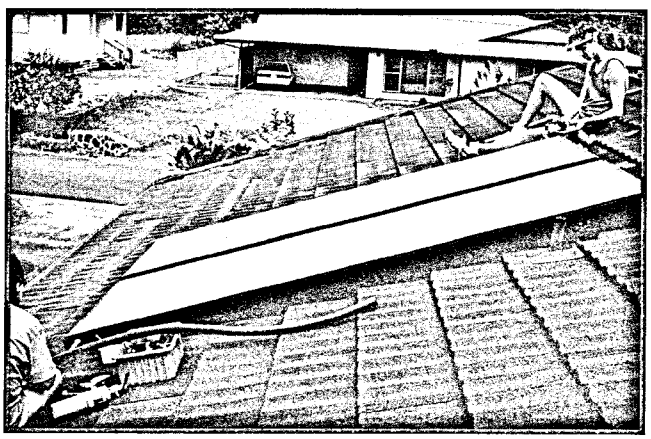
During 1994 DBEDT hired a consultant to assist with evaluation of 15 state buildings' potential for performance contracting. UH-Hilo was selected for a pilot/demonstration project since it showed a potential 10-year energy savings of over $1 million. DBEDT staff and their consultant met with the UH Procurement and Property Management Office, UH-Hilo officials and the UH community college officials to develop a request for proposals, evaluation materials and a schedule for implementing the project at UH-Hilo. At the end of 1994, seven proposals for the UH-Hilo project were being evaluated to select a contractor for the project. During 1995 DBEDT staff will monitor performance.

DBEDT plans to work with UH to issue another Request for Proposals (RFP) for performance contracting at Kauai Community College (KCC) and an RFP that bundles energy efficiency requirements for the remainder of the community colleges in 1995. Potential for performance contracting in other state buildings will also be evaluated.

Home Energy Rating Systems and Energy Efficient Mortgages; Life Cycle Cost Analysis of Water Heating Technologies for Low Income Housing.

The Energy Efficient Mortgage (EEM) Program began in 1989 to provide technical assistance to ensure that energy efficiency is considered throughout the design, financing and construction of residential projects. DBEDT's efforts led to the Federal Housing Administration's permitting Hawaii's lending institutions to increase a home buyer's qualifying ratios by one percent whenever the buyer purchases a newly constructed home with a federally approved solar water heating system. Efforts continued to encourage other lenders to follow the FHA's requirements. DBEDT continued to monitor efforts to develop national guidelines for Home Energy Rating Systems (HmERS) and to determine appropriate Hawaii standards for energy efficiency technologies.

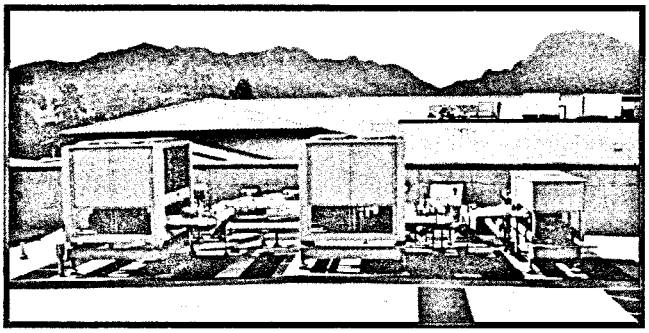
The Lihue Civic Center saved about 80,269 kWh through retrofits



RESIDENTIAL SOLAR WATER HEATING EQUIPMENT.

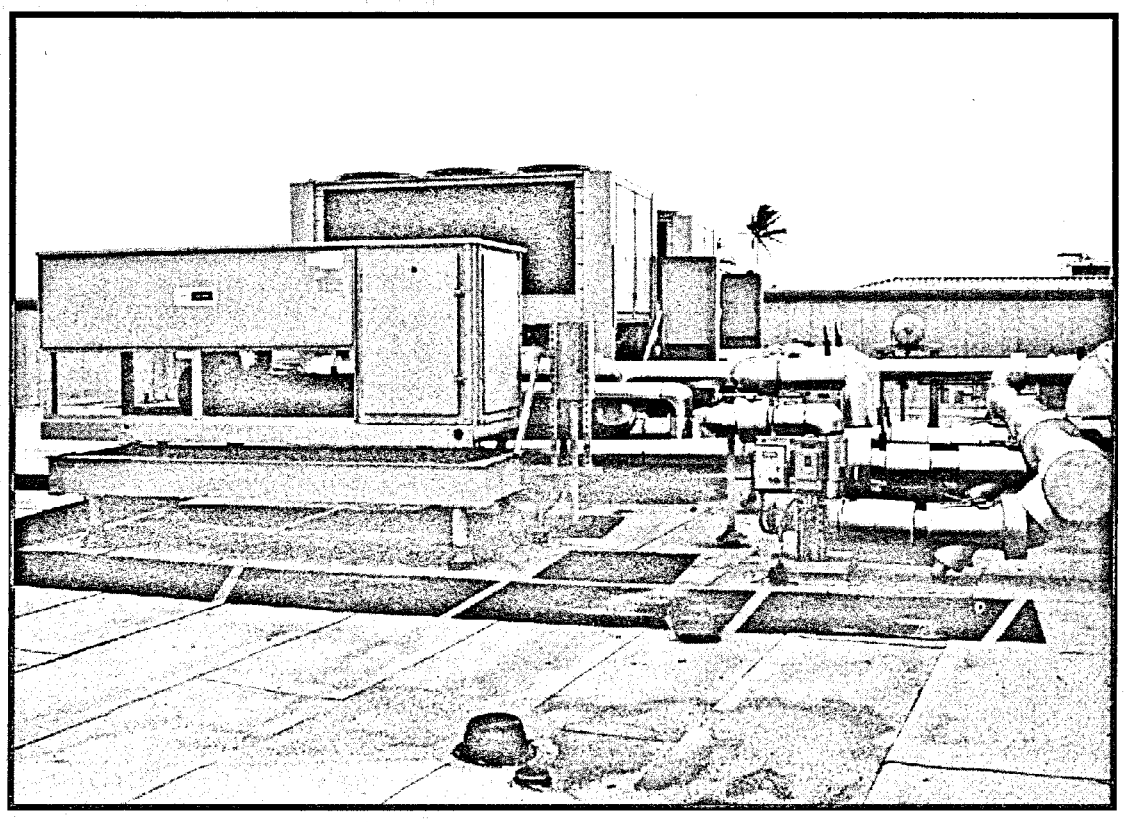
In this regard, DBEDT's support led to the passage of Act 255 by the 1992 Hawaii Legislature. This Act requires that after January 1, 1992, the Housing Finance and Development Corporation (HFDC) shall require, as a condition of approval of any residential development project constructed with state funds, located on state lands or otherwise subsidized by the state, the installation of solar water heating equipment to heat residential water according to the following percentages of units approved between 1992 and 1995: 30 percent in 1993, 40 percent in 1994 and

ABOUT 60,000 HOUSEHOLDS IN HAWAII USE SOLAR WATER HEATERS, MAKING HAWAII THE STATE WITH THE NATION'S HIGHEST PER CAPITA INSTALLATION OF THESE SOLAR DEVICES.



HFDC between 1993 and 1995. DBEDT has developed rules for alternative water heating systems, an agreement with HFDC for joint responsibilities, forms for reporting water heating usage and a database for HFDC to use for reporting purposes.

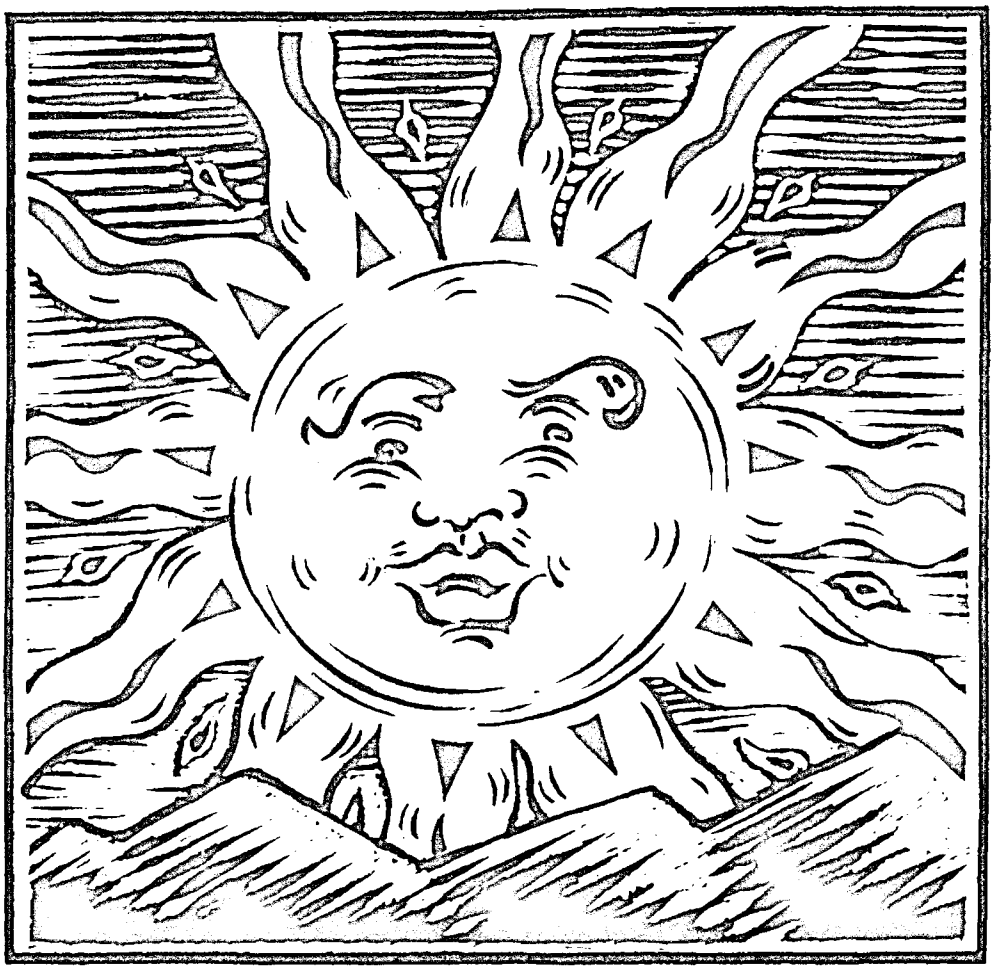
Section 102 of the National Energy Policy Act of 1992 requires that the U.S. Secretary of Energy issue voluntary guidelines for HmERS and encourage consistency with the EEM program. The DBEDT is following this effort but will wait until national ratings are established before pursuing a Hawaii program.



RETROFIT OF LIHUE CIVIC CENTER. DBEDT provided a $125,000 grant in 1993 to match $514,946 from the County of Kauai to retrofit the air-conditioning and ventilating system in the Lihue Civic Center. After a year of monitoring, the project showed a 15 percent drop in energy consumption. The savings realized during this first year of operation amounted to approximately 80,269 kilowatt hours (kWh).

(TOP AND ABOVE)
ENERGY EFFICIENT AIR-CONDITIONING AND VENTILATION SYSTEMS INSTALLED AT THE LIHUE CIVIC CENTER.

50 percent in 1995. The Act further requires that DBEDT adopt rules with respect to alternate water heating systems to be installed in the remaining units not required to have solar water heating equipment. DBEDT is required to submit a report to the Legislature in January 1996 evaluating the overall life-cycle cost as well as energy efficiency in all types of water heating systems, including solar water heating, installed by



The Sun Powers Streetlights in Kaumakani Camp.

DBEDT provided seed money to support the installation of 70 solar-powered streetlight fixtures for the Kaumakani Camp, located on the island of Kauai. Currently, the first 14 of 70 streetlights have been installed. Upon completion, Kaumakani Camp will be the first community in the state using this solar-powered technology.

Neighbor Island Energy Assistance Program.

DBEDT provided funding to the counties of Kauai and Maui for energy conservation programs on their respective islands. The program serviced single-family homeowners and small retailers, and coordinated energy conservation classes with Hawaii schools and community colleges. Additionally, the Neighbor Island offices 1) facilitated and promoted the Model Energy Code within the County; 2) implemented the provisions under Act 182, HRS, relating to the development of county emergency plans to be consistent with State Energy Emergency Plans; and 3) worked collaboratively with DBEDT, the regulated industries, conservation groups and the PUC on integrated resource planning.

DBEDT contracted with the County of Hawaii to link statewide energy-related projects for the island of Hawaii. The projects included (a) implementing IRP, (b) implementing EEP Planning, (c) promoting the adoption of the Model Energy Code, (d) coordinating Energy Audits and (e) implementing energy conservation practices within the county operations.

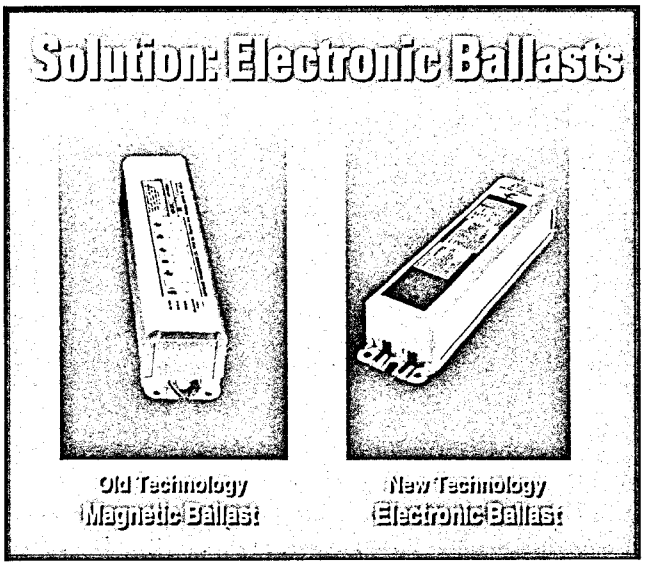
Retrofit Grants.

DBEDT provided $157,240 in energy efficient retrofit grants to Damien High School, St. John Vianney School, Maryknoll School, St. Francis School, St. Patrick's School, Hilo Hospital, St. Anthony's School, Holy Trinity School and St. Theresa School. The Institutional Conservation Program (ICP) provided these institutions with 50 percent matching federal funds to retrofit their buildings with energy-efficient lighting, cooling and other equipment. Past ICP recipients save $2 million in reduced utility bills each year.

Model Energy Code.
Act 168 became state law which mandates that the counties adopt building efficiency standards based on the American Society of Heating, Refrigerating and Air-Conditioning Engineers' Standard 90.1 by October 24, 1994. The City and County of Honolulu signed into law on October 27 Ordinance 94-75, which adopts the model energy code, excluding low-rise residences. The County of Hawaii adopted on November 23, Ordinance 94-123. The Hawaii County ordinance also incorporated the Model Energy Code (MEC) except for low-rise residences. The Counties of Kauai and Maui are expected to consider similar legislation in 1995. All measures are based on cost-effectiveness. The potential savings are tremendous: 20 years after statewide adoption, the MEC could provide energy savings large enough to power more than 28,500 homes a year; Hawaii will have avoided consumption of more than 4 million barrels of oil which would have cost consumers about $241 million; and it will reduce the need to build an additional 50 MW of peak electrical generating capacity.

In the more than 15 years since adoption of prior energy codes, appliances and equipment such as water heaters, lights and air conditioners have become far more efficient; better ways have been found of constructing buildings to take advantage of natural cooling, heating and lighting; and better materials have been found to make buildings more energy efficient. In addition, professionals have learned how to design energy-using systems so that they operate much more efficiently.

ELECTRONIC BALLASTS RUN FLUORESCENT LAMPS WITH FAR LESS ELECTRICITY THAN MAGNETIC BALLASTS. THEY ALSO ELIMINATE THE PROBLEMS OF LAMP FLICKER AND BALLAST HUM, AND PRODUCE ALMOST NO HEAT.



DBEDT provided $157,240 in energy efficient retrofit grants

THE MODEL ENERGY CODE IS BASED ON ECONOMICS. CODE MEASURES ARE QUICKLY PAID BACK THROUGH ENERGY SAVINGS.

More than 60 percent of the petroleum used in Hawaii is used by the transportation sector. Reducing transportation energy demand and developing alternative transportation fuels will significantly impact petroleum products usage.

TRANSPORTATION

Transportation fuels development and demand projections must be integrated with efforts to conserve fuels use and reduce the demand. This coordinated approach is at the heart of the development of a transportation energy strategy for the state.

Alternative modes of ground transportation such as walking, bicycling, riding buses and vanpooling help save energy and reduce traffic congestion, delays and air pollution. DBEDT has worked with a variety of state, county and private agencies to find and support ways of saving energy and reducing traffic congestion.

SEVERAL THINGS TO CONSIDER WHEN COMPARING ALTERNATIVE FUELS:

- SOCIETAL IMPACT
- ENERGY SECURITY
- THE ENVIRONMENT
- ENERGY DENSITY
- PERFORMANCE
- AVAILABILITY

DBEDT, along with nine other organizations, has joined and endorsed the program for the City & County of Honolulu through a Memorandum of Understanding (MOU). The MOU is a formal, non-binding statement of the signees' commitment to achieve the program goals: 1) developing local industry and creating an alternative-fuel related industry; 2) developing reasonable costing alternative fuels and supporting infrastructure; 3) reducing operation and maintenance cost of vehicles; 4) reducing state and national dependence on imported petroleum for transportation fuel; 5) reducing air pollution caused by transportation fuel; 6) maintaining records and statistics of alternative fuel vehicles to determine best fuel, vehicle and task fit; 7) educating participating members, as well as the public, on alternative fuels and alternative fuel vehicles and technology; and 8) promoting efficient management and maximum utilization of existing local energy resources. The participating organizations include the U.S. General Services Administration, the USDOE, the City & County of Honolulu, the Honolulu Public Transit Authority, HECO, GASCO, HNEI, PICHTR and U.S. Electricar.

More than 60% of Hawaii's petroleum is used for transportation

CLEAN CITIES.

The Clean Cities Program is a nation-wide program designed to promote the use of alternative fuel vehicles (AFVs) in urban communities and to provide refueling and maintenance facilities for their operation. Coordinated by the USDOE, the program encourages local governments and organizations to form partnerships in developing markets for AFVs.

Thirty cities have been designated or are currently seeking designation from the USDOE as "Clean Cities."

ALTERNATE TRANSPORTATION FUELS.

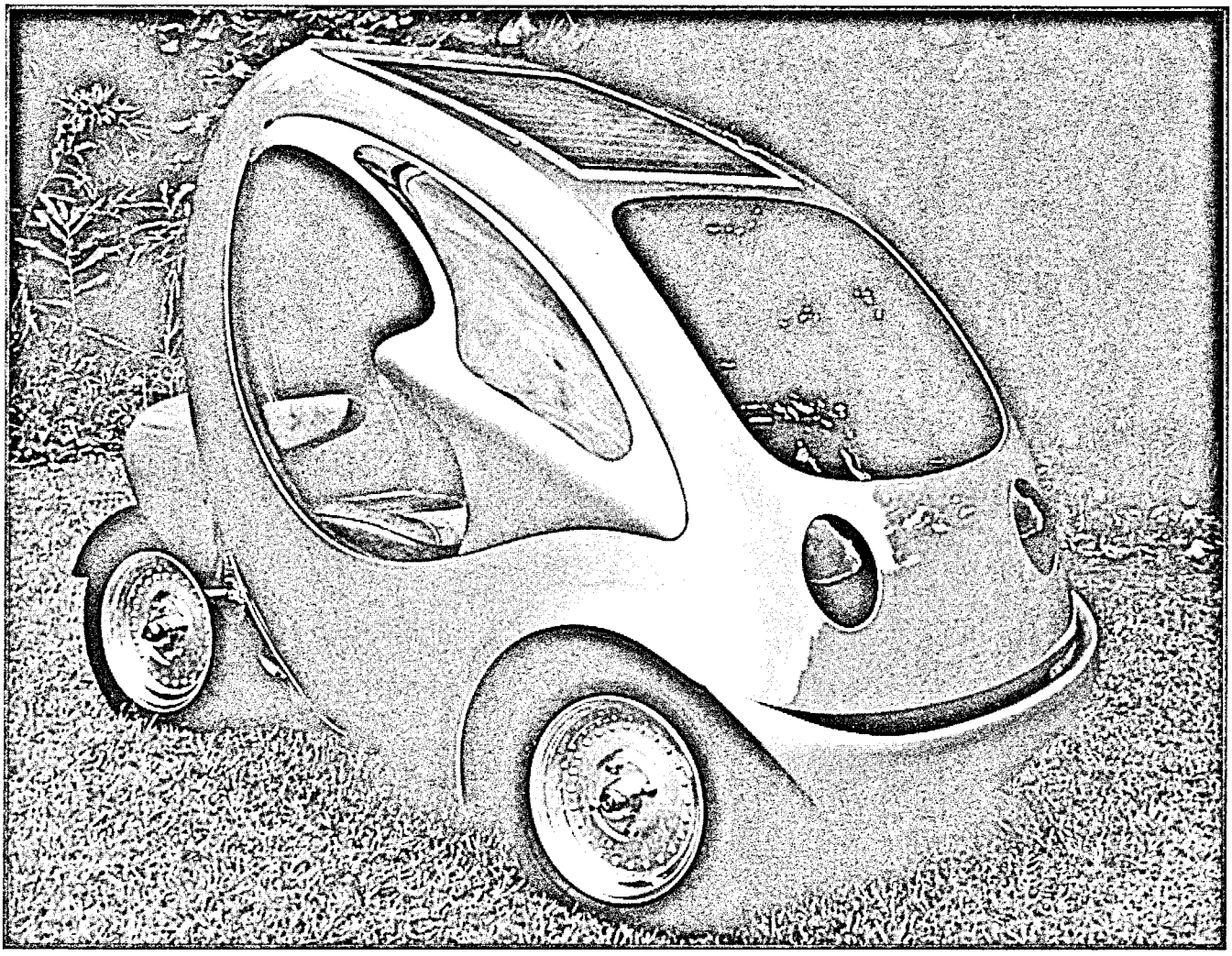
Federal support for alternative transportation fuels, combined with private sector and local interest and support, have fueled several joint public/private transportation energy projects with potential to provide, clean renewable fuels and energy sources for vehicles.

Alternative Fuels in Fleets.

A Federal law passed in 1992 requires Federal, State, county and private fleets to purchase alternative-fueled vehicles. Federal fleets in Hawaii are already operating a number of alternative fuel vehicles.

Hawaii Electric Vehicle Demonstration Project.

On August 18, 1993, the Federal Advanced Research Projects Agency awarded a $5 million grant to the State's High Technology Development Corporation (HTDC) to conduct a two-year electric vehicle demonstration program. The Federal funds are to be matched by $6.5 million from members of the Hawaii Consortium. The program will demonstrate electric vehicles' workability in Hawaii's favorable weather and short commuting distances. The Consortium consists of: HTDC and its parent agency, DBEDT; Hughes Power Control Systems; EML/Kaman Corporation; Solar Electric Engineering; Suntera Corporation; Electric Power Technology, Inc.; HECO and its subsidiaries; KE; the UH; the City & County of Honolulu; the County of Kauai; KCC and the Pacific Missile Range Facility. Vehicles include buses, sedans, station wagons and pickup trucks. Each is equipped with data acquisition devices to monitor performance.



SUNTERA CORPORATION'S ELECTRIC-POWERED "SUNRAY" CAN AVERAGE 100 MILES BETWEEN CHARGES, HAS A TOP SPEED OF 55 MPH AND HAS A LIFE EXPECTANCY OF ABOUT 20-30 YEARS.

In model year 1996, for affected State agency fleets, 10 percent of new vehicles purchased must be alternative-fueled; in 1997, 15 percent; in 1998, 25 percent; in 1999, 50 percent; and 75 percent in model years 2000 and thereafter. DBEDT will provide information on alternative fuels and vehicles and coordinate assistance to affected fleets.

HAWAII'S M85 VARIABLE-FUELED DEMONSTRATION VEHICLE.

The Suntera Corporation, a company located on the Island of Hawaii, is currently building five composite-body electric vehicles for the program.

Another of the program's highlights is the world's largest electrically powered transit bus, a 40-foot vehicle using an adaptation of a motor developed for an electric-powered Army tank. The electric bus was built by EML/Kaman for the City & County of Honolulu.

In addition, the demonstration project established a conversion, service and maintenance center in Honolulu's Kakaako district where operators and conversion personnel are being trained. Pickup trucks and sedans provided by Solar Electric Engineering are being converted to run on electricity at the center.

SUSTAINABLE BIOMASS ENERGY PROGRAM.
DBEDT participated in three projects funded by the USDOE, with support from state and private organizations, which evaluated the feasibility and best approach to using crops and agricultural lands for the production of energy and fuels. Each project focused on a specific area within the state, but the results are applicable statewide.

ETHANOL PRODUCTION TECHNOLOGY EVALUATION.
DBEDT continued to sponsor an evaluation of optimal processes, feedstocks and current technology. The feedstocks of particular interest are sugarcane, grass and tree trimmings, mixed waste paper and food waste.

ETHANOL BLENDS.
A blend of 10 percent ethanol and 90 percent gasoline may be used in gasoline-powered vehicles without any vehicle modifications. This ethanol blend is considered an "oxygenated fuel" and is currently being marketed in 44 other states as a mid-grade or premium gasoline. Ethanol can be

made in Hawaii from locally-available materials and agricultural products such as sugarcane. Act 199 of the 1994 legislative session provided the Director of DBEDT with the authority to mandate the use of ethanol in gasoline beginning in 1996.

ALCOHOL FUELED VEHICLE DEMONSTRATIONS. DBEDT continued its participation in a demonstration involving flexible-fueled vehicles capable of operating on M85 (85 percent methanol plus 15 percent gasoline), gasoline alone or any mixture of the two. Alcohol-fueled vehicles could operate on locally-produced alcohol fuels.

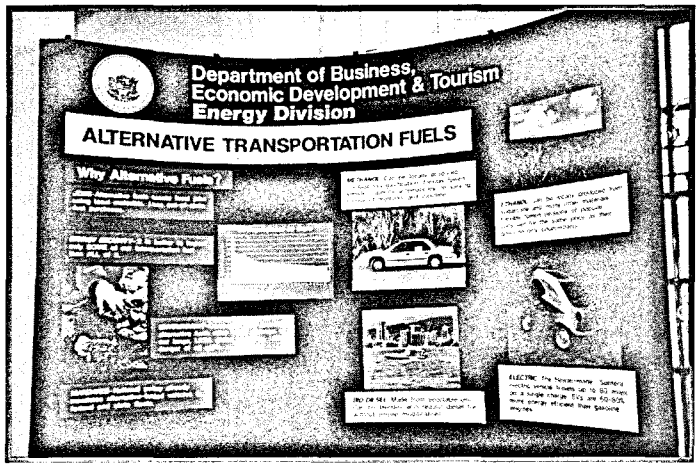
Through the Oahu Metropolitan Planning Organization, DBEDT continued to provide technical assistance on two transportation planning task forces – the Oahu Regional Transportation Plan Committee and the Model Development Task Force – and assisted in the evaluation of energy impacts of transportation plan alternatives.

[1] U.S. Department of Transportation, A Summary: Intermodal Surface Transportation Efficiency Act of 1991. FHWA-PL-92-008.

Alcohol-fueled vehicles could operate on locally-produced fuels

OAHU METROPOLITAN PLANNING ORGANIZATION.
Due to the U. S. Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA), transportation planners are faced with new requirements for performing evaluations, including evaluations of energy impacts, which were not previously required. ISTEA has as its stated purpose:

> *"to develop a National Intermodal Transportation System that is economically efficient, environmentally sound, provides the foundation for the Nation to compete in the global economy and will move people and goods in an energy efficient manner."*[1]



DBEDT'S ALTERNATIVE TRANSPORTATION FUELS EXHIBITION DISPLAY.

ETHANOL = A COLORLESS LIQUID THAT BURNS WITH A PALE FLAME, PRODUCING WATER AND CARBON DIOXIDE. IT CAN BE MADE FROM HYDROCARBONS SUCH AS AGRICULTURAL RESIDUE.

DBEDT continued a strong program of community outreach and education to increase public awareness of the state's over-dependence on imported fossil fuels, the need to conserve energy and the importance of developing the renewable/sustainable energy resources and technologies for Hawaii. The program actively involved Hawaii's communities, schools, businesses and residents of all ages. Exhibitions, contests, workshops, educational programs and publications helped extend energy knowledge to all segments of the state and engage participants in energy education activities.

COMMUNICATION AND EDUCATION

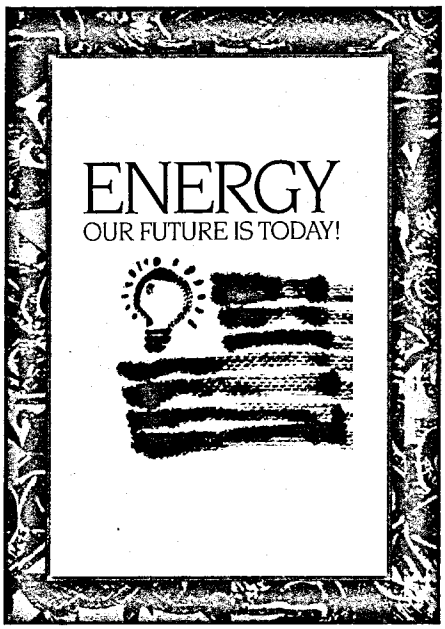
STATEWIDE SCHOOL POSTER CONTEST ON ENERGY AND HAWAII ENERGY TIDE CALENDAR.

DBEDT sponsored and coordinated its annual Statewide Poster Contest on Energy which included artwork entries from public and private school students throughout the state. The purpose of the contest was to increase student and public awareness of Hawaii's urgent need to reduce its dependence on imported oil and to show how the wise use of energy and care for our fragile environment go hand-in-hand. The contest was co-sponsored by Aloha Airlines, Bank of Hawaii, Island Television KITV-4, Town & Country Surf Designs and DBEDT. DBEDT received about 1,000 posters from 252 teachers and 96 schools. The 13 student winners were honored in a ceremony with the Governor on May 24. Each student received a Certificate of Excellence signed by the Governor, a $100 U.S. Savings Bond from Bank of Hawaii and a $50 merchandise certificate from Town & Country Surf Designs. Each Neighbor Island student winner and their accompanying parent/guardian received round-trip air transportation from Aloha Airlines to attend the ceremony.

The poster contest drew 1,000 entries from 96 schools statewide

ENERGY AWARENESS MONTH.

By gubernatorial proclamation, October was "Energy Awareness Month in Hawaii." DBEDT informed the public about numerous events through news releases and articles in various local news media. Activities included tours of power plants, exhibitions and presentations. One of the more visible events was a two-day Energy Awareness Month Exhibition at Ala Moana Center.



DBEDT sponsored and coordinated the exhibition which hosted 13 exhibitors and reached over 2,100 consumers. DBEDT distributed more than 7,000 energy-related publications and 5,300 promotional items during the two-day exhibition.

The winning entries were used in a 30-second commercial produced by Island Television KITV-4 for its Earthday, Everyday Program. The entries were also displayed at Pearlridge Center, Windward Mall and at Kahala Mall. The 13 winning posters are featured in the colorful 1995 Hawaii Energy Tide Calendar, another DBEDT educational publication.

GREAT HAWAIIAN ENERGY CHALLENGE.

DBEDT revised its home energy conservation activity which was first provided to Hawaii public schools in 1991. Entitled "The Great Hawaiian Energy Challenge" (GHEC), it included an information sheet on energy, ways to save energy and an energy checklist assignment for students to complete at home. Upon completing the assignment, each student received a coupon for a free order of fries, compliments of McDonald's Restaurants of Hawaii.

The 1994 version of GHEC was sent to Hawaii public school fourth graders. About 2,896 students participated, including 129 of 190 fourth grade classrooms. Teachers' evaluations of the project were positive with nearly every teacher requesting that the activity be continued.

Mini-Solar Vehicle Project.

DBEDT co-sponsored with the Hawaii Department of Education (DEduc) a statewide program for Hawaii public intermediate and high school students to design, build and demonstrate model solar-powered vehicles. The goal of the 1993-1994 Mini-Solar Vehicle Project was to use photovoltaic cells to produce a radio-controlled, small-scale, solar-powered vehicle through teamwork and the integration of science, technology, math, language arts, and vocational and environmental education. A project notebook documenting the planning and building process, technical report, school and community involvement, educational outreach activities, financial records and evaluation were an integral part of the requirements.

Six intermediate and 19 high schools participated in the two-day, third annual Performance Meet held in April at the Neal Blaisdell Center. At the meet each team's documentation and vehicle were evaluated. The vehicles performed in a variety of events to display their efficiency, power and maneuverability, including wind tunnel, dynamometer, road, speed and ramp tests.

National Energy Education Development Project.

DBEDT continued to bring the National Energy Education Development Project (NEED) to Hawaii's schools. NEED is a national network of educators, students and leaders in industry, government and the community committed to increasing and enhancing energy education in the nation's schools. Using an interdisciplinary approach, the NEED program utilizes peer teaching to develop student leadership and communication skills, project planning, energy education and self-evaluation methods. As a consequence of NEED in the classroom, 15 student-initiated energy and environmental education workshops, presentations and projects were accomplished during 1994.

Energy Youth Awards.

A team of McKinley High School students and teachers won the DBEDT-sponsored Hawaii Energy Youth Awards program for their outstanding series of 11 energy and environmental education projects. As a result, they represented the state at the national NEED 14th Annual Youth Awards Program for Energy Achievement held in Washington, D.C. During the awards ceremony, their accomplishments were recognized and the team placed as one of three finalists in the Senior Level School of the Year category.

(left to right) Kihei Elementary first grader Marie Janiszewski shows off her winning poster design at the Governor's Office while Vaa Moeone and Garett Wachi of Kailua High School demonstrate NEED activities at the annual Energy Awareness Month Exhibition.

Power Trek '94.

DBEDT sponsored and coordinated with the DEduc Power Trek '94, a six-day energy and environmental leadership training conference. The conference was held from August 20-25, 1994, at Camp Timberline on the Island of Oahu.

Utilizing information, materials and activities from NEED and other resources, student and teacher teams were trained to teach the 10 sources of energy, the importance of energy conservation and efficiency, renewable energy resources, solid waste management and environmental issues. The focus of the conference was on the relationship of the built and natural environments, and the importance of being actively involved in planning community developments.

Field trips allowed delegates to experience developed areas and the needs and effects of the built environment: a desalinization plant, Ko Olina Beach, AES Barbers Point coal plant, H-POWER and Waimanalo Gulch Sanitary Landfill. The visit to the James Campbell Building showed how buildings and communities can be designed to be energy efficient, environmentally friendly and esthetically pleasing. Natural environment field trips took delegates to the Campbell Industrial Park sink holes, Cultural Learning Center at Kaala, Honouliuli Contour Trail and the Palehua-Palekea Trail.

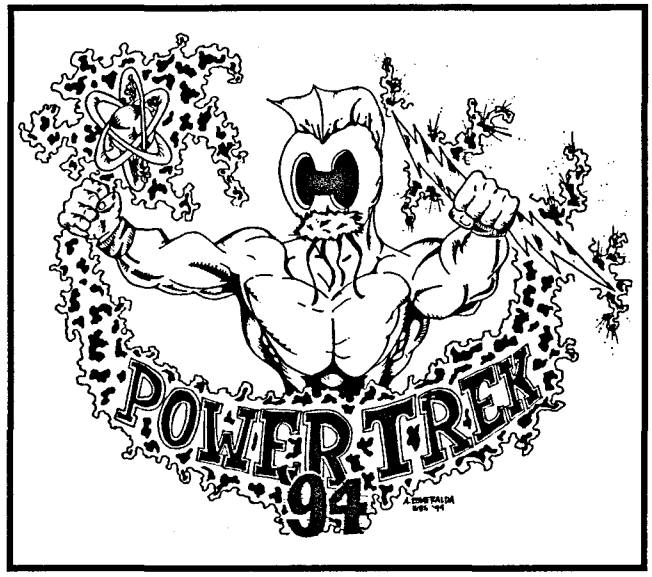
The 65 delegates, staff and junior staff also developed leadership and communication skills and prepared plans for teaching others what they learned. Ideas and planning for workshops and projects for the coming school year were initiated at Power Trek. Participants were from the islands of Hawaii, Kauai, Maui, Oahu and Rota (Commonwealth of the Northern Mariana Islands). Two staff and two junior staff members from the State of Nevada assisted DBEDT at Power Trek.

Teacher and Student Education.

A continuing goal of DBEDT and the three Neighbor Island Energy Extension Service offices is to provide teachers and students with energy information they can use in their daily lives and teach to others. An extension of this goal is to have teachers integrate energy education with their classroom curriculum. At the request of teachers, presentations were made to students on a variety of energy topics.

Some of the workshops and presentations used activities, information and materials from the NEED project. The workshops and presentations educate students and teachers about energy and help empower students to become peer teachers and leaders in the field of energy. In addition to the energy and environmental education projects mentioned above, presentations and exhibitions by DBEDT staff resulted in the distribution of over 95,000 publications and 13,000 promotional items. This translated to an outreach to over 20,000 people.

A three-credit, two-week course entitled, "Energy Education for a Sustainable Future," was conducted by DBEDT staff in June. Twenty-one elementary level teachers learned about Hawaii's energy situation, electricity generation, fossil fuels, renewable energy resources, energy conservation, waste management, water management, IRP and DSM. The teachers visited the facilities at HECO, Chevron refinery, H-POWER, MUPC and the Honolulu Board of Water Supply. They also visited a PV-powered home and a watercress farm fed by artesian springs.



THE ABOVE GRAPHIC, CREATED BY WAIPAHU HIGH SCHOOL JUNIOR AILEEN ESMERALDA, WAS FEATURED AS THE POWER TREK '94 CONFERENCE T-SHIRT DESIGN.

Non-Credit Energy Courses.

The College of Continuing Education and Community Service at UH-Hilo was contracted by DBEDT to assist and co-sponsor a series of energy-related classes. A DBEDT-HEES staff member coordinated and designed the classes which included topics on solar water heating and residential photovoltaic energy systems.

In 1994, DBEDT distributed over 95,000 publications statewide

A "Fun in the Sun" course for educators was conducted by the DBEDT-Hawaii Energy Extension Service Office (DBEDT-HEES) on Kauai, in cooperation with the Kauai Energy Extension Service Office and UH-Manoa. This one-credit course focused on how solar energy works and ways to use the sun to enrich classroom science activities relating to heat and electricity. The participating teachers received hands-on experience with working solar devices and participated in energy games, songs and other exercises.

Resource Teacher Position.

DBEDT continued to fund a resource teacher to serve as a liaison between DBEDT and DEduc to assist with the various DBEDT energy education projects such as Power Trek '94 and school presentations and workshops. The teacher also assisted with coordinating the Mini-Solar Vehicle Project, DBEDT's Statewide Poster Contest on Energy, DBEDT's Hawaii Energy Tide Calendar, the GHEC Worksheet and other energy-related projects with DEduc.

Curriculum Development.

DBEDT continued the development of a statewide energy education program for teachers in grades three through six. The goal is to make students more aware of their energy use and the energy use of others, help them realize the importance of wise energy use and development and to spur them to actively participate in ways to make the State more energy independent.

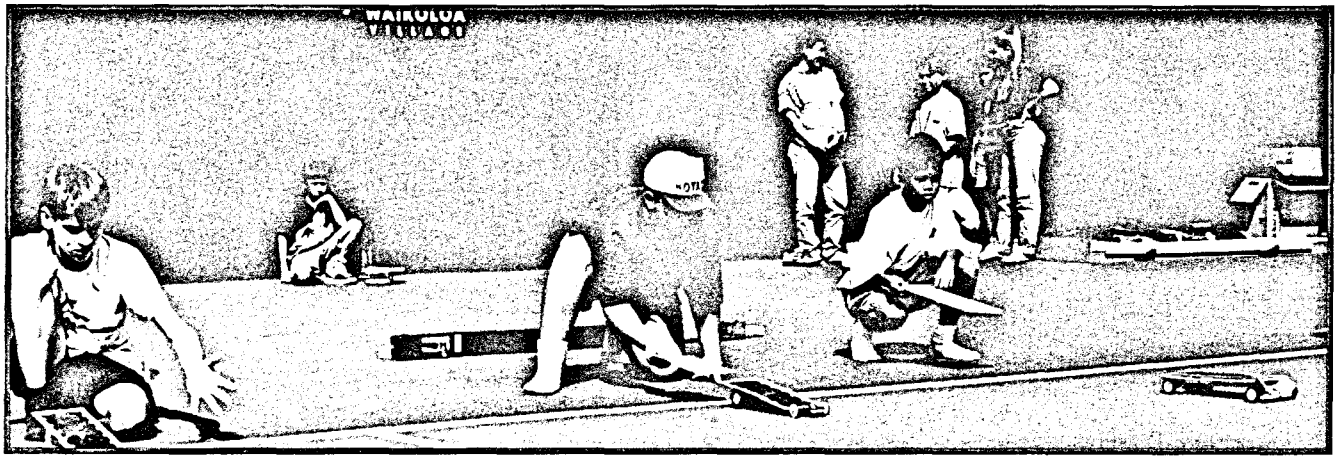
Hawaii Science Bowl.

The First Annual Hawaii Science Bowl, co-sponsored by DBEDT, was held on March 12, 1994, at the Honolulu Community College. The competition showcased high school student teams displaying their knowledge and skills in science, technology and energy. Twelve Hawaii high schools participated in the dual round-robin event. Punahou Academy won the competition and became the state representative at the USDOE's National Science Bowl, which was held in Washington, D.C., April 24-25, 1994.

Renewable Energy focused on the Pacific Region and included participation from the Pacific Island Territories. Over 4,500 DBEDT publications and 2,400 promotional items were distributed to more than 1,200 conference attendees visiting from Africa, Asia, Australia, Europe, the Pacific Island Territories and the Americas.

Awards for DBEDT's Energy Communications.

DBEDT's "The Great Hawaiian Energy Challenge" series of video public service announcements (PSA) received third place honors in the audio/visual category at the 1994 National Network of Energy & Education Professionals Conference. The PSAs focused on Hawaii's dependency on oil for energy needs, promoted energy conservation/efficiency practices, emphasized the urgent need to further develop our renewable energy resources and addressed the environmental implications of the State's continued dependence on imported oil.



Students prepare their solar-powered cars for a race in the Junior Solar Sprint. The Sprint was part of a solar mini-vehicle demonstration held at the First World Conference on Photovoltaic Energy Conversion.

World Conference on Photovoltaic Energy Conversion.

DBEDT participated in and helped coordinate the exposition portion of the First World Conference on Photovoltaic Energy Conversion at the Hilton Waikoloa Village, December 4-9, 1994. The conference, organized by the Institute of Electronic and Electrical Engineers, was designed to provide an international forum for scientists, engineers, government and industry leaders, educators and others involved in the research, development and application of photovoltaic power. DBEDT and DEduc conducted a solar mini-vehicle demonstration in which 10 high schools displayed their PV cars in road, speed, ramp and trailer pull tests. DBEDT also participated as an exhibitor with display information on energy conservation and alternative transportation fuels. In addition, a Photovoltaic Applications Workshop and a Forum on

Transitions Newsletter.

Transitions publicizes energy-related events and issues in Hawaii and provides practical information on successful energy projects that are applicable to the needs of Hawaii and the Pacific region. Its purpose is to develop an energy-literate citizenry able to understand and support state energy initiatives and to encourage energy diversification in Hawaii and throughout the Pacific.

Transitions targets decision-makers, energy professionals, energy innovators, educators and the general public. While 85 percent of its readers are Hawaii residents, Transition's readership reaches the U.S. Mainland and foreign countries.

In 1994 four quarterly issues were published and marked the newsletter's 12th anniversary. Most of the articles were written by DBEDT staff. The current mailing list is approximately 5,700.

Hawaii is extremely vulnerable to both economic changes and shortage problems affecting petroleum supplies because of its geographical isolation. Petroleum cartels, politically unstable petroleum producing countries and economic fluctuations can affect the cost and supply of petroleum to the state.

ENERGY EMERGENCY PREPAREDNESS

A critical part of DBEDT's contingency planning is to deal quickly and effectively with supply disruptions. DBEDT's biennial energy emergency planning involves coordinating, reviewing and updating state and county plans in conjunction with the State Civil Defense, the Federal Response Plan, the military and private industry.

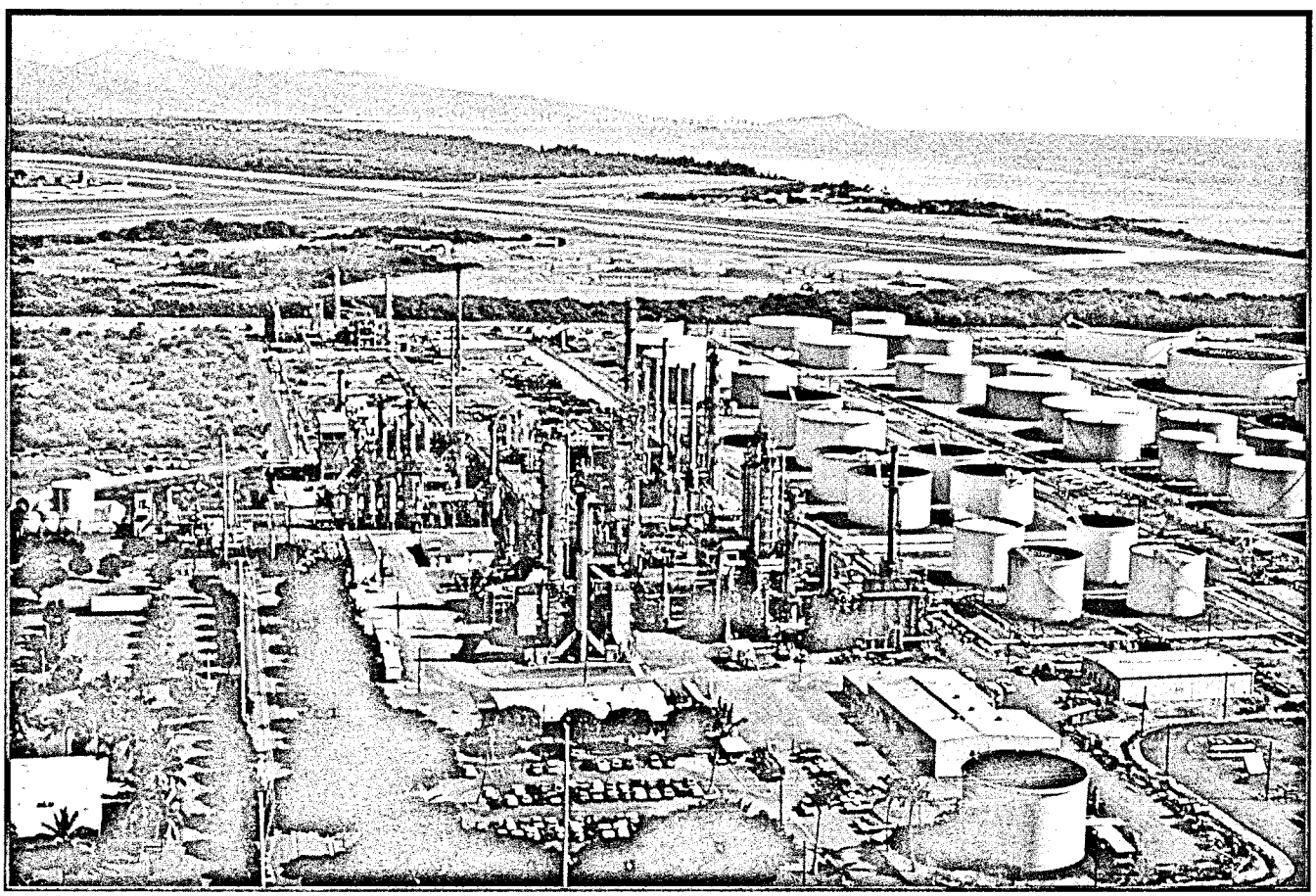
IN 1992, HAWAII RANKED HIGHEST AMONG ALL THE STATES IN TERMS OF PETROLEUM DEPENDENCE (90.4 PERCENT).

DBEDT provides principal EEP staff support to the Governor and the Energy Resources Coordinator to fulfill their statutory responsibilities to ensure effective planning and preparedness for and timely and effective response to any energy emergency, irrespective of cause. Since 1988, the State has strongly supported the revitalization and continual improvement of the state's EEP program. Specific accomplishments include:

- Revision of Hawaii's EEP statute – Chapter 125C, HRS, by Act 59, SLH 1994, through an Administration initiative, to incorporate aviation fuels into the State's Emergency Fuel Set-Aside Program. It is believed that Hawaii is the only state that includes aviation fuels in its set-aside program.

- Developed and conducted an energy emergency simulation in May 1994. An industry/government exercise design committee included participants from energy utilities, petroleum refiners and distributors, and emergency managers from federal, state and local governments.

- Currently conducting a statewide energy vulnerability assessment as Project 6 of the Hawaii Energy Strategy Program. This project is assessing energy infrastructure (electricity, oil and gas) to determine its vulnerability to damage from natural disasters. The project is also reviewing public and private energy emergency plans to identify areas for improvement. This project is being funded by a Federal Emergency Management Agency grant of $100,000 with an equal state match.



PICTURED HERE IS ONE OF HAWAII'S TWO OIL REFINERIES LOCATED AT CAMPBELL INDUSTRIAL PARK ON THE ISLAND OF OAHU.

Regional Petroleum Reserve.
For nearly 20 years, Hawaii has urged that the Federal government establish a 10-million barrel RPR, or 90-day supply, in Hawaii, as required by the U.S. Energy Policy and Conservation Act of 1975. The state has secured commitments from HECO and the military for the use of over a million barrels of storage declared surplus to operational needs; however, these facilities require at least $34.6 million to restore them to full service. Further, the current Federal administration continues to oppose the establishment of RPRs.

As an interim alternative to an RPR, the State has provided analytical support on this issue to the Congressional Delegation, especially Senator Daniel Akaka who introduced the 1994 Emergency Petroleum Supply Act. Although not adopted in 1994, it is anticipated that this measure will be reintroduced in the 1995 Congress to recognize Hawaii's unique vulnerability by permitting the state to obtain guaranteed access to and priority loading of oil from the U.S. Strategic Petroleum Reserve in the event of a Presidential drawdown, such as was conducted during the Persian Gulf crisis of 1990-91.

Energy Emergency Infrastructure Data Entry & Maintenance on State Civil Defense Computerized Geographic Information System.
In cooperation with State Civil Defense (CD), DBEDT has assumed responsibility for data entry and maintenance for energy emergency infrastructure data on CD's geographic information system, a computerized mapping system used for emergency management. DBEDT has also completed entry of statewide service station data (e.g., name, address, exact location on map, fuel storage capacity by fuel type, etc.) and plans to update all bulk fuel storage and distribution data next. Additionally, DBEDT has created a statewide service station database for ease of identifying and sorting service station data by supplier, island, fuel type sold, etc., to be used during energy emergencies or other energy program activities.

Critical to contingency planning is dealing with supply disruptions

Appendices

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WORLD ENERGY RESERVES AND RESOURCES

Estimates of the future availability of world crude oil and natural gas are based upon current estimates of world reserves and resources. Reserves as commonly defined are the "Proven Reserves," oil and natural gas that is known with a good degree of certainty to exist and can be recovered under present economic, operating and technical conditions. Resources are undiscovered recoverable oil and gas resources thought to exist in geologic strata favorable for crude oil extraction.

Because these data are based upon estimation and judgment, large shifts in these estimates occur as experts modify their estimates.

Estimates of world crude oil and natural gas reserves in 1993 and published in *Oil & Gas Journal* reveal the following: [1]

Estimated world crude oil reserves increased marginally during 1993. Average oil production declined by 0.06 percent from 1992's average to 59.6 million barrels per day (b/d).

Nineteen ninety-three brought large production declines in the United States and Commonwealth of Independent States (CIS) and other former members of the old Soviet Union. The United States production dropped by 275,000 b/d to a yearly average of 6.9 million b/d in a trend not likely to be reserved under current Federal leasing policies. CIS output fell by 1.1 million b/d to an estimated 7.8 million b/d.

The Organization of Petroleum Exporting Countries (OPEC) control 77 percent of the world's crude oil reserves. The Western Hemisphere controls 15 percent and Western Europe only 2 percent. Also in 1993, the United States, Mexico and Pakistan experienced large oil reserve declines. The United States oil reserves fell by 937 million barrels (bbl), Mexico's reserves by 373 million bbl and Pakistan's by 209 bbl.

A disparity in ratios of oil reserves to production shows where most future output growth will occur: OPEC and the Middle East. OPEC's collective reserve/production ratio is 86 years compared with the world's ratio of 46 years. The higher reserve/production ratio indicates greater potential for development.

[1] Data published in *Oil & Gas Journal*, December 27, 1993.

WORLD CRUDE OIL & NATURAL GAS RESERVES: JAN. 1, 1994

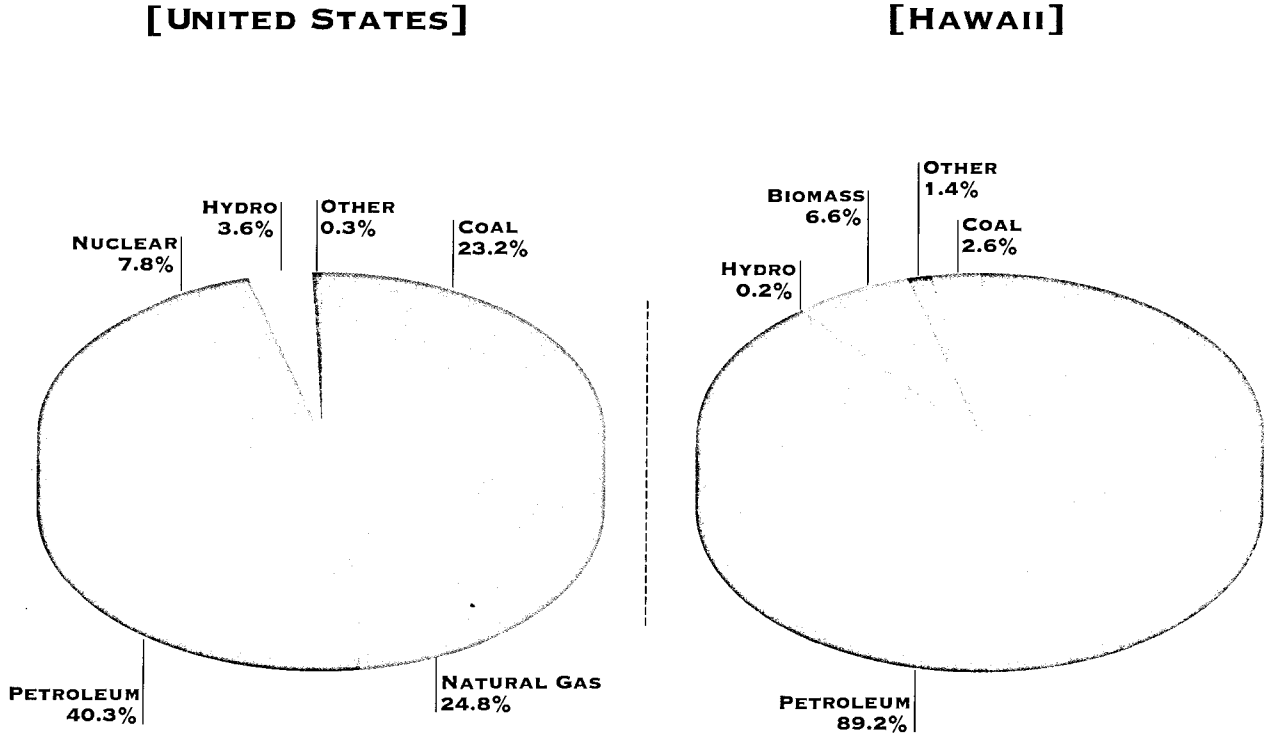
Country or Region	Crude Oil (Billion bbl)	Percent	Natural Gas (Tril cu ft)	Percent
North America	**79.7**	**7.98**	**330.8**	**6.59**
Canada	5.1	0.50	94.8	1.89
Mexico	50.9	5.10	71.0	1.41
USA	23.7	2.38	165.0	3.29
Central & S. America	**74.0**	**7.42**	**197.5**	**3.94**
Venezuela	63.3	6.34	128.9	2.57
Other	10.7	1.08	68.6	1.37
West Europe and North Sea	**16.6**	**1.67**	**191.1**	**3.81**
Mid East	**662.9**	**66.34**	**1,581.0**	**31.52**
Abu Dhabi	92.2	9.23	188.4	3.76
Iran	92.9	9.29	730.0	14.55
Iraq	100.0	10.01	109.5	2.18
Kuwait	94.0	9.41	52.4	1.04
Saudi Arabia	258.7	25.89	185.4	3.70
Other	25.1	2.51	315.3	6.29
Africa	**62.0**	**6.20**	**343.5**	**6.85**
Libya	22.8	2.28	45.8	0.91
Nigeria	17.9	1.79	120.0	2.39
Other	21.3	2.13	177.7	3.55
Far East, Oceania	**20.6**	**2.07**	**295.5**	**5.89**
India	5.9	0.59	25.4	0.51
Indonesia	5.8	0.58	64.4	1.28
Malaysia	4.3	0.43	76.7	1.53
Other	4.6	0.47	129.1	2.57
E. Europe, China, Other Communist Areas	**83.2**	**8.32**	**2,076.8**	**41.40**
Former USSR	57.0	5.70	1,997.0	39.81
China	24.0	2.40	59.0	1.18
Other	2.2	0.22	20.8	0.41
Total OPEC	**772.1**	**77.28**	**2,020.4**	**40.28**
World Total	**999.0**	**100.00**	**5,016.2**	**100.00**

Source: *Oil & Gas Journal*, December 23, 1993.

NATION AND HAWAII

In 1993, the United States as a whole depended upon petroleum for about 40 percent of its energy needs, proportionately about the same as the previous year. Coal and natural gas supplied approximately 23 and 25 percent respectively. Nuclear supplied almost 8 percent and hydroelectricity 4 percent. In addition, wind, geothermal, biomass and other energy sources accounted for less than 1 percent.

In contrast to the national average, Hawaii in 1993 depended upon petroleum for almost 90 percent of its energy needs. Biomass, from the sugar plantations along with municipal solid waste from H-POWER, was used to produce electricity in excess of 6 percent. Coal, solar water heating, hydroelectricity, wind and geothermal made up the balance contributing about 4 percent.



PRIMARY ENERGY CONSUMPTION • UNITED STATES & HAWAII • 1993

PERCENTAGE BY ENERGY SOURCE

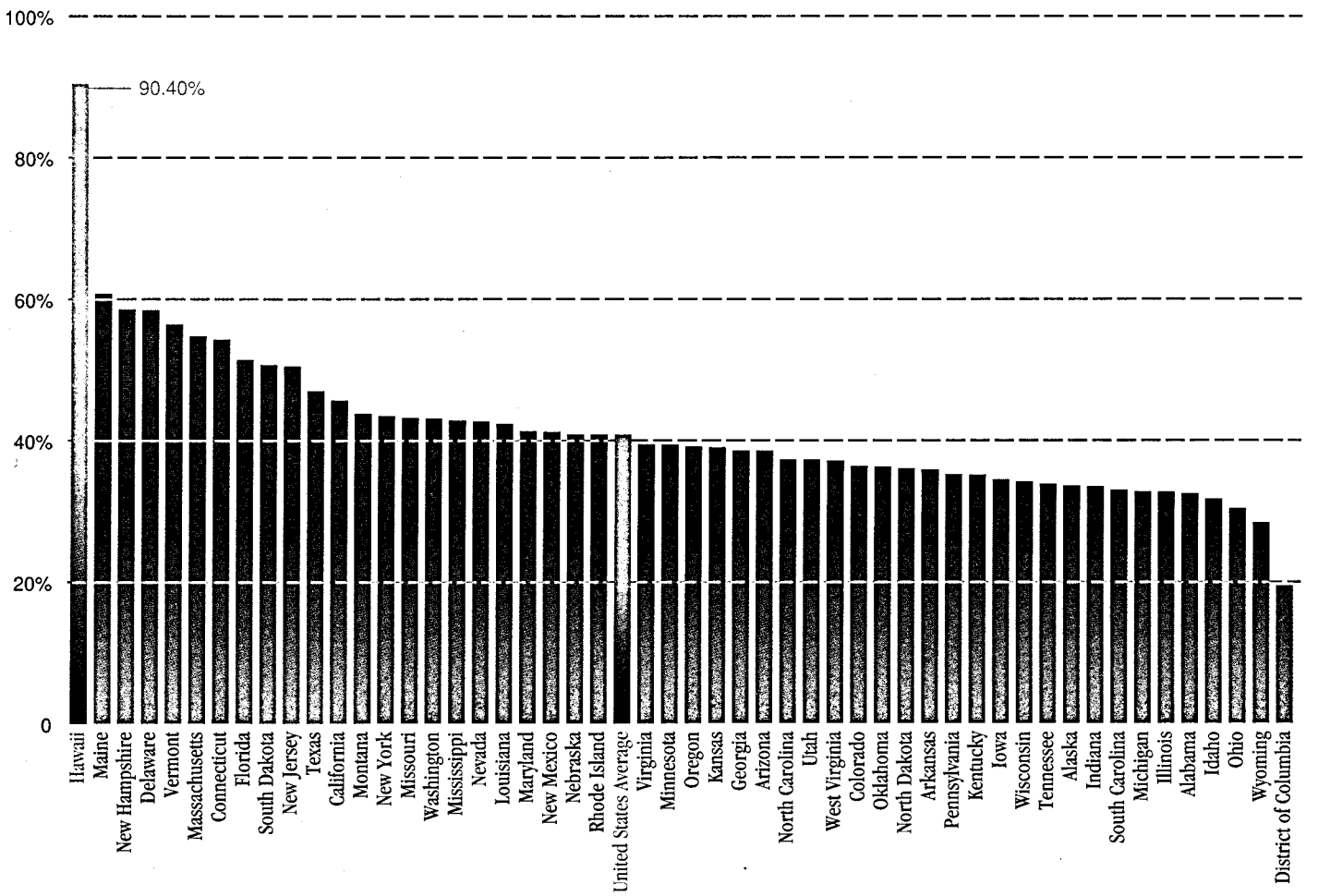
Source: U.S. Department of Energy and Hawaii Department of Business, Economic Development & Tourism.

Hawaii is unique among the 50 states in that more than 90 percent of its energy comes from oil.

Because it is isolated geographically, Hawaii cannot draw power from neighboring states. It has no conventional energy resources such as oil, coal or natural gas. Therefore, Hawaii must import every barrel of oil and ton of coal it uses.

Tourism, the largest component of Hawaii's economy, is dependent upon air transportation. As a result, jet fuel accounts for over 33 percent of the state's total energy consumption.

In 1992, Hawaii ranked highest among all the states in terms of dependence upon petroleum (90.4 percent).



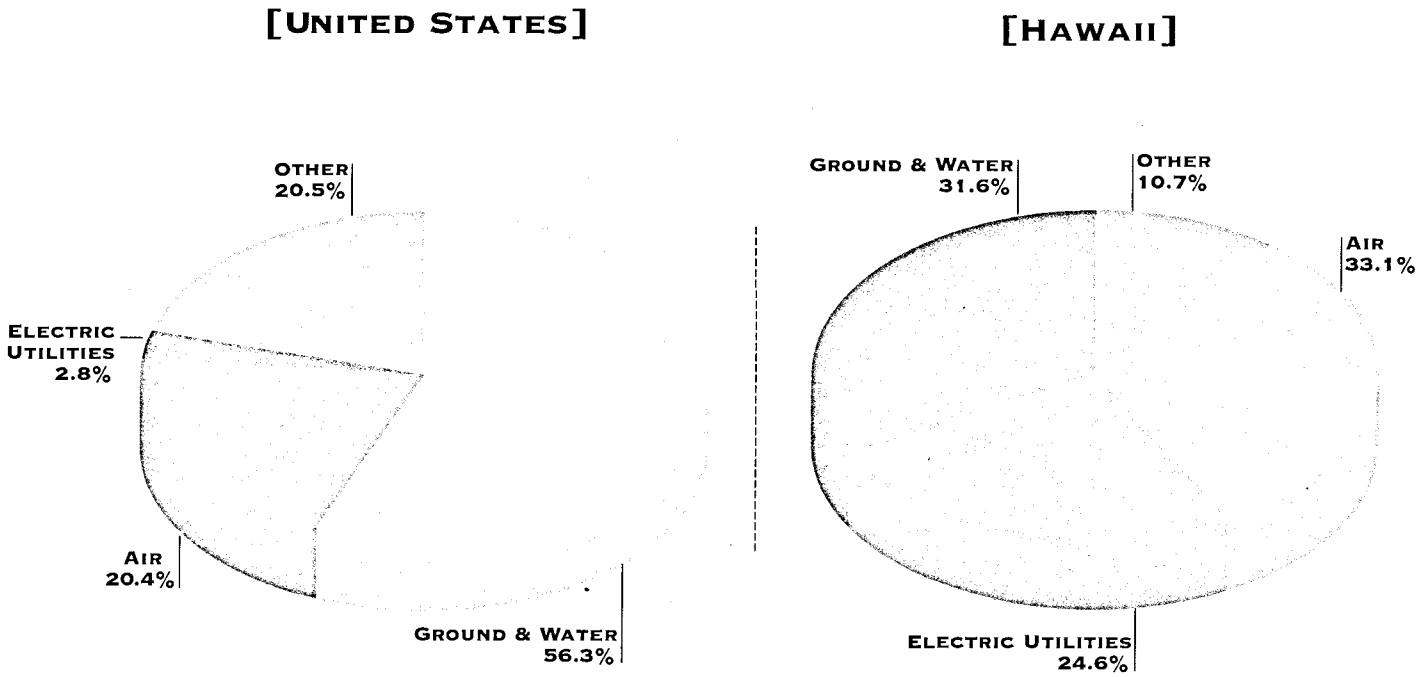
PETROLEUM DEPENDENCY BY STATE • 1992

PERCENT OF TOTAL ENERGY USE

Source: U.S. Department of Energy and Hawaii Department of Business, Economic Development & Tourism.

PRIMARY PETROLEUM CONSUMPTION BY SECTOR • NATION AND HAWAII • 1992

Similar to the United States as a whole, Hawaii consumes more than 60 percent of its oil for transportation purposes. However, over 33 percent of Hawaii's oil consumption goes to air transportation, compared with the national average of about 20 percent. Approximately 56 percent of the nation's oil consumption goes to ground and water transportation compared with about 31 percent in Hawaii. And about 25 percent of Hawaii's oil is used for electricity generation. In the nation as a whole, only about 3 percent of its oil is used for electricity generation. Coal is by far the dominant fuel in contrast to Hawaii where oil makes up about 85 percent of the electricity sector's fuel.



PETROLEUM CONSUMPTION BY SECTOR • UNITED STATES & HAWAII • 1992

Source: U.S. Department of Energy and Hawaii Department of Business, Economic Development & Tourism.

In 1993, the United States depended upon oil for 3.5 percent of its electricity generation. Coal was used to generate 56.9 percent of the nation's electricity. Nuclear plants produced 21.2 percent, natural gas 8.9 percent and hydroelectricity 9.2 percent. In contrast to the rest of the nation, Hawaii used petroleum to produce 74 percent of its electricity. Coal produced about 16 percent while biomass from sugar plantations and municipal solid waste was used to generate 7.7 percent of the state's electric power. The remaining 2.5 percent came from hydroelectricity, wind and geothermal.

HAWAII ELECTRICITY PRODUCTION: 1992 AND 1993 (THOUSAND KWH)

Source	1992	Percent	1993	Percent
Petroleum	8,556,142	84.7	7,576,280	74.1
Coal	625,903	6.2	1,591,824	15.6
Biomass	459,730	4.6	435,104	4.3
Municipal Solid Waste	373,508	3.6	349,344	3.4
Hydroelectric	66,472	0.7	77,645	0.8
Windpower	20,707	0.2	23,553	0.2
Geothermal	1,261	*	154,710	1.5
Photovoltaics	28	*	32	*
Landfill-Produced Methane	Not Available	Not Available	10,147	0.1
Total	**10,103,751**	**100.0**	**10,218,639**	**100.0**

* Less than 0.1 percent.
Source: Hawaii Department of Business, Economic Development & Tourism.

UNITED STATES ELECTRICITY PRODUCTION BY UTILITIES: 1992 AND 1993 (MILLION KWH)

Source	1992	Percent	1993	Percent
Coal	1,575,895	56.3	1,639,151	56.9
Nuclear	618,776	22.1	610,291	21.2
Natural Gas	263,872	9.4	258,915	8.9
Hydroelectric	239,559	8.6	265,063	9.2
Petroleum	88,916	3.2	99,539	3.5
Other [1]	10,200	0.4	9,565	0.3
Total	**2,797,218**	**100.0**	**2,882,524**	**100.0**

[1] Includes geothermal, wood, waste, wind, photovoltaic and solar thermal energy sources.
Source: U.S. Department of Energy.

In 1992, electric utilities in Hawaii and the District of Columbia were dependent on oil for more than 84 percent of their electricity generation needs.

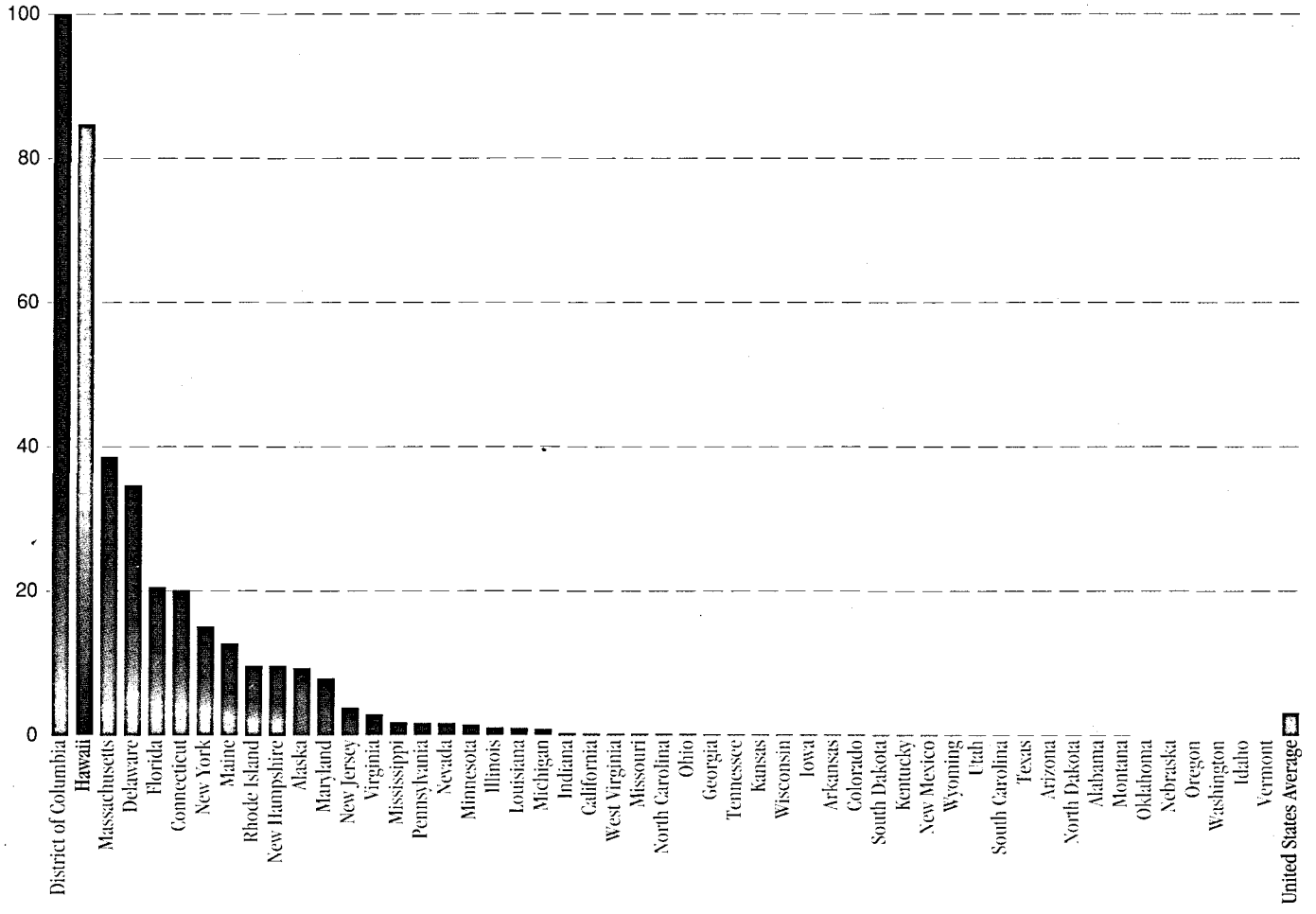
Electric utilities in Massachusetts, third highest in petroleum dependency, depended on oil for over 38 percent for their production.

Utilities in the United States as a whole were dependent on oil for only 3 percent for electricity generation.

Electric utilities in 8 states were dependent on oil between 9 percent and 35 percent; utilities in another 8 were dependent between 1 percent and 8 percent; and utilities in the remaining 32 states depended on oil for less than 1 percent for electricity generation.

Most states relied on coal for electricity generation and, in fact, the United States as a whole used coal to generate over 56 percent of its electricity in 1992.

This chart illustrates the wide range of oil dependency for electricity generation among states. All states use oil for this purpose but states that use less than 0.2 percent do not show a bar because of the scale of this chart.

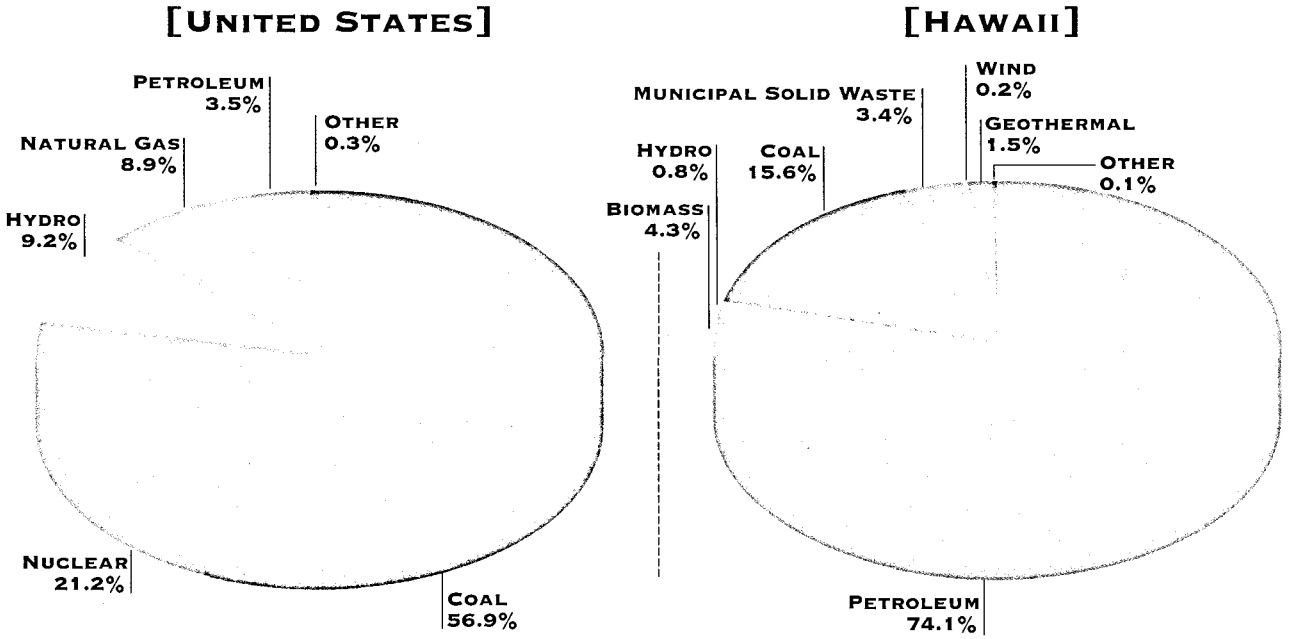


OIL DEPENDENCY OF ELECTRIC UTILITIES • 1992

Source: U.S. Department of Energy.

ELECTRICITY GENERATION BY SOURCE • 1993

In 1993, over 74 percent of Hawaii's total electricity production depended on oil. In contrast, the nation as a whole used oil for about 4 percent of its electricity production. Coal accounted for over half the nation's electricity output.

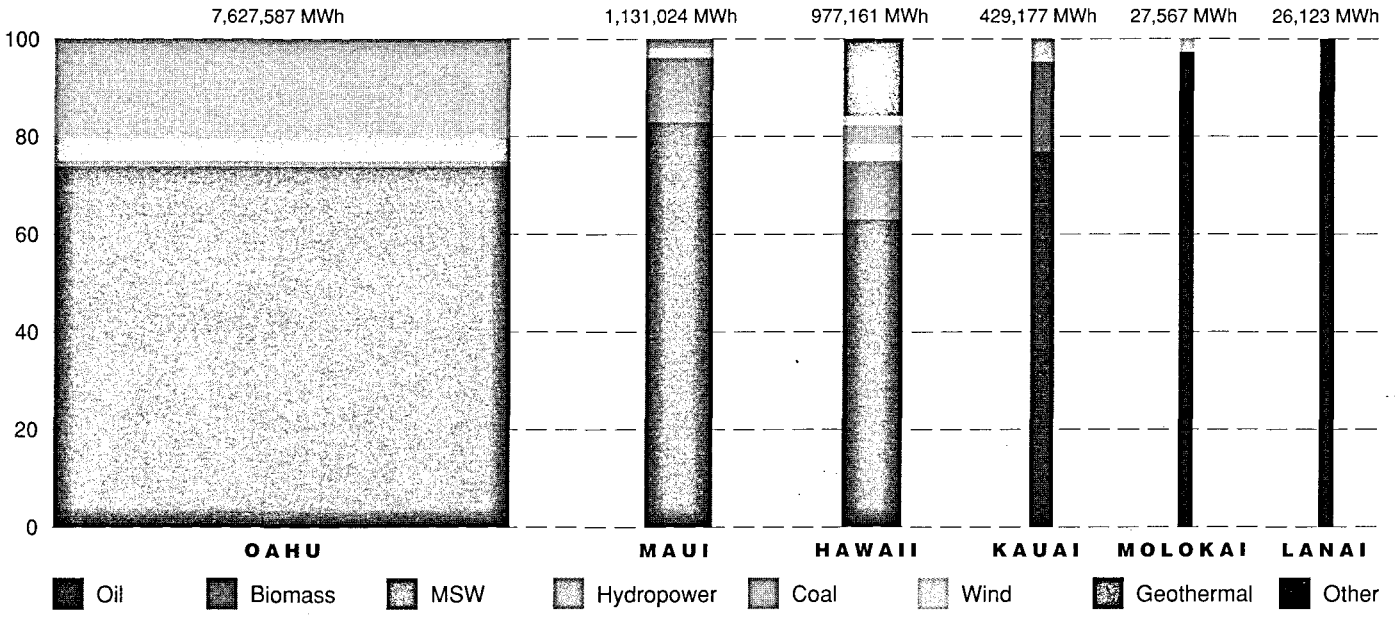


Source: U.S. Department of Energy and Hawaii Department of Business, Economic Development & Tourism.

ELECTRICITY GENERATION BY ISLAND • 1993

(Area of bars are proportional to electricity generation on each island)

Reliance on oil for electricity generation varies from island to island, ranging from total dependence on Lanai to a low of about 63 percent on the Island of Hawaii.



Source: Hawaii Department of Business, Economic Development & Tourism.

ELECTRICITY GENERATION BY FUEL TYPE OR SOURCE • HAWAII • 1993

ELECTRICITY GENERATION BY FUEL TYPE OR SOURCE • HAWAII • 1993 • (THOUSAND KWH)

	Total	Petroleum	Biomass	MSW	Hydro	Wind	Geothermal	Coal	PV	LPM
State Total	**10,218,639**	**7,576,280**	**435,104**	**349,344**	**77,645**	**23,553**	**154,710**	**1,591,824**	**32**	**10,147**
Oahu	7,627,587	5,639,835	88,875	349,344	0	4,336	0	1,535,050	0	10,147
Kauai	429,177	330,048	79,249	0	19,880	0	0	0	0	0
Hawaii	977,161	615,450	116,941	0	35,055	18,472	154,710	36,533	0	0
Maui County	1,184,715	990,947	150,039	0	22,710	745	0	20,241	32	0
Maui	1,131,024	938,002	150,039	0	22,710	0	0	20,241	32	0
Molokai	27,567	26,822	0	0	0	745	0	0	0	0
Lanai	26,123	26,123	0	0	0	0	0	0	0	0

Source: *HECO's Annual Report, KE's Annual Report, PVUSA Quarterly Report, H-POWER, HSPA-Energy Report.*

ELECTRICITY GENERATION BY FUEL TYPE OR SOURCE • HAWAII • 1993 • (PERCENT)

	Total	Petroleum	Biomass	MSW	Hydro	Wind	Geothermal	Coal	PV [1]	LPM
State Total	**100.0**	**74.1**	**4.3**	**3.4**	**0.8**	**0.2**	**1.5**	**15.6**	**0.0**	**0.1**
Oahu	100.0	73.9	1.2	4.6	0.0	0.1	0.0	20.1	0.0	0.1
Kauai	100.0	76.9	18.5	0.0	4.6	0.0	0.0	0.0	0.0	0.0
Hawaii	100.0	63.0	12.0	0.0	3.6	1.9	15.8	3.7	0.0	0.0
Maui County	100.0	83.6	12.7	0.0	1.9	0.1	0.0	1.7	*	0.0
Maui	100.0	82.9	13.3	0.0	2.0	0.0	0.0	1.8	*	0.0
Molokai	100.0	97.3	0.0	0.0	0.0	2.7	0.0	0.0	0.0	0.0
Lanai	100.0	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

[1] PVUSA-Maui.
* Less than 0.01 percent.

Source: *HECO's Annual Report, KE's Annual Report, PVUSA Quarterly Report, H-POWER, HSPA-Energy Report.*

PRIMARY ENERGY CONSUMPTION BY SOURCE • HAWAII • (TRILLION BTU)

Year	Total	Petroleum	Biomass	Hydro-electric	Geo-thermal	Solar Hot Water	Wind	Coal	Municipal Solid Waste
1960	120.4982	98.8532	21.3450	0.3000	0	0	0	0	0
1961	141.3156	116.6716	24.3440	0.3000	0	0	0	0	0
1962	137.1934	111.5904	25.4030	0.2000	0	0	0	0	0
1963	143.8698	117.6498	26.0200	0.2000	0	0	0	0	0
1964	153.9604	126.0344	26.7260	1.2000	0	0	0	0	0
1965	160.6014	131.6284	27.8730	1.1000	0	0	0	0	0
1966	175.5990	146.7910	27.6080	1.2000	0	0	0	0	0
1967	196.1247	166.3587	28.6660	1.1000	0	0	0	0	0
1968	214.9613	185.2063	28.7550	1.0000	0	0	0	0	0
1969	221.9387	192.5367	28.4020	1.0000	0	0	0	0	0
1970	225.2299	197.2279	26.9020	1.1000	0	0	0	0	0
1971	241.0916	212.8486	27.3430	0.9000	0	0	0	0	0
1972	245.1282	218.3842	25.8440	0.9000	0	0	0	0	0
1973	250.5421	223.7861	25.7560	1.0000	0	0	0	0	0
1974	237.2659	212.2739	23.9920	1.0000	0	0	0	0	0
1975	238.3572	213.4572	24.0000	0.9000	0	0	0	0	0
1976	240.5195	215.5195	24.0000	1.0000	0	0	0	0	0
1977	254.5484	229.5889	24.0000	0.9000	0	0.0595	0	0	0
1978	259.1148	233.5357	24.4000	0.9000	0	0.2791	0	0	0
1979	278.4501	253.0344	24.0000	0.9000	0	0.5157	0	0	0
1980	273.8809	248.0109	24.2000	0.9000	0	0.7700	0	0	0
1981	273.3227	245.5086	24.0900	0.7356	0	1.1185	0	1.8700	0
1982	272.1129	244.3151	23.9200	1.0939	0.1572	1.3567	0	1.2700	0
1983	279.0303	250.6283	24.8500	0.8865	0.1886	1.5269	0	0.9500	0
1984	276.3700	248.4026	24.3650	0.7796	0.2075	1.7683	0	0.8470	0
1985	266.2178	238.6470	23.1430	0.9808	0.1886	2.1327	0.1697	0.9560	0
1986	271.0562	242.5857	23.9670	1.0562	0.1823	2.1644	0.6036	0.4970	0
1987	284.2042	256.4061	22.1840	0.9670	0.1446	2.1914	0.8236	1.4875	0
1988	306.9212	279.1052	22.7080	0.9826	0.1629	2.1931	0.4185	1.3509	0
1989	314.9631	289.2301	20.8020	1.0183	0.1435	2.3310	0.4189	0.8715	0.1478
1990	306.7040	280.8740	18.1200	1.0700	0	2.3400	0.2900	0.8900	3.1200
1991	315.5060	289.9000	17.9000	1.0000	0	2.3000	0.3060	0.8000	3.3000
1992	321.7222	290.8500	16.9840	0.7226	0.0168	2.3000	0.2573	6.9207	3.6708
1993p	304.7958	266.6563	16.8310	0.8024	1.5988	2.3000	0.2352	13.2237	3.1484

p = preliminary.
Source: *HECO's Annual Report, Act 65, Kauai Electric's Annual Report, HSPA - Energy Report, Hawaii Department of Taxation, PVUSA Quarterly Report.*

PRIMARY ENERGY CONSUMPTION BY SOURCE • HAWAII • (PERCENT BY SOURCE)

Year	Petroleum	Biomass	Hydro-electric	Geo-thermal	Solar Hot Water	Wind	Coal	Municipal Solid Waste	Total
1960	82.04	17.71	0.25	0	0	0	0	0	100.00
1961	82.56	17.23	0.21	0	0	0	0	0	100.00
1962	81.34	18.52	0.15	0	0	0	0	0	100.00
1963	81.78	18.09	0.14	0	0	0	0	0	100.00
1964	81.86	17.36	0.78	0	0	0	0	0	100.00
1965	81.96	17.36	0.68	0	0	0	0	0	100.00
1966	83.59	15.72	0.68	0	0	0	0	0	100.00
1967	84.82	14.62	0.56	0	0	0	0	0	100.00
1968	86.16	13.38	0.47	0	0	0	0	0	100.00
1969	86.75	12.80	0.45	0	0	0	0	0	100.00
1970	87.57	11.94	0.49	0	0	0	0	0	100.00
1971	88.29	11.34	0.37	0	0	0	0	0	100.00
1972	89.09	10.54	0.37	0	0	0	0	0	100.00
1973	89.32	10.28	0.40	0	0	0	0	0	100.00
1974	89.47	10.11	0.42	0	0	0	0	0	100.00
1975	89.55	10.07	0.38	0	0	0	0	0	100.00
1976	89.61	9.98	0.42	0	0	0	0	0	100.00
1977	90.19	9.43	0.35	0	0.02	0	0	0	100.00
1978	90.13	9.42	0.35	0	0.11	0	0	0	100.00
1979	90.87	8.62	0.32	0	0.19	0	0	0	100.00
1980	90.55	8.84	0.33	0	0.28	0	0	0	100.00
1981	89.82	8.81	0.27	0	0.41	0	0.68	0	100.00
1982	89.78	8.79	0.40	0.06	0.50	0	0.47	0	100.00
1983	89.82	8.91	0.32	0.07	0.55	0	0.34	0	100.00
1984	89.88	8.82	0.28	0.08	0.64	0	0.31	0	100.00
1985	89.64	8.69	0.37	0.07	0.80	0.06	0.36	0	100.00
1986	89.50	8.84	0.39	0.07	0.80	0.22	0.18	0	100.00
1987	90.22	7.81	0.34	0.05	0.77	0.29	0.52	0	100.00
1988	90.94	7.40	0.32	0.05	0.71	0.14	0.44	0	100.00
1989	91.83	6.60	0.32	0.05	0.74	0.13	0.28	0.05	100.00
1990	91.58	5.91	0.35	0	0.76	0.09	0.29	1.02	100.00
1991	91.88	5.67	0.32	0	0.73	0.10	0.25	1.05	100.00
1992	90.40	5.28	0.22	0.01	0.72	0.08	2.15	1.14	100.00
1993p	87.49	5.52	0.26	0.52	0.75	0.08	4.34	1.03	100.00

p=preliminary.
Source: Hawaii Department of Business, Economic Development & Tourism.

PRIMARY ENERGY CONSUMPTION AND ENERGY CONSUMPTION PER DOLLAR OF CONSTANT GROSS STATE PRODUCT • HAWAII • 1960 - 1993

Year	Energy Consumed (Trillion Btu)	Constant GSP (Thousands of 1982 $)	Quantity (Thousand Btu per 1982 $)	Annual Change (Percent)
1960	120.4982	5,248,100	22.960	—
1961	141.3156	5,250,000	26.917	17.2
1962	137.1934	5,471,000	25.076	–6.8
1963	143.8698	5,606,200	25.663	2.3
1964	153.9604	6,167,500	24.963	–2.7
1965	160.6014	6,714,300	23.919	–4.2
1966	175.5990	7,083,500	24.790	3.6
1967	196.1247	7,329,400	26.759	7.9
1968	214.9613	7,932,500	27.099	1.3
1969	221.9387	8,905,600	24.921	–8.0
1970	225.2299	9,324,600	24.154	–3.1
1971	241.0916	9,806,500	24.585	1.8
1972	245.1282	10,464,500	23.425	–4.7
1973	250.5421	10,982,400	22.813	–2.6
1974	237.2659	10,948,500	21.671	–5.0
1975	238.3572	11,596,600	20.554	–5.2
1976	240.5195	11,746,400	20.476	–0.4
1977	254.5484	12,103,300	21.031	2.7
1978	259.1148	12,482,900	20.758	–1.3
1979	278.4501	12,972,100	21.465	3.4
1980	273.8809	13,690,500	20.005	–6.8
1981	273.3227	14,022,500	19.492	–2.6
1982	272.1129	13,691,000	19.875	2.0
1983	279.0303	14,210,000	19.636	–1.2
1984	276.3700	14,637,000	18.882	–3.8
1985	266.2178	15,107,300	17.622	–6.7
1986	271.0562	15,807,600	17.147	–2.7
1987	284.2042	16,458,600	17.268	0.7
1988	306.9212	17,506,000	17.532	1.5
1989	314.9631	18,578,100	16.953	–3.2
1990	306.7040	19,525,600	15.708	–7.3
1991	315.5060	19,573,100	16.119	2.6
1992	321.7222	19,084,400	16.858	4.6
1993p	304.7958	18,607,290	16.380	–2.8

p=preliminary.
Source: Hawaii Department of Business, Economic Development & Tourism.

PRIMARY ENERGY CONSUMPTION AND PER CAPITA CONSUMPTION HAWAII • 1960 - 1993

Year	Primary Energy Consumption (Trillion Btu)	De Facto Population (July 1)	Millions of Btu	Annual Change (Percent)
1960	120.4982	651,200	185.040	—
1961	141.3156	668,200	211.487	14.3
1962	137.1934	693,600	197.799	-6.5
1963	143.8698	694,500	207.156	4.7
1964	153.9604	711,200	216.480	4.5
1965	160.6014	715,400	224.492	3.7
1966	175.5990	724,600	242.339	8.0
1967	196.1247	742,600	264.105	9.0
1968	214.9613	758,800	283.291	7.3
1969	221.9387	778,800	284.975	0.6
1970	225.2299	798,600	282.031	–1.0
1971	241.0916	833,100	289.391	2.6
1972	245.1282	869,800	281.821	–2.6
1973	250.5421	901,300	277.979	–1.4
1974	237.2659	923,700	256.865	–7.6
1975	238.3572	943,500	252.631	–1.6
1976	240.5195	970,300	247.882	–1.9
1977	254.5484	992,300	256.524	3.5
1978	259.1148	1,014,300	255.462	–0.4
1979	278.4501	1,042,700	267.047	4.5
1980	273.8809	1,055,400	259.504	–2.8
1981	273.3227	1,062,600	257.221	–0.9
1982	272.1129	1,084,600	250.888	–2.5
1983	279.0303	1,109,200	251.560	0.3
1984	276.3700	1,130,500	244.467	–2.8
1985	266.2178	1,137,800	233.976	–4.3
1986	271.0562	1,167,500	232.168	–0.8
1987	284.2042	1,186,500	239.532	3.2
1988	306.9212	1,200,400	255.682	6.7
1989	314.9631	1,245,600	252.861	–1.1
1990	306.7040	1,257,000	243.997	–3.5
1991	315.5060	1,275,900	247.281	1.3
1992	321.7222	1,272,100	252.906	2.3
1993p	304.7958	1,271,200	239.770	–5.2

p=preliminary.
Source: Hawaii Department of Business, Economic Development & Tourism.

PETROLEUM CONSUMPTION • HAWAII • (THOUSAND BARRELS)

Year	Total	Aviation Gas	Diesel	Jet Fuel	Kerosene	LPG/ SNG	Motor Gasoline	Residual Fuel Oil	Other
1960	17,430	2,582	886	5,011	91	112	3,429	4,766	553
1961	20,474	2,994	1,663	5,558	69	140	3,546	5,926	578
1962	19,459	1,790	1,637	5,532	55	172	3,708	5,974	591
1963	20,444	1,084	1,362	6,892	49	232	3,756	6,431	638
1964	21,801	561	1,761	7,682	50	257	3,861	6,965	664
1965	22,777	626	1,612	8,275	49	219	4,082	7,230	684
1966	25,448	870	1,378	10,158	37	242	4,294	7,801	668
1967	28,785	477	1,208	12,802	33	285	4,526	8,818	636
1968	32,009	268	1,420	14,723	27	298	4,882	9,738	653
1969	33,469	195	1,601	14,834	29	912	5,176	10,056	666
1970	34,320	162	1,695	14,884	153	938	5,691	10,154	643
1971	37,047	165	1,709	16,939	80	963	5,872	10,701	618
1972	37,962	165	1,776	16,839	52	945	6,202	11,338	645
1973	38,922	153	1,837	17,043	41	942	6,608	11,575	723
1974	36,927	145	1,951	15,432	75	966	6,543	11,122	693
1975	37,106	133	1,948	15,363	76	872	6,766	11,255	693
1976	37,473	130	2,337	14,202	129	1,036	7,029	11,871	739
1977	39,823	147	2,865	14,875	169	877	7,406	12,695	789
1978	40,458	141	3,567	14,861	146	702	7,639	12,556	846
1979	44,115	152	6,567	15,276	40	1,583	7,506	12,167	824
1980	43,126	199	5,987	14,116	9	1,573	7,231	13,196	815
1981	42,680	55	4,604	16,451	0	1,285	7,033	13,223	29
1982	42,326	45	4,569	15,427	0	1,335	6,823	14,121	6
1983	43,400	215	4,853	14,724	0	1,360	7,274	14,958	16
1984	43,067	74	5,513	14,398	0	1,273	7,682	14,077	50
1985	41,787	65	4,262	17,297	0	1,292	7,528	11,293	50
1986	42,340	45	4,157	16,486	0	1,281	8,063	12,253	55
1987	44,837	29	3,124	18,775	0	1,333	8,911	12,606	59
1988	48,587	175	5,289	19,648	0	1,350	8,491	13,574	60
1989	50,484	51	4,749	20,399	0	1,476	8,755	15,054	0
1990	48,990	45	5,541	19,239	0	1,490	8,940	13,735	0
1991	50,364	45	5,355	18,720	0	1,490	8,958	15,796	0
1992	50,569	48	6,067	16,423	0	2,375	9,100	16,556	0
1993p	46,462	39	5,007	17,700	0	1,648	9,154	12,913	0

p=preliminary.
Source: Act 65, Hawaii Department of Taxation, HECO's Annual Report, Kauai Electric's Annual Report, Hawaii Department of Business, Economic Development & Tourism.

ELECTRICITY SALES & GROSS STATE PRODUCT • HAWAII • 1960 - 1993

Year	GSP (Thousands of 1982 $)	ELECTRICITY SALES BY UTILITIES (THOUSAND kWH) Total	Residential	Other	Total kWh Sales per $1,000 of Constant GSP	Annual Change (Percent)
1960	5,248,100	1,602,197	580,849	1,021,348	305	—
1961	5,250,000	1,766,031	624,730	1,141,301	336	10.19
1962	5,471,000	1,966,105	678,628	1,287,477	359	6.83
1963	5,606,200	2,078,571	730,317	1,348,254	371	3.17
1964	6,167,500	2,284,275	786,118	1,498,157	370	–0.11
1965	6,714,300	2,445,025	853,086	1,591,939	364	–1.68
1966	7,083,500	2,639,866	912,616	1,727,250	373	2.34
1967	7,329,400	2,832,469	989,785	1,842,684	386	3.70
1968	7,932,500	3,109,256	1,083,233	2,026,023	392	1.43
1969	8,905,600	3,426,052	1,174,502	2,251,550	385	–1.85
1970	9,324,600	3,758,094	1,270,732	2,487,362	403	4.76
1971	9,806,500	4,167,127	1,375,308	2,791,819	425	5.44
1972	10,464,500	4,562,568	1,493,840	3,068,728	436	2.60
1973	10,982,400	4,867,850	1,581,855	3,285,995	443	1.66
1974	10,948,500	5,113,906	1,635,978	3,477,928	467	5.38
1975	11,596,600	5,334,755	1,676,438	3,658,317	460	–1.51
1976	11,746,400	5,615,210	1,750,618	3,864,592	478	3.91
1977	12,103,300	5,831,610	1,779,314	4,052,296	482	0.79
1978	12,482,900	6,004,891	1,799,024	4,205,867	481	–0.16
1979	12,972,100	6,197,426	1,851,457	4,345,969	478	–0.69
1980	13,690,500	6,345,531	1,852,984	4,492,547	463	–2.98
1981	14,022,500	6,424,016	1,855,837	4,568,179	458	–1.16
1982	13,691,000	6,332,707	1,801,297	4,531,410	463	0.97
1983	14,210,000	6,425,578	1,814,336	4,611,242	452	–2.24
1984	14,637,000	6,606,255	1,837,954	4,768,301	451	–0.19
1985	15,107,300	6,635,158	1,879,027	4,756,131	439	–2.69
1986	15,807,600	7,025,739	1,959,447	5,066,292	444	1.20
1987	16,458,600	7,298,178	2,070,052	5,228,126	443	–0.23
1988	17,506,000	7,719,029	2,148,275	5,570,754	441	–0.56
1989	18,578,100	7,970,360	2,239,356	5,731,004	429	–2.70
1990	19,525,600	8,310,537	2,320,550	5,989,987	426	–0.79
1991	19,573,100	8,564,032	2,385,276	6,178,756	438	2.80
1992	19,084,400	8,643,562	2,430,152	6,213,410	453	3.51
1993p	18,607,290	8,657,905	2,453,830	6,204,075	465	2.73

p=preliminary.
Source: Hawaii Department of Business, Economic Development & Tourism.

ELECTRICITY SALES AND DE FACTO POPULATION • HAWAII • 1960 - 1993

Year	De Facto Population (July 1)	ELECTRICITY SALES BY UTILITIES (THOUSAND KWH)			Total kWh Sales Per De Facto Population (kWh)	Annual Change (Percent)
		Total	Residential	Other		
1960	651,200	1,602,197	580,849	1,021,348	2,460	—
1961	668,200	1,766,031	624,730	1,141,301	2,643	7.42
1962	693,600	1,966,105	678,628	1,287,477	2,835	7.25
1963	694,500	2,078,571	730,317	1,348,254	2,993	5.58
1964	711,200	2,284,275	786,118	1,498,157	3,212	7.32
1965	715,400	2,445,025	853,086	1,591,939	3,418	6.41
1966	724,600	2,639,866	912,616	1,727,250	3,643	6.60
1967	742,600	2,832,469	989,785	1,842,684	3,814	4.70
1968	758,800	3,109,256	1,083,233	2,026,023	4,098	7.43
1969	778,800	3,426,052	1,174,502	2,251,550	4,399	7.36
1970	798,600	3,758,094	1,270,732	2,487,362	4,706	6.97
1971	833,100	4,167,127	1,375,308	2,791,819	5,002	6.29
1972	869,800	4,562,568	1,493,840	3,068,728	5,246	4.87
1973	901,300	4,867,850	1,581,855	3,285,995	5,401	2.96
1974	923,700	5,113,906	1,635,978	3,477,928	5,536	2.51
1975	943,500	5,334,755	1,676,438	3,658,317	5,654	2.13
1976	970,300	5,615,210	1,750,618	3,864,592	5,787	2.35
1977	992,300	5,831,610	1,779,314	4,052,296	5,877	1.55
1978	1,014,300	6,004,891	1,799,024	4,205,867	5,920	0.74
1979	1,042,700	6,197,426	1,851,457	4,345,969	5,944	0.40
1980	1,055,400	6,345,531	1,852,984	4,492,547	6,012	1.16
1981	1,062,600	6,424,016	1,855,837	4,568,179	6,046	0.55
1982	1,084,600	6,332,707	1,801,297	4,531,410	5,839	–3.42
1983	1,109,200	6,425,578	1,814,336	4,611,242	5,793	–0.78
1984	1,130,500	6,606,255	1,837,954	4,768,301	5,844	0.87
1985	1,137,800	6,635,158	1,879,027	4,756,131	5,832	–0.21
1986	1,167,500	7,025,739	1,959,447	5,066,292	6,018	3.19
1987	1,186,500	7,298,178	2,070,052	5,228,126	6,151	2.21
1988	1,200,400	7,719,029	2,148,275	5,570,754	6,430	4.54
1989	1,245,600	7,970,360	2,239,356	5,731,004	6,399	–0.49
1990	1,257,000	8,310,537	2,320,550	5,989,987	6,611	3.32
1991	1,275,900	8,564,032	2,385,276	6,178,756	6,712	1.52
1992	1,272,100	8,643,562	2,430,152	6,213,410	6,795	1.23
1993p	1,271,200	8,657,905	2,453,830	6,204,075	6,811	0.24

p=preliminary.
Source: Hawaii Department of Business, Economic Development & Tourism.

ELECTRICITY SALES • HAWAII • 1960 - 1993 (ELECTRIC UTILITIES)

	Customer Accounts (Number at end of year)			Power Sold (Thousand kWh)			Revenues (Thousand $)		
Year	Total	Residential	Other	Total	Residential	Other	Total	Residential	Other
1960	157,578	132,440	25,138	1,602,197	580,849	1,021,348	39,284	17,265	22,019
1961	162,452	136,788	25,664	1,766,031	624,730	1,141,301	42,137	18,153	23,984
1962	167,101	140,661	26,440	1,966,105	678,628	1,287,477	46,282	19,603	26,679
1963	171,832	144,638	27,194	2,078,571	730,317	1,348,254	48,499	20,733	27,766
1964	177,684	149,547	28,137	2,284,275	786,118	1,498,157	52,133	21,971	30,162
1965	183,723	154,822	28,901	2,445,025	853,086	1,591,939	55,472	23,519	31,953
1966	190,276	160,784	29,492	2,639,866	912,616	1,727,250	59,362	24,905	34,457
1967	196,417	166,256	30,161	2,832,469	989,785	1,842,684	63,685	26,763	36,922
1968	202,167	171,346	30,821	3,109,256	1,083,233	2,026,023	69,599	29,034	40,565
1969	210,330	178,569	31,761	3,426,052	1,174,502	2,251,550	75,417	31,181	44,236
1970	219,003	186,282	32,721	3,758,094	1,270,732	2,487,362	84,096	34,068	50,028
1971	226,514	193,043	33,471	4,167,127	1,375,308	2,791,819	98,829	38,824	60,005
1972	205,309	201,903	34,406	4,562,568	1,493,840	3,068,728	109,213	42,560	66,653
1973	246,255	210,740	35,515	4,867,850	1,581,855	3,285,995	126,454	48,674	77,780
1974	255,901	219,633	36,268	5,113,906	1,635,978	3,477,928	151,188	57,145	94,043
1975	263,816	226,836	36,980	5,334,755	1,676,438	3,658,317	215,678	76,881	138,797
1976	270,035	232,070	37,965	5,615,210	1,750,618	3,864,592	235,999	83,957	152,042
1977	275,616	237,557	38,059	5,831,610	1,779,314	4,052,296	271,553	92,917	178,636
1978	284,064	244,863	39,201	6,004,891	1,799,024	4,205,867	313,722	105,846	207,876
1979	293,061	252,898	40,163	6,197,426	1,851,457	4,345,969	354,595	118,862	235,733
1980	301,544	260,358	41,186	6,345,531	1,852,984	4,492,547	459,251	146,397	312,854
1981	305,927	265,042	40,885	6,424,016	1,855,837	4,568,179	699,031	214,584	484,447
1982	313,009	270,712	42,297	6,332,707	1,801,297	4,531,410	723,622	222,423	501,199
1983	319,449	276,194	43,255	6,425,578	1,814,336	4,611,242	659,089	205,889	453,200
1984	324,384	280,518	43,866	6,606,255	1,837,954	4,768,301	702,899	217,447	485,452
1985	330,407	285,117	45,290	6,635,158	1,879,027	4,756,131	672,600	213,478	459,122
1986	337,563	291,222	46,341	7,025,739	1,959,447	5,066,292	562,344	182,110	380,234
1987	347,086	299,758	47,328	7,298,178	2,070,052	5,228,126	602,835	195,277	407,558
1988	354,887	306,375	48,512	7,719,029	2,148,275	5,570,754	587,528	189,689	397,839
1989	362,290	312,347	49,943	7,970,360	2,239,356	5,731,004	644,789	207,296	437,493
1990	370,952	320,215	50,737	8,310,537	2,320,550	5,989,987	749,845	238,103	511,742
1991	380,963	328,899	52,064	8,564,032	2,385,276	6,178,756	785,896	251,553	534,343
1992	385,055	332,863	52,192	8,643,562	2,430,152	6,213,410	818,525	265,667	552,858
1993p	394,825	340,932	53,893	8,657,905	2,453,830	6,204,075	922,797	302,054	620,743

p=preliminary.
Source: Hawaii Department of Business, Economic Development & Tourism.

AVERAGE KWH USE AND RATES • HAWAII • 1960 - 1993 (ELECTRIC UTILITIES)

	Customer Accounts (Number at End of Year)			Average Power Sold (kWh per Customer)			Average Rate ($ per kWh)			Average Rate (Constant $ per kWh)		
Year	Total	Residential	Other	Total	Residential	Other	Total	Residential	Other	Total	Residential	Other
1960	157,578	132,440	25,138	10,168	4,386	40,630	0.0245	0.0297	0.0216	0.0783	0.0950	0.0689
1961	162,452	136,788	25,664	10,871	4,567	44,471	0.0239	0.0291	0.0210	0.0743	0.0905	0.0655
1962	167,101	140,661	26,440	11,766	4,825	48,694	0.0235	0.0289	0.0207	0.0718	0.0881	0.0632
1963	171,832	144,638	27,194	12,097	5,049	49,579	0.0233	0.0284	0.0206	0.0697	0.0847	0.0615
1964	177,684	149,547	28,137	12,856	5,257	53,245	0.0228	0.0279	0.0201	0.0677	0.0829	0.0597
1965	183,723	154,822	28,901	13,308	5,510	55,082	0.0227	0.0276	0.0201	0.0660	0.0801	0.0583
1966	190,276	160,784	29,492	13,874	5,676	58,567	0.0225	0.0273	0.0199	0.0637	0.0773	0.0565
1967	196,417	166,256	30,161	14,421	5,953	61,095	0.0225	0.0270	0.0200	0.0619	0.0745	0.0552
1968	202,167	171,346	30,821	15,380	6,322	65,735	0.0224	0.0268	0.0200	0.0594	0.0711	0.0531
1969	210,330	178,569	31,761	16,289	6,577	70,890	0.0220	0.0265	0.0196	0.0559	0.0674	0.0499
1970	219,003	186,282	32,721	17,160	6,822	76,017	0.0224	0.0268	0.0201	0.0539	0.0646	0.0485
1971	226,514	193,043	33,471	18,397	7,124	83,410	0.0237	0.0282	0.0215	0.0549	0.0653	0.0498
1972	205,309	201,903	34,406	22,223	7,399	900,977	0.0239	0.0285	0.0217	0.0537	0.0639	0.0487
1973	246,255	210,740	35,515	19,768	7,506	92,524	0.0260	0.0308	0.0237	0.0557	0.0660	0.0508
1974	255,901	219,633	36,268	19,984	7,449	95,895	0.0296	0.0349	0.0270	0.0574	0.0678	0.0525
1975	263,816	226,836	36,980	20,221	7,391	98,927	0.0404	0.0459	0.0379	0.0718	0.0815	0.0674
1976	270,035	232,070	37,965	20,794	7,543	101,794	0.0420	0.0480	0.0393	0.0711	0.0811	0.0666
1977	275,616	237,557	38,059	21,158	7,490	106,474	0.0466	0.0522	0.0441	0.0750	0.0841	0.0710
1978	284,064	244,863	39,201	21,139	7,347	107,290	0.0522	0.0588	0.0494	0.0781	0.0879	0.0739
1979	293,061	252,898	40,163	21,147	7,321	108,208	0.0572	0.0642	0.0542	0.0770	0.0864	0.0730
1980	301,544	260,358	41,186	21,043	7,117	109,079	0.0724	0.0790	0.0696	0.0872	0.0952	0.0839
1981	305,927	265,042	40,885	20,999	7,002	111,732	0.1088	0.1156	0.1060	0.1187	0.1261	0.1156
1982	313,009	270,712	42,297	20,232	6,654	107,133	0.1143	0.1235	0.1106	0.1176	0.1270	0.1138
1983	319,449	276,194	43,255	20,115	6,569	106,606	0.1026	0.1135	0.0983	0.1033	0.1143	0.0990
1984	324,384	280,518	43,866	20,366	6,552	108,702	0.1064	0.1183	0.1018	0.1028	0.1143	0.0984
1985	330,407	285,117	45,290	20,082	6,590	105,015	0.1014	0.1136	0.0965	0.0949	0.1064	0.0904
1986	337,563	291,222	46,341	20,813	6,728	109,326	0.0800	0.0929	0.0751	0.0732	0.0850	0.0686
1987	347,086	299,758	47,328	21,027	6,906	110,466	0.0826	0.0943	0.0780	0.0719	0.0821	0.0678
1988	354,887	306,375	48,512	21,751	7,012	114,832	0.0761	0.0883	0.0714	0.0625	0.0726	0.0587
1989	362,290	312,347	49,943	22,000	7,169	114,751	0.0809	0.0926	0.0763	0.0629	0.0719	0.0593
1990	370,952	320,215	50,737	22,403	7,247	118,060	0.0902	0.1026	0.0854	0.0653	0.0743	0.0619
1991	380,963	328,899	52,064	22,480	7,252	118,676	0.0918	0.1055	0.0865	0.0620	0.0713	0.0584
1992	385,055	332,863	52,192	22,448	7,301	119,049	0.0947	0.1093	0.0890	0.0611	0.0705	0.0574
1993p	394,825	340,932	53,893	21,928	7,197	115,118	0.1066	0.1231	0.1001	0.0666	0.0769	0.0625

p=preliminary.
Source: Hawaii Department of Business, Economic Development & Tourism.

ENERGY PROGRAM FUNDING

DEPARTMENT OF BUSINESS, ECONOMIC DEVELOPMENT & TOURISM – ENERGY DIVISION

PROGRAM BUDGET BY TECHNOLOGY

FISCAL YEAR ENDING JUNE 30, 1994

Description	General Funds	Capital Improvement Projects	Oil Overcharge Funds				Other Federal	Private	Totals
			Exxon	Warner	Stripper	Subtotal			
ALTERNATE TECHNOLOGIES/RESOURCES:									
Geothermal	125,000	0	0	0	0	0	0	0	125,000
Solar Photovoltaics	0	0	25,943	0	0	25,943	0	0	25,943
Solar Thermal	25,000	0	0	0	0	0	0	0	25,000
Biomass	0	2,000,000	0	0	0	0	0	0	2,000,000
Pumped Storage Hydro	0	0	0	0	0	0	0	0	0
Anaerobic Digestions	0	0	5,633	0	0	5,633	0	0	5,633
Total-Alternate Technologies	**150,000**	**2,000,000**	**31,576**	**0**	**0**	**31,576**	**0**	**0**	**2,181,576**
CONSERVATION:									
Buildings	80,000	0	178,481	0	275,000	453,481	0	187,122	720,603
Transportation	0	0	127,500	0	0	127,500	0	0	127,500
Education	4,596	0	201,712	78,393	242,271	522,376	108,324	0	635,296
Commercial/Industrial	0	0	84,047	6,547	10,023	100,617	0	0	100,617
Integrated Resource Planning	0	0	0	0	0	0	0	0	0
Demand-Side Management	75,000	0	384,228	0	0	384,228	0	0	459,228
Total Energy Conservation	**159,596**	**0**	**975,968**	**84,940**	**527,294**	**1,588,202**	**108,324**	**187,122**	**2,043,244**
ENERGY PLANNING:									
Strategic Energy Planning	330,000	0	408,113	0	0	408,113	0	0	738,113
Energy Emergency Planning	35,000	0	37,175	0	0	37,175	0	0	72,175
Regional Petroleum Reserve	0	0	25,000	0	0	25,000	0	0	25,000
Total-Energy Planning	**365,000**	**0**	**470,288**	**0**	**0**	**470,288**	**0**	**0**	**835,288**
Grand Totals	**674,596**	**2,000,000**	**1,477,832**	**84,940**	**527,294**	**2,090,066**	**108,324**	**187,122**	**5,060,108**

Source: Hawaii Department of Business, Economic Development & Tourism.

HYDROELECTRIC POWER PLANTS IN HAWAII: 1993

Island	Location	Stream	MW Capacity	Gross Generation (MWh)	Annual Oil Equiv.* (1000 Bbl)	Owner
Hawaii	Hilo	Wailuku	1.50	7.15	11.92	HELCO Puueo
	Hilo	Wailuku	0.75	3.66	6.10	HELCO Puueo
	Hilo	Wailuku	0.75	2.67	4.45	HELCO Waiau
	Hilo	Wailuku	0.35	0.81	1.34	HELCO Waiau
	Hilo	Ainako	0.01	0.04	0.07	Wenko Energy
	Hawi	Kohala Ditch	0.01	0.93	1.55	Hawi Ag & Energy
	Waimea	Waimea/ Waikaloa Pipeline	0.04	0.15	0.25	Hawaii County
	Haina	Hamakua Ditch	0.80	1.99	3.32	Hamakua Sugar
	Hilo	Wailuku	12.00	17.65	29.42	Wailuku River Hydro-electric Power Co.**
	Waimea	Kahua	—	—	—	Kahua Ranch***
	Island Total:		**16.21**	**35.05**	**58.42**	
Kauai	Waimea	Waimea	1.00	3.89	6.48	Kekaha Sugar[1]
	Waiawa	Kekaha Ditch	0.50			
	Lihue	Wailua Ditch	0.50	1.65	2.75	Lihue Plantation[2]
	Lihue	Wailua Ditch	0.80			
	North	Wainiha	3.80	10.90	18.17	McBryde Sugar
	Kalaheo	Alexander Res.	1.00	1.81	3.02	McBryde Sugar
	Kaumakani	Makawili	1.25	1.63	2.72	Olokele Sugar
	Island Total:		**8.85**	**19.88**	**33.14**	
Maui	Kaheka	Wailoa Ditch	1.50	16.43	27.38	HC&S
	Paia	Wailoa Ditch	0.90	6.21	10.35	HC&S
	Hamakua	Wailoa Ditch	0.50	0.15	0.25	HC&S
	Lahaina	Kauula[3]	0.50	0	0	Pioneer Mill Co., Ltd.
	Island Total:		**3.40**	**22.79**	**37.98**	
State Total			**28.46**	**77.72**	**129.54**	

* Oil equivalent based on 600 kWh per barrel of oil. Totals are rounded.
** Facility dedicated on July 30, 1993, but began providing electricity to HELCO in May 1993.
*** Research facility.
1 Combined generation with Kekaha Ditch 0.50 MW.
2 Combined generation with Wailua Ditch 0.80 MW.
3 Out of service during 1992 and 1993.

WIND FARM POWER IN HAWAII • 1993

Island	Location	No. of Units	Model	Capacity Each kW	Total Capacity MW	Gross Generation MWh	Annual Oil Equiv. (1000 Bbl)	Owner
Hawaii	Kahua Ranch	18/1	Jacobs	17.5/10	0.3	0.28	0.47	Kahua
	Kahua Ranch	3	Carter	25	0.1	0.15	0.25	Kahua/PICHTR
	Lalamilo*	120	Jacobs	20	2.3	3.56	5.93	HEI
	South Point	37	Mitsubishi	250	9.3	13.67	22.78	Kamaoa Wind Energy Partners
						0.02	0.03	Independents+
	Island Total:	**179**			**12.0**	**17.68**	**29.46**	
Molokai	Moomomi	3	Vestas	100	0.3	0.75	1.25	Zond Pacific
	Island Total:	**3**			**0.3**	**0.75**	**1.25**	
Oahu	Kahuku**	13	Westinghouse	600	7.8	2.08	3.47	Makani Uwila
	Kahuku**	1	MOD-5B	3,200	3.2	2.26	3.77	Makani Uwila
	Island Total:	**14**			**11.0**	**4.34**	**7.24**	
State Total		**196**			**23.3**	**22.77**	**37.95**	

* The total MW capacity is for the 120 units. Lalamilo is expecting to be at 75 percent capacity in early 1995.

** The HERS Makani Moae wind farm in Kahuku, Oahu, was closed by HERS parent company HEI in October 1992. HERS was purchased in April 1993 by New World Power Corporation, which renamed it Makani Uwila Power Corporation, resumed operation of the wind farm and resumed providing electricity to HECO.

\+ There are approximately 10 small privately owned wind generators selling power to HELCO. The generators vary in size from 10 kW-27 kW.

Gross generation is approximate for calendar year 1993 and will vary with annual wind conditions.

Oil equivalent based on 600 kWh per barrel of oil. Totals are rounded.

The following legislation on energy-related subjects was signed into law by the Governor in 1994. Material presented here represents summarized information; for complete details refer to full copies of the Acts.

Act 59 RELATING TO AVIATION FUEL SET-ASIDE FOR EMERGENCY AND ESSENTIAL SERVICES. Amends the laws relating to the emergency fuel set-aside program to provide that up to 10% of aviation gasoline and up to 5% of jet fuel used for emergency and essential intrastate air transport services shall be set-aside to alleviate the hardship of a petroleum shortage. (Hawaii Revised Statutes (HRS) sections affected: 125C-03, 125C-21, 125C-23.) Effective date: May 6, 1994.

Act 96 RELATING TO ENERGY. Separates the energy functional area as an individual section within the planning statute. Clarifies energy self-sufficiency to mean increased indigenous energy resources used in proportion to imported energy use. An energy policy objective was added requiring increased energy security in the face of threats to Hawaii's energy system and supplies. A requirement was added regarding energy planning and energy resource selection for comprehensive and in-depth accounting of direct and indirect costs and benefits to ensure that "externalities" are considered. Adds emphasis to energy efficiency and the use of alternate fuels within the transportation energy sector in both the energy and transportation sections of the State Plan. (HRS sections affected: 226- (1 Section), 226-17, 226-18.) Effective date: June 8, 1994.

Act 168 RELATING TO BUILDING CODES. Mandates that energy efficiency building standards based on the design requirements for improvements of energy utilization in buildings developed and approved by the American Society of Heating, Refrigerating and Air Conditioning Engineers, Incorporated (ASHRAE, 90.1), shall be incorporated by each county into its building code by October 24, 1994 (instead of July 1, 1978). (HRS sections affected: 46-19.5, 46-19.6.) Effective date: June 21, 1994.

Act 176 RELATING TO THE PUBLIC UTILITIES COMMISSION. Requires rules, guidelines, or other standards of a public utility which interpret federal or state laws governing nonutility generators, or which make a nonutility generator monetarily responsible for the public utility's costs and profits of doing business to be approved by the Public Utilities Commission before adoption. (HRS sections affected: 269- (1 Section.) Effective date: June 21, 1994.

Act 199 RELATING TO GOVERNMENT ASSISTANCE. Authorizes the Director of Business, Economic Development, and Tourism to adopt rules to mandate the use of ethanol in transportation fuel, and thus diversify the State's economy by accelerating the development and production of alternative transportation fuels. Requires gasoline sold in the State for use in motor vehicles to contain 10 percent ethanol by volume. Provides criteria. Allows the Director to authorize the sale of gasoline that does not meet the provisions of this section if sufficient quantities of competitively priced ethanol are not available or if the requirement would cause undue hardship. Requires each distributor to file certified statements with the Director showing the price and amount of ethanol available; the amount of ethanol-blended fuel sold by the distributor; the amount of non-ethanol-blended gasoline sold by the distributor; and any other information required by the Department. Provides for penalties. (HRS sections affected: As amended: 486E- (1 Section).) Effective date: July 1, 1996 (Approved June 21, 1994).

Act 209 RELATING TO PUBLIC UTILITIES. Allows nonfossil fuel producers to continue to receive reimbursement for the difference between the cost of alternative fuels and the cost of heavy fuel oil when there is a shortage of heavy fuel oil by extending the repeal date of Act 130-1992 to June 30, 1995. Deletes the qualifying requirements for a nonfossil fuel producer when nonfossil fuel sources are not available. Further directs the Public Utilities Commission to confer with utility companies, the consumer advocate, nonfossil fuel energy producers, and other interested parties to determine the effects of Act 130-1992, and report to the 1995 Legislature. (HRS sections affected: As amended: Act 29-1993.) Effective date: June 21, 1994.

Act 219 RELATING TO THE ISSUANCE OF SPECIAL PURPOSE REVENUE BONDS TO ASSIST AN INDUSTRIAL ENTERPRISE. Authorizes issuance of special purpose revenue bonds for the construction of a demonstration fuel-grade ethanol production plant in Hamakua, Hawaii, or in Kau, Hawaii, or in Waialua, Oahu, or in any other appropriate location in the State. Authorization to issue special purpose revenue bonds shall lapse on June 30, 1997. (HRS sections affected: None.) Effective date: June 22, 1994.

DBEDT - Energy Division 1994 Publications

- *State Energy Resources Coordinator's Annual Report, 1994*
- *1994 Hawaii Energy Tide Calendar*
- *Hawaii Model Energy Code: Energy Efficiency Standard For Building, July 1993*
- *Hawaii Model Energy Code: Impact Analysis, December 1993*
- *Hawaii Model Energy Code: Application Manual, August 1994*
- *Power Trek '94 (The Pacific Region Energy/Environmental Leadership Training Conference) Memories Book, August 1994*
- *Transitions Quarterly Newsletter*
- *A Home-Owner's Guide to Solar Water Heating with Oahu Sunshine Map, August 1994*
- *Hawaii's Energy Coloring Book, June 1994*
- *Have Some Energy on the House ... Solar, November 1994*
- *Proceedings of the Second Hawaii Energy Strategy Workshop, January 1994*
- *Hawaii Energy Strategy Program Status Report, December 1993*
- *Hawaii Energy Strategy Project 2: Fossil Energy Review (5 Volumes), December 1993*
- *Hawaii Energy Strategy Project 5: Transportation Energy Strategy, December 1994*

1994 ERC Report Acronyms

AFVs	=	Alternative Fuel Vehicles
b/d	=	Barrels Per Day
bbl	=	Barrel
BGF	=	Biomass Gasification Scale-Up Facility
Btu	=	British Thermal Unit
CD	=	Civil Defense
CIS	=	Commonwealth of Independent States
DBEDT	=	Hawaii Department of Business, Economic Development & Tourism
DBEDT-HEES	=	Hawaii Department of Business, Economic Development & Tourism-Hawaii Energy Extension Service
DEduc	=	Hawaii Department of Education
DLNR	=	Hawaii Department of Land and Natural Resources
DSM	=	Demand-Side Management
EEM	=	Energy Efficient Mortgages
EEP	=	Energy Emergency Preparedness
EPAC	=	Energy Policy Advisory Committee
ERC	=	Energy Resources Coordinator
GASCO	=	The Gas Company
GHEC	=	The Great Hawaiian Energy Challenge
GW	=	Gigawatt
GWh	=	Gigawatt Hour
HECO	=	Hawaiian Electric Company, Inc.
HELCO	=	Hawaii Electric Light Company, Inc.
HEP	=	Hawaii Integrated Energy Policy Development
HERS	=	Hawaiian Electric Renewable Systems
HES	=	Hawaii Energy Strategy
HFDC	=	Housing Finance and Development Corporation
HmERS	=	Home Energy Rating Systems
HNEI	=	Hawaii Natural Energy Institute
HRS	=	Hawaii Revised Statutes
HTDC	=	High Technology Development Corporation
ICP	=	Institutional Conservation Program
IRP	=	Integrated Resource Planning
ISTEA	=	Intermodal Surface Transportation Efficiency Act
KCC	=	Kauai Community College
KE	=	Kauai Electric
KERZ	=	Kilauea East Rift Zone
kTherms	=	Kilotherms
kW	=	Kilowatt
kWh	=	Kilowatt Hour
LPG	=	Liquefied Petroleum Gas (Propane)
LPM	=	Landfill-Produced Methane
MEC	=	Model Energy Code
MECO	=	Maui Electric Company, Ltd.
MOU	=	Memorandum of Understanding
MSW	=	Municipal Solid Waste
MUPC	=	Makani Uwila Power Corporation
MW	=	Megawatt
MWh	=	Megawatt Hour
NEED	=	National Energy Education Development Project
NELHA	=	Natural Energy Laboratory of Hawaii Authority
OPEC	=	Organization of Petroleum Exporting Countries
OTEC	=	Ocean Thermal Energy Conversion
PGV	=	Puna Geothermal Venture
PICHTR	=	Pacific International Center for High Technology Research
PSA	=	Public Service Announcement
PUC	=	Public Utilities Commission
PV	=	Photovoltaics
PV4U	=	Photovoltaics for Utilities
RFP	=	Request For Proposals
RPR	=	Regional Petroleum Reserve
SNG	=	Synthetic Natural Gas
SOH	=	Scientific Observation Hole
UH	=	University of Hawaii
USDOE	=	United States Department of Energy

ELECTRICITY

WATT	=	Basic unit of electric power.
1 WATT	=	Rate of energy transfer equivalent to 1 ampere flowing under the potential of 1 volt with a power factor of 100 percent.
KILOWATT (kW)	=	1,000 watts.
KILOWATT HOUR (kWh)	=	Amount of energy consumed or produced in 1 hour at a rate of 1,000 watts.
MEGAWATT (MW)	=	Unit of power equal to 1,000 kW.
MEGAWATT HOUR (MWh)	=	1,000 kW consumed or produced for 1 hour.
GIGAWATT (GW)	=	Unit of power equal to 1,000 MW.
GIGAWATT HOUR (GWh)	=	1,000 MW consumed or produced for 1 hour.

NATURAL GAS

Btu (British thermal unit)	=	Standard unit for measuring a quantity of heat energy, either electricity, natural gas or any other source of energy.
1 Btu	=	Amount of heat required to raise the temperature of 1 pound of water 1 degree Fahrenheit at sea level. (3,412.7 Btu = 1 kWh, and 1 Btu = 0.00001 therms)
1 therm	=	100,000 Btu. Natural gas is sold to ultimate customers by energy content (therms).
MCF	=	1,000 cubic feet. Natural gas is measured by volume (MCF) in producer pipeline transactions.
1 MCF	=	Energy content of approximately 1,050,000 Btu or 10.5 therms.

OIL

1 Barrel	=	42 U.S. gallons, or 5.6 cubic feet, or 159 liters or approximately 6,000,000 Btu.

Notes

NOTES

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