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Hawaii Alternative Fuels Utilization Program

Phase 3

Final Report

HAWAII NATURAL ENERGY INSTITUTE
School of Ocean and Earth Science and Technology
University of Hawaii at Manoa
August 1996

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DISCLAIMER

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Phase 3

Final Report

to the

U.S. Department of Energy

Grant No. DE-FG01-90CE50310

by

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August 1996

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HAWAII ALTERNATIVE FUELS UTILIZATION PROGRAM-PHASE 3

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EXECUTIVE SUMMARY

The Hawaii Alternative Fuels Utilization Program originated as a five-year grant from the U.S. Department of Energy (USDOE) to the Hawaii Natural Energy Institute (HNEI) of the University of Hawaii at Manoa. The objective of the program was to stimulate the use of alternative ground transportation fuels in Hawaii. Originally, research aimed at overcoming technical impediments to the widespread adoption of alternative fuels was an important facet of the program; however, at the request of USDOE, research efforts were ceased and the program focused on demonstrating alternative fuel vehicles and educating the public on alternative fuels.

This report describes alternative-fuel-demonstration and related activities that took place in Phase 3 of this program. Grants for Phases 4 and 5, which were originally intended to be part of the Hawaii Alternative Fuels Utilization Program, were not awarded to HNEI.

Demonstration activities centered on the use of methanol-based fuels in methanol flexible fuel vehicles (FFVs). The primary fuel was M85, a mixture of 85% methanol and 15% regular unleaded gasoline. Plans originally called for the purchase and demonstration of ethanol FFVs and/or the testing of methanol FFVs fueled with ethanol. Owing to difficulties in obtaining ethanol FFVs and conflicts with warranties offered by original equipment manufacturers, plans to include ethanol fueling in this program were abandoned.

In addition to the basic demonstration element, a series of public outreach activities took place to inform and educate the people of Hawaii on alternative transportation fuels and alternative fuel vehicles. Efforts also were directed toward establishing a public M85 fueling station in Hawaii and encouraging the general public to purchase methanol FFVs. Special activities were performed on the islands of Molokai, Oahu, and Maui, covering vehicle demonstrations, public outreach, and education.

Efforts to engage the general public and businesses, directly, in the purchase of methanol vehicles or, cooperatively, in the establishment of a public methanol fueling station, were unsuccessful. Although interest was expressed by various individuals and companies to participate in such activities, the newness of the technology and the uncertainty of economic viability proved to be significant deterrents.

In spite of the failure to achieve some of the stated objectives of the program, a number of successes can be reported in promoting alternative transportation fuels and vehicles in Hawaii, including the:

- Installation of an M85 underground storage tank and dispensing station which served FFVs belonging to the university, and state and federal agencies;

- Purchase and demonstration of a small fleet of FFVs and dedicated methanol vehicles on Oahu and the island of Maui, cooperatively by HNEI and State's Energy Division;

- Stimulation of importation to Hawaii of a fleet of FFVs by the federal GSA Fleet Management Center in Honolulu;

- Participation in a wide variety of public events featuring vehicle demonstrations, handout materials, and textual displays to educate the general public on alternative transportation fuels and vehicles; and

- Maintenance of performance records for the HNEI FFVs, to provide information concerning successful operation and fuel economy with M85 as well as gasoline.

INTRODUCTION

The Hawaii Alternative Fuels Utilization Program originated as a five-year grant (Grant No. DE-FG01-90CE50310) awarded by the U.S. Department of Energy (USDOE) to the Hawaii Natural Energy Institute (HNEI) of the University of Hawaii at Manoa. The overall program included research and demonstration efforts aimed at encouraging and sustaining the use of alternative (i.e., substitutes for gasoline and diesel) ground transportation fuels in Hawaii.

Originally, research aimed at overcoming technical impediments to the widespread adoption of alternative fuels was an important facet of this program. Metals in contact with methanol exhibit corrosion rates and kinetic mechanisms that are different from metals in traditional hydrocarbon fuels or in aqueous systems. To better understand the underlying phenomena, corrosion was explored in an earlier stage of this program using Electrochemical Impedance Spectroscopy and Molecular X-Ray Fluorescence Spectroscopy methods of analysis. By using those two methods in an integrated manner, both the rate and chemical nature of methanol corrosion could be determined. Alcohol fuels, particularly methanol, produce non-luminous flames that are nearly invisible during daylight; this poses potential safety problems relating to fire detection and suppression. Enhancing the visibility of methanol flames could increase the acceptability of alcohol fuels as alternatives to traditional hydrocarbon transportation fuels. To address the problem of poor flame visibility, pool flame luminosities of methanol/additive mixtures were investigated theoretically and experimentally earlier in this program. HNEI was instructed by USDOE to terminate all research efforts prior to the end of the previous phase (Phase 2) of this program; therefore, this phase (Phase 3) concentrated on demonstration of alternative fuel vehicles and on public education (in support of demonstration efforts).

Demonstration activities centered on the use of methanol-based fuels in alternative fuel vehicles (AFVs). The primary fuel used was M85, a mixture of 85% methanol and 15% regular unleaded gasoline. An M85 fueling station was established for fueling the methanol AFVs. This station was installed at the J.K.K. Look Laboratory, a facility of the University of Hawaii at Manoa, located near Kewalo Basin in Honolulu. The initial demonstration efforts involved the operation of dedicated methanol vehicles — vehicles capable of running only on M85 fuel. In the present phase, operations were expanded to include flexible fuel vehicles (FFVs) which can operate on M85 or regular unleaded gasoline or any combination of these two fuels.

Additional demonstration work was accomplished in attempting to involve other elements of Hawaii in the promotion and use of alcohol fuels for ground transportation in Hawaii. These activities gave attention to three different geographic areas within the Hawaiian Islands, with the intention of involving the private and public sectors in the demonstration of alcohol-based ground transportation. The three areas targeted were the islands of Molokai, Maui, and Oahu (with emphasis on Honolulu). Each of these areas was addressed in a concentrated manner, with the aim of initiating a successful methanol-based ground transportation demonstration program. When it became obvious that an attempt would be unsuccessful in one area, efforts moved to another area. Some successes were accomplished in each area, but no truly integrated demonstration program was achieved under this program.

Research activities, which took place in earlier phases of this program, were summarized in previous final reports submitted to USDOE. This report focuses on demonstration activities relating to Phase 3 of this program and on those activities performed in earlier phases which are related to Phase 3. Phases 4 and 5, which were originally intended to be part of the Hawaii Alternative Fuels Utilization Program, were not awarded to HNEI.

DEMONSTRATION EFFORTS

Alternative Fuels and Vehicles

The demonstration program has focused on the use of methanol fuel for ground transportation. The primary fuel employed was M85, a blend of 85% methanol and 15% regular unleaded gasoline.

Initial demonstration efforts began with a small fleet of dedicated methanol vehicles. Those vehicles could operate only on M85 and, therefore, were limited because they would be inoperable if M85 fuel were not available at the time or place needed. At first, the dedicated methanol units were filled with M85 using 5-gallon fuel containers, while an underground methanol storage tank and dispensing system was being constructed at the University of Hawaii's J.K.K. Look Laboratory near Kewalo Basin in Honolulu. Following construction, fueling of methanol vehicles in Hawaii has been performed almost exclusively from this M85 station.

Methanol FFVs were purchased in this phase of the program for use in the demonstration. Because such units are capable of operating on M85 or 100% regular unleaded gasoline or any combination of those two fuels, they overcome a major limitation of the dedicated methanol units, since widely-available gasoline fuel can be used whenever M85 is not available. During a portion of this phase, one FFV was transported to the island of Maui for inclusion in demonstration efforts there. For the duration of that element of the demonstration program, the FFV operated only on unleaded gasoline because plans for establishing an M85 fueling station on Maui were never implemented (see section on Maui).

The original objectives of this program also included the purchase and testing of ethanol FFVs and/or the testing of methanol FFVs fueled with ethanol. Provisions were made with the University's Chemical Stock-Room (the only unit in the State authorized to distribute neat ethanol) for HNEI to obtain sufficient quantities of ethanol to initiate an ethanol demonstration to parallel the methanol demonstration. However, while the ethanol demonstration was being planned, HNEI could not obtain assurances from original equipment manufacturers that ethanol FFVs would be made available for purchase by HNEI or that the warranties of methanol FFVs fueled with ethanol would be honored; hence, plans to include ethanol fueling in this program were abandoned. Much later, Ford Motor Company indicated the availability of ethanol FFV Tauruses, but by that point, it was too late to include such vehicles in this program.

Demonstration Program Elements

The overall goal of this program was to encourage and sustain the use of methanol for ground transportation fueling in Hawaii. Several elements were included in the program in pursuit of that goal. First, a suitable methanol fuel dispensing facility was established (Fig. 1). Even though the Look Laboratory M85 station was restricted to users that had formal cooperative agreements with HNEI and, therefore, was not a true public fueling station, it did bring methanol fueling capability to the State of Hawaii. Methanol FFVs (and dedicated methanol vehicles) were obtained and operated in various areas within the Hawaiian Islands. These two elements formed the basis for the demonstration of methanol fueling and alternative-fuel vehicle operation in Hawaii. Most of the basic demonstration efforts were conducted in Honolulu, Hawaii's population center, on the island of Oahu.

Fig. 1. M85 fueling station at J.K.K. Look Laboratory.

Beyond these basic elements, a series of public outreach activities took place as part of this program to inform and educate the people of Hawaii on alternative transportation fuels and the vehicles which use them. In addition, efforts were directed toward establishing a public M85 fueling station in Hawaii and encouraging the general public to purchase methanol FFVs. Moreover, special analyses, studies, and demonstration efforts were carried out on the neighbor islands of Molokai and Maui, with further work in vehicle demonstration, public outreach, and educational activities being conducted. One vital aspect of the neighbor island interactions was the presence of the Maui biomass gasifier facility (see discussion on Maui) which might produce methanol in the future.

The following sections present highlights of the work which was performed in this program on Molokai, Oahu, and Maui. Molokai was chosen for analysis because of its special nature: a single, isolated unit within Hawaii with relatively small size and population. As such, that island appeared to be a good focal point, being somewhat manageable in dimensions of interest, specifically in analyzing the requirements for converting to a methanol fuel economy. Having a much larger population and being a central hub for business activity, the island of Oahu was an obvious place for pursuing general fuel and vehicle demonstrations, as well as the most logical site for a public M85 fueling station. Maui was also an appropriate place for examination because it is the site of the biomass gasifier facility; furthermore, it has Maui Community College, which, with its closed-circuit-TV educational system serving the three islands of Maui County (Maui, Molokai, and Lanai), would form a central point for educating the public on alternative transportation systems.

Molokai

The energy industry in Hawaii is heavily dependent on imported energy. This is especially true for ground transportation fuels, i.e., gasoline and diesel fuel, which are made solely from imported oil. One method for producing methanol is gasification of biomass and conversion of the product gas, catalytically, into methanol. The production of methanol (and other alternative fuels) from biomass resources is of particular interest to Hawaii because locally grown biomass could be converted in an integrated manner into electric power and ground transportation fuel (methanol). Such an integrated scheme would be useful in achieving the transition of an entire community from imported oil to indigenous bioenergy.

In the previous phase of this program, Molokai was selected as a model community for examining all of the pertinent issues involved in such a transition. Molokai has demonstrated good agricultural potential for biomass production. It is relatively small and has limited population and total energy demand. These features combine to make Molokai a manageable model for considering a transition on an entire community to an alternative fuel. In addition to being the basis for a transition study, that island was also seen as an appropriate site for a small demonstration on methanol FFVs.

In all of the various elements examined in the transition process and demonstration program for Molokai, significant efforts were expended in working closely with the community to inform the locals about alternative fuels and AFVs. The Molokai Energy Task Force, which meets once a month to discuss energy matters, was instrumental in this regard. This Task Force consists of representatives from a wide range of interests within the community (government, non-profit agencies, business, agriculture, and the general public). Preliminary discussions between HNEI and the Task Force spurred much interest in establishing an alternative fuels demonstration and modeling effort on Molokai. Several representatives from HNEI attended a series of Molokai Energy Task Force meetings over a period of about one year. The alternative fuels project was described during several meetings and a request to conduct a study on Molokai was presented and approved unanimously by the Task Force.

During interactions with the Task Force, it was suggested that a fleet of approximately six FFVs would form a good starting point for demonstration efforts on Molokai. The plan was to encourage participants on Molokai to purchase FFVs which could run on gasoline until an M85 fueling station was established on Molokai using funds from this program. This plan was approved by the Task Force. Appeals were made to members of the Task Force, and appropriate business and government organizations on Molokai with vehicle fleets were contacted to stimulate purchasing of FFVs for the demonstration. In addition, an informative and positive article about methanol and methanol-powered vehicles was placed in both of Molokai's newspapers (Attachment 1). This article provided details about the program and the different methanol FFVs which were available at the time. It also encouraged individuals and/or organizations to participate in the study by purchasing one or more FFVs. It was made clear that the program would cover any incremental costs for purchasing and operating the FFVs, so that any vehicle in the program would not cost more than the gasoline-equivalent model, and the cost of M85 would be adjusted so that it did not exceed that for the equivalent amount of gasoline. Unfortunately, little interest was expressed in participating in the alternative fuels demonstration on Molokai. The fact that participants did not step forward to purchase any FFVs is somewhat understandable based on conditions on Molokai. The island is relatively depressed economically (having an average income that is lower than the state average and an agricultural base with high unemployment), has little desire for the types of vehicles available as FFVs (there was a preference for pickup trucks, vans, and compact vehicles), and has generally traditional, conservative attitudes (i.e., desire to continue with customary equipment, and concern over new and different machines).

The investigation of transitioning to methanol fuel on Molokai was completed. This study included a variety of possibilities for the future. Five different cases were explored, including a Base Case, in which methanol FFVs gradually replaced gasoline passenger vehicles and methanol was imported from the mainland at the lowest price possible, and four alternative cases involving the establishment of a biomass plantation and construction of a bio-methanol plant. In each case, a phased program was explored, including a 12-year transition period with the development of all steps needed to achieve the goals. Costs for implementing the steps necessary ranged from $14 million in the Base Case to $136 million for the most ambitious case involving a biomass plantation and bio-methanol plant. A report covering all details of the transition study was submitted to USDOE.

Oahu

After attempts at establishing an FFV demonstration with community participants on Molokai proved unsuccessful, new efforts were begun in Honolulu. It was felt that some of the factors that led to failure in implementing a demonstration program on Molokai would be absent in Honolulu. Furthermore, successful demonstration of FFVs in Honolulu would provide experience useful to the Molokai situation and contribute to building confidence in FFVs for the people of Molokai and elsewhere in the state.

A series of presentations was made to government agencies and businesses to encourage participation in a methanol FFV demonstration program. Some interest was expressed, but the absence of a public M85 fueling situation was a deterrent. There was concern that the cost to establish a public fueling station within any government agency or business would be excessive. Attempts also were made by HNEI and the Energy Division of the Hawaii State Department of Business, Economic Development and Tourism (DBEDT) to obtain commitments by private companies to cooperate in establishing one or more public M85 fueling stations. Initial interest was expressed by a major gasoline retailer in the state, BHP Gas Express (a division of BHP Hawaii, Inc.), and several meetings suggested that a favorable view was being given to locating an M85 fueling station at a BHP Gas Express retail outlet which was scheduled for expansion. Unfortunately, the company decided against methanol, electing instead to focus its efforts and resources on liquefied petroleum gas (which is produced by BHP Gas Company, a separate division of BHP Hawaii, Inc.).

Since no outside participants stepped forward to purchase FFVs for a demonstration program, it was decided to proceed with a less ambitious internal plan to obtain a small fleet to at least launch a demonstration project using vehicles of the flexible fuel design. Two Chevrolet Lumina FFVs were purchased by HNEI, in cooperation with DBEDT (Fig. 2). HNEI began demonstrating one of these vehicles, primarily in Honolulu, and DBEDT began demonstrating the other. DBEDT activities, in cooperation with HNEI, have included an extensive public education/outreach program, with display of the vehicles at exhibits on Oahu and the neighbor islands.

After the FFV demonstration was underway, the federal GSA Fleet Management Center in California became aware of our efforts. That office contacted HNEI about making the Look Laboratory M85 fueling station available to the GSA Fleet Management Center in Honolulu, in the event that methanol FFVs were sent to its Honolulu office. HNEI agreed to cooperate with GSA in this endeavor and entered into an agreement with the GSA office in Honolulu to provide M85 fuel and tracking of fuel usage on a vehicle-by-vehicle basis for GSA. An initial group of FFVs arrived at GSA's Honolulu office, including several Dodge Spirits and a Ford Taurus. HNEI moved ahead with its own demonstration efforts and subsequently arranged for a special showing of several FFVs at a University of Hawaii open house (Fig. 3). Several thousand people, including more than 1,200 school children, and their teachers and parents, attended the two-day event. HNEI's display consisted of posters and handout materials (Attachment 2), plus three methanol FFVs, including one from each of the Big Three automobile manufacturers, Chrysler, Ford, and GM.

Although considerable success was attained in the public demonstrations of methanol vehicles, the goals of true community involvement in participant fleet demonstration and the establishment of a public M85 fueling station had not been met. Explorations continued in an effort to generate community participation elsewhere.

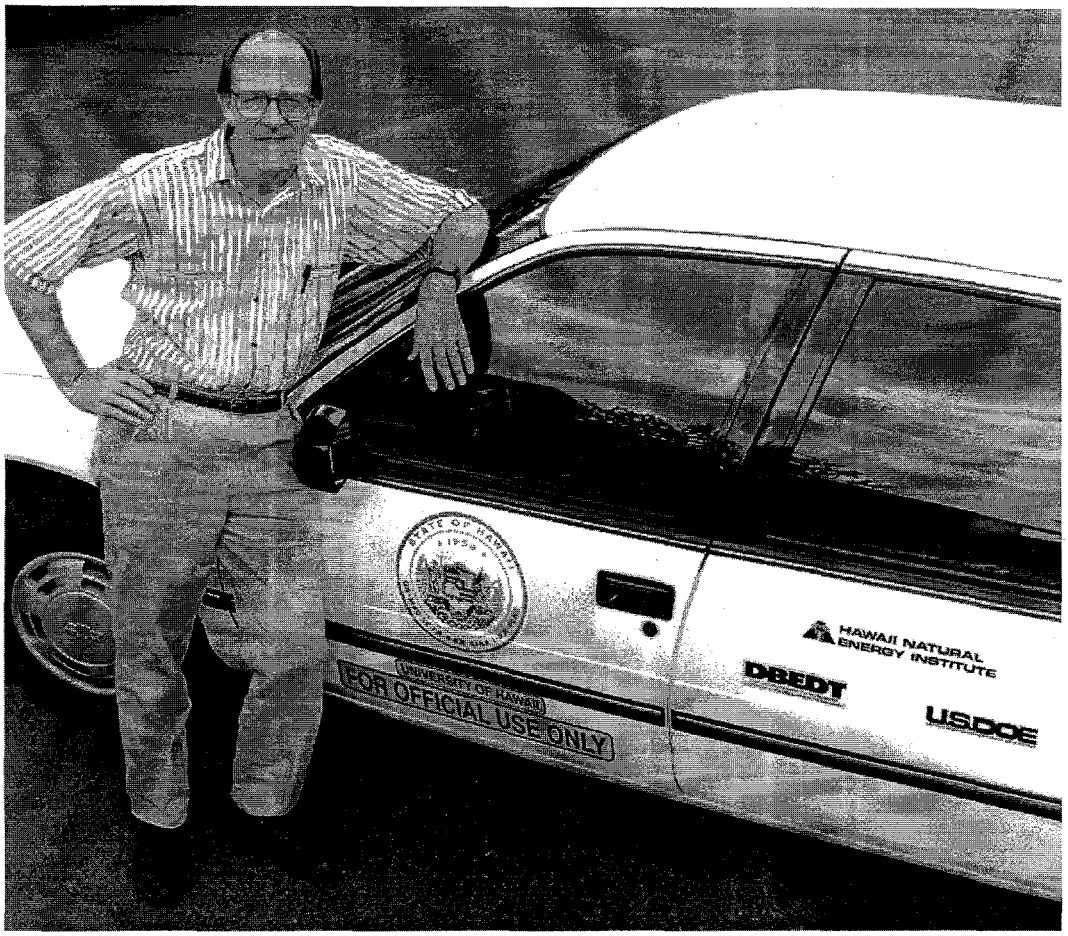


Fig. 2. Methanol FFV purchased by HNEI for demonstration program on Oahu and exhibits on neighbor islands.

Maui

The island of Maui seemed to be a logical location for an integrated alternative fuels demonstration program involving methanol. In the planned third phase of the biomass gasifier facility program headed by the Pacific International Center for High Technology Research (PICHTR), a portion of the gas generated would be converted into methanol via a catalytic process (Fig. 4). Having locally produced methanol and foregoing the importation of methanol to the islands, would provide for a much more meaningful integrated methanol demonstration program. Following the failure to establish a community-based fleet demonstration and a true public M85 fueling station on Oahu, Maui was targeted as a potential site for a methanol fuel demonstration program.

Early discussions with a number of Maui governmental and educational leaders eventually led to plans for an integrated demonstration project on that island. Informal agreements were reached with the County of Maui, Maui Community College, and Maui High School. Interest was expressed by Maui Oil Company to participate by placing a public M85 fueling station at its Kahului fueling facility.

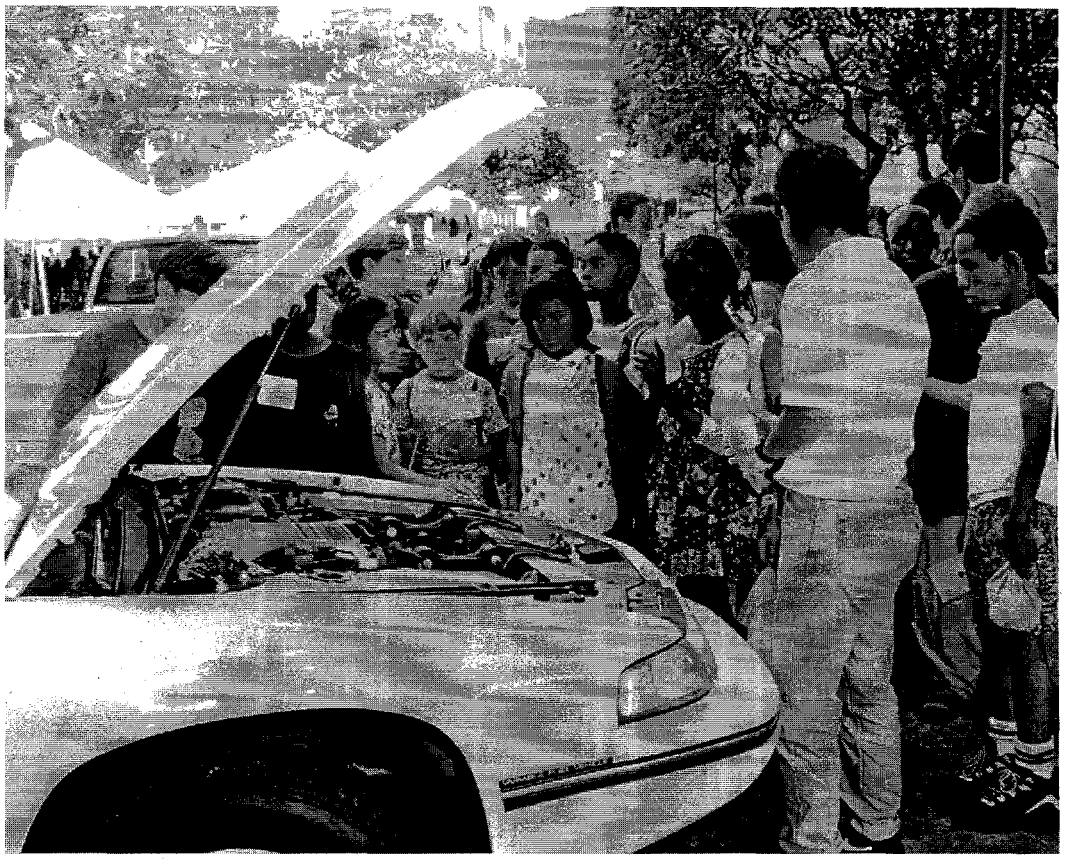
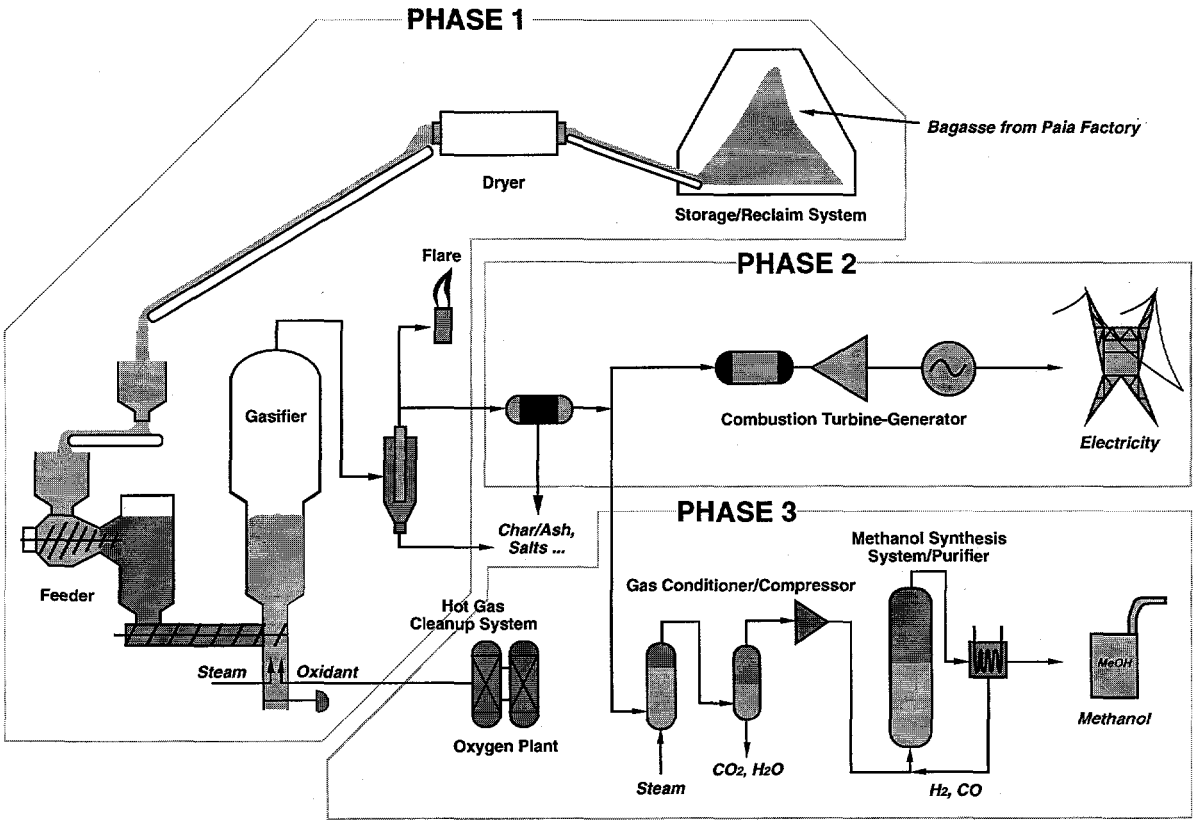


Fig. 3. Open-house demonstration at University of Hawaii, displaying FFVs produced by Big Three automobile manufacturers.

The key element in the overall plan was a letter of cooperation from Maui County, pledging to purchase FFVs in forthcoming county fleet additions and allocate space within the county corporation yard for a temporary M85 fueling facility. A draft Memorandum of Understanding (MOU), covering all activities, was prepared. Maui Community College (MCC) was to participate with special public demonstration of one of the HNEI FFVs and preparation of an educational video on alternative fuels and vehicles for airing on its closed-circuit TV channel reaching all three islands of Maui County (Maui, Molokai, and Lanai). Maui High School would participate by obtaining a new FFV and/or using the MCC FFV in its driver education program, and including a training element on alternative fuels and vehicles in the same program. Draft MOUs for the work to be done at MCC and Maui High School were also prepared.

An MOU between HNEI, MCC, and PICHTR was completed (Attachment 3) and implementation was initiated. HNEI shipped its Lumina FFV to Maui and the demonstration program began with a prominent designated parking area for this vehicle (Fig. 5). Work on the educational video commenced.

Completion of the MOU with Maui County was delayed by a number of administrative and legal complications (plans for relocating the corporation yard and liability issues concerning



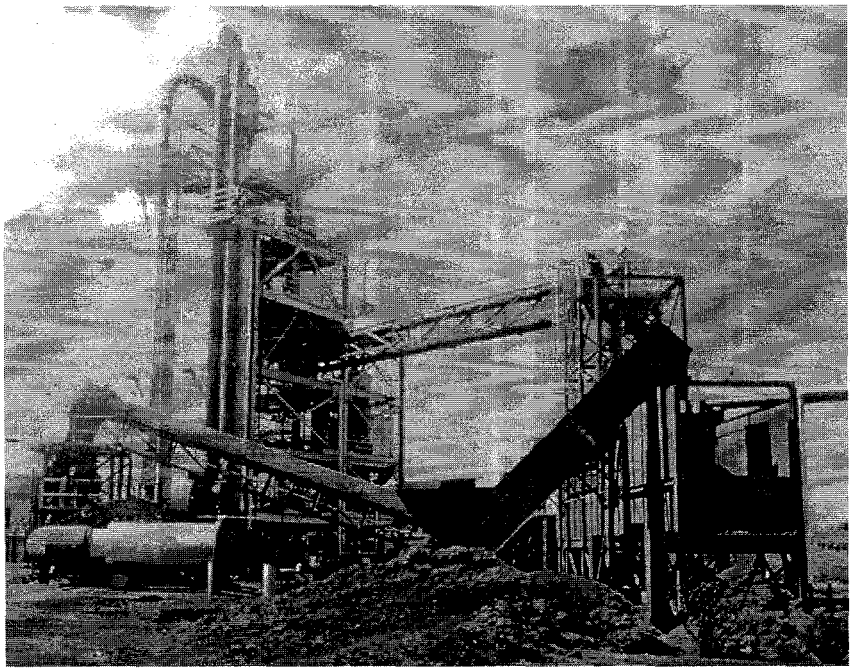


Fig. 4. PICHTR Biomass Gasifier Facility scale-up project in Paia, Maui. (a) Graphic showing three phases of project, with Phase 3 involving methanol production which would supply locally-produced methanol for FFV demonstration; (b) actual biomass gasifier facility in 1995.

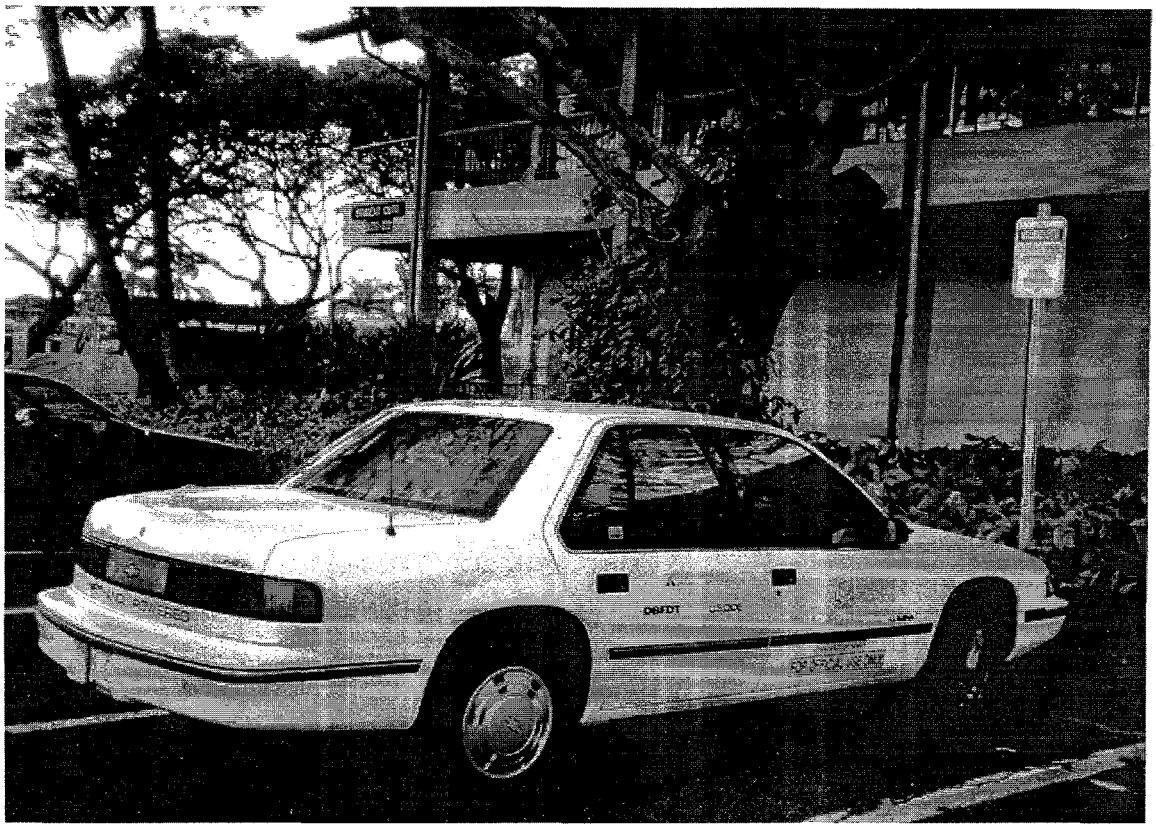


Fig. 5. Exclusive parking area established for HNEI FFV at Maui Community College.

methanol fuel hazards). Purchase of FFVs was also delayed by complications and administrative difficulties (inability to meet certain county vehicle model needs and prolonged illness by a key administrator). These delays prevented implementation of key features of the Maui plan, and this inactivity resulted in diminished interest in the entire program on the part of the main county administrator. Seeing that difficulties were being experienced in establishing the fueling station, the administrator felt less encouraged to pursue obtaining FFVs for the county fleet. Ultimately, it became obvious that the county would not be able to fulfill its original commitments.

Although plans to include ethanol fueling on Oahu were abandoned owing to a lack of ethanol FFVs from original equipment manufacturers (refer to section "Demonstration Efforts — Alternative Fuels and Vehicles"), when it became obvious that an M85 fueling station would not be installed on Maui, the idea of fueling a portion of the county vehicles with a gasoline-ethanol blend was explored with county administrators. Some of the logistical issues were worked out, but, as with earlier attempts with methanol, Maui County was unable to commit to an ethanol fuel program.

With the failure in accomplishing primary portions of the Maui methanol fueling effort and with the Maui biomass gasifier facility project falling behind schedule (pushing the methanol-production phase of that project farther into the future) it was clear that the planned

demonstration program could not be achieved on that island. The HNEI FFV was returned to Oahu and possibilities on Oahu were once again examined.

Oahu Revisited

Continued cooperation in providing M85 fuel to the GSA Fleet Management Center in Honolulu resulted in an expansion of the GSA methanol FFV fleet in Hawaii. Initially, that fleet consisted of six vehicles. Over time, this was increased to a total of 12 GSA methanol FFVs being fueled from the HNEI M85 station. At one time, there was a total of 17 methanol vehicles assigned for fueling at the Look Laboratory M85 dispensing station (including the FFVs being demonstrated by HNEI and DBEDT and dedicated methanol vehicles).

In conjunction with previous efforts to stimulate interest in the demonstration program, HNEI joined several other public and private groups in developing and signing an MOU to participate in the City and County of Honolulu's Clean Cities Program. The MOU aimed to develop local industry and infrastructure, and educate the public on alternative fuels and thereby stimulate the use and reduce the cost of alternative transportation systems in Honolulu. HNEI pledged to continue its demonstration and data collection on methanol FFVs, operate the Look Laboratory M85 fueling station, and participate in the Maui biomass gasifier facility project with the goal of producing methanol at the facility and earmarking a portion of that fuel for a demonstration on Oahu.

In the interest of producing a greater impact in the demonstration program on Oahu, plans were developed for an expanded effort over a longer period of time, involving increasing the total number of methanol FFVs and obtaining additional methanol to increase the M85 fuel supply accordingly. With a larger fleet of methanol FFVs being demonstrated for a longer period, it was felt that the demonstration program would be able to stimulate interest and confidence in methanol vehicles to the point where businesses and/or the general public would begin to participate. This optimism was spurred by the very positive publicity that the GSA effort received locally (e.g., see excerpts from local television news report, Fig. 6, and excerpt from Clean Cities newsletter, Attachment 4).

It was learned that a significant quantity of methanol might be available on Oahu through the U.S. Navy. A proposal was prepared to obtain that methanol and continue operation of the HNEI M85 fueling station well beyond the USDOE-funded program. This proposal included the necessary budget for accomplishing the objectives of the expanded effort and included costs for methanol fuel, additional equipment for keeping individual fueling records for an expanded fleet, and operating costs for maintaining the M85 station. The proposal required cost-sharing by the GSA Fleet Management Center in Honolulu, HNEI, and DBEDT. In this plan, the GSA fleet would be able to more than double its number of units in an expanded demonstration. DBEDT did provide a positive commitment to participate in this new effort, but the GSA Fleet Management Center in Honolulu was unable to obtain such a commitment from higher level authorities.

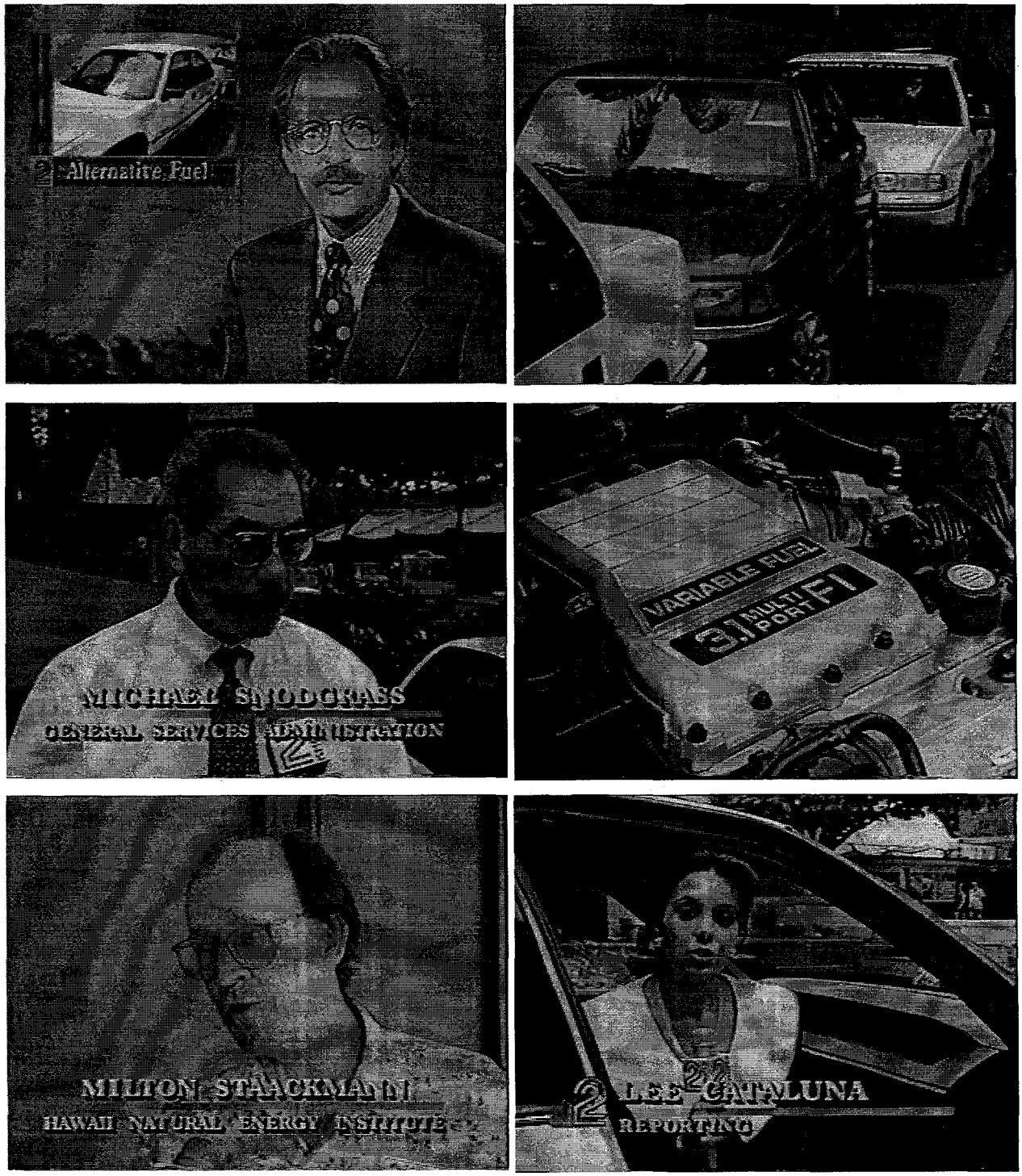


Fig. 6. Frames extracted from local television news report on GSA-Hawaii/HNEI methanol vehicle program.

Failure in securing participation and cost-sharing by GSA led to cancellation of the expansion effort on Oahu. For a variety of reasons, the GSA office decided not to expand its fleet of methanol FFVs in Hawaii, but, instead, has chosen to reduce its fleet of FFVs. With this combination of factors, the offer of methanol from the U.S. Navy had to be turned down, since there were insufficient funds to continue fueling operations in Honolulu into the future.

As a result of the above circumstances, HNEI has been unable to pursue plans for an expanded demonstration of methanol vehicles and fuel on Oahu. In a show of good faith and in support of the concept of alternative transportation fuels, HNEI will continue to operate the M85 fueling station at Look Laboratory for as long as the existing fuel supply and HNEI's internal funds allow.

Achievements in Demonstration Program

In spite of the failure to achieve some of the objectives of this overall program, a number of real successes can be reported in promoting alternative transportation fuels and vehicles in Hawaii:

- Installation of an M85 underground storage tank and dispensing station;
- Purchase and demonstration of a small fleet of FFVs and dedicated methanol vehicles on Oahu and the island of Maui, cooperatively by HNEI and DBEDT;
- Stimulation of importation to Hawaii of a fleet of FFVs by the GSA Fleet Management Center in Honolulu;
- Participation in a wide variety of public events with demonstration vehicles, handout materials, and textual displays to educate the general public on alternative transportation fuels and vehicles; and
- Maintenance of performance records for the HNEI FFVs, to provide information concerning successful operation and fuel economy with M85 as well as gasoline.

QUANTITATIVE RESULTS

The two Lumina FFVs, assigned to HNEI and to DBEDT, performed reliably over the nearly three years of this phase (Phase 3) of the demonstration program. To ensure that the M85 being dispensed at the Look Laboratory fueling station was sound, on several occasions, samples of fuel were sent to independent laboratories on the mainland for analysis, with each sample yielding positive results. Most of the operating time involved performance on M85 fuel as dispensed from the Look Laboratory station; however, the FFVs also operated on 100% gasoline during a small portion of the demonstration program and on blends of M85 and 100% gasoline while transitioning between M85 and gasoline. Both FFVs were delivered to HNEI with

gasoline in the fuel tanks, so initially, they operated on gasoline. With subsequent addition of M85, operation continued over several fueling incidents with increasing percentages of methanol in the fuel tank, until a nominal 85% concentration of methanol was achieved. For the DBEDT vehicle, M85 was utilized for the remainder of this demonstration. The HNEI vehicle, however, experienced two additional transitions in methanol percentages because M85 was not available during the period of demonstration on Maui. There was the initial transition from 85% methanol (15% gasoline) to 0% methanol (100% gasoline), after shipment of the vehicle to Maui. This was followed by a similar transition back to 85% methanol, upon return of the vehicle to Honolulu and the resumption of fueling with M85.

The 12 vehicles of the Honolulu GSA Fleet Management office were supplied a total of 3,287 gallons of M85 fuel over the duration of the cooperative program between HNEI and GSA. The quantities are broken down by year in Fig. 7.

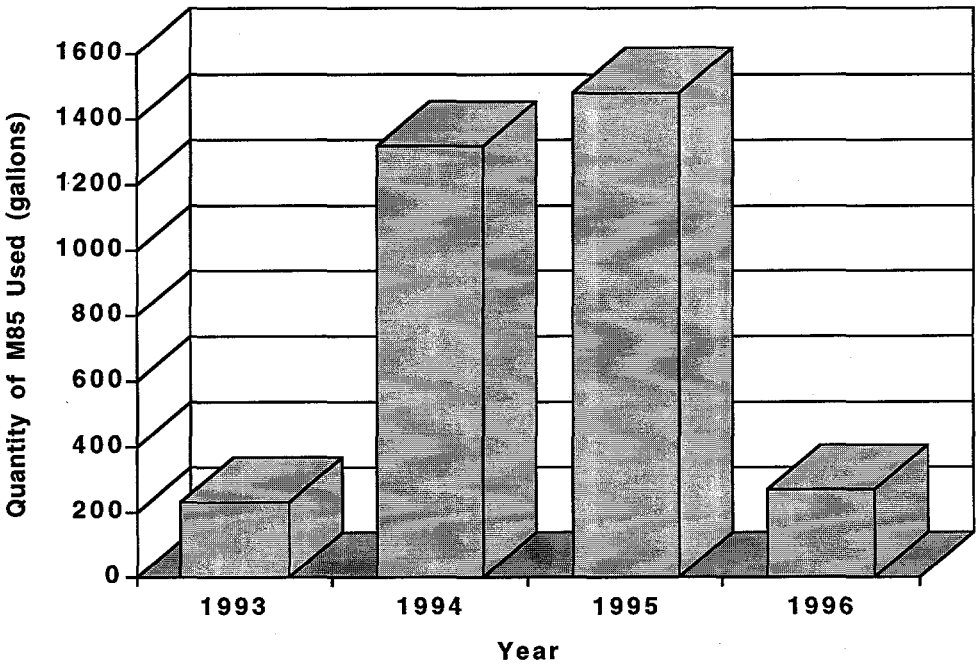


Fig. 7. Consumption of M85 by GSA Hawaii fleet during present phase of demonstration program.

M85 fuel was supplied to the GSA office over a total period of 31 months, with an average of just over 106 gallons per month being consumed. The peak monthly usage was 173 gallons and the minimum monthly usage (during GSA's first month of participation) was 12 gallons.

The FFV demonstrated by DBEDT was supplied a total of 837 gallons of M85 fuel from the beginning of operation of that vehicle (shortly after the vehicle was purchased and released for use in 1993) through June 5, 1996. The quantities are broken down by year in Fig. 8.

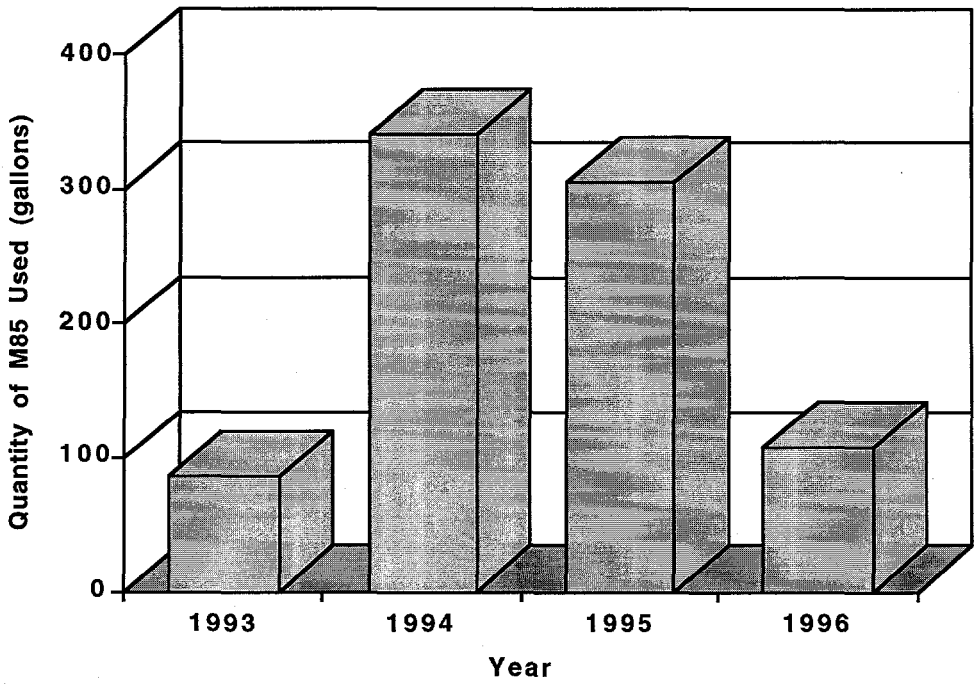


Fig. 8. Consumption of M85 by DBEDT FFV during present phase of demonstration program.

M85 fuel was supplied to the DBEDT vehicle over a total period of 30 months, with an average of almost 28 gallons per month consumed. The peak monthly usage was 55 gallons and the minimum monthly usage was zero gallons.

The FFV demonstrated by HNEI was supplied a total of 334 gallons of M85 fuel from the beginning of operation of that FFV (shortly after the vehicle was purchased and released for use in 1994) through June 18, 1996. The quantities are broken down by year in Fig. 9.

M85 fuel was supplied to the HNEI vehicle over a total period of 15 months (this excludes the period when the vehicle was on loan to Maui Community College, where no M85 was available), with an average of about 16 gallons per month being consumed. The peak monthly usage was 40 gallons and the minimum monthly usage (during the first month of operation of that vehicle) was 3 gallons.

In summary, during the period that individual vehicle records were maintained, which includes the entire time that FFVs were being fueled, a total of 5,343 gallons of M85 fuel was dispensed (through June 18, 1996). Of this quantity, the FFVs were fueled with a total of 4,458 gallons and the dedicated methanol vehicles with a total of 885 gallons. The quantities are broken down by year in Fig. 10.

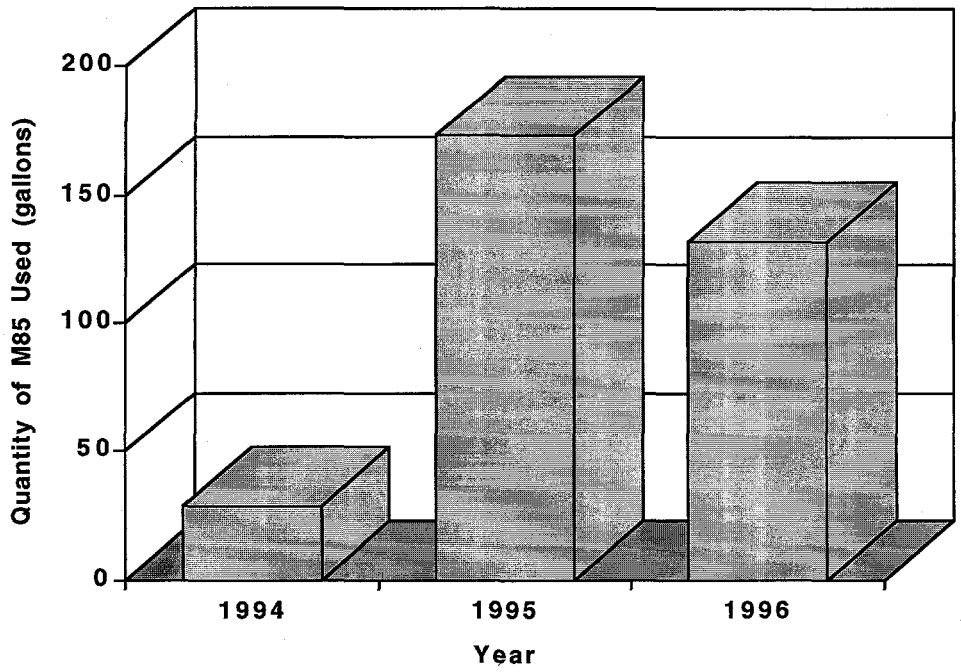


Fig. 9. Consumption of M85 by HNEI FFV during present phase of demonstration program (FFV spent portions of 1994 and 1995 on Maui, where no M85 was available).

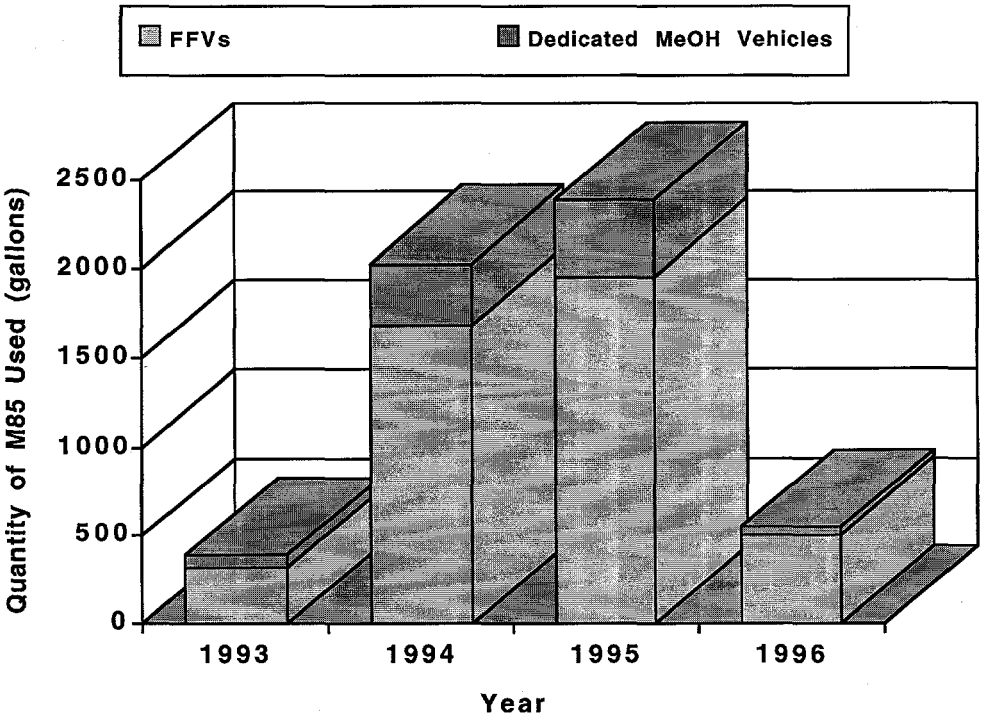


Fig. 10. Consumption of M85 by all methanol-fueled vehicles (FFVs and dedicated methanol vehicles) during present phase of demonstration program.

Records concerning fuel economy are available for about 3,200 miles of operation for the HNEI FFV. During about 1,400 miles of operation on Maui, the fuel economy averaged 18.1 miles per gallon while operating on 100% gasoline. While operating on Oahu using M85, the fuel economy averaged 6.8 miles per gallon of M85 for a distance of about 1,800 miles. This translates to about 12.0 miles per gallon, gasoline equivalent. The difference in fuel economies can at least be partially explained by the fact that the Maui experience included trips with an average distance of roughly 20 miles while the Oahu experience had trips with an average distance of roughly 10 miles. Shorter trips and more stop-and-go travel characterized the Oahu experience and contributed to the poorer fuel economy under M85 fueling.

Similar records are available for about 3,300 miles of travel for the DBEDT FFV, all on M85. The fuel economy achieved was 8.7 miles per gallon of M85 or 15.3 miles per gallon, gasoline equivalent. During this time, the vehicle had trips which averaged about 11 miles.

CONCLUSIONS

Significant results have been achieved in the demonstration elements of this program, aimed at encouraging the use of alcohol ground transportation fuels and vehicles in Hawaii. Specifically, a series of tangible accomplishments can be delineated which clearly showed the successful use of methanol as a blended fuel in FFVs as well as in dedicated methanol vehicles. Furthermore, extensive efforts were made in conducting public displays of the vehicles and literature concerning alternative fuels and vehicles.

Specific accomplishments include the following:

- Installation of an M85 fueling station;
- Demonstration of five methanol vehicles (including two FFVs) by HNEI and DBEDT;
- Stimulation of importation of 12 FFVs by the GSA Fleet Management Office in Honolulu; and
- Participation by HNEI in several public events, involving thousands of attendees, such as, open houses at the University of Hawaii at Manoa, the Hawaii Transportation Association Annual Conference, local parades, and Earthfest '96.

Activities conducted in attempts to engage the general public and businesses, directly, in the purchase of methanol vehicles or, cooperatively, in the establishment of a public methanol fueling station, were unsuccessful. Much interest was generated in the subject and certain individuals and companies gave serious consideration to becoming directly involved. In all cases, however, the newness of this technology and the uncertainty of economic viability proved to be deterrents to active participation. In general, nearly everyone who would have paid any attention to the information presented on the concept of alcohol fuels for ground transportation

was favorable to the ideas presented, but bottom-line considerations prevented serious action on their part.

In Hawaii, the only remaining viable alternatives to gasoline- or diesel-powered vehicles are liquefied petroleum gas (LPG) vehicles and electric vehicles (EVs). LPG vehicles have been operating in Hawaii for some years and a local supply of LPG is available on Oahu. Within the last two years, a public LPG dispensing station was established in Honolulu. Interest which had been expressed initially in collaborating with HNEI to build a public methanol fueling station was abandoned when the targeted company decided to pursue LPG as a preferred alternative fuel. Some of the governmental units on Oahu have elected to pursue LPG vehicles for their fleets, especially since there is extensive experience with such vehicles and the fuel is locally available at a public fueling station.

The arena of EVs has also gained ground in the last two years. U.S. Electricar has established an assembly plant in Honolulu for converting gasoline vehicles into EVs and the Suntera organization is involved in designing and constructing EVs on the Big Island of Hawaii. The local electric utility companies in Hawaii are involved in operating EVs. They are committed to demonstrating these vehicles and bringing them to commercialization in Hawaii. This is not surprising since utility companies have a vested interest in the "fuel" for EVs (electricity).

Two major lessons were learned from this effort, regarding how to achieve success in an alternative transportation fuel program. Perhaps the first lesson should have been obvious from the beginning of this program — success in this type of program can be achieved only with significant expenditure of money in providing incentives for the purchase of vehicles, fuel, and fuel-dispensing stations. Initial efforts to make the FFVs available at the same price as conventional vehicles spurred no interest from private businesses, governmental agencies, or the general public. The program was able to attract serious interest in purchasing vehicles only by offering an incentive of up to $1,000 per vehicle and even in this case the interested party failed to follow through and actually purchase any vehicles. California has been able to establish a sound methanol vehicle demonstration program, but only after offering extensive incentives at all levels, including multi-million dollar incentives to automobile manufacturers.

The second lesson is less obvious — success of an alternative fuel program depends on having a fuel supplier with a vested interest in the fuel being promoted. Such interest did not exist in Hawaii. There are no manufacturers or major retailers of methanol in the state. Our attempts to interest a local petroleum-product distributor in establishing a public M85 fueling station were not successful, even though we offered to cover about one-half of the cost of establishing such a station. The distributor's decision to instead pursue LPG as an alternative fuel ultimately led to our failure to establish a public M85 fueling station. In this case, M85 would have competed with LPG, for which the supplier had a vested interest. If there had been a supplier of methanol in the islands, our chances for cooperation surely would have been much higher and a public M85 fueling station probably would have been established.

ATTACHMENT 1

ADVERTISEMENT PLACED IN MOLOKAI NEWSPAPER SEEKING PARTICIPANTS FOR METHANOL DEMONSTRATION PROGRAM

IN THE MATTER OF

Hawaii Natural Energy Institute USDA Methanol Program
PO#8491006 dated 12-19-91 per Milton Staakmann

Participants Sought
for Moloka'i Methanol Car Project

(Honolulu)--The Moloka'i Energy Committee has voted to approve use of Moloka'i in a study of methanol-powered automobiles. The study is being done by the Hawaii Natural Energy Institute (HNEI) of UH, under contract with the U.S. Department of Energy. Methanol is an alternative fuel for motor cars which burns with much less pollution than gasoline and could be produced in Hawaii. Moloka'i will be involved in two ways. First, it will be used as a model area to see what it would take to have methanol replace gasoline, if methanol were to become the fuel of the future. Second, Moloka'i will be the location of a demonstration fleet (up to six cars) of flexible-fuel vehicles (FFVs) which can operate on regular unleaded gasoline or methanol fuel (actually a mixture called M85, consisting of 85% methanol and 15% regular unleaded gasoline) or any combination of the two fuels.

Ford and General Motors are making FFVs and the next batch to be built will be done on a regular assembly line, from the ground up, just like normal cars. The first ones will be the Chevy Luminas, beginning in April or May 1992. Next will be the Ford Tauruses in November or December 1992 (or later). Chrysler will also have models out late in 1992 or early 1993.

HNEI is looking for operators for this fleet of six vehicles on Moloka'i. Each operator would purchase the vehicle as normal from a dealer and then operate it like a normal car. Some paperwork would have to be kept, so we have a record of performance. Extra costs for the methanol feature of the vehicle will be absorbed by the program and the methanol fuel will be sold at a price equivalent to gasoline (the actual extra cost absorbed by HNEI. So, for a participant in this program, costs for purchasing and operating the car will be the same as if a normal, gasoline-burning car were used. HNEI will build a methanol fueling station on Moloka'i for the use of all participants. Service and warranty work will be handled just as for a normal car --- service personnel will receive special training from the manufacturer on the few differences involving methanol use.

Individuals interested in participating in this program should call Milton Staackmann in Honolulu at 956-2348 as soon as possible. We need to get this program going soon.

(Moloka'i Advertiser-News: January 3, 1992)

AFFIDAVIT OF PUBLICATION

STATE OF HAWAII, } S.S.
County of Maui,

........Susan Peabody... being duly sworn, deposes and says that he is a clerk, duly authorized to execute this affidavit of

G & S ENTERPRISES,

publisher and agent for the Molokai Advertiser-News; that said newspaper is a newspaper of general circulation in the state of Hawaii; that the attached is a true notice as was published in the aforementioned newspaper as follows:

Molokai Advertiser-News ...1.... time(s),

on ....January 3, 1991 [1992]

..

and that the affiant is not a party to or in any way interested in the above entitled matter.

Susan Y. Peabody

Subscribed and sworn to before me this

6th day of Jan. A.D. 1992

[signature] L.S.

Notary Public of the ~~First~~ Second Judicial Circuit State of Hawaii
My Commission expires May 9, 1994

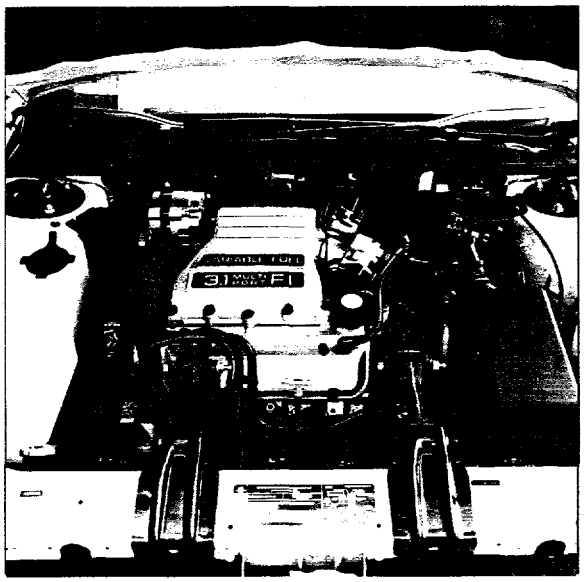
ATTACHMENT 2

HANDOUT DESCRIBING FFVs DISTRIBUTED AT UNIVERSITY OF HAWAII OPEN HOUSE

FLEXIBLE FUEL VEHICLES HAVE ARRIVED IN HAWAII!

Flexible Fuel Vehicles (FFVs) are the newest development in the automobile industry, which allows cars to run on alternative fuels. While most cars use regular unleaded gasoline or methanol, the FFVs can use either of these fuels, or a combination of both.

Methanol, which can be produced in Hawaii, will be a viable alternative in fueling vehicles for the future. A biomass gasifier facility, to be built on Maui, will be able to produce methanol from sugarcane waste (bagasse), from wood chips, or from other feedstocks derived from biomass products.



The Hawaii Natural Energy Institute has been fortunate to receive two Chevy Lumina vehicles, funded through the U.S. Department of Energy and the State Department of Business and Economic Development and Tourism, which will be used in a demonstration project here in Hawaii. In addition to these cars, there is a local Federal fleet of vehicles, which will also participate in an expanded demonstration project in 1994. There are hundreds of FFVs in operation, especially in California. So watch for these FFVs in your neighborhoods soon.

ALTERNATIVE FUELS AND VEHICLES FOR HAWAII'S FUTURE

- FEDERAL LEGISLATION ON ALTERNATIVE FUEL VEHICLES
  - Requires Federal and large private fleets to use alternative fuels
  - Provides tax breaks for purchase of alternative fuel vehicles
- STATE OF HAWAII DRAFT ENERGY POLICY
  - Calls for reducing dependence on imported petroleum
  - Calls for increasing our energy security
- OVER 90% OF OUR ENERGY IS FROM IMPORTED PETROLEUM
- LIQUID FUELS IN HAWAII USE TWO-THIRDS OF ALL OUR ENERGY
- WHAT ROLE DOES THE HAWAII NATURAL ENERGY INSTITUTE PLAY?
  - Continuing research on alternative fuels from biomass
  - Developing alternative fuels produced in Hawaii
  - Demonstrating the use of alternative fuel vehicles
  - Examining transition to an alternative fuel economy
- HELP HAWAII TO CREATE A BRIGHTER FUTURE BY:
  - Building energy security
  - Cutting dependence on oil
  - Creating local jobs
  - Improving the environment

For more information, contact:

HNEI

Hawaii Natural Energy Institute
School of Ocean & Earth Science & Technology
University of Hawaii at Manoa
2540 Dole Street, Holmes 246
Honolulu, Hawaii 96822
Phone: (808) 956-8890 Fax: (808) 956-2336

ATTACHMENT 3

MEMORANDUM OF UNDERSTANDING BETWEEN HNEI, MCC, AND PICHTR

MEMORANDUM OF UNDERSTANDING

This Memorandum of Understanding (MOU), dated September 21, 1994, sets forth an agreement regarding the activities to be performed under the Cooperative Alternative Fuels Utilization Program, including the establishment of an M85 (85% methanol, 15% gasoline) fueling station, provision and demonstration of a methanol alternative fuel vehicle, preparation and airing of an educational video tape, and efforts in a preliminary fleet demonstration implementation. The following organizations are Parties to this MOU:

Hawaii Natural Energy Institute (HNEI)
Maui Community College (MCC)
Pacific International Center for High Technology Research (PICHTR)

RECITALS

WHEREAS, HNEI is engaged in a contract with the U.S. Department of Energy to promote the use of alternative ground transportation fuels in Hawaii; and PICHTR will be operating under a subcontract to assist HNEI in conducting this contract;

WHEREAS, alternative transportation fuels such as methanol and ethanol can be produced in Hawaii from locally grown trees and grasses, including sugarcane; and the use of such fuels would not only displace gasoline produced from imported petroleum (making the state more energy secure as well as creating local jobs) but would result in less air pollution;

WHEREAS, the island of Maui is the location of the Biomass Gasifier Facility (BGF), currently under construction adjacent to the HC&S sugarmill at Paia; the BGF will initially be capable of converting up to 100 tons per day of bagasse or other biomass feedstock into a fuel gas and in a later phase, a synthesis plant will be added to convert a portion of this fuel gas into methanol which could be used in an alternative transportation fuel; and PICHTR is the prime contractor for the BGF under funding from the U.S. Department of Energy, the State of Hawaii, and others;

WHEREAS, MCC has the capabilities required to prepare commercial quality videotape programs and to conduct promotion and demonstration programs for the Maui community; and has an interest in participating in a program furthering the use of alternative fuels in Hawaii;

WHEREAS, HNEI and PICHTR feel that the above factors indicate the usefulness of promoting alternative fuels through a program of education and demonstration on Maui;

NOW, THEREFORE, in consideration of the foregoing premises and of the mutual promises and covenants contained herein, all of the above Parties agree as follows:

ARTICLE 1: COOPERATIVE AGREEMENT

1.1 Education and Demonstration Collaboration: The Parties intend to collaborate with each other to perform educational and demonstration activities for promotion of alternative fuels on Maui. The contemplated collaboration will consist of the following:

- preparation of a videotape program and airing the tape on local TV;
- installation of an M85 fueling station;
- demonstration of a flexible fuel vehicle in the community; and
- efforts in a preliminary demonstration fleet implementation.

1.2 Scope of Agreement: The Parties agree to proceed with the Education and Demonstration Collaboration in accordance with the terms set forth in this MOU, provided that any Party may at any time terminate its participation in the Collaboration by giving the other Parties 90 days advance notice in writing and closing out any other related agreements or contracts, including resolution of outstanding financial issues and removal of materials/equipment and/or restoration of the site.

ARTICLE 2: CHARTER STATEMENT

The Parties agree that the various elements described in this MOU will be established, operated, and conducted to support the Cooperative Alternative Fuels Utilization Program for promotion of alternative fuels in Hawaii.

ARTICLE 3: OBJECTIVES

The Parties agree to pursue specific objectives that are synergistic with and supportive of:

- showcasing and demonstrating the suitability and reliability of alternative fuels and alternative fuel vehicles in real-world conditions;
- objectives of the U.S. Department of Energy;
- objectives of Hawaii's Energy Strategy Program and Integrated Energy Policy; and
- promotion of Maui County as a progressive and environmentally concerned region.

ARTICLE 4: BENEFITS

The Parties agree that overall benefits are the potential reduction of the dependence on and use of imported petroleum, strengthening of local industry, and associated improvements to air

quality. The Parties agree further that the proposed education and demonstration program will help:

- educate the general public about alternative fuels and alternative fuel vehicles;

- build the potential user's level of confidence that alternative fuels and alternative fuel vehicles will perform as advertised or claimed; and

- contribute positively to the image of Maui as a progressive and environmentally concerned region, with special worthiness from a tourism perspective.

ARTICLE 5: RESPONSIBILITIES

5.1 Overall. The Parties agree that a team approach will be used to meld the capabilities of HNEI, MCC, and PICHTR. The responsibilities of the Parties are discussed herein.

5.2 HNEI will:

(1) independent of the arrangement with MCC, provide the following for this program:

(a) technical assistance, manpower, and funding, as requested by PICHTR;

(b) costs for purchase and installation of an M85 fueling station, including a 2,000-gallon aboveground storage tank;

(c) 1800 gallons of M85 fuel for the station; and

(d) funding for incentives of up to $1,000 per vehicle for purchase of up to ten vehicles under a fleet demonstration program to be identified with the assistance of MCC; and the necessary funding for incentivizing the cost of the M85 fuel such that the fleet operator will be able to purchase this fuel at or less than the cost of equivalent gasoline.

(2) specifically provide the following to MCC for this program:

(a) the loan of one 1993 Chevrolet Lumina methanol flexible fuel vehicle (FFV); and

(b) an amount not to exceed $17,100 for conducting the education and demonstration efforts on Maui, including an amount not to exceed $15,000 for the production and airing of the educational video tape, an amount not to exceed $1,200 for obtaining and applying a vehicle logo plus painting the vehicle, and an amount not to exceed $900 for vehicle maintenance and record keeping.

5.3 MCC will:

(1) produce an educational video tape on alternative fuels and alternative fuel vehicles (AFVs); this tape will link methanol AFVs (specifically, methanol FFVs) with the development of

the Biomass Gasifier Facility on Maui; the finished tape will be broadcast on the MCC educational cable channel for at least ten hours of total airing time spread over at least a four-week period; information and follow-up inquiries will be solicited on the tape, and inquiries will be forwarded to PICHTR for response;

(2) take the educational video tape of item (1), re-edit it if necessary for use by HNEI/PICHTR, and make copies of the re-edited version for use by HNEI/PICHTR in its education program;

(3) coordinate with HNEI/PICHTR in identifying a site for the M85 fueling station at MCC, coordinate permitting activities with the contractor installing the station, and coordinate any special activities required at MCC during construction/installation activities (e.g., special traffic considerations) -- such activities will be called for only if the fueling station site will occur at MCC;

(4) coordinate with HNEI/PICHTR in receiving the unleaded gasoline and methanol for delivery into the storage tank of the completed M85 fueling station, if necessary;

(5) coordinate with HNEI/PICHTR in receiving the methanol FFV from Honolulu, proceed with painting or otherwise decorating this vehicle, fueling the vehicle with M85 fuel only (except under emergency conditions, when unleaded gasoline can be used for fueling), maintaining a vehicle log for each use and refueling of the vehicle (as specified on the vehicle log sheets), sending copies of the vehicle log sheets on a monthly basis, and performing vehicle checks and maintenance as specified on the instructions provided with the vehicle log sheets and on the required maintenance sheet provided by HNEI/PICHTR;

(6) coordinate with HNEI/PICHTR in demonstrating the vehicle in public displays and other promotions as well as participating with the State Department of Education in the drivers education program involving FFVs;

(7) assist HNEI/PICHTR in identifying and approaching potential participants in a fleet demonstration program involving up to ten methanol FFVs;

(8) produce a report on all activities conducted under the Education and Demonstration Collaboration, including a delineation of all videotape showings, public displays and demonstration events with number of exposures, dates, places, numbers of people involved, etc.; and

(9) provide coordination and administrative support throughout the life of this program.

5.4 PICHTR will:

(1) provide a central point of contact for MCC; and

(2) contribute a $50,000 cost share into the overall Cooperative Alternative Fuels Utilization Program, including the provision of funding for 50% of the salary for a staff support position required for the project, complementing the support from the U.S. Department of Energy.

ARTICLE 6: TERM

The Parties agree this MOU is effective on the date first written above and, unless terminated earlier by agreement, the term shall be until June 21, 1995, the current expiration date of the applicable HNEI grant with the U.S. Department of Energy. Extension of the term of this MOU shall be as mutually agreed, in accordance with Article 7, dependent upon extension of the above named grant.

ARTICLE 7: MISCELLANY

7.1 Amendment. This MOU can be modified only by written amendment signed by the duly authorized representatives of all of the Parties. Any purported amendment not in writing and not so signed shall be invalid and void.

IN WITNESS HEREOF, these duly authorized representatives of the Parties listed below, hereby execute this Memorandum of Understanding.

Hawaii Natural Energy Institute

By _____ Dated: 9/20/94

Name and Title

"HNEI"

Maui Community College

By _____ Dated: 8/31/94

Name and Title

"MCC"

Pacific International Center for High Technology Research

By _____ Dated: 9/21/94

Name and Title

"PICHTR"

University of Hawaii

By _____ Dated: 12.02.94

MARVIN S. ENOKAWA
Director-Contracts & Grants

ATTACHMENT 4

EXCERPT FROM CLEAN CITIES NEWSLETTER DESCRIBING GSA FFV PROGRAM

Reprint - removed for separate processing