ENERGY EVALUATION

For The Kauai Lagoons Golf Course Pumping Systems
Lihue, Hawaii

March 20, 2002

PROCESS ENERGY SERVICES, LLC

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Sponsored by: The Kauai Energy Extension Office

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for the

KAUAI LAGOONS GOLF COURSE PUMPING SYSTEMS

March 2002

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Supported by:

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Tourism's Energy Resources and Technology Division

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SECTION 1. EXECUTIVE SUMMARY

This energy audit presents the results of Process Energy's analysis of the Kauai Lagoon's Water Pumping Systems for the Golf Course Irrigation System. The objectives of the report included the following:

1. Provide an overview of the golf course irrigation system that includes a discussion on system operation and simplified schematics of the pumping and piping systems.

2. Assemble energy, flow and equipment operational information based on the data collected to develop an "energy balance" that will serve as a baseline of system energy use.

3. Discuss the energy audit findings and recommendations. The recommendations will be presented as "energy measures" and include savings calculations, estimated project costs, and life cycle cost analysis to evaluate project cost effectiveness.

If the enclosed projects are accepted by Kauai Lagoons, Process Energy Services and the Energy Extension Service Kauai (EES-Kauai) will assist Kauai Lagoons with project implementation through preparation of equipment selection criteria for equipment purchases and assist with bid or proposal document review. In addition, Process Energy Services will conduct a public workshop coordinated through EES-Kauai and Kauai Lagoons after the final report is accepted.

The development of an *energy balance* or *energy use baseline* is important to establish how all energy consuming equipment is operated, and where energy dollars are being spent over a one-year time frame. For pumping systems, monthly baseline information typically includes equipment hours of operation, flow, energy use and electric utility consumption and demand. Figure 1.1 graphically shows where energy is currently being used for the Kauai Lagoon System. A full twelve-month energy balance is included in Appendix A.

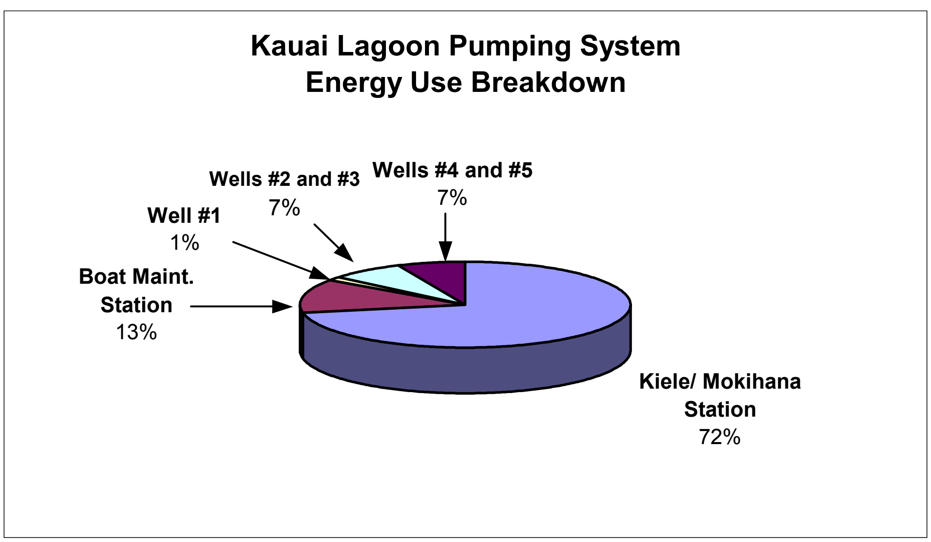

Figure 1.1 Kauai Lagoon Pumping System Energy Use

As the energy saving projects were developed, each measure was prioritized based on ease of implementation, cost effectiveness and ability for each project to support subsequent measures. The projects have been categorized as energy conservation measures (ECMs), for projects that require a capital investment, energy supply measures (ESMs), that reduce energy costs through alternative power sources or energy rate schedule adjustments, and operational measures (OMs), for operational measures that can be difficult to quantify, but are good “energy practices” that will improve system efficiency and can be done at a minimal cost.

The Project Evaluation Economic Summary (Table 1.1) provides an overview of our estimates of the total project costs and annual savings. A more detailed summary of the qualified measures and their associated savings is presented in Table 1.2.

Table 1.1
EVALUATION ECONOMIC SUMMARY

Annual Baseline Energy Costs for Kauai Lagoon Pump Systems
(8/2000-7/2001 for Boat Pump Station)

2001 Electric Use (kWhs)	1,008,910
2001 Electric Costs	$285,482

Cost and Savings Summary

Savings	
Annual Energy Savings after Project Implementation (kWhs)	318,294
Annual Energy Cost Savings after Project Implementation	$102,421
Percent of Current Energy Costs	36%
Project Costs	
Estimated Cost of Projects	$392,602
Kauai Electric Incentive	$165,865
Adjusted Cost	$226,737
Cost Effectiveness (including KE incentive)	
Simple Payback	2.2 Years
Present Net Value of Savings (over a 20 year equipment life)	$888,259
Reduced Plant Emissions Based on Hawaii Electric Power Sources	
Carbon Dioxide (*1364* lbs/MWh)	434,153 lbs/year
Sulfur Dioxide (.008 lbs/MWh)	2.5 lbs/year
Nitrous Oxides (.921 lbs/MWh)	293 lbs/year

Table 1.2
RECOMMENDED ENERGY PROJECTS

	Cost Saving Measures	Annual Savings ($)	Annual kW Savings	Annual kWh Savings	Initial Cost ($)	Simple Payback (yrs)
	OPERATIONAL MEASURES					
OM 1	Develop an Energy Management Program	--	--	--	--	--
OM 2	Purchase Instruments to Monitor System Efficiency	$6,655	--	33,045	$12,000	1.8
OM 3	Correlate Flow and Distribution to Irrigation Needs	--	--	--	--	--
OM 4	Minimize Impact of Infiltration and Pond Evaporation	--	--	--	--	--
	ENERGY CONSERVATION MEASURES					
ECM 1	Install Small Pressure Pumps	$3,534	--	17,549	$12,458	3.5
ECM 2	Replace Inefficient Pumps	$18,200	--	91,500	$82,536	4.5
ECM 3	Replace Motors with Premium Efficiency Type	$6,263	15.0	21,964	$68,609	10.9
ECM 4	Install Variable Speed Drives and Improve Controls	$45,001	190.0	154,236	$171,838	3.8
	ENERGY SUPPLY MEASURES					
ESM 1	Install Demand Controls	$15,391	138.0	--	$18,687	1.2
ESM 2	Install Power Factor Correction Capacitors	$8,409	--	--	$26,474	3.1
	Total Energy Program Cost and Savings	**$103,453**	**343**	**318,294**	**$392,602**	**3.8**
	Kauai Electric Incentives				**$165,865**	
	Adjusted Program Cost and Savings	**$103,453**	**343**	**318,294**	**$226,737**	**2.2**

SECTION 2. INTRODUCTION

The goal of the enclosed energy report was to provide a comprehensive assessment of energy use for the Kauai Lagoon Pumping Systems and identify specific improvements to reduce energy use. Instead of only focusing on technology-specific improvements such as more sophisticated controls, variable speed drives and premium efficiency motors, the analysis also reviewed energy supply and operational adjustments that could reduce energy costs.

After a review of the energy bills for the Kauai Lagoon Pumping Systems, it was apparent that the majority of the energy use was for the irrigation process versus the water supply wells. Based on this, most of our analysis has been focused on the irrigation pump systems where we reviewed electric utility rate schedule charges, equipment efficiency, the impact of system leakage on energy costs, and application of new controls.

As we reviewed the well supply system operation, we discovered that indirect improvements proved to be the best long-term solution to reduce energy use. These improvements focused on maximizing the use of the no-cost effluent water supply from the nearby wastewater treatment plant, increasing pond capacity where possible, and minimizing distribution leakage. The recommended improvements are expected to reduce well supply operating hours and facility energy costs, and help Kauai Lagoons reduce their dependence on well water for irrigation.

For the high-energy irrigation pumping systems (Kiele, Mokihana and Boat Maintenance Pump Systems), we have recommended improvements that include high efficiency pumps, motors and variable speed drives. With the emphasis on energy savings, this report encourages Kauai Lagoons to reduce usage of these pump systems whenever possible. This must be balanced with the need to comply with Irrigation Management and Affirmative Action Plan (IMAAP) that encourages Kauai Lagoon's to maximize the use of wastewater effluent. With the proposed addition of the new injection wells, the need to use the irrigation pumps to dispose of the effluent when irrigation is not required will also help reduce Kauai Lagoon's energy costs.

The projects presented in this audit are interactive and affect project cost effectiveness depending on the implementation strategy selected. We have attempted to prioritize the projects based on project cost and ease of implementation. However, the cost effectiveness or viability of each project can change quickly in the event of unexpected equipment failures, system expansion upgrades or re-prioritizing projects.

For this report, Process Energy Services would like to thank Glenn Sato with the Kauai County Energy Extension Office, Paul Daniels with Kauai Electric, and David Nagao and Victor Nemeth with the Kauai Lagoons Resort Company for their assistance during the evaluation. Many of the projects identified in this report could not have been developed without David and Victor's on site assistance collecting data and answering the many questions on system operation. Thanks also to Greg Hunter and Sid Kent with Pacific Electro-Mechanical for providing cost estimates to do the proposed work and valuable insight on system operation.

SECTION 3. SYSTEM DESCRIPTION

3.1 General

The 740 acre Kauai Lagoons Resort consists of two golf courses adjacent to the Lihue Airport in Kauai. The two courses have a total irrigated area of approximately 351 acres with more than 50% of this area classified as “roughs”. The golf course water supply, storage and irrigation system provides the water needed to maintain lagoon levels, provides adequate water for irrigating the course and supplies several course water features. With the majority of it’s flow from the treated effluent discharge of the Lihue Wastewater Treatment Plant, the lagoon system is an excellent example of water reclamation, where treated wastewater can be used for an irrigation water supply source to conserve potable water supplies.

3.2 Water Supply Sources

The Kauai Lagoon water system is supplied from five on-site wells and treated effluent from the Lihue Wastewater Treatment Plant (WTP). The water system consists of two primary irrigation systems, which are the Golf Course Irrigation System and the Boat Maintenance Area Irrigation System. The Golf Course Irrigation System consists of Wells 1,2 and 3 and the water from the WTP that supplies Lake 1, Lake 2 and the Mokihana Pond. The Boat Maintenance Irrigation System is supplied by Wells 4 and 5 that discharge flow to a 40 acre lagoon. A summary of water supplies, storage, wells and control systems are shown in Table 3.1

Water Supply		
Water Supply	*Controls*	*Storage/Water Discharge*
Well #1 and Sewage Treatment Plant	*Original Design:* Timer for Well #1, Level controls in Lake #2 activate automatic valve to divert flow for injection if Lake is full. *Current Controls*: Manual operation	*Original Design*: If lake #2 is full, flow is diverted to Wells 2 & 3 for injection or to overflow weir to pasture area *Current Operation*: No injection at Wells 2 & 3, water overflows at weir
Well #2 Well #3	*Original Design:* Level switch in Lake #1 controls both wells. *Current Controls*: Manual operation	Well#2 supplies Lake #1 Well#3 supplies #5 Mokihana Pond or Lake #1
Well #4	*Original/Current Controls*: Timer	#8 Kiele Waterfall & Pond
Well #5	*Original/Current Controls*: Timer	“Odd shaped” 40 acre lagoon, if lake becomes full, water overflows weir.

Table 3.1 Water Supply and Storage

The estimated percentage of water from each supply source is shown in Figure 3.1. These percentages are based on the rated capacity of the wells, records from the wastewater plant effluent flow meter and energy use data. Total water supplied annually is estimated at 571 million gallons. For 2001, energy costs for water supplied from the wells was approximately $45,000. The cost for water supplied from the Wastewater Treatment Plant was $0.

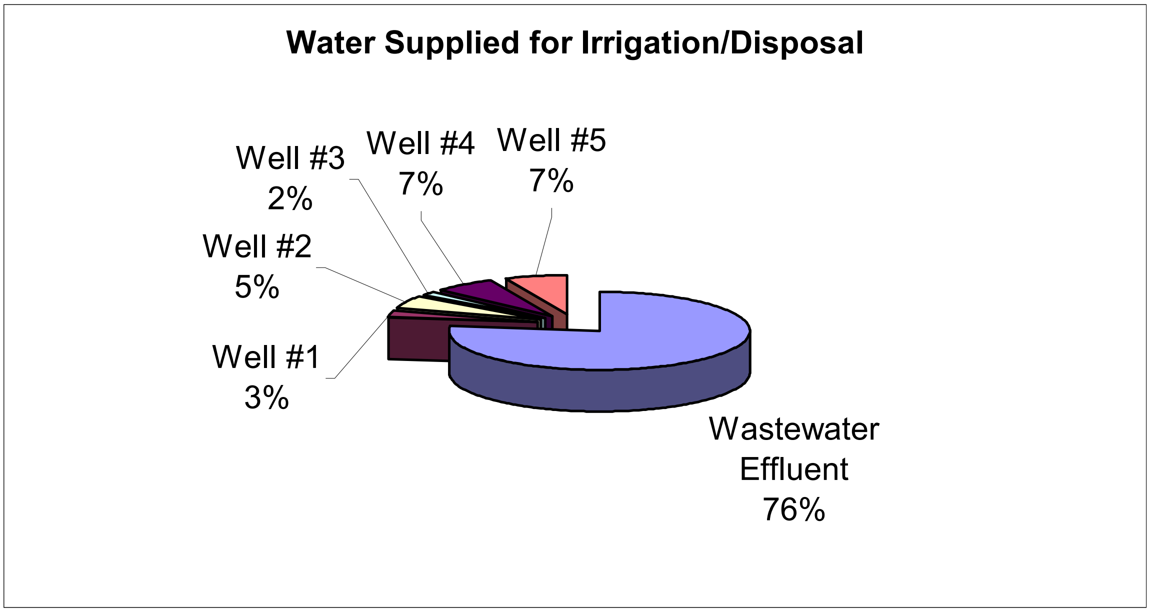

Figure 3.1 Water Supply Sources

The majority of the time, the average flow of 833 gpm received from the WTP is more than enough to maintain Lake #2 elevation for golf course irrigation. When Lake #2 becomes full and reaches a level of 133'-6", it overflows a weir where it flows to the "bad water" pond.

With the wastewater treatment plant supplying a "no-cost" source of water, the ideal irrigation system at Kauai Lagoons will store as much of this water as possible to prevent paying the energy costs of the water supply wells, and to reduce the dependence on these water sources. Although evaporation will always be an issue, the more effluent that can be stored in the ponds and lakes, the more energy will be saved by reducing well operation.

3.3 Water Storage

The water supplied from the wells and wastewater treatment plant is stored in the lakes, pond and lagoons shown in Table 3.2. As noted, several of the storage lake levels must be maintained for aesthetic purposes. Only Lake #1 and the 40 acre lagoon can have fluctuating water levels to provide maximum storage.

Water Storage	*Existing*	*Purpose*	*Existing*	*Highest*

	Capacity		Overflow	Level
Lake #1	--	Irrigation Supply	132’	132’
Lake #2	6.77 MG	Aesthetic	132’	134’
#5 Mokihana Pond	--	Aesthetic	--	--
40 Acre Lagoon	--	Irrigation Supply	--	--
#8 Kiele Waterfall and Pond	--	Aesthetic	--	--

Table 3.2 Water Storage Elevations

Evaporation and infiltration can be an inevitable cost of storing water. To minimize the impact of these water losses, we have recommended several improvements that have been included as operational measures, since they cannot be quantified without additional instrumentation. The first improvement is directed towards reducing water loss from the wastewater treatment plant to the lagoon storage ponds. Initially we recommended installing a hard-piping system for the open unlined ditch that directs flow from Well #1 and the Wastewater Treatment Plant to the overflow weir at Lake #1. However, we have recently been informed that a new effluent delivery system has been proposed that will include the installation of a hard piping system to Lake #2, and multiple injection wells located at the former stable area.

The second improvement focuses on increasing the storage level of Lake #2 from 132’ to 134.0’ to store as much effluent wastewater flow as possible to minimize well use. Based on the dimensions of the pond, this is approximately 2,000,000 gallons if the level is allowed to increase to 134.0’ before bypassing flow. If the lower “well activation” level is changed from 131’-8” to 130’-8” an additional 1,000,000 gallons will be available before the wells are needed. Increasing the storage capacity of the pond has also been recommended in the 11/99 Irrigation Management and Affirmative Action Plan (IMAAP).

3.4 Irrigation Pumping Systems

The Kauai Lagoon irrigation systems consist of the Kiele and Mokihana Pump Stations and the Boat Maintenance Irrigation Pump System. A description of how these pump systems are controlled is provided in Table 3.3.

Irrigation Pumping System Controls		
Irrigation/Transfer Pumps	**Controls**	**Distribution**
Kiele Pumps for Irrigation Mokihana Pumps for Irrigation	Pressure Switch set to maintain 115 psi Pressure Switch set to maintain 105 psi	Kiele pumps and Mokihana pumps provide majority of irrigation for entire course
Boat Maint. Irrigation Pump	Timer	Irrigation system around perimeter of lagoon

Table 3.3 Water Distribution Stations and Controls

With these pump systems representing over 85% of Kauai Lagoon's energy costs, most of the analysis performed in this report was focused on these systems using the following approach:

1. Review how the pump systems are operated and controlled in relation to irrigation needs, and how pump system operation and hours for each of the eight pumps relate to system needs to identify potential leakage, high system pressure and operational adjustments.

2. Review Kauai Electric energy rate schedule charges to determine energy consumption, demand and power factor penalty charges and evaluate if alternative rate schedules, demand controls or power factor correction capacitors could reduce costs.

3. Apply the U.S. Department of Energy's *Pump Systems Assessment Tool Software (PSAT)* and *Motor Master Software* to evaluate pump system efficiency and identify equipment (pump and motor) efficiency improvements.

4. Use *Fluidvision* Pump Software to model pump system operation when all 4 pumps are operated in parallel. This software is useful to evaluate how variable speed drives can be applied cost effectively, how much additional flow is gained when multiple pumps are operated, and the savings impact of maintaining a lower system pressure.

3.4.1 Kiele and Mokihana Pump Station Operation

The Kiele and Mokihana Pump Systems are housed in the same structure and are on the same electric meter. The piping arrangement for the Kiele Pump System is shown in Figure 3.2. The Mokihana Pump System has an identical piping arrangement.

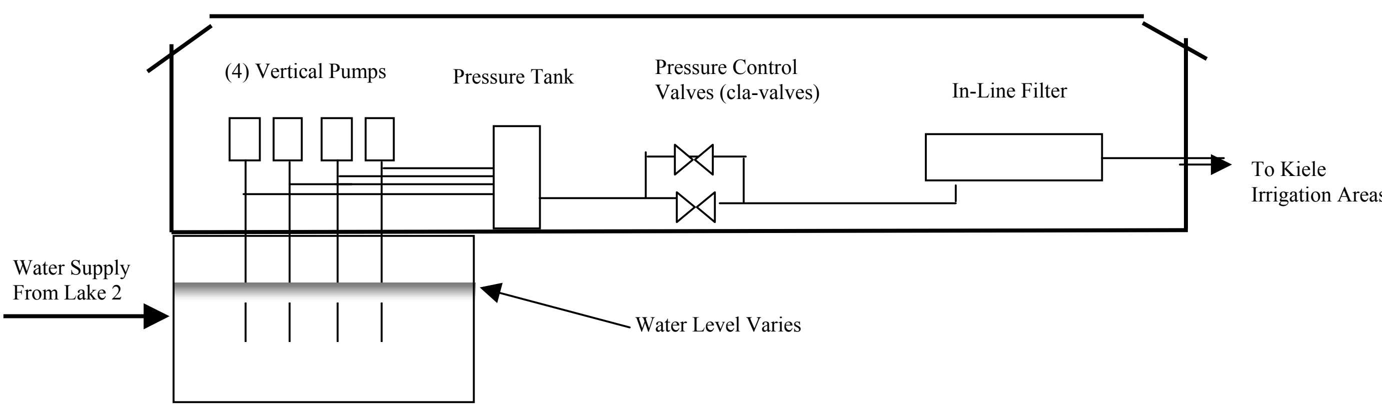

Figure 3.2 Pump System Piping Arrangement (Typical of 2)

The pump sizes, horsepower, flow and hours are shown on Table 3.4. Normal operation is for one of the four vertical pumps for the Kiele and Mokihana Systems to maintain system pressure when no irrigation is required (usually during the day), and to operate all four pumps in parallel (eight in operation at the same time for both pump systems) during the evening hours when irrigation is scheduled.

	Motor HP	*Est. kW*	*Pump Model*	*Rated Flow*	*2001 Hours*
Kiele Pump Station					
Pump #1	25	20	10L22	265	2141
Pump #2	100	81	12H110	1160	1896
Pump #3	125	104	12HH165	1600	951
Pump #4	125	94	12HH165	1600	928
Mokihana Pump Station					
Pump #1	25	15	10L22	265	1586
Pump #2	50	25	12L54	550	2513
Pump #3	75	38	12M90	800	1807
Pump #4	100	81	12H110	1160	1195
Total Demand		**~460 kW**			

Table 3.4 Pump Ratings and Hours

The design intent is to operate one 25 hp pump for each pump system on and off as needed to maintain system pressure when irrigation is not required. When irrigation is needed, the pumps are operated during the evening or early morning hours. Typically, the 4 pumps for each system are operated in parallel to increase system pressure and maximize flow. In the irrigation mode (manually activated by system operators), a computer control system manufactured by *Rainbird*, monitors flow and activates solenoid valves for each system area as programmed by the operators for irrigation needs. The Kiele Pump System services a total of 30 system zones, and the Mokihana Pump System services 24 system zones.

A review of individual pump operating hours over the last 12 months revealed that many times during the month, operations staff needed to operate the larger pumps for both systems (50, 75 and 100 hp) to maintain system pressure when irrigation was not taking place. For most golf course irrigation systems, a small 5 hp pump can often be used to maintain pressure during non-irrigation periods. Operating the larger pumps can compound this problem by increasing system pressure and leakage. The savings for using a 5 hp pump is reviewed in ECM #1.

3.4.1.1 Irrigation System Energy Charges

As seen from Table 3.4, both pump systems are supplied through one electric meter, and are typically in operation at the same time. The maximum kW demand recorded for each month is approximately 480 kW. At $10.45 per kW, the demand charge represents about 30% of each month's electric bill for this station. As shown in Table 3.4, the pump operating hours are fairly low and correspond to an average kWh energy use of 55,000 per month for an average load factor of 16%. The load factor provides an indication of how peak demand relates to consistent energy use during the month. If the pumps were used constantly, the load factor would be close to 100%.

Many facilities are able to alter the way a system is operated to prevent high demand charges by staggering equipment operation to prevent all equipment from being operated at the same time. Currently it is difficult to stagger the Kiele and Mokihana Pump Systems during the summer when all pumps are required at full capacity during the evening hours for several weeks. Unfortunately this creates a peak demand for the facility that impacts demand charges for many months. Based on the interactive effect of the recommended measures, staggering the operation of the Mokihana and Kiele Pump Stations will become more feasible after the capacity is improved by upgrading the Mokihana Pumps, installing variable speed drives and eliminating the cla-valves from the system piping. The increased pump system capacity expected from these improvements will increase flow and provide an opportunity to use demand controls as recommended in ESM #2.

Because both pump systems are supplied through one electric meter, the high demand realized monthly requires that the station be billed under Kauai Electric Rate Schedule “P”. The high demand charge appears to be an unavoidable cost, however, a review of the Kauai Electric Rate Schedule “J” shows that if an electrical service is under 100 kW, the demand charge is reduced to $6.08/kW. Although the rate for kWhs is slightly higher, the lower charge for demand could reduce overall energy costs by over $20,000 annually. However, Kauai Electric has recently indicated that separating electric services for a facility is not allowed unless it is done for the purposes of leasing or renting parts of the facility. Based on this restriction, the only option to avoid high demand charges is to pursue “peak shaving” where an alternative source of power is used during high demand periods, or “peak shedding” where the load of a facility is alternated to distribute load more evenly. The peak shedding concept appears to be the most viable strategy and is discussed in ESM #1.

Up to this point, the “ESMs” reviewed have focused on energy use (kWhs) and demand (kW) charges for the Kiele and Mokihana Pump Station. Another opportunity to reduce utility energy charges is to increase the station’s power factor. This charge is shown on Kauai Electric’s monthly bill through the measured KVAR and increases the billed kWhs in relation to the service’s power factor. As compared to an ideal power factor of 100%, the station power factor has typically been in the high 70s or low 80s. Based on the expectation that the power factor will be improved with the addition of variable speed drives, the cost effectiveness of ESM #2 should be re-evaluated after the vsds are installed.

3.4.1.2 Irrigation Pump Efficiency

Over the last several years, Kauai Lagoons has worked with Pacific Electro-Mechanical to perform preventive maintenance evaluations every 6 months. This is an excellent way to insure that the pumps and controls are operating properly, and to inspect the system components. As part of this effort, pump performance data that includes flow, amps and pressure has been collected as well. Based on this data, we were able to use a pump efficiency software program called PSAT (Pump System Assessment Tool), which was developed through the Department of Energy’s Best Practice Program. The program compares collected field data with a database of pump efficiencies from the Hydraulic Institute and motor efficiencies from the Department of Energy’s Motor Master Program database. This comparison provides an “optimization rating” for each pump system on a scale of 0-100 (a score of 90 or above is considered satisfactory). A sample program display is shown in Figure 3.3.

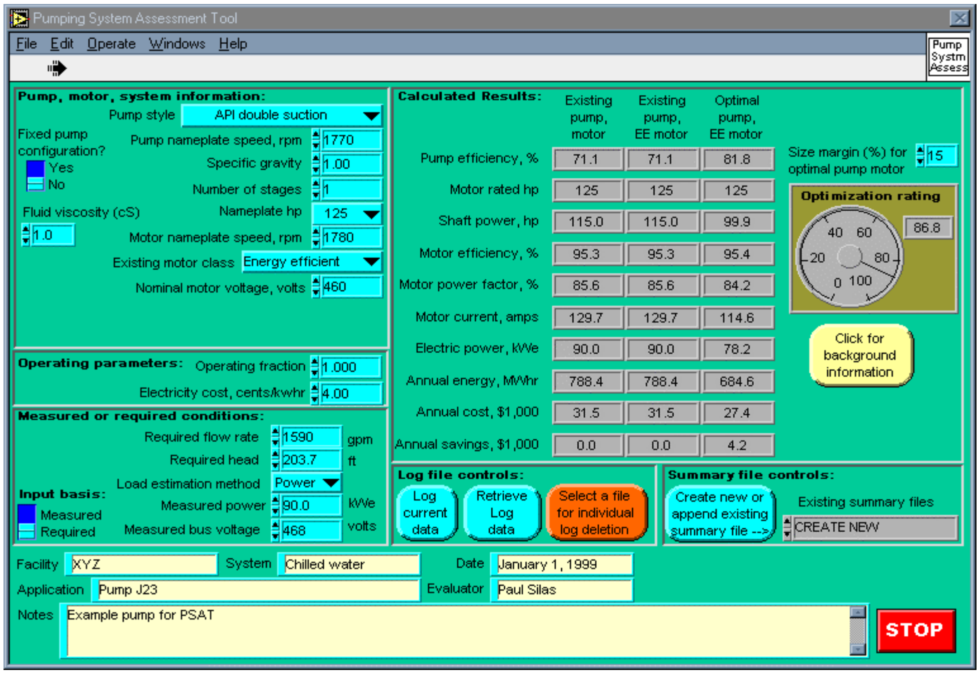

Figure 3.3 Example PSAT Screen

The program results for the Kiele and Mokihana Pump systems are shown below in Table 3.5. Flow and head measurements were based on the recent data taken by Pacific Electro-Mechanical.

	Flow (gpm)	*Amps*	*Head (ft)*	*PSAT Grade*
Kiele Pump Station				
Pump #1	280	38.2	277	100
Pump #2	1240	116	277	98
Pump #3	1500	138	300	99
Pump #4	1520	137	300	100
Mokihana Pump Station				
Pump #1	130	31	265	68
Pump #2	320	38	277	93
Pump #3	460	81	277	84
Pump #4	985	116	293	84

Table 3.5 PSAT Results

As shown in the above data, the Kiele pumps appear to be operating very efficiently, compared to several of the Mokihana Pumps. Based on the results of the program, it is estimated that the reduced pump/motor efficiency for Mokihana pumps #1,#3 and #4 is costing Kauai Lagoons an additional $5,900 in annual energy costs. Replacing these pumps is reviewed in ECM 2.

Applying the PSAT program is the first step to evaluating pump and motor system efficiencies. After this preliminary analysis is done, a specific review of each pump system is needed to evaluate improvements to increase system efficiency. For the Kiele and Mokihana Systems, this includes replacing or repairing existing low efficiency pumps, upgrading standard motors to premium efficient type motors and eliminating or replacing high head-loss valves.

The high head loss “cla-valves” are located on each pump system discharge, and are typically installed to equalize pressure and prevent surges to the irrigation system when the pumps are activated. The cla-valves are automatically opened after the pumps are operating, and fully open after about 3 minutes to prevent pressure surges that could rupture plastic piping in the system. The disadvantage to these valves is the high head loss that occurs even when the valve is fully open. Many facilities have found that the application of variable speed drives with appropriate controls provide the capabilities to slowly increase pump flow and pressure to prevent surges. As a result of this improvement, often times the cla-valves can be removed from the system.

3.4.1.3 Application of Variable Speed Drives

Variable speed drives (VSDs) or variable frequency drives (VFDs) have been used extensively for pump systems to improve flow, pressure control and system efficiency. When variable speed drives are applied properly, energy savings and reduced maintenance expenses can often be realized, however, when they are misapplied, they can actually increase energy use and result in a wasteful expense that is never recovered.

Some of the key elements to applying VSDs successfully is to apply the drives to pump systems that have the majority of total pumping head in frictional head, (piping and valves losses) instead of high static head (pumping from a low elevation to a higher elevation), and to have the flexibility to reduce system pressure without compromising the system end-use. The Kiele and Mokihana systems pass the first test of being a predominantly frictional head system, but have some limitations on how the system pressure can be reduced. After some discussions with David and Victor, we determined that the pump systems could be operated with the pressure adjustments listed below in Table 3.6.

	Pressure Maintained at Pumps (psi)	*System Pressure after Cla-Valve (psi)*	*New Proposed System Pressure w/ vsds (psi)*
Kiele Pump Station	130-140	115	105
Mokihana Pump Station	130-140	105	95

Table 3.6 Pressure Adjustments

The energy savings of applying a VSD for one pump can usually be evaluated with simple hand calculations using the manufacturer’s pump curve. However, since normal operation of the pump systems is to operate four pumps in parallel, the analysis becomes more complex and is best evaluated with a software program. We used a program called *Fluidvision* developed by

Diagnostic Solutions for this analysis. The advantages of using this program include the ability to determine which pumps provide the greatest savings through the application of VSDs, the savings impact of system pressure adjustments and how pump system efficiency is affected at reduced motor speeds.

The results of our analysis show that the installation of VSDs on Kiele Pump #3 and Mokihana Pump #2 appear to be the best application to recognize the highest energy savings. Although applying VSDs on additional pumps did increase savings slightly, the cost of including additional variable speed drives did not prove to be cost effective.

For the Kiele and Mokihana Pump Systems, the key considerations that provided savings by using VSDs included the opportunity to eliminate the existing cla-valves and maintaining a lower system pressure. The cla-valves (and corresponding pressure losses) could be eliminated based on the ability of variable speed drives to slowly increase pump speed at a programmed rate to prevent pressure surges. The impact of adjusting system pressure precisely with a variable speed drive provides the control needed to achieve energy savings by modulating pump speed based on a designated system pressure setpoint.

The importance of reducing system pressure without compromising irrigation effectiveness is a key aspect of applying VSDs to this system. After the project is completed, the operations staff should make additional efforts to reduce system pressure even further, if possible, to maximize savings. ECM 4 reviews this project in more detail.

3.4.2 Boat Maintenance Pump Station Operation

The Boat Maintenance Pump System is housed in an enclosed structure. The piping arrangement for the pump system is shown in Figure 3.4.

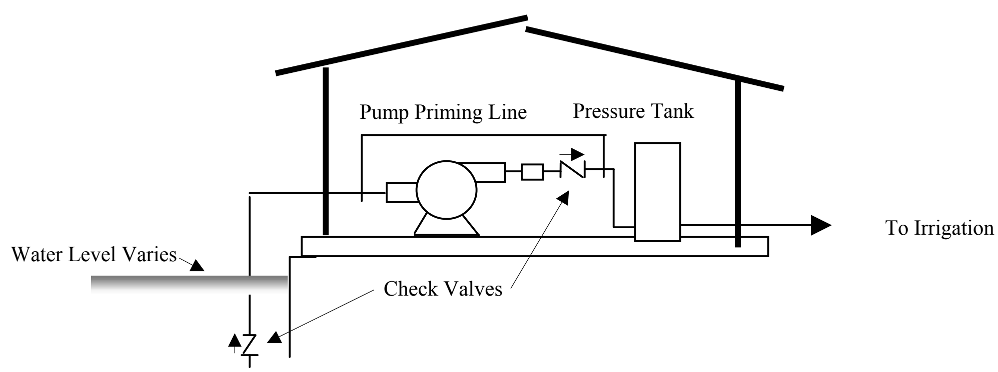

Figure 3.4 Boat Maintenance Pump System Piping Arrangement

The pump sizes, horsepower, flow and hours for 2001 are shown below in Table 3.7. Normal operation is to manually start the pump during the day when irrigation is required.

	Motor HP	*Est. kW*	*Pump Model*	*Rated Flow*	*Estimated Hours Between 8/2000 and 7/2001*

Boat Maintenance Pump	30	29	2Y-3600	290	5750
Total Demand		**29 kW**			

Table 3.7 Boat Maintenance Pump Rating and Hours

The 30 hp pump is manufactured by Cornell and was originally equipped with an 8.44" impeller. Based on a discharge pressure of 119 psi, the corresponding flow rating obtained from the manufacturer's pump curve is 290 gpm. The rated efficiency at this flow rate is 71%, however based on flow and pressure measurements, we have estimated an actual pump efficiency of 45%.

3.4.2.1 Pump Energy Charges

The average demand recorded for this pump station was approximately 29 kW. At $6.08 per kW the demand charge represents only about 6% of each month's electric bill for this station. As shown in Table 3.7, the pump operating hours are fairly high and correspond to an average kWh energy use of 13,787 per month for an average load factor of 65%. For this pump station, we used energy consumption data between 8/2000 and 7/2001 that reflected normal pump system operation instead of the data for the 2001 calendar year, since the pump was off-line for several months due to repairs.

Based on the inability to stagger demand for this station and no power factor charges, no energy supply measures have been recommended for this station.

3.4.2.2 Pump Efficiency

From the data collected on site, we used the PSAT program (Pump System Assessment Tool) to evaluate pump system efficiency. The results are shown in Table 3.8.

	Flow (gpm)	*kW*	*Head (ft)*	*PSAT Grade*
Boat Maintenance Pump	250	29	245	60

Table 3.8 PSAT Results

As seen from the above data, the existing pump appears to be operating very inefficiently. Based on the results of the program, it is estimated that the reduced pump/motor efficiency for this station is costing Kauai Lagoons an additional $10,500 in annual energy costs. Due to the poor efficiency rating of the pump, instead of refurbishing the unit, we have recommended replacing the pump and motor as described in ECM 2.

3.4.2.3 Application of Variable Speed Drives

As recommended for the Kiele and Mokihana Pump Systems, we reviewed installing a VSD for the Boat Maintenance Pump System. The addition of a VSD could prevent the pressure surge that is currently occurring within the system during pump start-up, that has recently damaged the distribution system piping. However, based on a simple payback of over 10 years, this project did not prove to be cost effective based on energy savings.

Note: A portion of the savings that could have been realized by applying a VSD for the Boat Maintenance Pump could be captured by downsizing the proposed new pump in ECM #3, depending on system pressure requirements.

SECTION 4. ENERGY USE

4.1 Pump System Energy Use and Cost

Electric service for all Kauai Lagoon Pump Stations is provided by Kauai Electric. A summary of energy use for each of the pump stations is shown in the tables and graphs included in this section. Table 4.1 lists the golf course irrigation pump system accounts and corresponding rate schedule costs. Tables 4.2 through 4.6 provide a twelve-month history of energy use and cost for each Kauai Lagoon pump station account. The energy use and demand for each account directly reflects the pump system operation for each station with the exception of the account for Wells 2 and 3, which also includes energy use at the stable facilities.

Description	Cost/kWh	Demand Cost	Monthly Service Charge	Power Factor Penalty
Kiele and Mokihana Rate Schedule “P”	*First 400 kWhs: $0.15279/kWh *Over 400 kWhs: $0.13324/kWh	$10.45/kW	$346.51	Yes
Boat Maintenance Station Rate Schedule “J”	All kWhs: $0.16031/kWh	$6.08/kW	$36.48	No
Well #1 Rate Schedule “G”	All kWhs: $0.19118/kWh	None	$21.89	No
Wells #2 & #3 Rate Schedule “J”	All kWhs: $0.16031/kWh	$6.08/kW	$36.48	No
Wells #4, #5 and T. Pump Rate Schedule “G”	All kWhs: $0.19118/kWh	None	$21.89	No

* per kW of demand

As shown above in Table 4.1, the cost of kWhs (consumption) and demand (kW) varies depending on the rate schedule classification.

SECTION 5. RECOMMENDED MEASURES

This section describes the proposed operational measures (OMs), energy supply measures (ESMs) and energy conservation measures (ECMs) discussed in the report. The measures are interactive in the order they are listed. All project costs and savings figures are preliminary and should be verified before proceeding with each project.

5.1 Operational Measures

Operational measures are low cost improvements that are focused more on accountability, collecting system data and developing procedures to optimize system operation on a daily basis. Typically, these measures cannot be justified based on quantifiable energy savings, but are considered to be good "energy efficient practices" that will provide long-term benefits.

5.1.1 OM #1 Develop an Energy Management Program

Description

Developing an energy management program is an essential first step to begin improving systems efficiency. Even though this recommendation cannot be directly related to calculated savings, it is a critical first step that will often determine if energy projects are successful. The key attributes of an effective program include the following:

- Designate an individual responsible for energy management.
- Develop an energy management team that meets on a regular basis to track energy related projects, and provide a means for staff to suggest new cost saving ideas.
- Establish an "energy savings fund" that can be funded by a percentage of the energy savings realized. This fund should be used to finance future energy related projects.
- Provide accountability for follow-up tasks that affect energy savings projects and track "lost savings" when projects get delayed.
- Emphasize the importance of repairing out of service equipment, repairing leaks as soon as they are identified and monitoring system performance.
- Review monthly electric bills and compare with flow pumped and irrigation needs to baseline system performance.
- Promote the success of Kauai Lagoon's energy program.

Calculations

This measure is a low cost operational measure that is the "cornerstone" to a successful energy program, and does not require specific savings to support the effort.

Preliminary Cost Estimate

Since most of the effort for this OM is based on the use of existing staff, no direct cost has been associated with this measure.

Cost and Savings Summary

Savings from all projects presented in this report can be used to help justify this recommendation.

5.1.2 OM #2 Purchase Instruments to Monitor System Efficiency and Leakage

Description

This measure recommends the installation of new instrumentation, flow meters and pressure taps to allow Kauai Lagoon staff to monitor the irrigation system on a regular basis to discover poor performing equipment, distribution system leaks and verify energy savings.

Leakage is an unavoidable part of operating an extensive irrigation system, however, the ability to recognize and correct leakage in a timely manner is the key to preventing wasted pumping system energy.

At a minimum, new instrumentation should include the following:

- Pressure taps on either side of filter
- Portable pressure transducer (Fluke PV-350)
- Power Meter (Fluke 43-B)
- Portable clamp-on flow meter to monitor piping sections (Panametrics PT-868)
- Additional pressure taps along distribution piping

Calculations

Most water distribution systems have a leakage rate of 15 to 20% due to pipe leaks, joint separation or a malfunctioning sprinkler head. Based on an estimated 5% improvement in the system leakage rate that could be realized through the use of the proposed new instrumentation, the following savings could be realized.

2001 Annual Irrigation System Energy Costs:	$201,000 (Kiele and Mokihana Station)
Portion of energy costs for kWhs:	$133,092
Cost of energy for a 5% leakage rate:	*$6,655*

Preliminary Cost Estimate

Item	Qty	Unit Cost Material	Labor	Total
Portable Flow Meter	1	$ 7,000	n/a	$ 7,000
Pressure taps	10	$ 200	n/a	$ 2,000
Portable Pressure/Amp Instruments	1	$ 3,000	n/a	$ 3,000
Overhead and Profit (20%)				$ 0
Construction Contingency (10%)				$ 0
Labor and Materials Subtotal				*$12,000*
Engineering/Project Management (15%)				$ 0
Hawaii State Tax (4.167%)				$ 0
Total				**$ 12,000**

Cost and Savings Summary

The cost and savings estimate for this OM is summarized below.

Annual Energy Savings	33,045 kWh
Annual Demand Savings	N/A
Annual Energy Cost Savings	$6,655
Project Cost	$12,000
Simple Payback	1.8 years

5.1.3 OM #3 Correlate Flow and Distribution to Irrigation Needs

Description

OM #1 and #2 have focused on laying the groundwork to increase the awareness of energy use and monitor system performance. The next step recommended to optimize system operation is to baseline irrigation effectiveness compared to the flow distributed. This effort could be as advanced as a control system that schedules irrigation needs based on satellite weather profiles and soil moisture content instrumentation. However, the intention of this measure is to develop a procedure using existing system information initially to document flow for each area, review this data on a regular basis and identify areas that could become over-irrigated.

The operations staff at Kauai Lagoons currently uses on-site weather station data that includes evaporation rates and measured rainfall to help determine appropriate irrigation rates. Based on the staff's experience and daily observations, pump system operation is adjusted as needed.

This OM recommends working with the existing methods used by operations staff to develop a baseline of irrigation distributed to each area. This information could be extracted from the existing *Rainbird* control system and would be in a format similar to the spreadsheet provided in Appendix B. The purpose of documenting this data is to help determine where potential over-irrigated areas are and make control system adjustments as needed to reduce pumping system energy costs. The increased awareness that this recommendation will provide is a key component of an efficient operation.

Calculations

Specific cost savings cannot be quantified for this measure.

Preliminary Cost Estimate

Cost for this measure will be minimal, if existing resources are used.

Cost and Savings Summary

Cannot be applied directly.

5.1.4 OM #4 Minimize Impact of Infiltration and Pond Evaporation

Description

Evaporation and infiltration can be an inevitable cost of storing water. To minimize the impact of these water losses, we have recommended several improvements that have been included as operational measures, since they cannot be quantified without additional instrumentation.

The first improvement is directed towards reducing water loss from the wastewater treatment plant to the lagoon storage ponds. Initially we recommended installing a hard-piping system for the open, unlined ditch that directs flow from Well #1 and the wastewater treatment plant to the overflow weir at Lake #1. However, we have recently been informed that a new effluent delivery system has been proposed that will include the installation of a hard piping system to Lake #2, and installation of multiple injection wells located at the former stable area. This improvement will help prevent water losses currently occurring with the unlined ditch. However, there will be times when excess effluent is not needed, but must still be disposed of. The flexibility of using the hard piping or unlined ditch for each occasion will help optimize this process.

The second improvement focuses on increasing the storage level of Lake #2 from 132’ to 134.0’ to store as much effluent wastewater flow as possible to minimize well use. Based on the dimensions of the pond, this is approximately 2,000,000 gallons, if the level is allowed to increase to 134.0’ before bypassing flow. If the lower “well activation” level is changed from 131’-8” to 130’-8”, an additional 1,000,000 gallons will be available before the wells are needed. Increasing the storage capacity of the pond has also been recommended in the 11/99 Irrigation Management and Affirmative Action Plan (IMAAP).

Although this OM cannot be quantified at this time, it is an important energy measure to maximize use of “no-cost” water instead of using the system wells.

Calculations

Specific cost savings cannot be quantified for this measure

Preliminary Cost Estimate

Adjusting control system elevations can be done at minimal cost.

Cost and Savings Summary

Cannot be applied directly.

5.2 Energy Conservation Measures

The recommendations discussed in this section are categorized as energy conservation measures or "ECMs" for projects that require a capital investment.

5.2.1 ECM #1 Install Small Pressure Pumps

Description

A review of individual pump operating hours over the last 12 months revealed that many times during the month, operations staff operated the larger pumps for both systems (50, 75 and 100 hp) to maintain system pressure. For golf course irrigation systems, such as Kauai Lagoons, typically a 5 hp pump can be used to maintain pressure when irrigation is not taking place. Operating the larger pumps can compound system leakage by increasing system pressure, resulting in a higher leakage rate. Based on the interactive impact of how the measures have been presented in this report, distribution system leakage is expected to be less after implementation of the recommended operational measures. With a lower leakage rate, the installation of small pressure pumps installed under this ECM will be viable.

Calculations

Savings for this ECM is based on installing small pressure pumps and improved controls to maintain a lower pressure of 80 psi during non-irrigation periods, instead of the current practice of maintaining 115 psi for the Kiele System and 105 psi for the Mokihana System. We have conservatively used the 25 hp pumps for the savings estimate, even though 50, 75 and 100 hp pumps have also been used to maintain pressure for both systems. Although more savings could be realized if leakage is still occurring after implementation of the "OMs" recommended in this report (since lower pressure would correspond to less leakage), we have based the savings only on reducing system pressure.

<u>Kiele Pump System</u>

Pump #1: 280 gpm @277' TDH at 81% efficiency (based on field testing)

Operating hours: 2141
Total gallons pumped annually: 35,968,800

From PSAT software print-outs in Appendix B, ECM 2:

kW (from PSAT software): 20.1
Annual kWh: 43,034

<u>Proposed 5 hp pump with new pressure controls</u>

5 hp pump: 85 gpm @185’ TDH (operated at 80 psi pressure)

Total gallons pumped annually: 35,968,800
Operating hours (at 85 gpm): 7052

$$kWh = \frac{\text{Head * Flow * .746 kW/hp}}{\text{3960 * Pump and motor efficiency}}$$

$$kWh = \frac{\text{185 ft * 85 gpm *.746}}{\text{3960 * 75\% * 75\%}} \text{ * 7052 hours}$$

Annual kWh = 37,138
kWh Savings = 5,896

Mokihana System

Pump #1: 130 gpm @243’ TDH at 47% efficiency (based on field testing)

Operating hours: 1586
Total gallons pumped annually: 12,370,800

From PSAT software print-outs in Appendix B, ECM 2:

kW (from PSAT software): 15.4
Annual kWh: 24,424

Proposed 5 hp pump with new pressure controls

5 hp pump: 85 gpm @185’ TDH (operated at lower pressure)

Total gallons pumped annually: 12,370,800
Operating hours (at 85 gpm): 2425

$$kWh = \frac{\text{Head * Flow * .746 kW/hp}}{\text{3960 * Pump and motor efficiency}}$$

$$kWh = \frac{\text{185 ft * 85 gpm *.746}}{\text{3960 * 75\% * 75\%}} \text{ * 2425 hours}$$

Annual kWh = 12,771
kWh Savings= 11,653

Preliminary Cost Estimate

Item	Qty	Unit Cost Material	Labor	Total
Installation of new 5 hp pumps	2	$ 2,000	$ 2,000	$ 8,000
Overhead and Profit (20%)				$ 1,600
Construction Contingency (10%)				$ 800
Labor and Materials Subtotal				*$ 10,400*
Engineering/Project Management (15%)				$ 1,560
Hawaii State Tax (4.167%)				$ 498
Total				**$ 12,458**

Cost and Savings Summary

The cost and savings estimates for this ECM are summarized below.

Annual Energy Savings	17,549 kWh
Annual Demand Savings	N/A
Annual Energy Cost Savings	$3,534
Project Cost	$12,458
Simple Payback	3.5 years

5.2.2 ECM #2 Replace Inefficient Pumps

Description

To evaluate pump system efficiency, energy, flow and pressure data for the Kiele, Mokihana and Boat Maintenance Pump Systems was inputted into the U.S. Department of Energy's PSAT software tool. The software compared the efficiency of each pump to similar pumps in the Hydraulic Institute Database. This comparison provided an "optimization rating" for each pump system on a scale from 0-100 (a score of 90 or above is considered satisfactory). The following data was collected from the program.

Pump	*PSAT Grade*
Kiele Pump Station	
Pump #1	100
Pump #2	98
Pump #3	99
Pump #4	100
Mokihana Pump Station	
Pump #1	68
Pump #2	93
Pump #3	84
Pump #4	84
Boat Maintenance Pump	60

Based on the results of the program, it is estimated that the reduced pump efficiency for Mokihana Pumps #1,#3, and #4, and the Boat Maintenance Pump is costing Kauai Lagoons an additional $14,500 in annual energy costs.

Since Kauai Lagoons may want to consider replacing only the pumps, we have evaluated replacing the existing standard efficiency motors with premium efficiency motors in ECM #3 with the exception of the proposed Boat Maintenance Pump replacement, which is expected to be incompatible with the existing motor.

Based on the interactive aspect of this report, even though Mokihana Pump #1 is not expected to operate as many hours after the 5 hp pressure pump is installed, improving the performance of this pump is important to maintain system reliability.

Calculations

Energy savings for improving Mokihana Pumps #1, #3, #4 and the Boat Maintenance Pump are shown in Appendix B.

Preliminary Cost Estimate

Item	Qty	Unit Cost Material	Labor	Total
Mokihana Pump #1 Replacement	1	$ 8,000	$ 4,000	$ 12,000
Mokihana Pump #3 Replacement	1	$ 12,000	$ 4,000	$ 16,000
Mokihana Pump #4 Replacement	1	$ 12,000	$ 4,000	$ 16,000
New Boat Maintenance Pump/Motor	1	$ 6,000	$ 3,000	$ 9,000
Overhead and Profit (20%)				$ 10,600
Construction Contingency (10%)				$ 5,300
Labor and Materials Subtotal				*$ 68,900*
Engineering/Project Management (15%)				$ 10,335
Hawaii State Tax (4.167%)				$ 3,301
Total				**$ 82,536**

Cost and Savings Summary

The cost and savings estimates for this ECM are summarized below.

Annual Energy Savings	91,500 kWh
Annual Demand Savings	Minimal
Annual Energy Cost Savings	$18,200
Project Cost	$82,536
Simple Payback	4.5 years

5.2.3 ECM #3 Replace Motors with Premium Efficient Type

Description

All the motors for the irrigation pump systems are standard efficiency units and have been in service approximately 20 years. This ECM reviews the potential energy savings of replacing these motors with more premium efficiency type motors.

One additional reason to replace the motors on Kiele Pump #3 & #4 (contactors will allow one vsd to be used with both pumps), and Mokihana Pump #4 is the proposed installation of variable speed drives for these pumps (presented in ECM #4). If a variable speed drive is applied using the old motors, the insulation could degrade at a faster rate and lead to premature motor failure. New inverter-duty premium efficiency motors are designed for the high voltage spikes that can occur with variable speed drives.

Calculations

Savings calculations were done using Department of Energy Motor Master Software. Results are included in Appendix B.

Preliminary Cost Estimate

Item	Qty	Material	Unit Cost Labor	Total
Premium Efficient Motors (all eight)	--	$ 59,299	$ 1,000	$ 60,299
Overhead and Profit (20% - included in pricing)				$ N/A
Construction Contingency (10%)				$ 6,030
Labor and Materials Subtotal				*$ 66,329*
Engineering/Project Management (15%)				$ 0
Hawaii State Tax (4.167%)				$ 2,280
Total				**$ 68,609**

Cost and Savings Summary

The cost and savings estimates for this ECM are summarized below.

Annual Energy Savings	21,964 kWh
Annual Demand Savings	15 kW
Annual Energy Cost Savings	$ 6,263
Project Cost	$68,609
Simple Payback	10.9 years

5.2.4 ECM #4 Install Variable Speed Drives and New Controls

Description

Variable speed drives (VSDs) have been used extensively for pump systems to improve flow, pressure control and system efficiency. When variable speed drives are applied properly, energy savings and reduced maintenance expenses can often be realized.

As discussed in Section 3, variable speed drives can be cost effectively applied to the Kiele and Mokihana Pump Systems. Specifically, the variable speed drives provide the most savings when used on Kiele Pumps #3 or #4, and Mokihana Pump #4.

The savings for this ECM is based on reducing the system pressure as part of this measure. If pressure cannot be reduced, the savings will not support the project cost. Facility staff should verify that the proposed lower system pressure does not compromise system operation by adjusting system controls, or reducing system pressure by keeping one pump off during system operation.

The estimated cost also includes a more advanced control system for each pump system to take advantage of the VSD's features and eliminate the need for the existing cla-valves.

Calculations

Reference Appendix B for savings calculations and manufacturer's information.

Preliminary Cost Estimate

Item	Qty	Unit Cost Material	Labor	Total
VSD/Controls for the Kiele System	1	$60,000	$ 6,800	$ 66,800
VSD/Controls for the Mokihana System	1	$55,500	$ 6,800	$ 62,300
Elimination of Cla-Valves	2	$ 500	$ 500	$ 2,000
Overhead and Profit (20%) – included in pricing				$ N/A
Construction Contingency (10%)				$ 13,100
Labor and Materials Subtotal				*$144,200*
Engineering/Project Management (15%)				$ 21,630
Hawaii State Tax (4.167%)				$ 6,008
Total				**$171,838**

Cost and Savings Summary

The cost and savings estimates for this ECM are summarized below.

Annual Energy Savings	201,000 kWh
Annual Demand Savings	136 kW
Annual Energy Cost Savings	$ 38,200
Project Cost	$171,838
Simple Payback	4.5 years

5.3 Energy Supply Measures

Energy supply measures are improvements that include investigating alternative utility rate schedules, altering the way power is used at a facility (demand controls, power factor correction) to reduce energy billing costs, or providing power through alternative energy sources.

5.3.1 ESM #1 Install Demand Controls

Description

Similar to most electric utilities, the Kauai Electric Rate Schedules for Commercial Accounts over 25 kW include a demand charge that is billed monthly. The charge is based on the highest kW use recorded at the electric meter over a 15 minute time interval. The peak demand for the Kauai Lagoon facilities is typically reached when all pumps at a station are operated at one time. Average monthly demand for each station is shown below:

Pump Station	*Average Demand over last 12 months*
Kiele and Mokihana Station	480 kW
Wells #2 & #3	54 kW
Boat Maintenance Pump	30 kW
Well #1	25 kW
Wells #4, #5 and Transfer Pump	23 kW

Electric utility peak demand charges can typically be reduced by alternating equipment operation using a demand controller. A demand controller is a simple device that monitors demand and interrupts selected equipment from operating, while other equipment is on-line. For a pump station, when the demand level is reduced after the pump shuts off, the other pump is allowed to be activated with existing controls. An example of this is the electric service for Wells #2 and #3. As shown above, the peak demand recorded in 2001 was 54 kW when both pumps were operated together over a 15 minute period. Since these pumps are operated less than 1000 hours per year, the pumps could be alternated with improved controls without affecting water supply to the system.

Many facilities are able to alter the way a system is operated to prevent high demand charges by staggering equipment operation to prevent all equipment from being operated at the same time. Currently, it is difficult to stagger the Kiele and Mokihana Pump Systems during the summer when all pumps are required at full capacity during the evening hours for several weeks. Unfortunately, this creates a peak demand for the facility that impacts demand charges for many months. Based on the interactive effect of the recommended measures, staggering the operation of the Mokihana and Kiele Pump Stations will become more feasible after the capacity is improved by upgrading the Mokihana Pumps, installing variable speed drives and eliminating the cla-valves from the system piping. The increased pump system capacity expected from these improvements will increase flow and provide an opportunity to use demand controls as recommended in this ESM.

Applying demand controls (or an electrical/mechanical interlock) at the Kiele/Mokihana Station will also prevent both systems from operating at the same time and save approximately 111 kW every month.

Calculations

Savings calculations are provided in Appendix B.

Preliminary Cost Estimate

Item	Qty	Unit Cost Material	Labor	Total
Demand Controls	2	$ 4,000	$ 2,000	$ 12,000
Overhead and Profit (20%)				$ 2,400
Construction Contingency (10%)				$ 1,200
Labor and Materials Subtotal				*$ 15,600*
Engineering/Project Management (15%)				$ 2,340
Hawaii State Tax (4.167%)				$ 747
Total				**$ 18,687**

Cost and Savings Summary

The cost and savings estimate for this ESM is summarized below.

Annual Energy Savings	N/A
Annual Demand Savings	138 kW
Annual Energy Cost Savings	$25,391
Project Cost	$18,687
Simple Payback	1.2 years

5.3.2 ESM #2 Install Power Factor Correction Capacitors

Description

For the pump stations that are billed on Kauai Electric's "P" Schedule, an adjustment is made on each monthly bill based on the power factor of the station. When the power factor is below 100%, a penalty is added to the bill that increases the demand charge (kW) and the consumption charge (kWhs). For Kauai Lagoons, this only applies to the Kiele/Mokihana Pump Station.

Power factor is defined as the ratio of real power to apparent power. In a purely resistive circuit, such as an incandescent light, the two are equal and power factor is unity or 1.0 (or 100%). In a circuit with inductive loads, such as an AC induction motor, there is reactive energy present (kVar) and apparent energy (kVA). As power factor decreases, the kVA value increases more than the real energy (kW).

Pump stations that have poor power factor can be improved by adding capacitance banks to the station electrical distribution system to increase kVar to bring the power factor back closer to unity (1.0). The Kiele and Mokihana Station already have capacitors installed, but these have not been working for years.

Calculations

Calculations are shown in Appendix B. These calculations do not include the potential power factor improvement if variable speed drives are installed. The savings for this ECM should be re-evaluated if vsds are installed first.

Preliminary Cost Estimate

Item	Qty	Unit Cost Material	Labor	Total
Capacitors ($20/kW)	450 kW	$ 9,000	$8000	$ 17,000
Overhead and Profit (20%)				$ 3,400
Construction Contingency (10%)				$ 1,700
Labor and Materials Subtotal				*$ 22,100*
Engineering/Project Management (15%)				$ 3,315
Hawaii State Tax (4.167%)				$ 1,059
Total				**$ 26,474**

Cost and Savings Summary

The cost and savings estimates for this ESM are summarized below.

Annual Energy Savings	N/A
Annual Demand Savings	N/A
Annual Energy Cost Savings	$8,409
Project Cost	$26,474
Simple Payback	3.1 years

APPENDIX A: ENERGY BALANCE

APPENDIX B: DATA/CALCULATIONS AND LCCA

KAUAI ELECTRIC INCENTIVE SUMMARY

OM 1

OM 2

OM 3

OM 4

ESM 1

ESM 2

ECM 1

ECM 2

ECM 3

ECM 4

APPENDIX C: KAUAI ELECTRIC RATE SCHEDULES

APPENDIX D: SYSTEM DRAWINGS

APPENDIX E: PUMP CURVES