ENERGY ASSESSMENT

AUDIT REPORT

WAR MEMORIAL COMPLEX

700 HALIA NAKOA STREET
WAILUKU, HI 96793

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1. EXECUTIVE SUMMARY

The County of Maui contracted with Green Building Hawaii (GBH), who has compiled a team of energy professionals by partnering with Energy Consulting Associates (ECA) and Advanced Energy Innovations (AEI) in order to perform an energy audit on the War Memorial Complex.

The baseline year used in this report will be 2015. This decision was made because it was the first full year of data in the 3-year study period and has a similar energy and water use profile as other years without any major usage fluctuations or anomalies.

There are nine electrical meters on the property, two water meters and one propane tank. The two properties use an average of 862,066 kWh per year at an average cost of $300,568. The electrical use of the property has increased by 72,103 kWh between 2015 and 2016, but energy costs have dropped by $3,998 due to utility rate reductions. Two of the meters have little to no usage through out the year, which makes the blended cost/kWh inaccurate. Without those two meters taken into consideration the blended cost/kWh would be $.347.

There are two water meters at the War Memorial Complex, one for each property. The majority of water use is provided by meter #4089170 with an average annual usage of 5,670 kGals at a cost of $68,438. The yearly water consumption of meter #35675601 was 385 kGals from July 2016 through June 2017 with a cost of $3,396.46.

The War Memorial Complex has one propane tank that serves the pool heater and showers. The annual average total propane usage for the property is 10,297 gallons with the average cost of $28,729.96. The usage varies from 12,819 gallons in 2015 to 9,063 gallons in 2016, which equates to a 30% decrease in usage. Reduced propane usage combined with a reduction in the cost per gallon resulted in a 35% decrease in the total spending on propane from 2015 to 2016.

The following charts show the energy use per fuel type by kWh, gallons and kBtus respectively. The bottom tables show the total property energy use in kBtus and cost.

Total Property Electrical Use Table in kWh					
	2014	2015	2016	2017	
Jan		62996	70385	63610	
Feb		71922	74003	71283	
Mar		63394	70949	74480	
Apr		73059	73709	81136	
May	66726	74238	83448		
Jun	72391	74910	77777		
Jul	67385	65936	75227		
Aug	72879	62742	78224		
Sep	67124	77462	73117		
Oct	73719	77693	83580		
Nov	68393	64637	72547		
Dec	62,583	67,204	75,330		3 Year Ave.
Totals	551,200	836,193	908,296	290,509	862,066
Total kBtus	1,880,694	2,853,091	3,099,106	991,217	2,941,369

Total Property Propane Use Table Per Gallon					
	2014	2015	2016	2017	
Jan		3,255	1,082	1896.7	
Feb		1458.4	1459.3	3497.4	
Mar		2913.49	1606.2	507.8	
Apr		1777.4	360	0	
May	209	440.9	384.2		
Jun	0	304	0		
Jul	0	0	0		
Aug	0	0	200		
Sep	240.3	181.5	0		
Oct	0	32.6	0		
Nov	1057.1	703.7	1323.8		
Dec	1,599	1,752	2,648		3 Year Ave.
Totals	3,106	12,819	9,063	5,902	10296.53
	283,644	1,170,740	827,742	539,021	940382

Since there are two fuel types on this property the audit team has calculated total energy cost based on kBtu usage. The following tables show the combined energy use and cost of the total

energy use of all fuel types on the property. Propane makes up 24.2% of the property energy use and has decreased from the 2015 baseline. Electricity makes up 75.8% of the energy use and has increased from the 2015 baseline. The overall energy use of the property has decreased since 2015. This decrease is fueled by more efficient propane usage.

Total Property Energy Cost Table					
	2014	2015	2016	2017	
Jan		$25,374.13	$22,744.87	$21,890.49	
Feb		$25,636.10	$22,633.30	$23,420.99	
Mar		$21,848.78	$22,765.61	$25,106.90	
Apr		$25,056.96	$23,677.07	$27,860.37	
May	$28,748.20	$25,988.71	$24,580.89		
Jun	$30,461.45	$26,264.37	$24,364.04		
Jul	$28,604.62	$24,065.58	$24,499.49		
Aug	$29,822.47	$23,146.96	$26,217.09		
Sep	$27,880.46	$26,376.94	$24,292.79		
Oct	$30,230.76	$24,928.19	$25,929.35		
Nov	$28,483.85	$20,852.40	$22,129.06		
Dec	$25,892.55	$21,458.30	$23,165.67		3 Year Ave.
Totals	$240,946.55	$327,836.07	$310,982.83	$113,221.45	$330,995.63

Total Property Energy Use Table in kBtus					
	2014	2015	2016	2017	
Jan		512222	338936	390263	
Feb		378594	385776	562635	
Mar		482389	388772	300503	
Apr		411607	284374	276836	
May	246757	293567	319814		
Jun	246998	283357	265375		
Jul	229918	224974	256675		
Aug	248663	214076	285166		
Sep	250974	280877	249475		
Oct	251529	268066	285175		
Nov	329902	284810	368433		
Dec	359597	389292	498877		3 Year Ave.
Totals	2,164,338	4,023,831	3,926,848	1,530,237	3,881,751

Two utility tracking options were investigated by the energy audit team. Portfolio Manager is a free international online database used to compare energy and water use between similar buildings. This database is time intensive to set up for each property but once it is set up it can be easy to update and can be updated by third party providers if needed. To create property accounts for the entire County it would be very time consuming to collect all of the data and input it into the database. The second option that the audit team looked into is an online database and dashboard provided by Kaua'i County that uses Tableau Public as a platform to customize utility information. This database should only take one day to set up and less than half an hour to update every month. The software costs $2,000 for the licensing fees. This database is more realistic on a countywide basis due to the easy upload and set up and it is also more interactive and customizable. This software is limited by MECO's ability to provide the data in the correct format.

An investment grade lighting audit was performed through out the War Memorial Complex in order to effectively identify energy conservation measures related to the existing lighting. Based on wattages and runtimes it is estimated that the annual energy cost for lighting is $151,858.96, which makes up 50% of the total annual electrical cost of the property. The existing demand for lighting, if all lighting was turned on at the property at the same time, would be 497 kW, the proposed demand after an LED retrofit would be reduced by 330 kW making it 167 kW, which reduces the demand by 66%. The current estimated annual usage is 635,408 kWh and the proposed usage is 173,228 kWh, which reduces usage by 73% on lighting. The proposed LED retrofit is estimated to cost $779,097.06 with a Hawaii Energy rebate estimated to be $52,951.60 making the final project cost around $726,145.46. With estimated energy savings of $151,858.96 the simple payback is approximately 4.78 years. With a minimum life expectancy of 10 years or more. Over the 10 year life expectancy the estimated energy savings is $1,518,589.59 based on current electrical rates.

This site consists of nine separate electric meters with varying rates, the following chart breaks out the savings by meter:(*2 meters not used and football meters are combined below). In the chart below the column, "Areas included" do not match actual locations, and these were only

used during the audit. More details about lighting savings per meter can be found in the "Utility Meter" sections below.

War Memorial Complex Reporting Period (ANNUAL NUMBERS LISTED BELOW)	5/31/2016	5/1/2017

Meter Name-ID	Areas Included	Energy Savings	kWh Saved	kW Saved	Project Cost	Rebates	SPB	ROI
Construction-115269	Construction Maintenance	$ 3,042.99	10,109.60	2.868	$ 14,426.18	$ 2,042.34	4.070	25%
Baseball-120347	Baseball Stadium	$ 22,150.41	56,506.15	102.688	$270,362.82	$ 5,415.31	11.961	8%
Football 1&2-82814&97348	Football Stadium & Maintenance	$ 41,874.79	100,781.67	110.153	$303,939.09	$12,822.43	6.952	14%
Gym-85111	Gym, Tennis Courts, DLNR Offices & Pool	$ 61,155.98	219,985.52	95.8752	$154,673.87	$26,452.33	2.097	48%
Aquatics-82792	Parks & Rec Offices	$ 9,550.98	32,376.20	7.063	$ 17,648.63	$ 2,760.48	1.559	64%
Parking-97424	Fields & Parks	$ 14,083.82	42,421.14	11.441	$ 18,046.53	$ 3,458.71	1.036	97%
PROJECT TOTAL		$ 151,858.96	462,180.29	330.0882	$779,097.12	$52,951.60	4.782	21%

As part of the audit, the team made an inventory of all mini split and central air conditioning units on the property. In total the property has twenty-five air conditioning units (not including window units), twenty-two mini-split units and three central air units. The audit team recommends the replacement of two central air conditioning systems and six mini-split systems. Two of the mini-split units do not operate enough to rationalize replacing but are at the end of life. Nine mini-split units would need to be analyzed more before recommendations. One central air conditioning unit and five of the mini-split units are still operating efficiently. It is recommended to start a maintenance contract for all air conditioning units through out the property. It is not possible to do a financial analysis on these retrofits due to not being able to get pricing from contractors in time.

The pool pump is estimated to cost $35,300 per year to circulate and filter the pool water. It is estimated that the pool water heater uses $29,965.65 a year on average. In total the pool water heater and pump use an estimated $65,265.65 of energy and propane to operate the pool per year. The pool pump is circulating the pool water more than needed and can be controlled to reduce flow and save an estimated 30% of the energy use. Compared to other pools that have been studied on Maui the Sakamoto pool is running more efficiently than average.

The War Memorial Complex property has a total of seven water heaters. Five of these units are fueled by propane and two are electric water heaters. The pool boiler is the largest of the water heaters with an estimated annual use of 9,500 gallons per year at a cost of $29,965.65. There are four propane water heaters for the locker rooms at the pool and gym. One of these water heaters is currently not operating and the remaining water heaters use an estimated 800 gallons of propane or $2,117 a year. The football stadium water heater is believed to be oversized, but due to limited run times only uses an estimated $80 a month. There is a 45-gallon electric water heater under the construction and maintenance office. Changing the propane water heaters to electric may open opportunities for the Fast Demand Response program or energy savings. More in depth studies would need to be performed to analyze potential energy savings for these systems.

The War Memorial Complex property uses 100% well water to provide irrigation. There are two pumps on the property to serve all the irrigation needs. Pump one is a 40 horsepower

motor that is over 18 years old. This unit has an estimated annual energy use of 38,194 kWh per year at a cost of $12,680.35 based on the blended utility rate for this meter. Pump two was identified as a 25-horse power motor and has recently been replaced. This unit has an estimated annual energy use of 9,665 kWh at a cost of $3,837.18. Based on comparable energy use between the two pumps we recommend performing an efficiency study on pump 1 to analyze potential energy savings with controls or a replacement unit.

The Fast Demand Response program that is offered by MECO allows customers with large demand loads to shed or increase those loads to assist MECO with meeting energy demand. After looking into the Fast Demand Response program with the County's MECO representative it was determined that none of the meters on this property would be eligible to be a part of that program at this time. It is possible to interconnect multiple meters on this property to potentially meet the requirements of this program but a more in depth study would need to be performed to analyze the financial benefits of this recommendation.

The Stem PowerScope energy monitoring and battery back up program is offered by MECO to analyze energy use of electrical meters to assist in battery design to reduce electrical demand. The goal of this program is to bring large commercial clients into lower rate schedules. This program would only be available to one meter on the property based on the guidelines of the program.

Out of the three available programs for photovoltaic (PV) energy production the only applicable opportunity for this property is the customer self supply program and this would only apply to two of the nine meters. Meter #85111, which provides energy to the gym building and meter #82792, which provides electricity to the aquatics and permitting offices would benefit from applying for this PV program. This program does not allow customers to sell energy back to MECO but can produce energy to meet the needs of the facility and install battery back up. More details are available in section 14.

Further details on all elements identified in this executive summary can be found in the associated sections in the body of the report.

2. Overview of the Project

The RFP and audit scope consisted of the following elements:

1) evaluation of the facilities current energy consumption and applicable rates and costs
2) creating an inventory and tracking of status quo energy consumption and cost baselines
3) elaboration of opportunities for moving the County facilities from its baseline to a state of improved energy consumption and effectiveness.

In order to fulfill these requirements the audit team has collected all utility information for the past three years, performed a lighting audit with financial analysis for the entire facility,

monitored energy use for several of the mechanical systems, as well as completed an in depth energy audit of the pool system.

To meet the goals of this project GBH has analyzed two different ways to track utility data for the War Memorial Stadium. These include Energy Star Portfolio Manager, and an online dashboard that was provided by Ben Grisham who is the Kauai Energy and Sustainability Coordinator. Each of the databases have different pros and cons that will be discussed later in the report. Through this process the audit team has been able to identify a baseline year to compare energy use both between buildings but also with comparable buildings in the national Energy Star database. Additionally, seasonal trends in energy use were identified. All utility bills were checked to ensure that they were on the correct rate schedule and were being charged appropriate rates.

Through conducting a financial grade lighting audit and creating a mechanical equipment database, GBH has been able to identify energy efficiency measures for these systems. Recommendations were produced through a study of the wattage and runtime of the equipment that involved both visual inspections and data logging of various pieces of equipment.

With collaboration from the site's MECO representative Conrad Copeland, GBH was able to identify the possibility of demand response, photovoltaic energy production, battery back up systems and energy monitoring opportunities. Through this process we identified which utility meters would be able to participate in certain programs based on their billing schedule and level of demand.

Energy monitoring equipment was installed on the War Memorial Gym building to monitor the energy use of the gym, the parks and recreation office and the planning and development offices. The pool pumps were monitored to analyze run times of the pumps, temperature of the water and how many times per day the water was circulated in the pool. Both of these monitoring systems provide online databases to track historical usage and flow rates. We will discuss the benefits of these systems in that area of the report.

After analyzing the utility bills from 2014 till 2017, the energy audit team decided to use 2015 as the baseline year for the study. There were no major variances in energy or propane use and it was the first full year of data from all utility meters. The meter that serves the construction and maintenance office and warehouse was not entirely connected until 2015.

3. Utility Meter and Energy Use Analysis

The main focus of this study was to analyze the water, energy and fuel use of the property to identify seasonal trends, annual energy use costs and any other anomalies involved with utility usage throughout the entire property. Utility bills were collected for a minimum of three years and inputed into different utility tracking databases. Once these databases were created the bills were analyzed and the following sections describe the findings

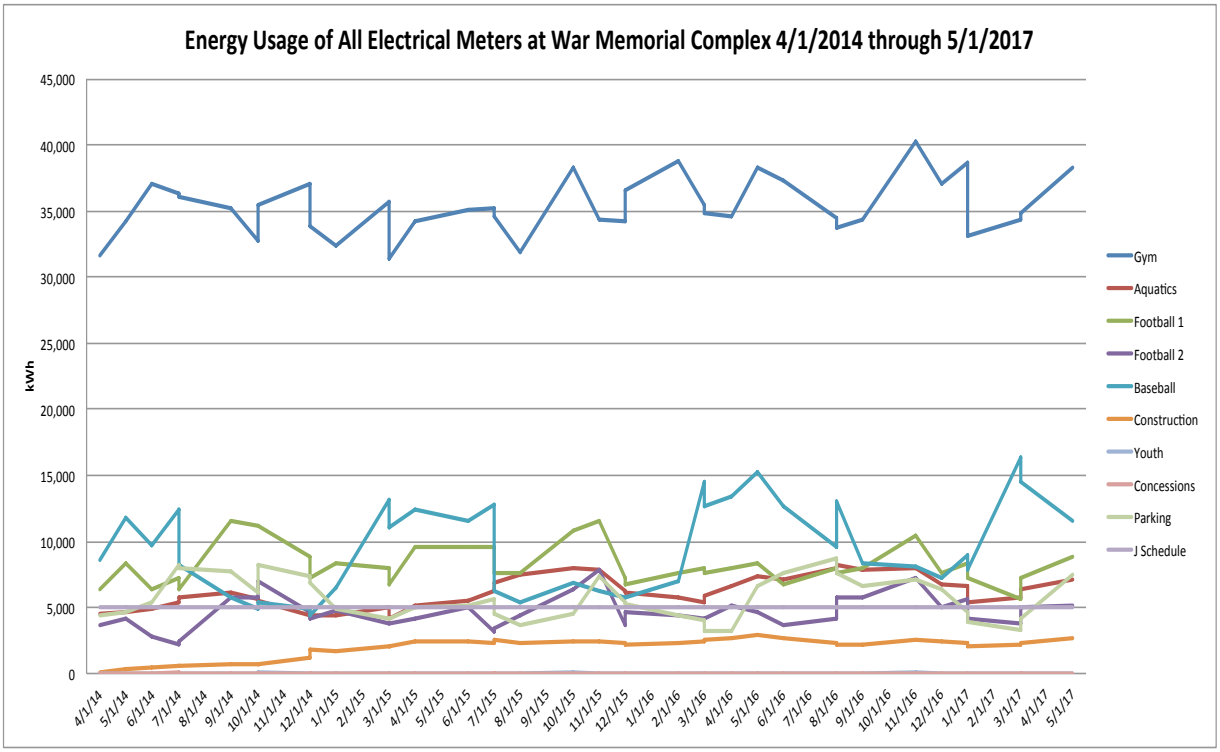
There are six meters on this property that are on J Schedule general service demand rates. This means that these meters are charged a demand charge that is calculated as the average between the current month's demand and the highest demand in the previous 11 months.

There are three meters on this property that are on a G Schedule general service non-demand rates. These properties do not receive a demand charge but are charged a higher usage charge that factors in fuel costs and service fees.

Appendix A is a map of the property showing the location of the electric meters and what buildings and areas they serve.

3.1 Property Energy Use Overview

These facilities are made up of two separate properties and have 8 different structures located on them. The total property has nine different active electric meters. Six of these meters are connected to buildings, and three meters are used for outdoor lighting and events in the fields. The two properties use an average of 862,066 kWh per year at an average cost of $300,568. The electrical use of the property has increased by 8% or 72,103 kWh between 2015 and 2016 but energy costs have dropped by $3,998 due to utility rate reductions. Two of the meters have little to no usage through out the year, which makes the blended cost/kWh inaccurate. Without those two meters taken into consideration the blended cost/kWh would be $.347.

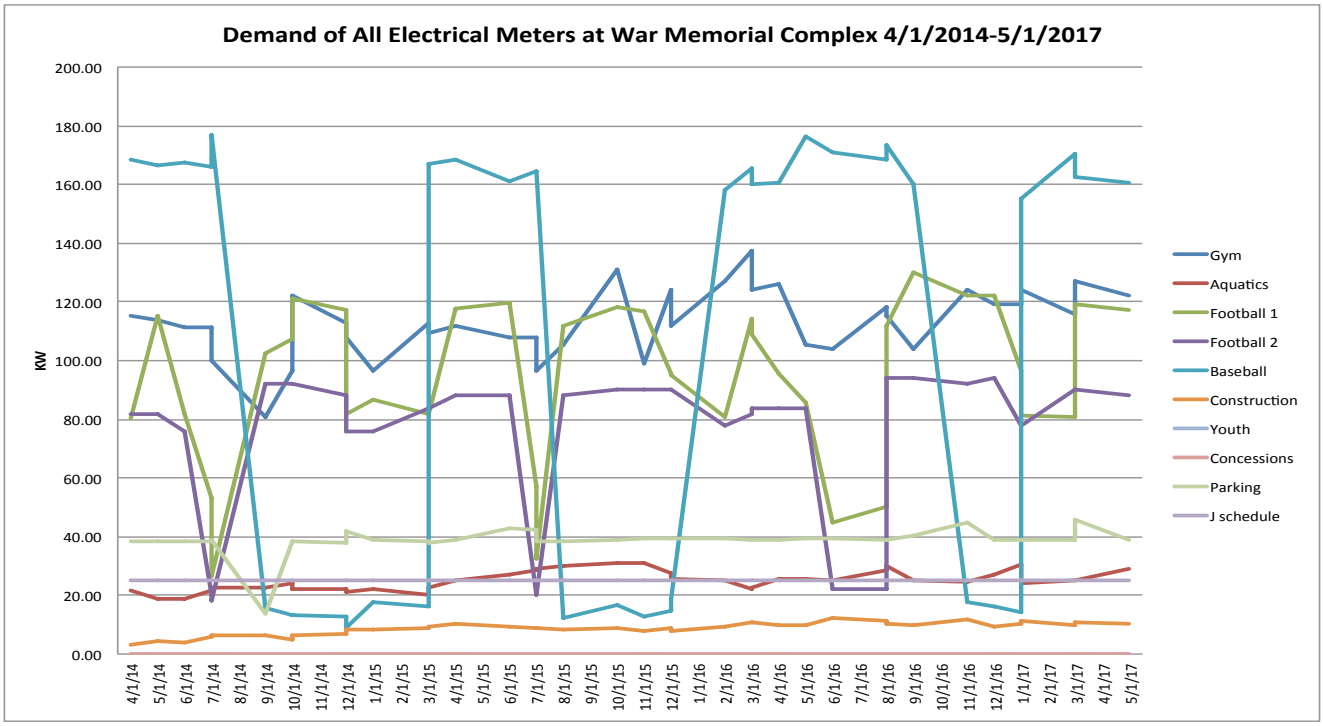


This graph shows the energy use of each meter on the property from April 2014 to May 2017. The purple line at 5,000 kWh shows the minimum usage for a J schedule meter The gym is

the largest energy consumer on the property, 3.3 times larger than the next largest energy consumer. This increase is due to the pool pumps running all the time, high wattage lighting in the gym that is used daily, and the air conditioning load of the offices that are attached to this building. The usage of this meter is not seasonal and has increased each year.

The youth baseball fields and concessions field both have no usage for the majority of the year except during events such as the fair. These meters cost the County of Maui $31 a month no matter what the usage is. Together the service charges on these meters cost $744 a year to provide energy to events throughout year.

Six of the nine electrical meters are on a J schedule utility rate and are charged for demand charges. Each meter's demand charges will be discussed in its own section. The maximum demand of the entire property in 2014-2015 was 539 KW and has increased steadily to 574 KW in the 2016-2017 year. The majority of this demand spike looks like it came from War Memorial Gym in March of 2016, increasing by 30 KW from the previous year, and again from Yamamoto Football Stadium in September of 2016, increasing demand by 16 KW from the previous year.



This graph shows the demand of each electric meter on the property from April 2014 to May 2017. The purple line at 25 KW shows the minimum demand for a J schedule meter. This graph shows that the baseball field has the highest demand on the property at 176.6 kW; but combined the two football field meters are significantly higher at around 224 KW. This demand spike is due to the high wattage stadium lighting in these areas. All three of these meters are extremely seasonal with extremely low off season demand.

The gym also has a very large demand, around 120 KW due to the high wattage lighting, air conditioning and the pool pumps. This meter is consistently around the same demand with one major spike in March of 2016. There are not any major seasonal fluctuations in demand for this meter.

One meter, aquatics, is on the border of the J schedule cut off, which is 25 KW demand and 5,000 kWh usage per month. If this meter could reduce its demand by 6 KW and its usage by 2,500 kWh per month it would be brought down to a G schedule electrical rate.

The utility meter names on the billing do not correlate with the buildings that they serve. For the use in this report the following meters will be labeled as follows. A more detailed description of each meter is found later in the report.

- Meter #85111-Gym etc.
- Meter #82792-Aquatics/Permitting
- Meter #97348-Football 1
- Meter #82814-Football 2
- Meter #120347-Baseball
- Meter #115269-Construction/Maintenance
- Meter #121727-Youth baseball
- Meter #65795-Concessions field
- Meter #97424-Parking Lot

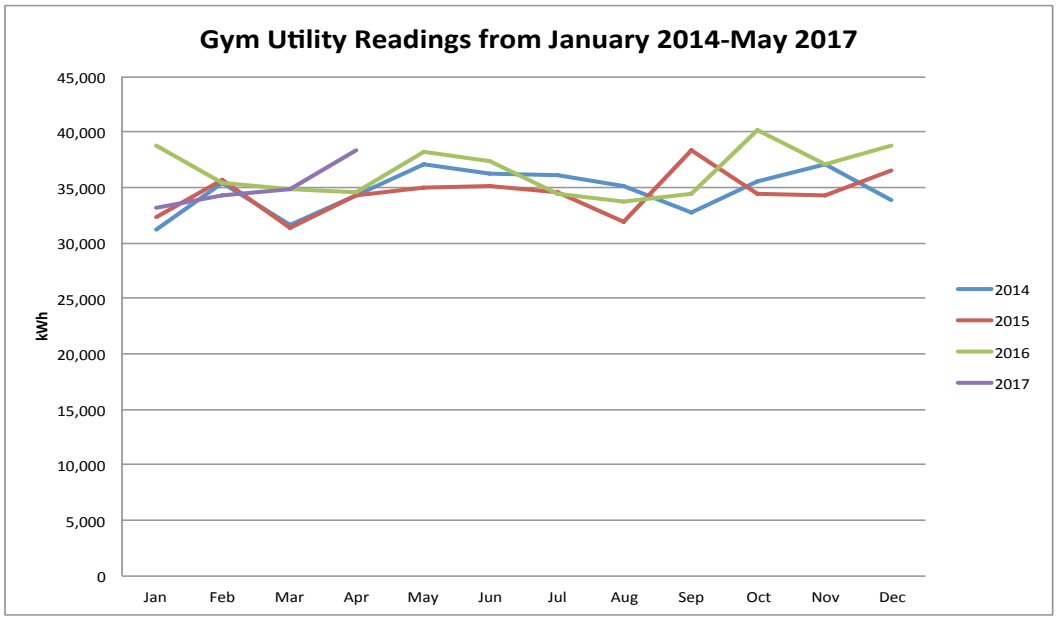
3.2 Meter #85111-Gym, Planning Department, Pool and Tennis Courts

This meter is on a Schedule J general service demand rate and serves the main facility on the property, which includes the gym, the pool, tennis courts, parks and recreation office, maintenance office and the planning and development department. The meter is physically located behind War Memorial Gym in an electrical closet near the rear access road. There is also a major sub panel located by the rear entrance to the gym, which controls the gym lighting, tennis court lighting and all of the offices.

The energy use of this meter is pretty consistent with three spikes a year, one in January, one in May and another in October. The average annual energy use over the study period is 378,533 kWh with a variance of 24,160 kWh between 2015 and 2016. The average monthly usage is 33,329 kWh. This meter is by far the largest energy user on the property with the next largest meter at less than half of the energy use. The blended cost/kWh for this meter over the last year would be $.278.

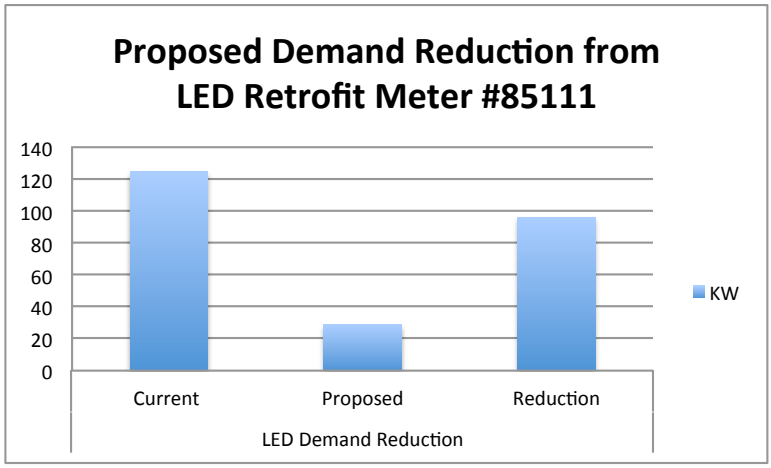
The demand of this meter fluctuates between 80.8 KW and 137.6 KW and is currently being charged at 124.8 KW from the most recent peak during the March billing cycle of 2017. The high

wattage gym lighting, the pool pump, the office lighting and all of the air conditioning systems for the office spaces all running at the same time cause this high demand.



If a full LED lighting retrofit was installed on the facilities served by this meter the estimated annual energy reduction would be 219,985 kWh or $61,155.98. The potential demand reduction would be an estimated 95.875 KW, which would bring the peak demand from 137.6 KW to 28.925 KW. This would keep this meter in the J rate schedule but would make it possible to reduce it even further with air conditioning retrofits as well as PV and battery backup to possibly bring it within the G rate schedule.

The project costs for an LED lighting retrofit are estimated at $154,673.87 with Hawaii Energy rebates estimated to be $26,452.33 making the final cost of $128,221. The simple payback period of this project would be 2.097 years with a return on investment of 48%. Note that the demand reduction is based on all lights being on at the same time during peak demand period.

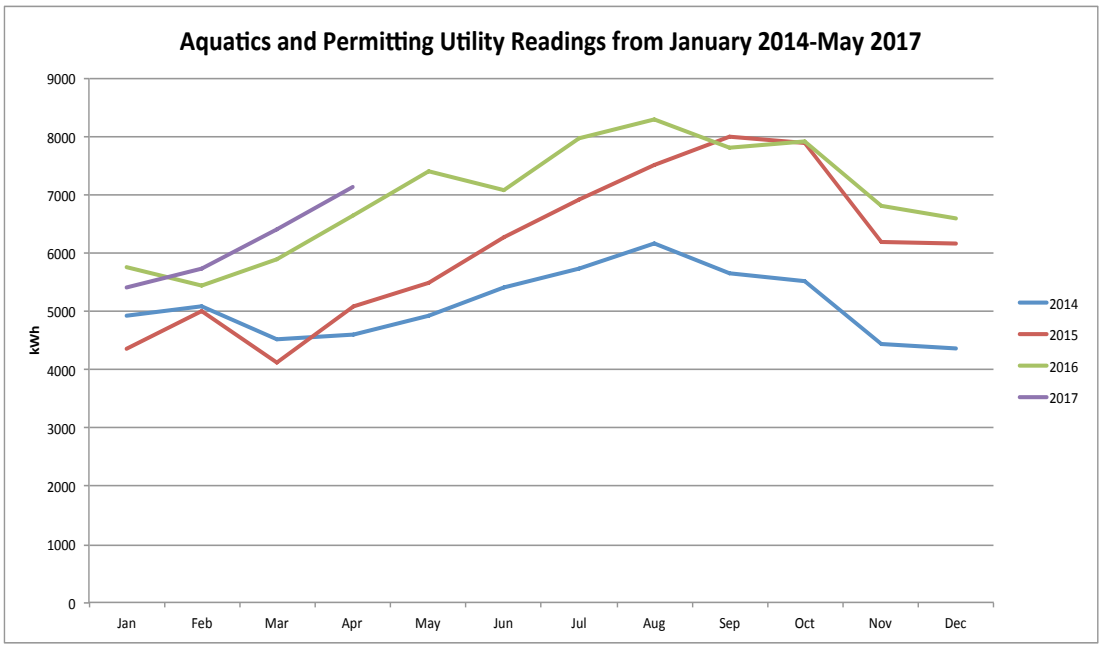


3.3 METER #82792-AQUATICS/PERMITTING OFFICE

This meter is on a Schedule J general service demand rate and serves the aquatics office and the permitting office. The meter is physically located behind the permitting office and next to the War Memorial Gym in an electrical closet. This closet also houses the central air conditioners 2 and 3 breaker boxes.

The energy use of this meter is very consistent with seasonal increases during the summer months. This seasonal increase is more than likely attributed to the increased cooling loads of the summer months. The slight increase of energy use each year is probably due to the reduced efficiency of the air conditioning units that cool this space. The average annual energy use over the study period is 74,453 kWh with a variance of 10,560 kWh between 2015 and 2016. The average monthly usage is 6,202 kWh. The blended cost/kWh for this meter over the last year would be $.295.

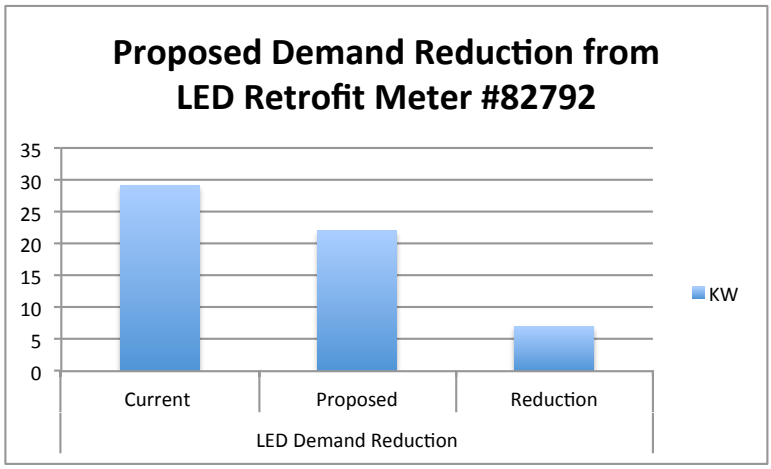
The demand of this meter fluctuates between 18.8 KW and 30.8 KW and is currently being charged at 29.2 KW from the most recent peak during the December billing cycle of 2016. The inefficient office lighting along with the old unmaintained central air conditioning systems are the major loads on this meter.



If a full LED lighting retrofit was installed on the facilities served by this meter the estimated annual energy reduction would be 32,376.20 kWh or $9,550.98. The estimated monthly energy use would be reduced by 2,666 kWh, which would bring the average monthly energy use to 3,297 kWh. The potential demand reduction would be an estimated 7.063 KW, which would bring the peak demand from 29.2 KW to 22.13 KW. This would bring this meter into the G rate schedule,

which at this time is charging $.3208 compared to $.3175 that the meter is being charged at its current rate.

The project costs for an LED lighting retrofit are estimated at $17,648.63 with Hawaii Energy rebates estimated to be $2,760.48 making the final cost of $14,888.15. The simple payback period of this project would be 1.559 years with a return on investment of 64%. Note that the demand reduction is based on all lights being on at the same time during peak demand period.

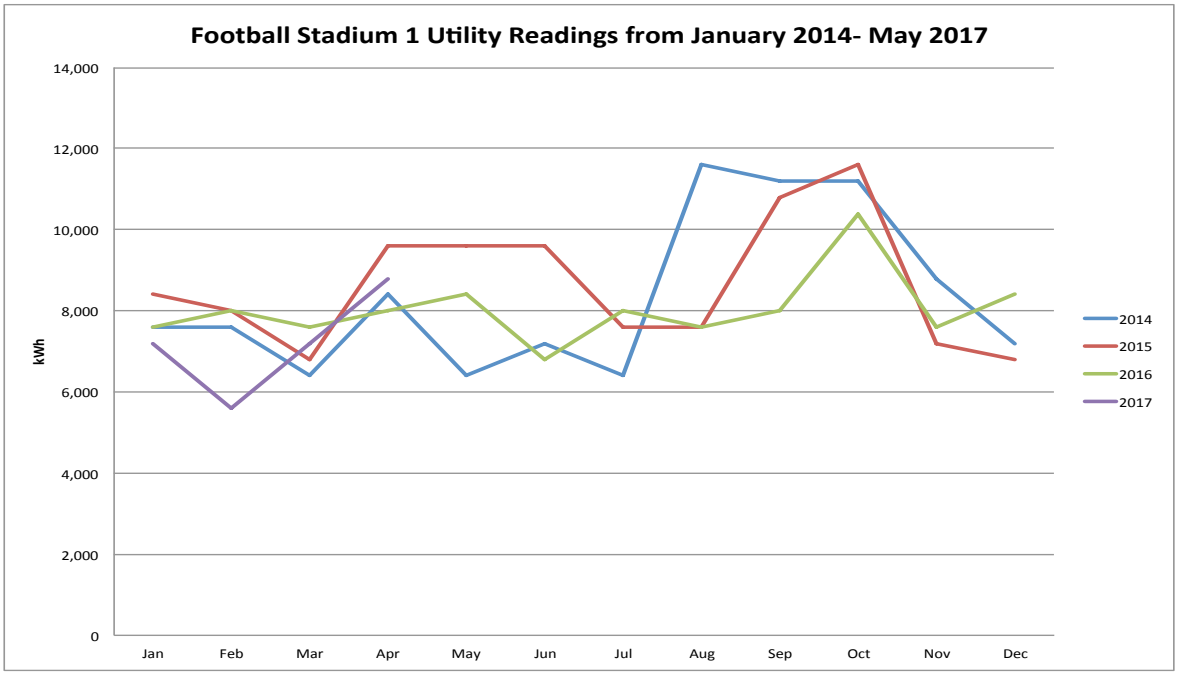


3.4 Meter #97348-Football Stadium 1, Parks Maintenance and Pump #2

This meter is on a Schedule J general service demand rate serves half of the football stadium lighting, the parks maintenance shop and the irrigation pump #2. The meter is physically located outside of the mechanical room underneath the bleachers of the Yamamoto track and football field. This mechanical room also houses all of the switching for the stadium lighting and the water heating system for the locker rooms.

The energy use of this meter fluctuates significantly during August through October. This seasonal increase is due to the events the facility is used for. The usage is not extremely high due to the limited run hours of the lighting on the field. The off-season energy use from April till June in 2015 may be due to irrigation pump use. The average annual energy use over the study period is 99,600 kWh with a variance of 7,200 kWh between 2015 and 2016. The average monthly usage is 8,299 kWh. The blended cost/kWh for this meter over the last year would be $.397.

The demand of this meter fluctuates between 26.4 KW and 132 KW and is currently being charged at 123.6 KW from the most recent peak during the September billing cycle of 2016. The high wattage stadium lighting and the irrigation pump are the majority of the demand on this meter.

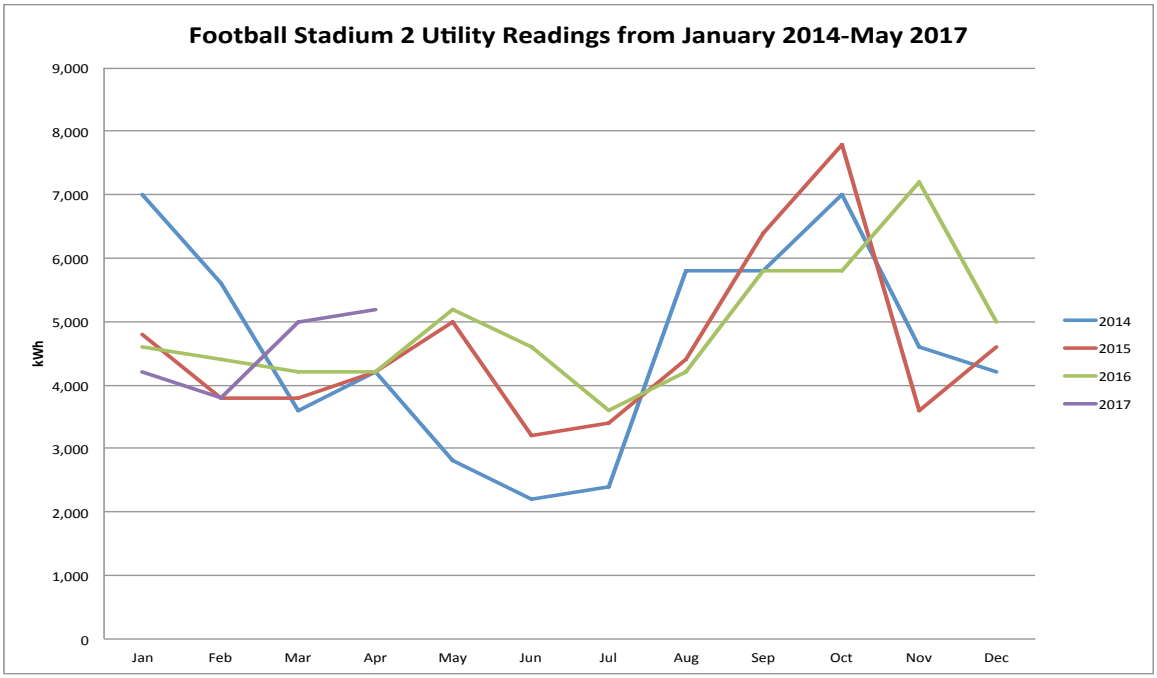


3.5 Meter #82814-Football Stadium 2

This meter is on a Schedule J general service demand rate serves the other half of the football stadium lighting as well as the concessions stand and announcers booth. The meter is physically located behind the announcer's booth inside the fenced in transformer station.

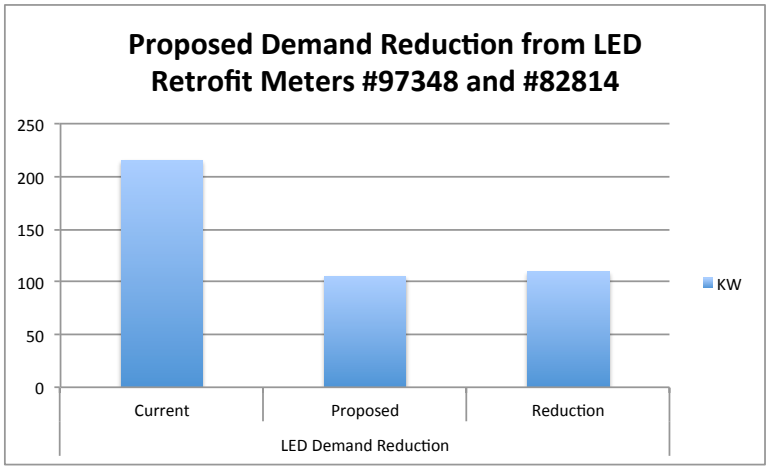
The energy use of this meter fluctuates significantly during August through October. This seasonal increase is due to the events the facility is used for. The usage is not extremely high due to the limited run hours of the lighting on the field. The off-season energy use from April till June in 2015 does not match "Football Stadium 1" which would support the assumption that the spike during that time came from irrigation use. The average annual energy use over the study period is 55,933 kWh with a variance of 4,800 kWh between 2015 and 2016. The average monthly usage is 4,660 kWh. The blended cost/kWh for this meter over the last year would be $.434.

The demand of this meter fluctuates between 18 KW and 94 KW and is currently being charged at 92 KW from the most recent peak during the September billing cycle of 2016. The high wattage stadium lighting and the irrigation pump are the majority of the demand on this meter.



Football stadium meters 1 and 2 were combined for the lighting study due to the fact that it is not possible to differentiate which lights are connected to what meter without a more in depth study. If a full LED lighting retrofit was installed on the facilities served by these meters the estimated annual energy reduction would be 100,781.67 kWh or $41,874.79. The potential demand reduction would be an estimated 110.153 KW, which would bring the peak demand from 215.6 KW to 105.447 KW. This would keep this meter in the J rate schedule.

The project costs for an LED lighting retrofit are estimated at $303,939.09 with Hawaii Energy rebates estimated to be $12,822.43 making the final cost of $301,179.42. The simple payback period of this project would be 6.952 years with a return on investment of 14%. Note that the demand reduction is based on all lights being on at the same time during peak demand period.

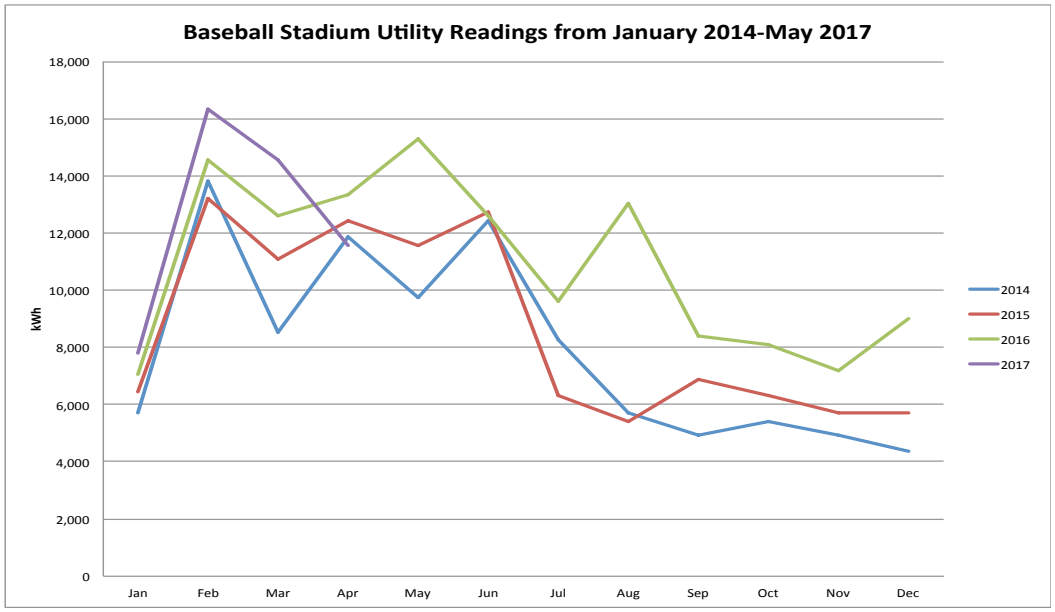


3.6 METER #120347-BASEBALL STADIUM

This meter is on a Schedule J general service demand rate serves the baseball stadium lighting as well as the concessions stand and announcers booth. The meter is physically located next to left field, inside the fenced in transformer station.

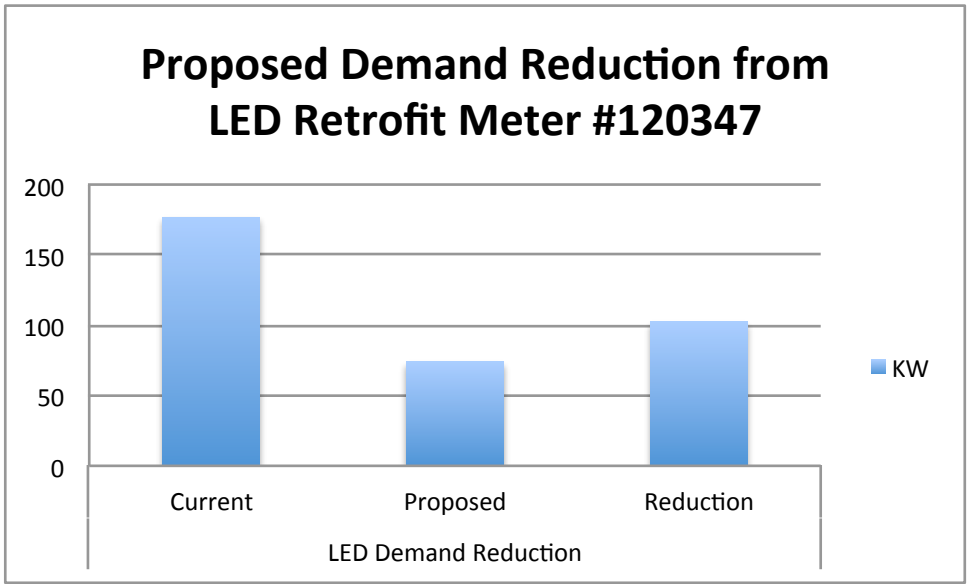
The energy use of this meter fluctuates significantly during February through June. This seasonal increase is due to the events the facility is used for and correlates to the baseball season. There are more events in this stadium than in the football stadium, which is why the usage is higher than the football stadium usage. The average annual energy use over the study period is 113,550 kWh with a variance of 27,000 kWh between 2015 and 2016. This increase in energy use could be contributed to increased usage of the facility over the years. The average monthly usage is 9,464 kWh. The blended cost/kWh for this meter over the last year would be $.392.

The demand of this meter fluctuates between 9 KW and 176.9 KW and is currently being charged at 168.6 KW from the most recent peak during the February billing cycle of 2017. The high wattage stadium lighting is the only large energy consumer on this meter.



If a full LED lighting retrofit was installed on the facilities served by this meter the estimated annual energy reduction would be 56,506.15 kWh or $22,150.41. The potential demand reduction would be an estimated 102.7KW, which would bring the peak demand from 176.9 KW to 74.2 KW. This would keep this meter in the J rate schedule.

The project costs for an LED lighting retrofit are estimated at $270,362.82 with Hawaii Energy rebates estimated to be $5,414.31 making the final cost of $267,602.34. The simple payback period of this project would be 11.961 years with a return on investment of 8%. Note that the demand reduction is based on all lights being on at the same time during peak demand period.

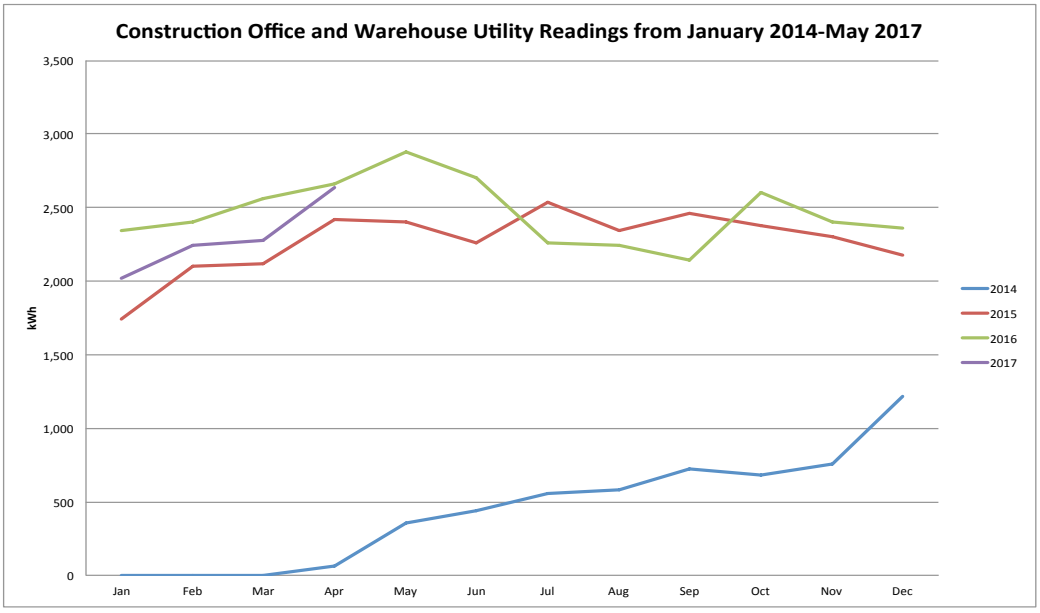


3.7 Meter #115269-Construction Offices and Warehouse

This meter is on a Schedule G general service non-demand rate and serves the construction offices and warehousing that services Maui County. The meter is physically located on the roadside of the last warehouse bay of the building.

The energy use of this meter has become pretty consistent since 2015, it looks like this meter was installed in 2014 and took some time to normalize. The variance of energy use is difficult to predict and is probably associated with the work that is being done at the facility. The average annual energy use over the study period is 24,240 kWh with a variance of 2,300 kWh between 2015 and 2016. This increase in energy use could be contributed to an increase in projects that are being performed at the facility. The average monthly usage is 2,030 kWh. The blended cost/kWh for this meter over the last year would be $.301.

The demand of this meter fluctuates between 3.2 KW and 12.3 KW and is currently not being charged for demand. The largest energy consumers for this meter are the mini split air conditioning systems and the mechanical tools used in the shop.



If a full LED lighting retrofit was installed on the facilities served by this meter the estimated annual energy reduction would be 10,109.6 kWh or $3,042.99. This meter is already on the G rate schedule so it is not paying for demand charges. The demand reduction would be 2.86.

The project costs for an LED lighting retrofit are estimated at $14,426.34 with Hawaii Energy rebates estimated to be $2,042.34 making the final cost of $12,384. The simple payback period of this project would be 4.07 years with a return on investment of 25%. Note that the demand reduction is based on all lights being on at the same time during peak demand period.

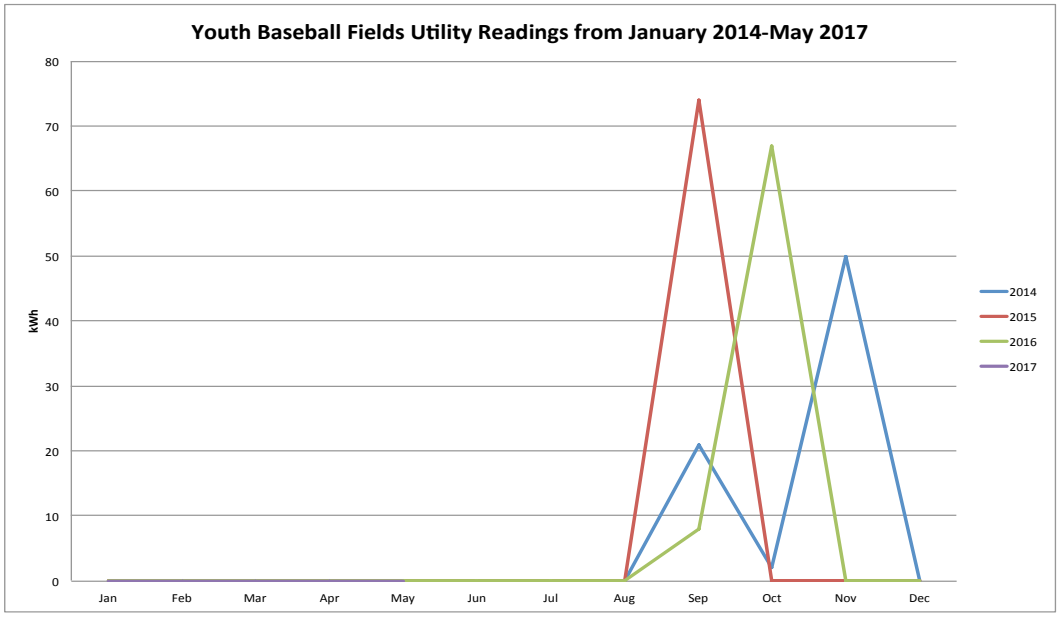
Since this meter is already on a G rate schedule we did not provide a graph for demand reduction.

3.8 Meter #121727-Youth Baseball Fields

This meter is on a Schedule G general service non-demand rate and serves the youth baseball fields and any events that may happen in that area. The meter is physically located near the right field of the closest youth baseball field to the stadium parking lot.

The energy use of this meter is 0 except during the months of September, October and November of each year. This energy use correlates to the county fair and other events that happen at that time. The average annual energy use over the study period is 75 kWh with a variance of 2 kWh between 2014 and 2016. Due to this meter not having any use for the majority of the year the County of Maui is paying $31 a month to keep this meter active. At the current G schedule utility rate this meter costs on average $23.84 per year for usage and $372 on meter charges. The blended cost/kWh for this meter over the last year would be $.392.

The demand of this meter is 0. The only energy consumer for this meter is event usage.



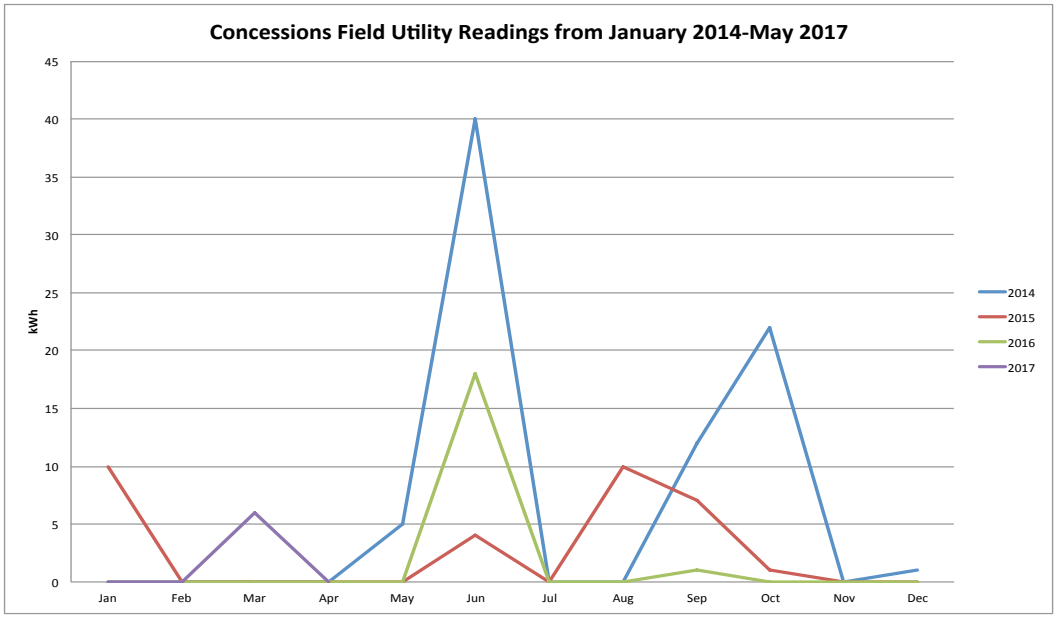
There are no lighting retrofits recommended for this meter.

3.9 Meter #65795-Concessions Field

This meter is on a Schedule G general service non-demand rate and serves the concessions field and any events that may happen in that area. The meter is physically located on a billboard on the road side of the concessions field.

The energy use of this meter is 0 except when there are events in this area. It looks like there are several events throughout the year that use this meter for energy and none of them seem to use very much energy. The average annual energy use over the study period is 44 kWh with a variance of 13 kWh between 2015 and 2016. Due to this meter not having any use for the majority of the year, the County of Maui is paying $31 a month to keep this meter active. At the current G schedule utility rate this meter costs on average $13.97 per year for usage and $372 on meter charges. The blended cost/kWh for this meter the last year would be $3.28. This blended cost/kWh is drastically increased due to the minimal usage and monthly meter costs.

The demand of this meter is 0. The only energy consumer for this meter is event usage.



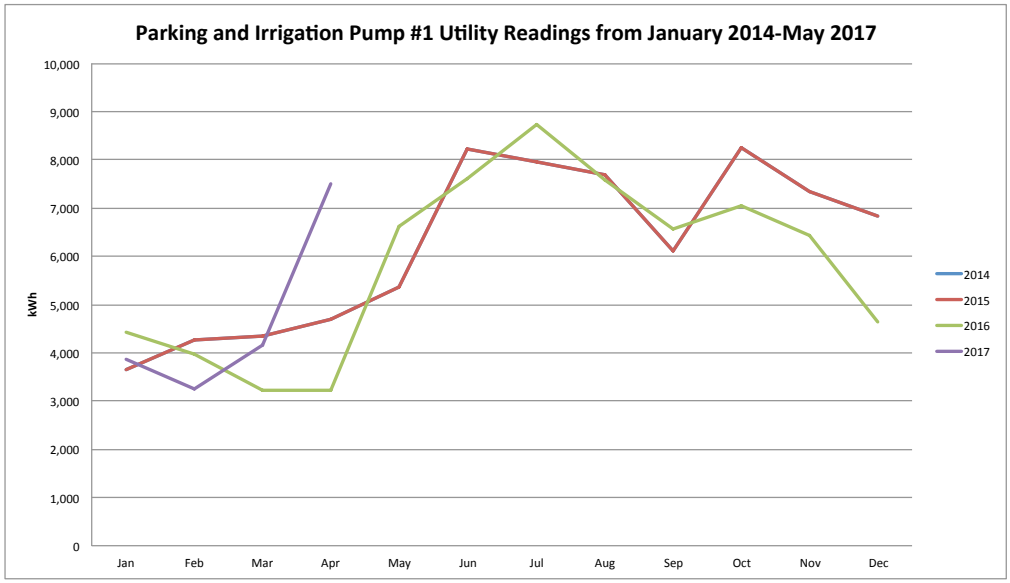
There are no lighting retrofits recommended for this meter.

3.10 Meter #97424-Parking Lot and Pump 1

This meter is on a Schedule J general service demand rate and serves the parking lot lighting and the irrigation pump #1. The meter is physically located on the back of a small building on the road side of the War Memorial parking lot.

The energy use of this meter fluctuates significantly during the summer months in order to pump water from the well for irrigation. The average annual energy use over the study period is 73,791 kWh with a variance of 4,608 kWh between 2015 and 2016. This reduction in energy use could be contributed to reduction of irrigation use in 2016. The average monthly usage is 5,728 kWh. The blended cost/kWh for this meter over the last year would be $.332.

The demand of this meter fluctuates between 13.8 KW and 45.7 KW and is currently being charged at 38.7 KW from the most recent peak in March of 2017. The largest energy consumers for this meter are the irrigation pump and the high wattage lighting for the parking lot.



If a full LED lighting retrofit was installed on the facilities served by this meter the estimated annual energy reduction would be 42,421 kWh or $14,083.82. The potential demand reduction would be an estimated 11.44 KW, which would bring the peak demand from 38.7 KW to 27.26 KW. This would keep this meter in the J rate schedule due to the fact that the irrigation pump is the largest load on this meter and it runs at different hours than the lighting.

The project costs for an LED lighting retrofit are estimated at $18,046.53 with Hawaii Energy rebates estimated to be $3,458.71 making the final cost of $14,587.82. The simple payback period of this project would be 1.036 years with an return on investment of 97%. Note that the demand reduction is based on all lights being on at the same time during peak demand period.

4. Water and Sewer Meters

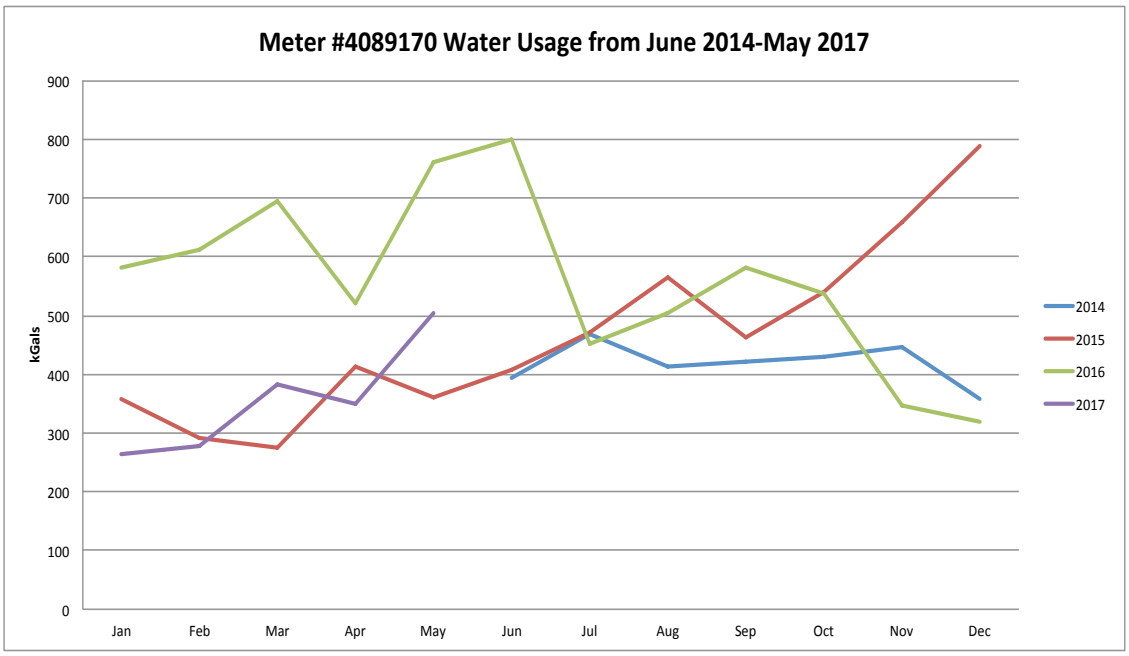
The War Memorial Complex has two water meters, one for each property. Meter #4089170 provides all domestic water to the gym, all of the offices, the pool, the youth baseball fields and the football stadium. Meter #35675601 provides all domestic water to the construction offices and warehousing and the baseball field. All irrigation is provided by the two well pumps detailed later under the "Pumps" section. Meter #35675601 did not include sewer costs in the data that was provided and the usage was minimal compared to the War Memorial Gym meter. For these reasons the audit team decided to focus only on the War Memorial Gym meter until more information was provided about meter #35675601.

The total annual use for domestic water and sewer services for the War Memorial Gym for the baseline year of 2015 was 5,594 kGals with a total cost of $68,501. Usage and cost increased significantly from 2015 to 2016 but based on the first five months of 2017 the usage has normalized again. The cost/kGal of water and sewer combined over the study period was $11.95 with the current combined rate at $12.34. This price has fluctuated from $11.52 in April 2015 up to $13.07 in February of 2017.

Appendix B is a map with the locations of the two water meters and the two pumps and the areas that they serve.

4.1 Meter #4089170-War Memorial Gym, Offices, Pool and Football Stadium

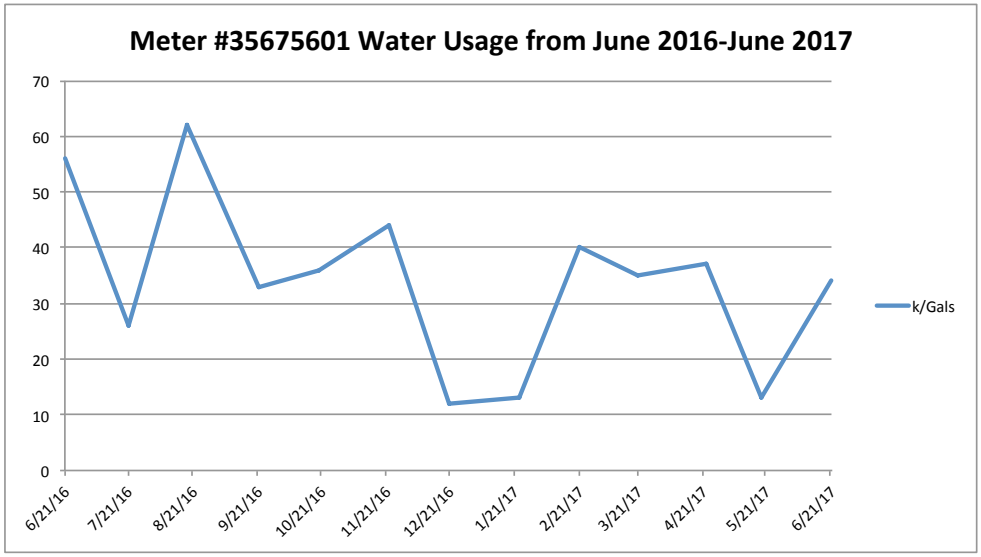
This meter provides domestic water to the majority of the War Memorial Complex including the gym, all of the offices, the pool, all of the showers, any fixtures in the youth baseball fields and the football stadium. The main uses of water on this meter are the showers and restrooms through out the property. The average annual water consumption is 5,670 kGals per year with an average cost of $68,437.95. There was a large spike in the water consumption of this meter that started in November of 2015 and lasted through June of 2016 with an unidentified cause. The spike started with a consumption of 539 kGals a month and increased to a maximum of 800 kGals before returning to normal usage patterns. The blended water and sewer rate from the most recent year of billing is $12.53/kGal. Both water and sewer rates tend to be increasing, starting at a combined rate of $11.52/kGal in July of 2014 and increasing to $12.34/kGal in May of 2017.



4.2 Meter #35675601-Construction and Maintenance Facility and Baseball Stadium

The data provided for meter #35675601 which provides domestic water for the construction and maintenance facility and the baseball stadium was not complete. The audit team received water bills for this facility from June 2016 till June 2017 but did not receive any information prior to that. During this period the bill only shows water usage with no sewer charge. It is unclear if there is not any data available before this period or if it was unable to be provided. Due to these limitations this meter was not included in the total water usage as it would have

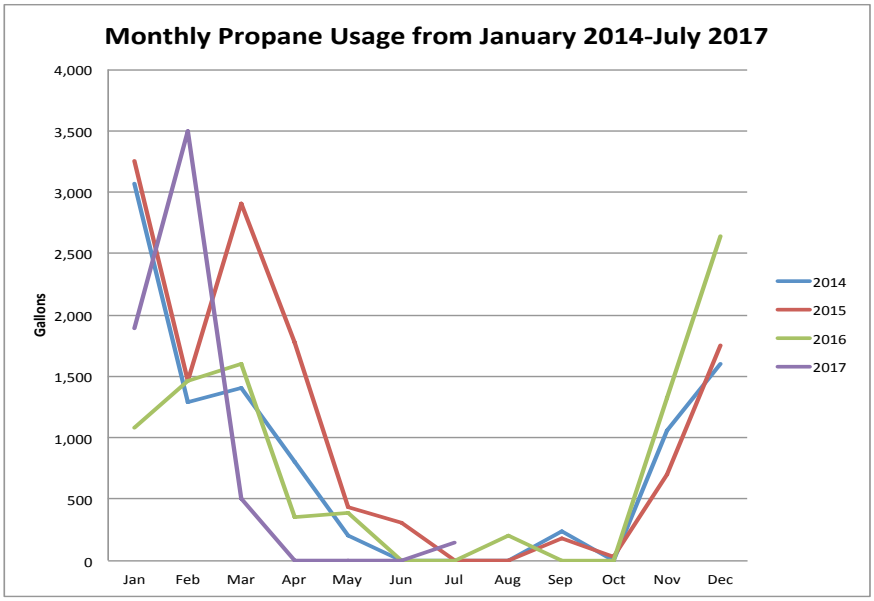
changed the cost/kGal due to not having any sewer charges. This meter only uses between 441 kGals in the 12-month period of data provided, which is less than one month of the usage and half the cost of the main meter.



5. PROPANE TANK USAGE

The War Memorial Complex has one propane tank that serves all of the propane needs for the property. It is currently serving the pool heating system, the water heaters for the showers in the pool locker rooms and the showers in the gym locker rooms. The average total propane usage for the property is 10,297 gallons with the average cost of $28,729.96. The usage varies from 12,819 gallons in 2015 to 9,063 gallons in 2016. This is a 30% decrease from 2015 to 2016. Due to reduced usage of propane as well as reduced cost per gallon of propane there was a 35% decrease in the total spending on propane from 2015 to 2016.

During the process of inputting data there is one propane delivery that shows that the propane company charged $134.20 for 42.69 gallons of propane. At the normal rate for propane at that time of $3.13 per gallon this should have been a charge of $1,318.77. This is either a typo in the billing or the County was charged 1/10th of the going rate for propane at that time.



6. Utility Tracking Opportunities

Two utility tracking options were investigated by the energy audit team to identify the pros and cons of each would be for Maui County and how easily the County could integrate them into their system. Portfolio Manager is an international online database used to compare energy and water use between similar buildings. This database is time intensive to set up for each property but once it is set up it is easy to update and can be updated by third party providers if needed. To create property accounts for the entire County would be very time consuming to collect all of the data and input it into the database. Portfolio Manager is a free database. The second option that the audit team looked into is an online database and dashboard provided by Kaua'i county that uses Tableau Public as a platform to customize utility information. This database should only take one day to set up and less than half an hour to update every month. In order to efficiently update the system MECO would have to provide the utility data in a format that can be uploaded to the database. The software costs $2,000 for the licensing fees. This database is more realistic on a county wide basis due to the easy upload and set up as. It is also more interactive and customizable.

6.1 Portfolio Manager

Energy Star Portfolio Manager is an online database of facilities through out the world that is managed by the EPA. Certain building types are able to apply for a rating that compares the energy, water and waste performance of the facility to similar facilities throughout the world. The database uses weather normalization to compare similar buildings in different areas of the world. For the purpose of this facility, the facility type is not available for an Energy Star score but it does allow for the user to calculate the site's energy use intensity, which expresses how much energy is

used per square foot of the area that uses energy. In this case that includes the parking areas, football field, baseball field, gym, pool and offices.

Benefits of using the Energy Star Portfolio Manager database is that it is a free program that provides a platform to easily upload your utility data to track over time. It can also be used as a tool to estimate savings of future projects, track return on investment on energy efficiency projects that have already been completed, and compare the facilities to similar facilities around the world. By breaking the fuel type down into kBtus , the database is able to combine the energy use of multiple different fuel types such as electricity and propane and provide a site energy use intensity number that can be compared to other facilities that use different fuel types. Once the property has been created it is easy to update the system with new utility data. Once the information has been updated the user can upload a statement of performance to confirm the energy use intensity of the site.

The challenge of using the Energy Star Portfolio Manager is that it can be difficult to collect all of the data for the property to create the database in the first place. This process is very detailed and time intensive but by accurately inputting all of the data points the database will be able to accurately calculate all the site's energy use intensity. Once this process has been completed the facility manager just needs to update the billing information on a regular basis. This should not take long since this site has only nine electric bills, one propane bill and two water bills. Some utility companies have partnered with the EPA to automatically upload this data. As of right now MECO does not offer this service but there are third party companies such as WegoWise that will offer this service for a fee.

If the County decides to move forward with Portfolio Manager, Green Building Hawaii will share the property database with all employees that are involved with the project as needed.

A Statement of Energy Performance was created through Portfolio Manager during the energy audit process and the following information was provided. The gross floor area of energy use is 300,123 square feet. This includes indoor areas as well as stadium and parking areas. Based on the total kBtu/square foot of 13.5 this property uses 58% less energy than other properties of its type. We believe that this facility rates lower than other facilities of its type due to its extremely low usage and minimal amounts of mechanical equipment.

Appendix C is a Statement of Energy Performance for the property

6.2 KUIC Utility Tracking Database and Dashboard

The KUIC utility tracking database and dashboard was brought to our attention by Ben Sullivan who is the Kaua'I energy and sustainability coordinator. He has provided access to the dashboard that Kauai uses to track their utility data as well as provided a spreadsheet for MECO to review to see if they can automate data uploads for the dashboard. Appendix D is a screenshot of the online dashboard. This online dashboard allows the user to compare properties, property

types, energy meters and performance as well as track projects that are getting budgeted or moving forward for each property.

The pros of this system are an easy to navigate dashboard that provides a visual overview of the performance of different properties to identify where the best opportunities for energy efficiency may be. The database can be updated in under half an hour a month if the utility provides the information in the proper format. The dashboard is customizable for the user and can provide different metrics based on the need of the user.

This online dashboard system is provided by Tableau Public and there is a one-time upfront cost of $2,000 for the software license. After that there are no further fees. The initial setup of the system can take some time but once the system is fully operational the data inputs take less than half an hour a month. Monitoring the data and customizing the dashboard is necessary to take advantage of the system and is up to the user on how much time should be used to track utility data. This option is also only possible if MECO agrees to provide the utility data in the format that can be uploaded into the database. At the time of submitting the report it was unclear if MECO would be able to provide this information in that format. Conrad Copeland informed me that it will be several months before he will get a chance to evaluate what resources are needed to complete the provided worksheet. He did express interest in using this platform or creating a platform very similar to use with MECO customers with large portfolios of buildings.

Appendix D is a screenshot of the online dashboard showing the energy use of all Kauai County facilities

7. LIGHTING

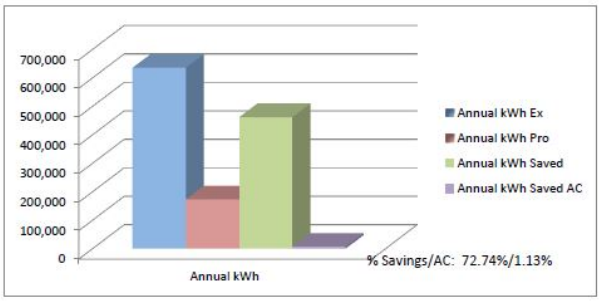
The lighting energy efficiency measures address all 1,056 fixtures throughout the entire campus. Some of the ballasts and lamps were not accessible at the time of the audit and a few assumptions were made to assess voltage, wattage and cost of fixture replacement. Before any equipment is ordered, the voltage and wattages should be confirmed to ensure proper equipment orders.

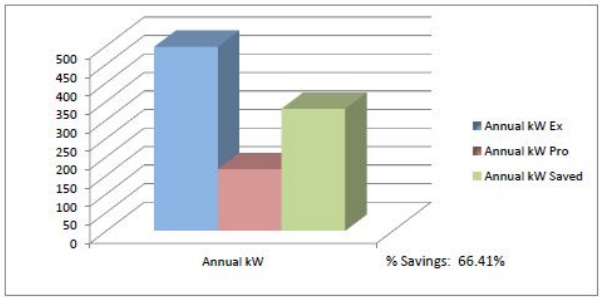
The estimated installed cost of the lighting retrofit is $779,097.06, with an estimated utility rebate of $52,951.60, leaving an estimated net cost of $726,145.46. The annual savings is estimated at $151,858.96, so the simple payback is approximately 4.78 years. This project will also eliminate approximately 272.24 tons of greenhouse gasses.

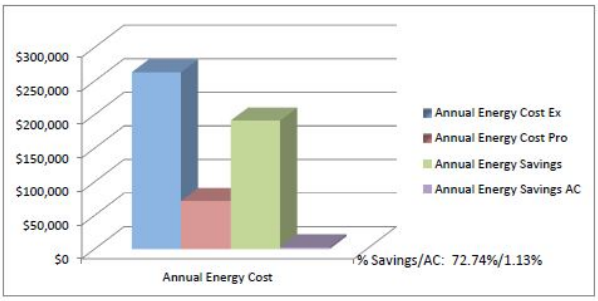
On the following page is the final assessment for the lighting project in totality:

Annual Green House Gas Reduction Estimate:			
CO2		**272.24**	**Tons**
Total Project Cost:		**779,097.06**	
Estimated Utility Incentive:		**52,951.60**	
TOTAL Investment:	**$**	**726,145.46**	
Estimated Space by Space EPAct Deduction:	$	-	
EPAct Cash Value:	$	-	***Based on 38% Corporate Tax Rate**
Yearly Lighting Expense:		**212,264.35**	
Estimated Annual Energy Savings:	**$**	**151,858.96**	
New Lighting Expense:		**60,405.39**	
Annual Estimated Maintenance Savings:		**5,192.22**	
Estimated 10 Year Energy Savings:	**$**	**1,518,589.59**	
Simple Payback in Years:		**4.78**	
Energy Reduction:		**72%**	
Total Estimated Switches:		**130**	
Total Estimated Sensors:		**358**	
Total Estimated Measured Rebate:	**$**	**19,572.00**	
Total Estimated Itemized Incentive:	**$**	**33,379.60**	
Total Estimated A/C Savings:	**$**	**2,982.04**	**7,202.99** kWh
Total Estimated kWh Savings:		**462,180.29**	
Total Estimated kW Savings:		**330.09**	

The energy efficiency measures will reduce electricity consumption by approximately 45.63%, which equates to 72% of the lighting energy. The peak demand will be reduced by 330.09 kW, which is 66.41% of the lighting load. The reduced heat load lowers air conditioning costs, although these savings along with maintenance savings was NOT added into the SPB or ROI in this report although it is listed throughout the report separately. These graphs better illustrate the savings estimates:







This is the estimated savings by space type:

Space Type	Annual kWh	Annual kWh	Annual kWh Saved	Annual kWh Saved-AC	Annual kW	Annual kW	Annual kW Saved	Watts	Watts
	Ex	Pro			Ex	Pro		Ex	Pro
Open Office	21,780.	7,854.	13,926.	1,392.6	6.083	2.64	3.443	6,083	2,640
Storage	7,485.03	2,120.02	5,365.01	.	2.98	1.528	1.452	2,980	1,528
Dining Area	7,684.08	2,432.82	5,251.26	525.126	2.49	1.23	1.26	2,490	1,230
Restrooms	15,797.51	4,656.38	11,141.14	114.428	4.853	2.5	2.353	4,853	2,500
Covered Exterior	16,047.31	6,604.27	9,443.03	.	11.591	5.867	5.724	11,591	5,867
Open Exterior	313,451.31	101,947.76	211,503.56	.	381.958	130.299	251.659	381,958	130,299
Office < 250 SF	57,860.79	16,962.19	40,898.6	4,089.86	16.379	6.674	9.705	16,379	6,674
Electrical/Mechanical	1,194.64	529.14	665.5	.	1.294	.612	.682	1,294	612
Conference/Meeting/Multipurpose	3,544.8	1,240.2	2,304.6	230.46	1.356	.72	.636	1,356	720
Corridor/Transition	13,095.72	4,692.05	8,403.67	793.72	3.186	1.555	1.631	3,186	1,555
Lobby	928.	360.	568.	56.8	.232	.12	.112	232	120
Gymnasium	176,539.68	23,829.76	152,709.92	.	64.608	13.177	51.431	64,608	13,177
Totals	635,408.87	173,228.58	462,180.29	7,202.994	497.01	166.922	330.088	497,010	166,922

7.1 Lighting ECM Breakdown

The following sections detail each Energy Conservation Measure (ECM) related to lighting in more detail. The initial description is the existing lighting with pictures followed by the proposed replacement lighting with estimated wattage reductions.

7.1.1 Retrofit 4' 4 Lamp Wraps & 2x4 4 Lamp Troffers to LED (summary ECM fixture report 1, 22, 39 & 56)

Description

There are 51 existing 4' 4-lamp wraps, 37 existing 2x4 4-lamp T8 troffers and 56 existing 2x4 4-lamp T12 troffers. The 4-lamp T8 fixtures all consume 116-watts per fixture and the T12 fixtures consume 172-watts per fixture.

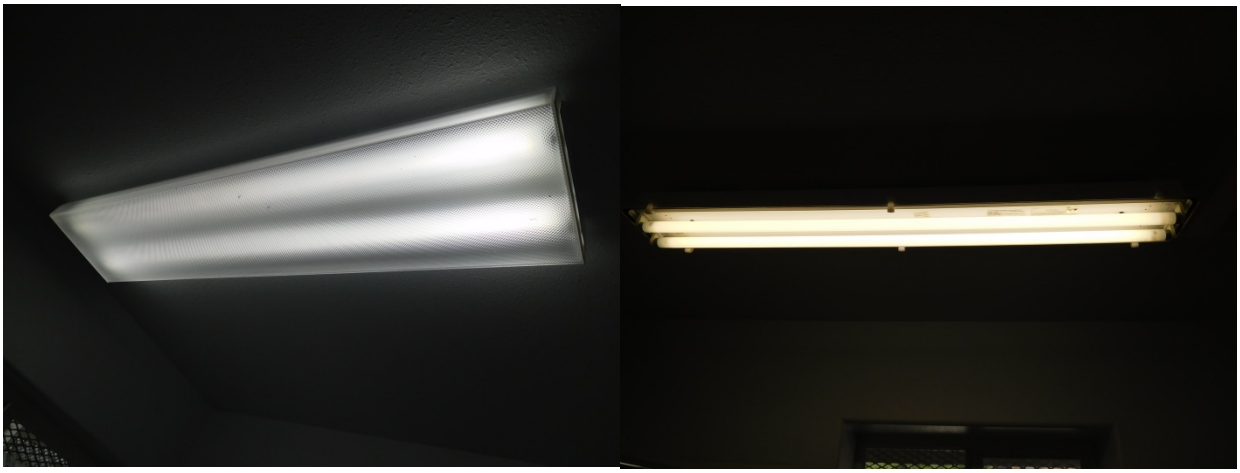
RECOMMENDATION

We are recommending retrofitting all of these with 4 4' LED tubes and a 60-watt driver, which will save approximately 56 & 112-watts respectively.

7.1.2 Retrofit 4' 2L Wrap, Vaportite & Strip Fixtures to LED (summary ECM fixture report 2, 3, 10 & 41)

DESCRIPTION

There are 41 existing 4' 2-lamp T8 wraps, 269 existing 4' 2-lamp T8 vaportites, 6 existing 2-lamp T8 strips, all-consuming 58-watts per fixture. There are also 2 existing 4' 2-lamp T12ES strips consuming 72-watts per fixture.



RECOMMENDATION

We are recommending retrofitting all of these with 2 4' LED tubes and a 30-watt driver, which will save approximately 28 & 42-watts respectively.

7.1.3 Retrofit PL Lamps to LED (summary ECM fixture report 4, 21 & 49)

DESCRIPTION

There is 1 existing 32-watt PL Fan Light, 27 existing 2x32-watt PL Recessed Fixtures and 5 existing 2x42-watt PL Wallpacks which consume 32, 64 & 84-watts respectively.

RECOMMENDATION

We are recommending retrofitting each lamp with a 12-watt PL LED lamp, which will save 20, 40 & 60-watts per fixture respectively.

7.1.4 Retrofit 23/32/90 Spiral CFL/A19 Fixtures to LED (summary ECM fixture report 5, 14, 37 & 38)

DESCRIPTION

There is 1 existing 32-watt CFL Wallpack, 3 existing 23-watt CFL wallpacks, 6 existing 90-watt incandescent jelly jar and 7 existing 23-watt CFL canopy fixtures consuming 32, 90 & 23-watts respectively.


RECOMMENDATION

We are recommending retrofitting these fixtures with a 13-watt LED A21 lamp, which will save 19, 77 & 10-watts respectively.

7.1.5 Retrofit 13/19/23/43 Spiral CFL/A19 fixtures to led (summary ECM fixture report 6, 13, 34, 36, 50 & 52)

DESCRIPTION

There is 1 existing 19-watt CFL keyless, 2 existing 43A19 bulkheads, 6 existing 23-watt CFL jelly jars and 1 existing 23-watt CFL keyless, which each consume 19, 43 & 23-watts respectively. There are also 6 existing keyless & 4 jelly jar with 13-watt CFL.


RECOMMENDATION

We are recommending retrofitting all of these fixtures except the 13-watt with a 10-watt LED A19 lamp which will save 9, 33 & 13-watts respectively. The 13-watt will be replaced with a 7-watt LED A19, which will save 6-watts.

7.1.6 Retrofit 8' Strip & Vaportite Fixtures to LED (summary ECM fixture report 7, 8, 18 & 40)

DESCRIPTION

There are 11 existing 8' 2-lamp T8 tandem and 6 existing 8' 2-Lamp T8 (8' lamps) vaportite, which consume 116 & 110-watts respectively. There are also 8 existing 8' T12 and 6 existing 8' 2-lamp T8 strips consuming 155 & 110-watts respectively.

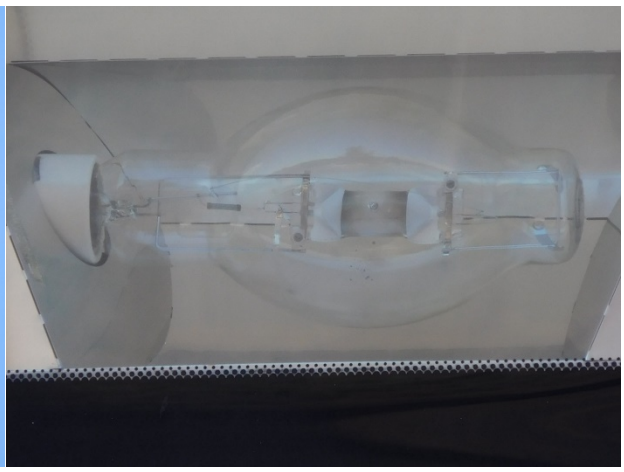
RECOMMENDATION

We are recommending retrofitting these fixtures with 2 URS LED bars and a 60-watt driver, which will save 56/50 & 95-watts respectively.

7.1.7 Retrofit 400w HID fixtures to LED (summary ECM fixture report 9 & 54)

DESCRIPTION

There are 2 existing floodlights and 2 existing horizontal floodlights each consuming 458-watts with the ballast draw.

RECOMMENDATION

We are recommending retrofitting the fixtures with a 120-watt LED corn cob lamp which will save about 338-watts per fixture.

7.1.8 Retrofit storage jelly jar fixtures to LED (summary ECM fixture report 11, 17, 19, 20, 28, 30, 32 & 61)

DESCRIPTION

There are 21 existing wallpacks and 9 existing canopy fixtures with 100-watt HPS consuming 125-watts per fixture. There are 14 existing wallpacks and 1 existing canopy fixture. with 70-watt HPS consuming 88-watts per fixture. There are 2 horizontal and 4 standard existing floodlights with 150-watt HPS consuming 188-watts per fixture.

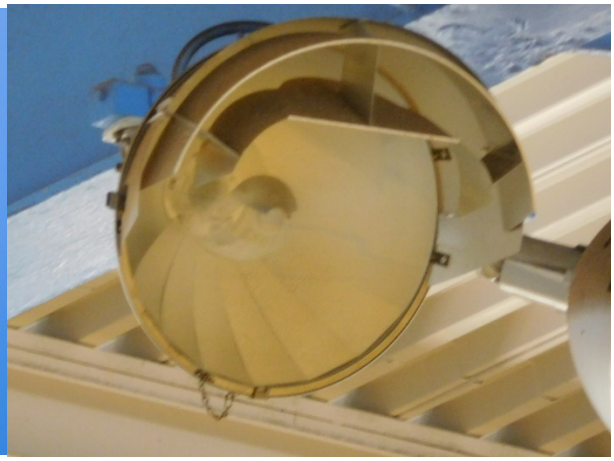

RECOMMENDATION

We are recommending retrofitting all of these fixtures with a 27-watt LED corn cob lamp which will save about 98/61/161-watts per fixture respectively.

7.1.9 Replace 1000w HID fixtures with LED (summary ECM fixture report 15 & 24)

DESCRIPTION

There are 12 existing 1000-watt floodlights and 46 existing 1000-watt Sportslight gixtures each consuming about 1080-watts including the ballast draw.



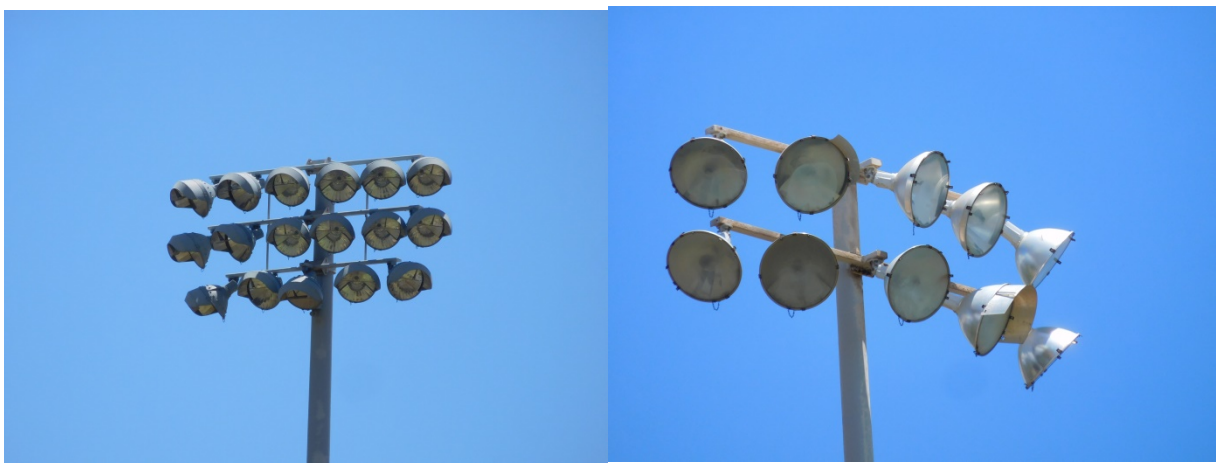
RECOMMENDATION

We are recommending replacing these fixtures with a 262-watt LED floodlight fixture, which will save about 818-watts per fixture.

7.1.10 Replace 1500w HID Fixtures with LED (summary ECM fixture report 16 & 62)

DESCRIPTION

There are 188 existing 1500-watt Sportslight fixtures, which consume about 1650-watts per fixture with the ballast draw and the lamps are only rated for 3,000-hours.



RECOMMENDATION

We are recommending replacing this entire system with 600-watt LED stadium lighting fixtures with dimming controls, which will save about 1,050-watts per fixture and the lamps are rated at 50,000-hours. In the "Supplemental Documents" folder there are point by point drawings for each field.

7.1.11 Retrofit 250w Fixtures to LED (summary ECM fixture report 23, 25 & 29)

DESCRIPTION

There is 1 existing 250-watt horizontal floodlight, 5 existing 250-watt wallpacks and 2 existing 250-watt floodlights all-consuming about 295-watts with the ballast draw.

RECOMMENDATION

We are recommending retrofitting all of the fixtures a 80-watt LED corncob lamp, which will save about 215-watts per fixture.

7.1.12 Retrofit 1L Strip & Wall Bracket Fixtures to LED (summary ECM fixture report 33, 43, 53 & 57)

DESCRIPTION

There are 4 existing 4' T12 strips, 1 4' T12ES strip and 15 4' T8 strips as well as 2 4' T12ES wall bracket fixtures all with 1-lamp each. They consume about 50/43/32-watts respectively.

RECOMMENDATION

We are recommending retrofitting each fixture with a 4' LED lamp and 18-watt driver, which will save about 32/25/14-watts respectively.

7.1.13 Retrofit 2x4 3-lamp Fixtures to LED (summary ECM fixture report 19 & 22)

DESCRIPTION

There are 9 existing 2x4 18-cell 3-lamp T8 parabolic fixtures, which consume 90-watts per fixture with the ballast draw.

RECOMMENDATION

We are recommending retrofitting each fixture with 3 4' LED lamps and a 44-watt driver, which will save about 46-watts per fixture.

7.1.14 Replace Exit Sign Fixtures with LED (summary ECM fixture report 42)

DESCRIPTION

There are 10 existing incandescent exist signs which consume about 30-watts per fixture.

RECOMMENDATION

We are recommending replacing these with a .08-watt LED exit sign, which will save about 29.2-watts per fixture.

7.1.15 Retrofit MR16 Fixtures to LED (summary ECM fixture report 44 & 46)

DESCRIPTION

There are 3 existing 3-Lamp and 4 existing 4-lamp 50-watt MR-16 ceiling and track heads each consuming 50-watts per lamp.


RECOMMENDATION

We are recommending retrofitting each lamp with a 7-watt LED lamp, which will save about 43-watts per lamp.

7.1.16 Replace 1000w Gym Fixtures with LED (summary ECM fixture report 47 & 48)

DESCRIPTION

There are 42 existing 1000-watt HID Hi-bays and an additional 16 existing directional Sportslight fixtures each consuming about 1080-watts with the ballast draw.


RECOMMENDATION

We are recommending replacing every fixture with a 216-watt LED hi-bay with wire guard, controls and ultra-performance LED components which will save about 864-watts per fixture without the control savings.

7.1.17 Retrofit 2x2 Fixtures to LED (summary ECM fixture report 55)

DESCRIPTION

There are 12 existing 2x2 2-lamp T12U troffers, which consume about 86-watts each with the ballast draw.

RECOMMENDATION

We are recommending retrofitting each fixture with 2 2' URS LED bars and a 44-watt driver, which will save about 42-watts per fixture.

7.1.18 Replace 4" & 6" Recessed Can Fixtures with LED (summary ECM fixture report 58, 59 & 60)

DESCRIPTION

There are 2 existing 4" recessed cans and 1 is 13-watt and 1 is 20-watt CFL. There are also 8 existing 6" recessed cans with 23-watt CFL.

RECOMMENDATION

We are recommending replacing the 4" can with a 10-watt LED can and the 6" with a 14-watt can, which will save 3/10/9-watts respectively.

7.2 CONCLUSION – NEXT STEPS & SUB FOLDER DETAILS

There is substantial potential for savings at The War Memorial Complex with an attractive return on investment.

In order to realize these savings, we recommend working with our team to apply for incentives, and obtaining price proposals from contractors.

Green Building Hawaii & Advanced Energy Innovations Inc. can assist you in implementing these recommendations by

- Completing forms for rebate & incentive applications
- Identifying and contacting contractors and suppliers to obtain bids
- Overseeing installation work and verifying that work complies with specifications
- Commissioning and testing completed systems to verify proper installation and performance

Please let us know if assistance in any of these areas is required, and we will be glad to meet with you, finalize scope, and prepare a firm fixed price proposal to provide the desired services.

7.3 SUB FOLDER DETAILS

PDF's imbedded in the main report are reference files used in the body of the report

Supplemental Documents are the point by point drawings for the Football and Baseball Stadiums

Contractor Bid Package contains all the documents that will be sent out to bid

Investment Grade Lighting Spreadsheet details every ECM along with full financial estimates

Pictures folder contains all the pictures taken during the audit which are also referenced in the contractor SOW as well as the Investment Grade Spreadsheet

8. HVAC

During the energy audit of the War Memorial Complex the audit team inventoried all mini split and central air conditioning units on the property. The property has a total of twenty-five air conditioning units, twenty-two mini-split units and three central air units. The planning and development offices and the maintenance offices have a total of thirteen mini-split systems and one central system. The parks and recreation office has four mini-split systems. The aquatics and permitting office share two large central air units as well as one mini-split to condition the server room in that building. The final four mini-split systems are located at the construction and maintenance offices. A map showing the location of the units can be found in Appendix E as well as a map of which unit is connected to which office space in Appendix F. There are also several window units located through out the property but due to access restriction to some spaces and a limit on time these units were not documented.

Several of the units were data logged to monitor the energy use and run times in order to compare energy use profiles and estimate annual energy use. These estimates are not precise due to seasonal changes in temperature and changes in usage but they do give an idea of comparable energy use from one unit to another. Some of the units were not monitored due to issues in accessing the electrical systems and for safety concerns. One of each type of unit was monitored except for the units at the construction offices and the energy use estimates can be used for comparison of age and models of the other units.

A visual inspection of each unit was performed to assess the condition of the units. Many of the units have become rusted, damaged and need to be replaced. These recommendations will be detailed in the following sections. The existing equipment list that the audit team received from the County does not have all of the information for all of the units so the age of the units are unknown. The equipment list also only detailed the model and serial numbers of the air-handling units for the mini-split systems so the audit team recorded the model and serial numbers of the condensing units that had specification labels that were readable. The refrigeration line sets go through the exterior wall and cannot be followed to the air-handling units so some assumptions were made as to which condensing units are connected to which air-handling units.

Appendix E is a Google Maps screen shot showing the location of all of the condensing units for the War Memorial Gym building

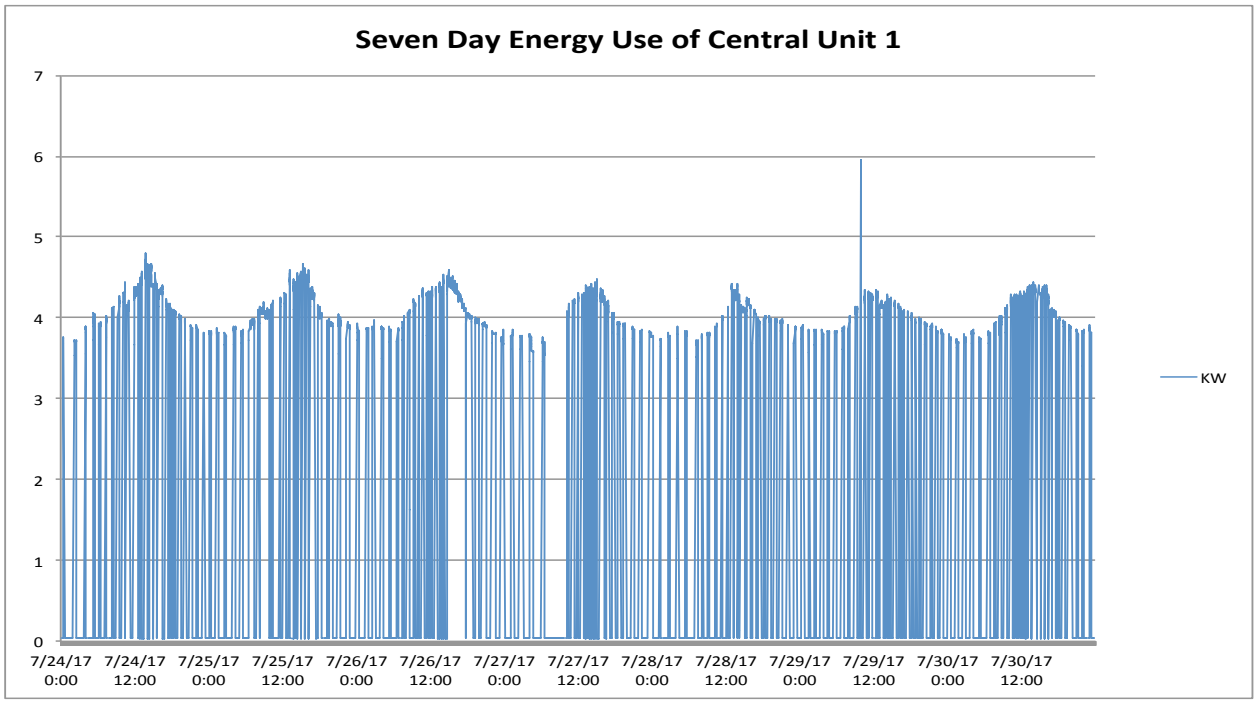
Appendix F is an office layout of the parks and recreation office, maintenance and planning and development offices with the offices labeled with the connected air conditioning system.

8.1 Central Unit 1

Central unit 1 condensing unit is located on the roof of the planning and development offices and the air handler is located in the ceiling of the offices. This unit serves the hallway and

the interior offices of the planning and development offices. This carrier air conditioning system is 3 tons and serves close to 9,550 cubic feet of office space. According to County records it was installed September 19th, 2013, which makes it 4 years old and has not reached its end of life. The audit team was able to monitor the energy use of this unit and it is estimated to use 13,169 kWh or $3,661 per year. This unit was originally purchased for $9,927.00.

The following graph is a visual representation of the seven-day energy use patterns of this unit.



This graph shows that the central air conditioning system uses around 4 KW of electricity when running. This unit ramps on and off all the time, which is a sign that the digital thermostat is not properly programmed to turn off or increase the temperature setting during the nights and weekends. This energy conservation measure can reduce the energy use significantly and is a no cost measure. For the size and run time of this unit it is operating at an average efficiency and is not recommended to be replaced.

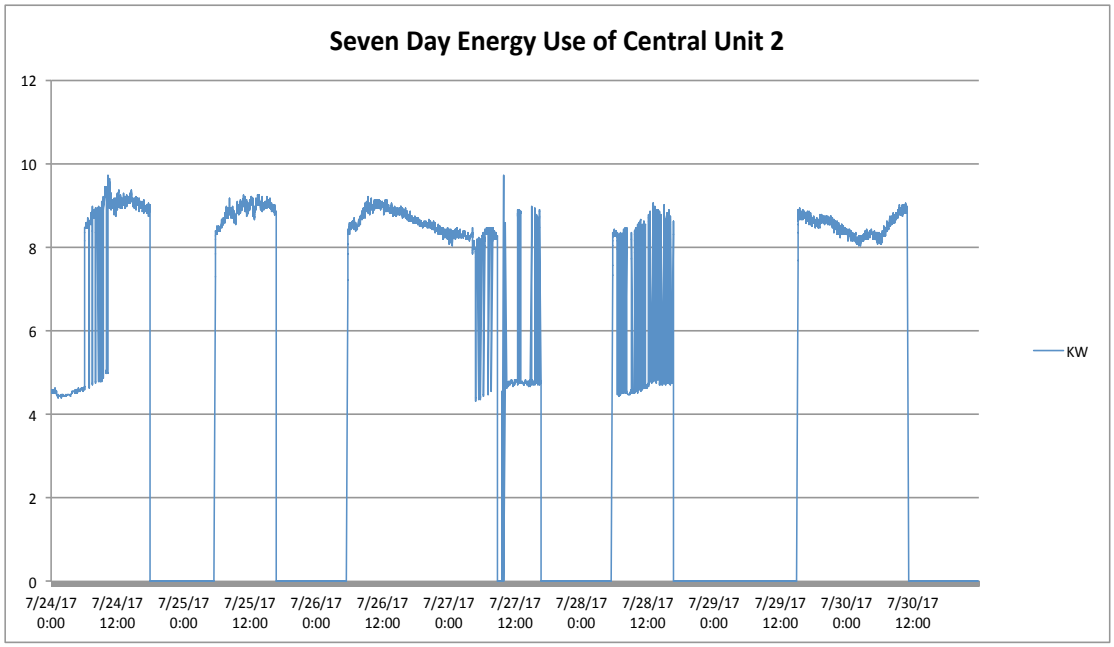
Recommendations:

- Set digital thermostat to turn off or increase temperature settings for nights and weekends
- Hire an air conditioning contractor to service the unit and start a maintenance contract for continual service
- Once the unit has reached its end of life replace with an Energy Star certified model
- Apply for Hawaii Energy rebates

8.2 Central Unit 2

Central unit #2 condensing unit is located on the roof of the aquatics and permitting office and the air handler is located in the ceiling of the offices. This unit serves half of the cubic footage of the aquatics and permitting office and central unit 3 serves the other half. This carrier air conditioning system is 10 tons and serves close to 20,924 cubic feet of office space. According to County records it was installed October 27th, 2007 making it 10 years old and has reached its end of life. The audit team was able to monitor the energy use of this unit and it is estimated to use 37,927 kWh or $11,378 per year. Visual inspection identified a significant amount of rust, the air filter had not been changed for a long time and was in serious need of maintenance. This unit was originally purchased for $11,933.50.

The following graph is a visual representation of the seven-day energy use patterns of this unit.



This graph shows that the central air conditioning system uses around 9 KW of electricity when running. This unit turns on in the morning when people come to work around 5:30 AM and runs constantly through out the day. It also ran through out the night twice during this seven day period which shows that this is probably on a manual thermostat and is not programmable. The nights that the system ran all night is a sign that the employees did not turn the system off when they left work. For the size and run time of this unit it is not operating at an acceptable efficiency and is recommended to be replaced.

Recommendations:

- This unit has reached end of life and needs to be replaced
- When replacing this unit it is recommended to have a third party load calculation done to ensure proper sizing of equipment

- When replacing this unit make sure to purchase Energy Star certified equipment
- Apply for Hawaii Energy rebates
- Once replaced program digital thermostat to only run on weekdays during work hours

8.3 Central Unit 3

Central unit #3 condensing unit is located on the roof of the aquatics and permitting office and the air handler is located in the ceiling of the offices. This unit serves half of the cubic footage of the aquatics and permitting office and central unit 2 serves the other half. This carrier air conditioning system is 10 tons and serves close to 20,920 cubic feet of office space. According to County records it was installed October 27th, 2007 making it 10 years old and has reached its end of life. The audit team was not able to monitor the energy use of this unit but it is the exact same size, model and age of central unit #2 and it serves almost the exact same amount of cubic feet, we estimated usage at the same 37,927 kWh or $11,378 per year. Since this unit was not monitored the run time and efficiency may be slightly different than central unit 2 but it can be inferred that they are very similar. Visual inspection significant amounts of rust, the air filter had not been changed for a long time and was in serious need of maintenance. This unit was originally purchased for $11,933.50

The following pictures show the condition of the unit.

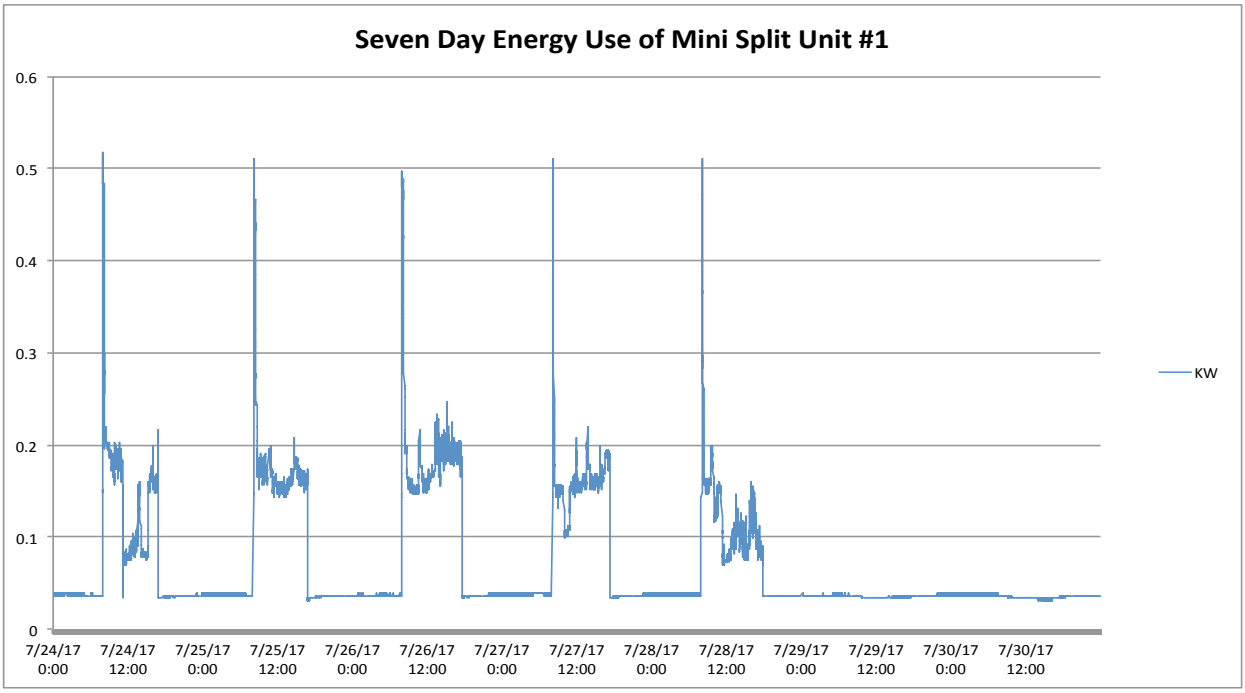
Recommendations:

- This unit has reached end of life and needs to be replaced
- When replacing this unit it is recommended to have a third party load calculation done to ensure proper sizing of equipment
- When replacing this unit make sure to purchase Energy Star certified equipment
- Apply for Hawaii Energy rebates

8.4 Mini Split Units 1 and 2

Mini split units 1 and 2 condensing units are located on the roof of the maintenance office and the air handlers are located in offices 4 and 5 in the maintenance offices. These Mitsubishi air conditioning systems are 3/4 ton and serve close to 1,760 cubic feet and 1,000 cubic feet of office space respectively. According to County records they were installed May 28th, 2014 making them 3 years old and have not reached their end of life. The audit team was able to monitor the energy use of one of these units and they are estimated to use 613 kWh or $170.51 per year. It is recommended to hire a contractor to service the units and get on a regular maintenance contract. These unit were originally purchased for $2,552 each.

The following graph is a visual representation of the seven-day energy use patterns of this unit.



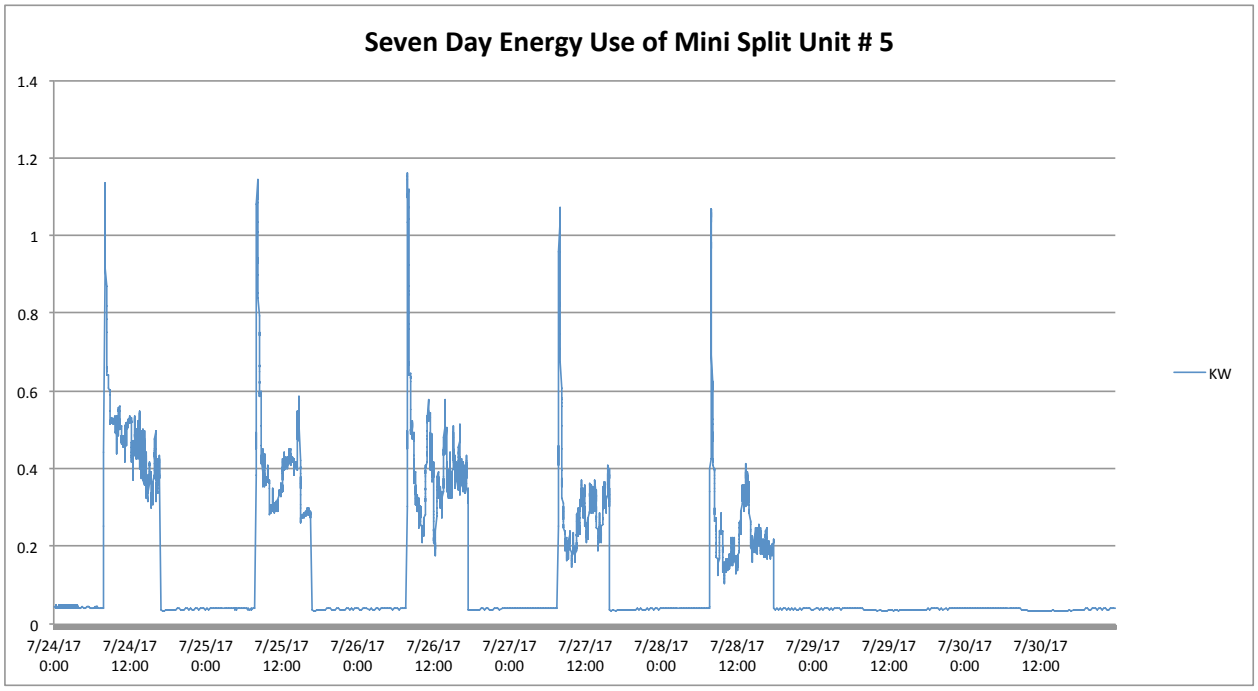
This graph shows that the mini-split unit #1 uses around .2 KW of electricity when running with a start up spike around .5 KW. This unit turns on in the morning when people come to work around 8:00 AM and runs constantly through out the day. It does not turn off but it does ramp down through out the day, which means that it is properly sized for the space.

Recommendations:

- It is recommended to hire a contractor to service the units and get on a regular maintenance contract.
- Once the unit has reached its end of life replace with an Energy Star certified model
- Apply for Hawaii Energy rebates

8.4 Mini Split Units 3 and 5

Mini split units 3 and 5 condensing units are located on the roof of the parks and recreation office and the air handlers are located in offices 1 and 3 in the parks and recreation offices. These Mitsubishi air conditioning systems are 1 ton and serve close to 1,440 cubic feet and 1,056 cubic feet of office space respectively. According to County records they were installed July 29th 2014 and September 19th 2014 making them 3 years old and they have not reached their end of life. The audit team was able to monitor the energy use of one of these units and they are estimated to use 1,105 kWh or $307 per year. It is recommended to hire a contractor to service the units and get on a regular maintenance contract. This unit was originally purchased for $2,980.



This graph shows that the mini-split unit #5 uses around .5 KW of electricity when running with a start up spike just above 1 KW. This unit turns on in the morning when people come to work around 8:00 AM and runs constantly through out the day. It does not turn off or ramp down through out the day, which means that it never hits set point and may be slightly under sized or the temperature settings are too low.

Recommendations:

- It is recommended to hire a contractor to service the units and get on a regular maintenance contract.
- Once the unit has reached its end of life replace with an Energy Star certified model
- Apply for Hawaii Energy rebates

8.5 Mini Split Unit 4

Mini split unit 4 condensing unit is located on the roof of the parks and recreation office and the air handler is located in office 2 of the parks and recreation offices. This Mitsubishi air conditioning system is 1 ton and serves close to 1,320 cubic feet. County records do not have any information on the installation date of this unit but it looks to be the same generation as units 1, 2, 3, and 5 and it has not reached its end of life. The audit team was not able to monitor the energy use of this unit but based on a visual inspection this unit is still in good condition and is of average efficiency and it is not recommended to replace it. It is recommended to hire a contractor to service the units and get on a regular maintenance contract. There is no record of how much was paid for this unit.

The following picture shows the condition of the unit.

Recommendations:

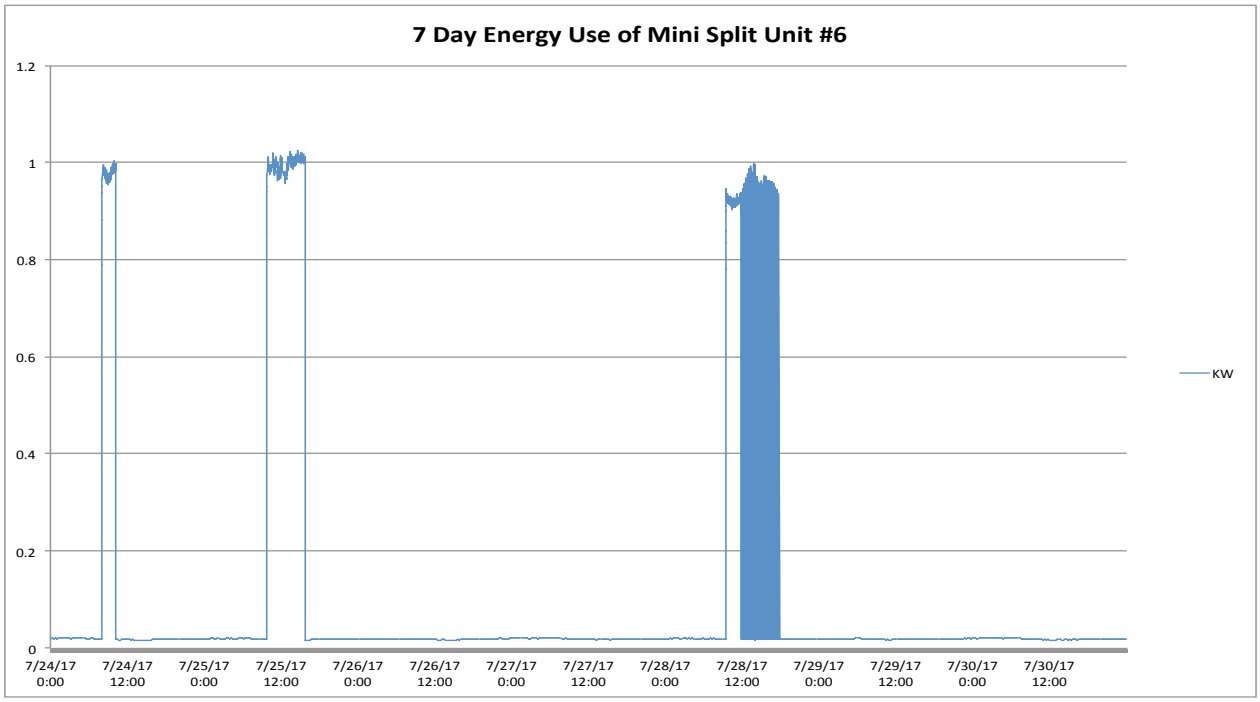
- It is recommended to hire a contractor to service the units and get on a regular maintenance contract.
- Once the unit has reached its end of life replace with an Energy Star certified model
- Apply for Hawaii Energy rebates

8.6 Mini Split Unit 6

Mini split unit 6 condensing unit is located on the roof of the parks and recreation office and the air handler is located in the parks and recreation conference room. This Fujitsu air conditioning

system is 3/4 ton and serves close to 900 cubic feet. County records show that this unit was installed on May 4th 2006 making it 11 years old and has reached its end of life. Due to the short run time of this unit even though it has reached end of life and is running very inefficiently there will not be a very good return on investment for this unit. The audit team was able to monitor the energy use of this unit and it is estimated to use 900 kWh or $250 per year. It is recommended to hire a contractor to service the units and get on a regular maintenance contract to get the most life from the unit before it breaks. This unit was originally purchased for $2,564.65.

The following graph is a visual representation of the seven-day energy use patterns of this unit.



This graph shows that this mini split air conditioning system uses around 1 KW of electricity when running. This unit is only used when there are meetings in progress in the conference room. The week it was monitored it was only used three times for a total of 15 hours. For the size and run time of this unit it is operating inefficiently but because of these limited run times the financial benefit of replacing this unit before it breaks down would not make sense.

Recommendations:

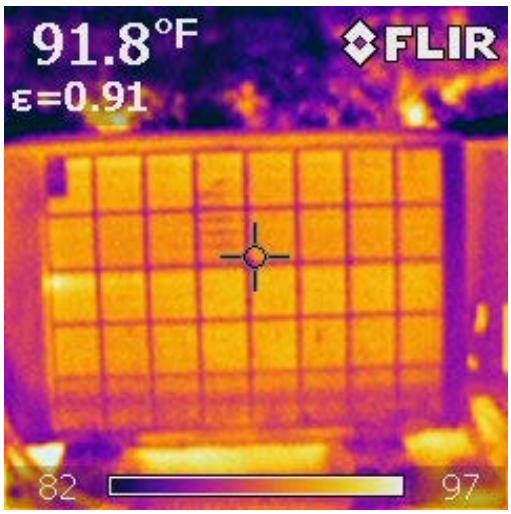
- It is recommended to hire a contractor to service the units and get on a regular maintenance contract.
- Once the unit has reached its end of life replace with an Energy Star certified model
- Apply for Hawaii Energy rebates

8.7 Mini Split Units 7, 8 and 9

Mini split unit7, 8 and 9 condensing units are located on the roof of the permitting and development offices and the air handlers are located in offices 6, 7 and 8. These Fujitsu air conditioning system is 1 ton and serves close to 950 cubic feet, 1,024 cubic feet, 1,080 cubic feet. County records show these units were installed on May 4th 2006, which makes them 11 years old and are close to reaching end of life. The audit team was not able to monitor the energy use of these units due to lack of access. Because none of these types of units were monitored we cannot provide an accurate energy assumption. The units look like they are still in good condition and we recommend monitoring the energy use of them before replacing them. It is recommended to hire a contractor to service the units and get on a regular maintenance contract to get the most life from the unit before it breaks. These units were originally purchased for $2754.67 each.

The following picture shows the condition of the units.

This infrared image shows that the coils are heated evenly and the system is operating correctly



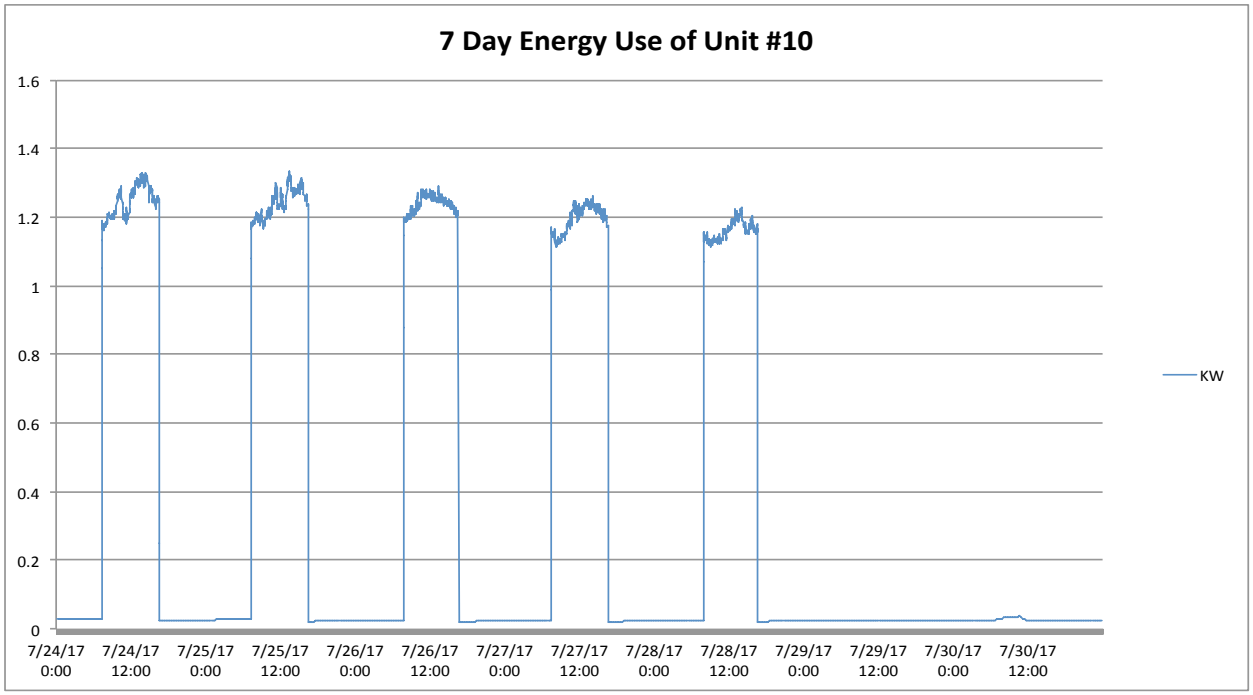
Recommendations:

- Monitor energy use of these units for accurate energy use profiles before replacing
- It is recommended to hire a contractor to service the units and get on a regular maintenance contract.
- Once the unit has reached its end of life replace with an Energy Star certified model
- Apply for Hawaii Energy rebates

8.8 Mini Split Unit 10

Mini split unit 10 condensing unit is located on the roof of the planning and development offices and the air handler is located in office 10. This Fujitsu air conditioning system is 1 ton and serves close to 1,152 cubic feet. County records do not show when this unit was installed but upon inspection this unit is old, has not been maintained and has reached its end of life. The audit team was able to monitor the energy use of this unit and it is estimated to use 3,012 kWh or $837.50 per year. This unit is the least efficient of the fleet of mini-split air conditioning units. Compared to the most efficient unit of similar size this unit uses 1,907 kWh more which equals $530.32 per year. It is recommended to replace this unit with a high efficiency, Energy Star certified unit of similar size. There is no record of how much was paid for this unit.

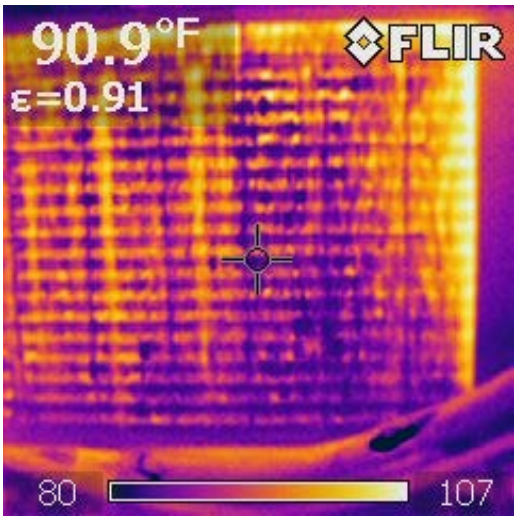
The following graph is a visual representation of the seven-day energy use patterns of this unit.



This graph shows that the mini-split unit #10 uses around 1.2 KW of electricity when running. This unit turns on in the morning when people come to work around 8:00 AM and runs constantly through out the day until 4:30 when the employee leaves the office. It does not turn off or ramp

down through out the day, which means that it never hits set point and may be slightly under sized or the temperature settings are too low.

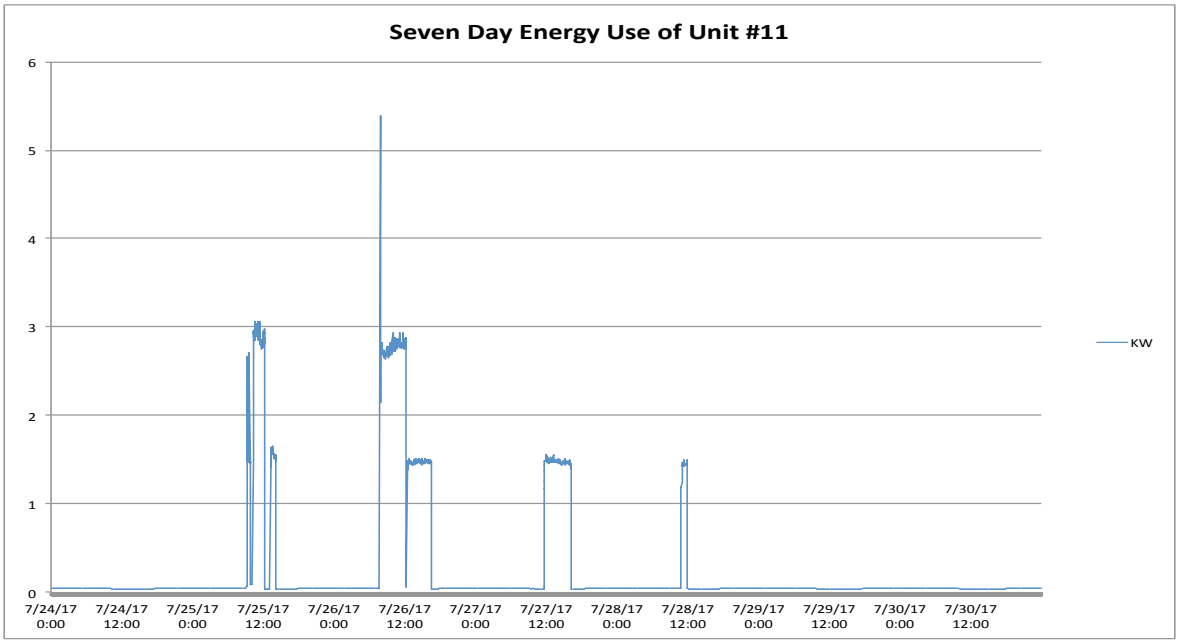
The following picture shows the condition of the unit and the infrared image shows the coils not evenly distributing the heat, which shows that the system is not operating appropriately.



8.9 Mini Split Unit 11

Mini split unit 11 condensing unit is located on the roof of the planning and development offices and the air handler is located in the main conference room. This Fujitsu air conditioning system is 1 and 1/2 ton dual zone unit and serves close to 5,800 cubic feet. County records do not show when this unit was installed but upon visual inspection this unit is near end of life and has not been properly maintained. Due to the short run time of this unit even though it is near end of life and is running very inefficiently there will not be a very good return on investment for this unit. The audit team was able to monitor the energy use of this unit and it is estimated to use 2,163 kWh or $601.34 per year. It is recommended to hire a contractor to service the unit and get on a regular maintenance contract to get the most life from the unit before it breaks. There is no record of how much was paid for this unit.

The following graph is a visual representation of the seven-day energy use patterns of this unit.



This graph shows that this mini split air conditioning system uses around 3 KW of electricity when running both zones or 1.5 KW when it is only running one zone. This unit is only used when there are meetings in progress in the conference room. The week it was monitored it was only used four times for a total of 11 hours. For the size and run time of this unit it is operating inefficiently but because of these limited run times the financial benefit of replacing this unit before it breaks down would not make sense. There is no record of how much was paid for this unit.

Recommendations:

- It is recommended to hire a contractor to service the unit and get on a regular maintenance contract
- Once the unit has reached its end of life replace with an Energy Star certified model
- Apply for Hawaii Energy rebates

8.10 Mini Split Unit 13

This unit is no longer functioning and has reached its end of life. County records show that this unit was installed April 7th 2008, which makes this unit 9 years old. During visual inspection we did not identify any isues with this unit but due to its age and the fact it is not working we recommend replacing as soon as possible.

The following picture shows the condition of the unit.

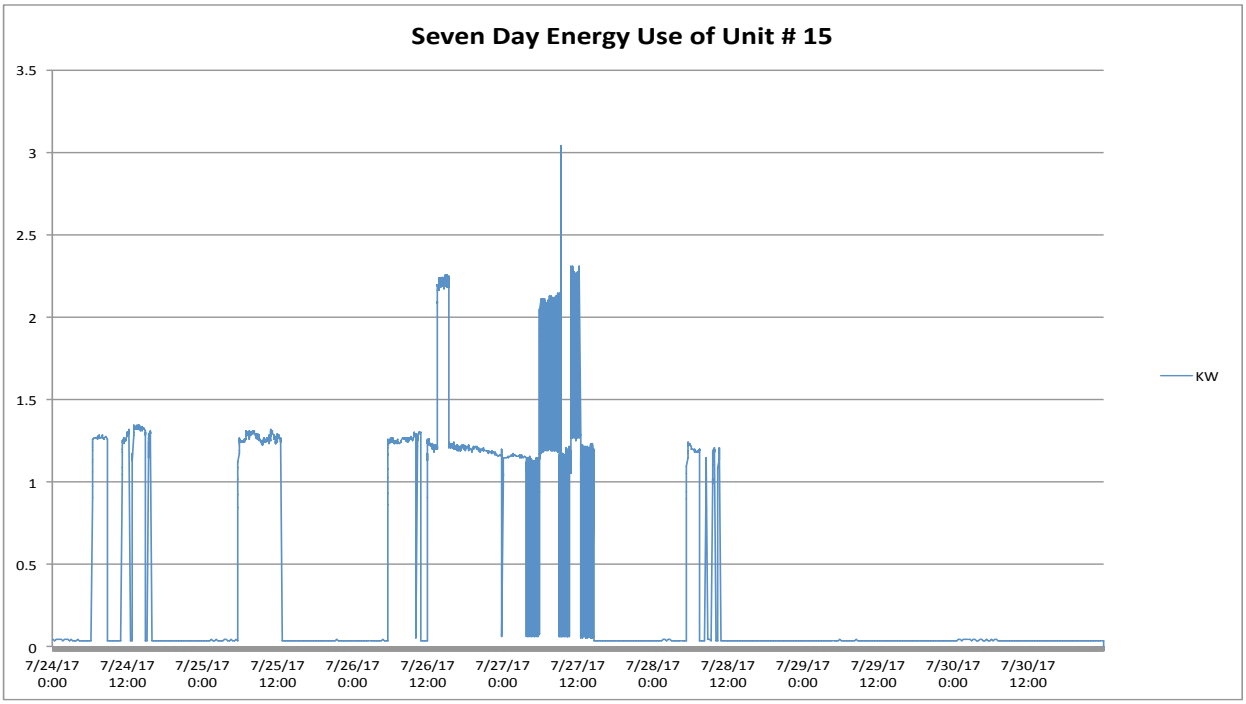
Recommendations:

- Replace this unit

8.11 Mini Split Units 12, 14, 15 and 16

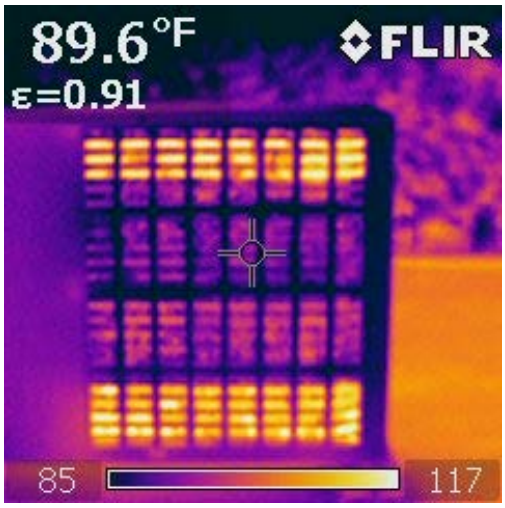
Mini split units 12, 14, 15 and 16 condensing units are located on the roof of the permitting and development offices and the air handlers are located in offices11, 12, 13, 14, 15, 16, 17 and 18. These Fujitsu air conditioning systems are 1 and 1/2 ton and each one serves two offices that are 720 cubic feet. County records do not show any of these units but upon visual inspection these units have reached their end of life. The audit team was able to monitor the energy use of, unit #15 and it is estimated to use 3300.5 kWh or $917.53 per year. To compare the annual energy use of this unit to other units that were monitored we could compare it to two ¾ ton units. Unit 3 uses 613 kWh per year, double that would make it 1,226 kWh or $341.01 per year. This would be a savings of $576.52 per year. It is recommended to replace these units with high efficiency, Energy Star certified units. There are no records of how much was paid for these units.

The following graph is a visual representation of the seven-day energy use patterns of this unit.



This graph shows that this mini split dual zone air conditioning system uses around 2.5 KW of electricity when running both zones or 1.25 KW when it is only running one zone. This unit is normally turned on when the employee gets to work and turned off when the employee leaves. It appears that these offices rarely run the unit at the same time. These units are running inefficiently and are near end of life, it is recommended to replace them.

The following picture shows the condition of the unit and the infrared image shows the coils not evenly distributing the heat, which shows that the system is not operating at optimum efficiency.



Recommendations:

- These units have reached end of life and need to be replaced
- When replacing these units replace with a similar sized unit or two ¾ ton single zone units
- When replacing these units make sure to purchase Energy Star certified equipment
- Apply for Hawaii Energy rebates

8.12 Mini Split Unit 17

Mini split unit 17 condensing unit is located on the roof of the planning and development offices and the air handler is located in the office 19. This Mitsubishi air conditioning system is 1 ton and serves close to 1,064 cubic feet. County records show this unit was installed January 9th 2006, which makes it 11 years old and is near reaching end of life. Upon visual inspection this unit has started to rust and needs maintenance. The audit team was not able to monitor the energy use of this unit due to accessibility. The units look like they are in average condition and we recommend monitoring the energy use of it before replacing it. It is recommended to hire a contractor to service the unit and get on a regular maintenance contract to get the most life from the unit before it breaks. This unit was originally purchased for $5,168.

The following pictures show the condition of the unit:

Recommendations:

- Monitor energy use of this unit for accurate energy use profiles before replacing
- It is recommended to hire a contractor to service the units and get on a regular maintenance contract.
- Once the unit has reached its end of life replace with an Energy Star certified model
- Apply for Hawaii Energy rebates

8.13 Mini Split Unit 18

Mini split unit 18 condensing unit is located on the roof of the permitting offices and the air handler is located in the server room. This Mitsubishi air conditioning system is 1 ton and serves close to 720 cubic feet with a constant heat load from the servers. County records show this unit was installed April 12th 2012, which makes it 5 years old and has not reached its end of life. Upon visual inspection this unit is still in good condition. The audit team was not able to monitor the energy use of this unit due to accessibility. It is recommended to hire a contractor to service the unit and get on a regular maintenance contract to ensure the best efficiency and get the most life from the unit before it breaks. This unit was originally purchased for $3,147.

The following pictures show the condition of the unit:

Recommendations:

- Monitor energy use of these units for accurate energy use profiles before replacing
- It is recommended to hire a contractor to service the units and get on a regular maintenance contract.
- Once the unit has reached its end of life replace with an Energy Star certified model
- Apply for Hawaii Energy rebates

8.14 Mini Split Units 19, 20 and 21

Mini split units 19, 20 and 21 condensing units are located behind the construction and maintenance offices. These Fujitsu air conditioning systems are 3/4 ton each and serve close to 900 cubic feet each. According to County records they were installed August 22nd 2011 making them 6 years old and they have not reached their end of life. The audit team was not able to monitor the energy use of these units but they are similar age and size as units one and two and they are estimated to use 613 kWh or $170.51 per year. It is recommended to hire a contractor to service the units and get on a regular maintenance contract. These units were originally purchased for $2,916 each.

The following pictures show the condition of the units:

Recommendations:

- It is recommended to hire a contractor to service the units and get on a regular maintenance contract.
- Once the unit has reached its end of life replace with an Energy Star certified model
- Apply for Hawaii Energy rebates

8.15 Mini Split Unit 22

Mini split unit 22 condensing unit is located behind the construction and maintenance office and the air handler is located in the break room. This Mitsubishi air conditioning system is 2 ton and serves close to 8,000 cubic. County records show this unit was installed August 22nd 2011, which makes it 6 years old and has not reached its end of life. Upon visual inspection this unit is still in good condition. The audit team was not able to monitor the energy use of this unit due to accessibility. There are no other units of this size on the property to compare this unit to. It is recommended to hire a contractor to service the unit and get on a regular maintenance contract to ensure the best efficiency and get the most life from the unit before it breaks. This unit was originally purchased for $4,999.97

The following picture shows the condition of the unit:

Recommendations:

- It is recommended to hire a contractor to service the units and get on a regular maintenance contract.
- Once the unit has reached its end of life replace with an Energy Star certified model
- Apply for Hawaii Energy rebates

8.16 HVAC Summary

- Central 1-Maintenance contract
- Central 2-Replace
- Central 3-Replace
- Mini split 1-Maintenance contract
- Mini split 2-Maintenance contract
- Mini split 3-Maintenance contract
- Mini split 4-Maintenance contract
- Mini split 5-Maintenance contract
- Mini split 6-Replace at end of life
- Mini split 7-More information needed
- Mini split 8-More information needed
- Mini split 9-More information needed
- Mini split 10-Replace
- Mini split 11-Replace at end of life
- Mini split 12-Replace
- Mini split 13-Replace
- Mini split 14-Replace
- Mini split 15-Replace
- Mini split 16-Replace
- Mini split 17-More information needed
- Mini split 18-More information needed

- Mini split 19-More information needed
- Mini split 20-More information needed
- Mini split 21-More information needed
- Mini split 22-More information needed

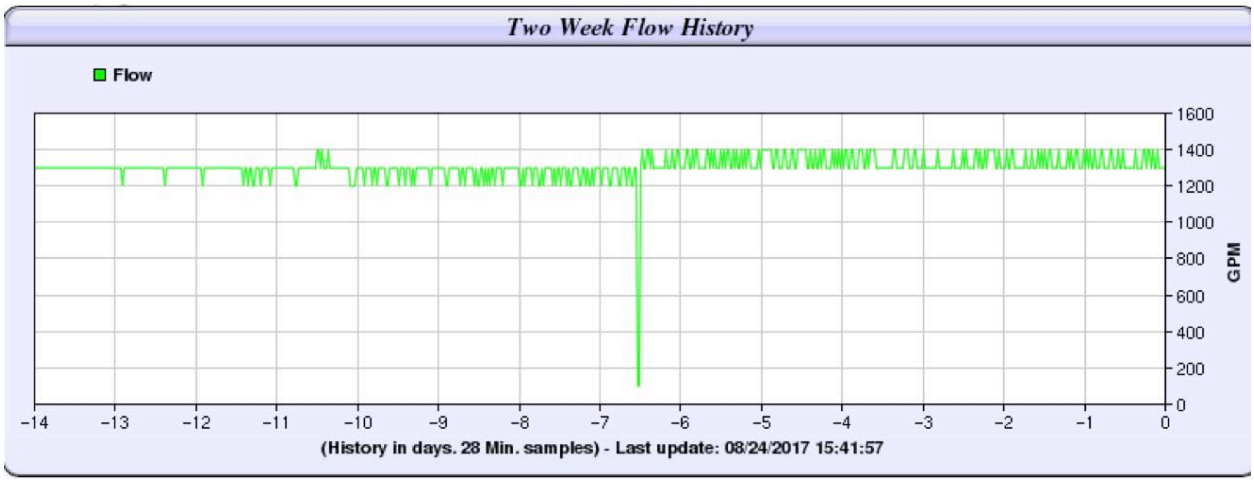
9 POOL

The pool located at War Memorial Complex is a 410,000 gallon pool and is used all year. The water is circulated by one 30 horsepower pump that is set to recirculate the water around four times per day. The flow meters that are currently installed are manual meters that are documented by the pool staff regularly but may not be accurate and there is no database of the readings. The pool is heated by a boiler that has a 3,500 kBtus input. The pool is only heated during the winter months in order to keep the temperature of the water around 78 degrees. The pool pump is estimated to use $35,300 per year to circulate and filter the pool water. The pool heater is the largest user of propane on the property. The average annual cost for propane over the three-year study period is $32,082.66. With the three operating water heaters the pool would use the majority of this usage. It is estimated that the pool water heater uses $30,000 a year on average. In total the pool water heater and pump use an estimated $64,300 of energy and propane to operate the pool per year.

9.1 POOL PUMP

The pool pump appears to be sized correctly at 30 horsepower. Monitoring data from a sonic flow sensor shows that the pump water flow is 1,200 to 1,400 Gallons per minute. This flow rate filters the pool water 4.2 to 4.9 times per day, slightly over the national NSBF guideline of 4 turnovers per day. It is run 24 hours per day at 13.5 kW with a yearly running cost of $35,300. We suggest installing a permanent sonic flow meter and a variable speed drive (VSD) pump controller. That way the speed could be lowered to four turnovers per day or possibly less when conditions allow it. We also suggest that an internet-based monitoring system be used to make the flow data available along with water temperature and alarms for low temperature, pump failure, and leak warnings sent in real time. This and other information could be tracked, displayed, and saved to file for future review and trend analysis.

The following chart shows the two week flow history of the pool from the sonic flow sensor online website.



This chart shows the flow rate of the pool before a back flush of the filters around 1,200-1,300 gallons per minute. Halfway through the monitoring period the pool is turned off and a change was made that increased the flow rate to 1,300-1,400 gallons per minute. This allows us to calculate the recirculation rate of 4.2-4.9 cycles per day and may allow the pool employees to reduce the amount of energy used in filtering the pool water by reducing the flow rate.

10 WATER HEATING

The War Memorial Complex property has a total of seven water heaters. Five of these units are fueled by propane and two are electric water heaters. The pool heater is the largest of the water heaters with an estimated annual use of 9,500 gallons of propane, or a cost of $29,965.65. There are four propane water heaters for the locker rooms at the pool and gym. One of these water heaters is currently not operating and the remaining water heaters use an estimated 800 gallons of propane or $2,117 a year. The football stadium water heater is a commercial sized unit and is oversized but due to limited run times only uses an estimated $80 a month. There is a 45 gallon electric water heater under the construction and maintenance office. The run time of this unit was not measured but it has no time clock and could save significant energy if it was scheduled to only operate during working hours. The energy guide label on the tank estimates an energy use of 4773 kWh and based on the most recent blended utility rate for this utility meter of $.30, the annual cost would be $1,431.

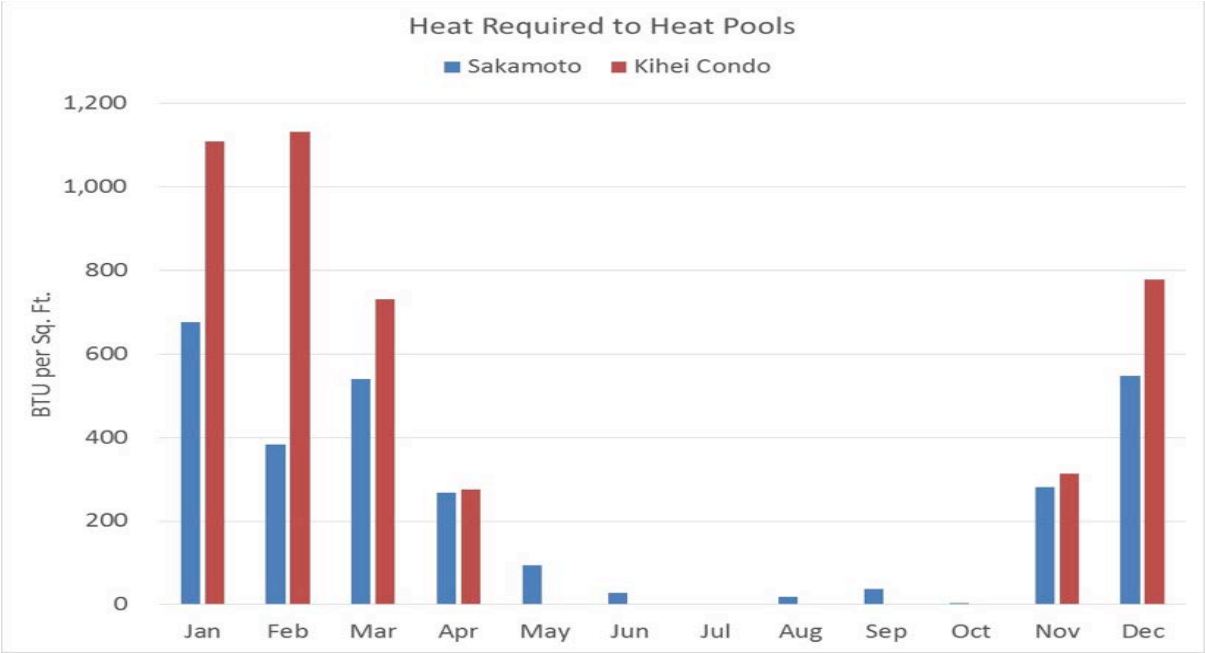
10.1 POOL HEATER

The pool water heater is a 3,500 kBtu sized boiler that uses propane as a fuel source. This unit was reportedly replaced within the past few years and only operates during the winter months to heat the pool to around 78 degrees. The average annual propane use during the three year period of this study was 9,718 gallons or $29,965.65 based on the average cost per gallon from 2016. During visual inspection the pool specialists noticed the greening of some of the fittings and dampness being present even without the boiler operating indicating possible small leaks. The boiler was not operational at the time of the study due to the warm temperatures during the

summer but by analyzing historic propane use information and interviewing pool employees the pool specialists provided the following recommendations.

The way the boiler is being operated appears to be inefficient in theory, although the data shows it to be using less propane than the average system of a peak of 1,000 BTU per square foot per day during the coldest months of the year. The chart below shows that the three year average in January is 650 BTU/sq ft/day. This is less than expected, as shown in the graph compared with a condo pool in Kihei.

A more in depth study is needed to analyze the financial benefits of retrofitting the unit to an electrical resistance unit or a heat pump system. The electrical resistance unit may make the facility qualified for demand response but may increase the facility to a P schedule that would increase rates. The heat pump system would reduce the over all energy use of the facility but may not be financially beneficial compared to the existing propane system.



Recommendations:

- The heater is run at a high temperature by slowing the flow rate and is partially looped back to reduce pipe condensation by preheating incoming water. The hot water is mixed and cooled downstream before reaching the pool. The reasoning being that is that the higher temperature water will heat the pool faster. However, the boiler should be able to transfer more BTU into the water if it is run at a lower temperature and higher flow rate. Adding a monitoring system that measures the temperatures to and from the boiler, the flow rate, and the boiler operating time, would allow for experimentation to achieve the optimum operational parameters.

- Install a heat pump to pre-heat the water going into the boiler. Heat pumps cost half as much to operate and could reduce the condensation problem. It may be possible to find one that could cool the pool when it gets too hot.
- Solar water heating is also a possibility, mounted to a shade structure for spectators, or atop any of the unused roof real estate available. One drawback of solar is that it only works during the day, when a lot of the heating needs to be done at night. Solar heating can also be used to cool the pool water by running it at night. There are hybrid panels available that produce hot water and also generate electricity.
- Using waste heat from the nearby air conditioners is another possibility.
- A liquid pool cover can work with any of these heating methods to raise the temperature a few degrees by reducing evaporation. They are available locally and on the internet.
- We recommend that an engineering study be performed by consultants experienced in these technologies, followed up by installing the most promising ones on the pools needing them most and monitoring the performance changes.

10.2 Pool Locker Room Water Heaters

The pool locker room water heaters are both 82 gallon propane water heaters. There is one unit for the men's locker room and one unit for the women's locker room. The County did not provide records of the age of the water heaters but during visual inspection it was determined that these units were very old and likely not very efficient.

Since the pool pump is turned off during summer months, the propane usage of these units was calculated by finding the propane usage during the summer, which was 200 gallons over three months, dividing that by three to find the total monthly usage, then dividing by three to find the usage per unit and then multiplying that by twelve. It is estimated that the annual usage for each water heater is 266.67 gallons of propane or $705.67 per year. It is likely that the units providing water to the pool locker rooms use more propane than the newer unit that provides water to the gym locker rooms.

The following pictures show the condition of the units:

Recommendations:

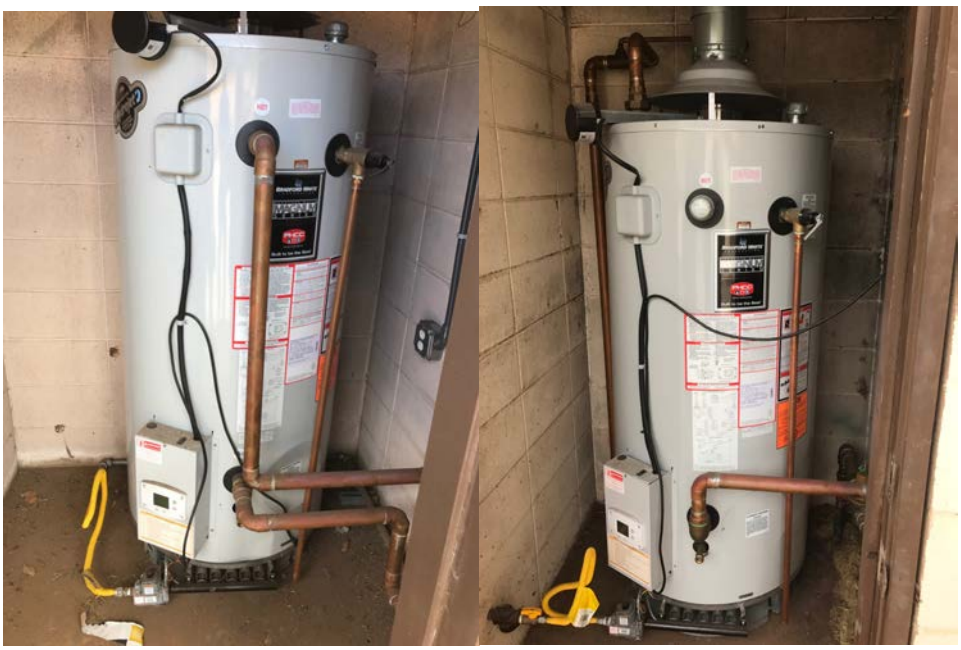
- Perform an engineering study to provide more information on cogeneration or solar water heating opportunities
- Maintain the existing equipment to ensure highest efficiency and extended life of equipment
- Insulate all hot water pipes

10.3 Gym Locker Room Water Heaters

The gym locker room water heaters are both 80-gallon propane operated water heaters. There is one unit for the men's locker room and one unit for the women's locker room. The County did not provide records of the age of the water heaters but staff said they had recently been replace. The men's locker room unit was set to 160 degrees during our initial inspection and upon recommendation of the audit team the temperature was reduced by 35 degrees to 125 degrees to reduce fuel use. The women's locker room unit was not energized and was not heating water upon our initial inspection. The audit team checked to see if the women's locker room showers had hot water and it was confirmed that they did not. This unit is not using any propane to heat water.

Since the pool pump is turned off during summer months the propane usage of these units was calculated by finding the propane usage during the summer, which was 200 gallons over three months, dividing that by three to find the total monthly usage, then dividing by three to find the usage per unit and then multiplying that by twelve. It is estimated that the annual usage for each water heater is 266.67 gallons of propane or $705.67 per year. It is likely that the units providing water to the gym locker rooms use less propane than the older units that provides water to the pool locker rooms.

The following pictures show the condition of the units:



Recommendations:

- Perform an engineering study to provide more information on cogeneration or solar water heating opportunities
- Maintain the existing equipment to ensure highest efficiency and extended life of equipment
- Troubleshoot the electrical problem for the women's locker room water heater if the showers are being used
- Insulate all hot water pipes

10.4 Football Locker Room Water Heater

This water heater is a commercial size 120-gallon water heater that has a 45 KW demand with a 115 gallon back up storage tank. This unit replaced a larger water heating system in 2009. During the audit this unit was identified as a possible large energy consumer so the audit team did an in depth analysis of the flow rates and energy use of the unit. It was determined that even though this unit is heavily oversized that it is operating efficiently and is estimated to only use $80 a month of electricity. Due to the rare use of this system the energy use is very low and the extra storage capacity allows the system to provide enough hot water for teams to shower after events. It was not clear if there were any events during the time of the study and we recommend doing a more in depth energy study during athletic season to find a more accurate energy use.

Recommendations:

- Monitor energy use during the athletic season to get a more accurate assessment of energy usage

- If the study shows the usage is high, perform an engineering study to determine if a hybrid heat pump could be cost effectively added to the system
- Maintain the existing equipment to ensure highest efficiency and extended life of equipment
- Insulate hot water pipes

10.5 Construction Maintenance Water Heater

This water heater is a residential size 45 gallon water heater and looks to be new and in good condition. The energy use of this unit was not monitored due to accessibility but during the inspection it was noted that there was no time clock on the unit. Without a time clock this unit will heat water through out the night and weekends wasting unneeded energy. The energyguide label on the tank estimates an energy use of 4773 kWh and based on the most recent blended utility rate for this utility meter of $.30, the annual cost would be $1,431. This unit is rated as an average efficiency. It is recommended that a time clock be installed on this unit and a more in depth study be done on the energy use of this unit to compare it to a higher efficiency system such as solar hot water or a residential heat pump system.

The following pictures show the condition of the unit and the energyguide label:

Recommendations:

- Do an engineering study to provide more information on cogeneration, heat pump or solar water heating opportunities
- Monitor energy use to get a more accurate assessment of energy usage
- Maintain the existing equipment to ensure highest efficiency and extended life of equipment

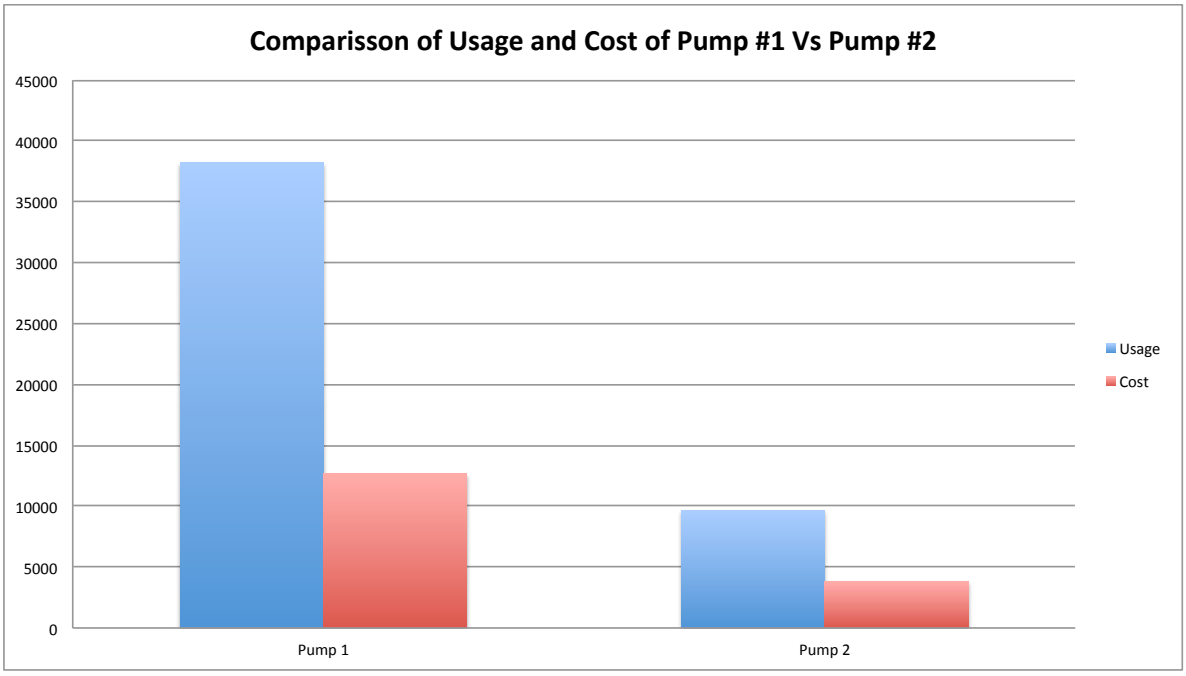
- Insulate hot water pipes

11 IRRIGATION PUMPS

The War Memorial Complex property uses 100% well water to provide irrigation to the baseball stadium, football stadium, youth baseball fields, the concession event field and all other landscaping. There are two pumps on the property, pump one is located next to the gym parking area and pump two is located by the maintenance shop near the football field. Pump one was identified as a 40 horse power motor that is over 18 years old. This unit has an estimated annual energy use of 38,194 kWh per year or $12,680.35 based on the blended utility rate for this meter. Pump two was identified as a 25 horse power motor and has recently been replaced. This unit has an estimated annual energy use of 9,665 kWh or $3,837.18. During the study period pump 1 ran 18 hours and pump 2 ran 22.8 hours. The difference in energy use between pump 1 and pump 2 was 28,528 kWh or $8,843.17. The total estimated energy use for irrigation at this site is 47,859 kWh with an estimated cost of $16,517.53. These estimates were made based off of the usage of the week the units were monitored. The study was done in the summer time when irrigation use is at its peak and estimated annual usage and cost may be higher than actual usage and cost. The amount of water pumped by each pump is unknown.

Appendix B is a map of the location of pumps, water meters and irrigation zones served by the pumps

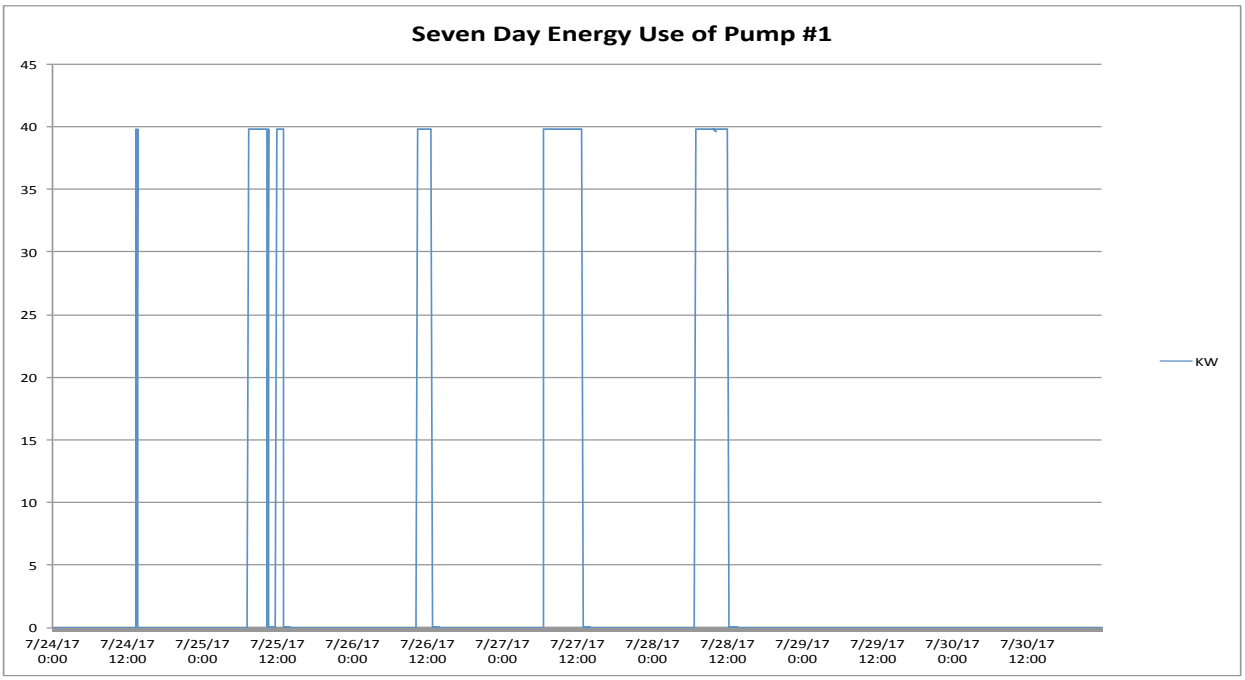
The following chart shows the difference in energy use and cost of pump #1 vs. pump #2:



11.1 Pump 1-War Memorial Gym

Pump #1 is located next to the parking lot for the War Memorial Gym and services all of the youth baseball fields, the concessions field and all landscaping around the war memorial gym building. It is a 40 horsepower unit that was identified as being over 18 years old by the lead irrigation employee. This unit has no controls and is turned on manually by the irrigation team. There are no automated timers and the zones are changed manually by turning the valves when the irrigation needs to be changed to a new zone. This pump provides irrigation to an estimated 609,000 square feet based on the information provided by the irrigation team. The annual usage per square foot would be .06 kWh, which would make the annual cost per square foot of irrigation to be $.021. During the energy monitoring study the pump ran for 18.4 hours making the use per hour 39 kWh and the cost per hour would be $1.74. It is unknown how many gallons were pumped during this time, which would be the best metric for efficiency.

The following graph is a visual representation of the seven-day energy use patterns of this unit.



This graph shows the operating hours of the pump. This pump has a single speed motor so the unit is either 100% on or off.

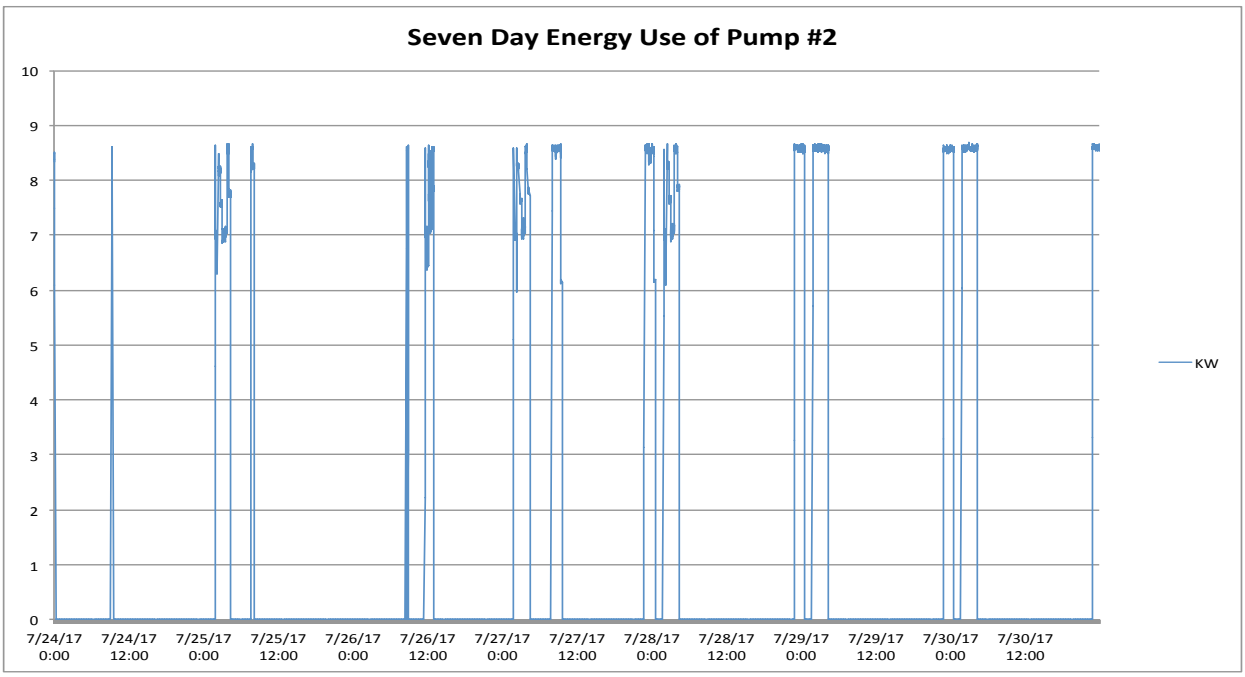
Recommendations:

- A more in depth study is needed to analyze the benefit of a new pump or VFD technology for energy savings

11.2 Pump 2-Football and Baseball Stadiums

Pump #2 is located next to the maintenance shop next to the football stadium and serves the football stadium, baseball stadium and landscaping around these areas. It is a 25 horsepower unit that was identified as being recently replaced by the lead irrigation employee. This unit has full digital controls including time clocks and scheduling. Directly up the hill from the pump is a water tower that the irrigation employees were not sure if the pump was connected to. This pump provides irrigation to an estimated 300,000 square feet based on the information provided by the irrigation team. The annual usage per square foot would be .03 kWh, which would make the annual cost per square foot of irrigation to be $.013. During the energy monitoring study the pump ran for 22.8 hours making the use per hour 8 kWh and the cost per hour would be $3.28. It is unknown how many gallons were pumped during this time, which would be the best metric for efficiency.

The following graph is a visual representation of the seven-day energy use patterns of this unit.



This graph shows the operating hours of this pump. This pump has a variable speed drive motor which allows the pump to change the speed of the pumping but the majority of the time the motor is 100% on.

Recommendations:

- Maintain pump on a regular basis

12 Fast Demand Response Opportunity

After exploring the Demand Response program with Conrad Copeland who is the account manager for Maui County at Maui Electric Co. (MECO) we found that none of the meters at this

location would fit the program at this time. The Demand Response program is designed for P schedule commercial utility customers who have loads over 50KW that would be able to drop a minimum of 50 KW within 10 minutes. Due to the fact that all of the meters are separated and none are on a P schedule makes this difficult. The fact that the majority of the load for this facility is high wattage lighting makes it unrealistic to drop 50 KW in 10 minutes. This would require turning all of the lighting off during events and that is not something that Maui County would likely do.

It is possible for J schedule accounts to apply for this program but most J schedule accounts do not have enough of load to drop 50 KW within 10 minutes.

If some or all of the meters were interconnected it would increase the chances of the facility to be on the Fast Demand Response program. A more in depth analysis of the financial benefits of this would need to be performed before investing in infrastructure changes.

13 STEM POWERSCOPE OPPORTUNITIES

The STEM program is a utility sponsored energy monitoring system that helps to analyze the opportunity for battery back up systems at facilities that are close to dropping into a lower utility rate schedule. This would be from Schedule P to Schedule J or from Schedule J to Schedule G. By monitoring the size of the peak demand and the length of the demand spike the utility can help size a battery back up system to smooth the demand spikes out to bring the customer into a lower utility rate schedule.

The only meter that is near dropping into a lower utility rate schedule is meter #82792 and energizes the Aquatics and Permitting offices. This meter has within the last few years increased its energy use and demand above the threshold of Schedule G and is now on the Schedule J rate schedule. We recommend applying for this program. It can take over 90 days to process the application and get approval but once approved the utility funds the purchase and installation of the equipment and the utility customer is responsible for the monthly cost of maintaining the energy monitoring database of $50 per month.

Between this program and installing energy efficient lighting and air conditioning systems this meter should easily be able to reduce its usage and demand to return to a G Schedule commercial utility customer.

14 PHOTOVOLTAIC ENERGY PRODUCTION OPPORTUNITIES

There are currently three programs offered by MECO to submit applications for photovoltaic (PV) energy production installations by customers. Customer grid supply allows the customer to export excess energy to the grid when overproducing energy at a discounted rate of $.17/kWh. Customer self supply allows the customer to install a PV system but all excess energy is curtailed and customer standard interconnection agreement similarly does not compensate for excess energy but is designed for facilities with base loads that will not likely be met by the PV system. Based on energy use patterns, the only meters that would be accepted into this program

would be the construction and maintenance facility, the aquatics and permitting office and the main gym building.

14.1 Customer Grid Supply Program

The customer grid supply program is similar to the traditional PV installation contract where the customer can sell energy back to the utility but now the rate that energy is purchased is at $.17/kWh, which is half of the current rate customers purchase energy from the utility. Some space has been opened in this program since last year but the original 5 megawatts that Maui was allowed has been contracted and the remaining space will not likely last long. The program capacity is a 100 kW system and battery back up options can provide increased capacity as well as load shedding opportunities in the evening. This program closes in October and it is not likely to open more space in the near future. Due to the short time line and regulations it is doubtful that the County would be able to have a design submitted and contract approved for this program. Based on energy use patterns, the only meters that would be accepted into this program would be the construction and maintenance facility, the aquatics and permitting office and the main gym building.

14.2 Customer Self Supply

Customer self supply is the alternative program that does not allow the customer to export energy back to the utility. All energy that is overproduced by the customer is curtailed and there is no financial benefit to the customer for over production of energy. This program is much easier to get accepted to and maybe the only opportunity for the County to apply for PV energy generation. There is a maximum generating capacity of 100 kWh, which far exceeds the needs of any electrical meter on the property. The customer is allowed to install batteries and controls to offset as much of the load as possible. All excess energy is curtailed so the utility is not effected by an increase in unused energy. If designed properly and combined with energy efficiency measures this option could help reduce the demand of two of the electric meters, #85111 and #82792 and possibly bring them from a J schedule rate to a G schedule rate. The rest of the meters do not have energy use patterns that would benefit from these programs very well. Since the majority of lighting is used in the evenings a large battery back up systems would be needed to make this program feasible.

14.3 Customer Standard Interconnection Agreement

Customer standard interconnection agreement is for larger scale customers who have no chance of back feeding to the utility grid. None of the meters at this property would meet the guidelines of this program. Other properties owned by Maui County may meet the guidelines of this program but none at War Memorial Complex.

15 Energy Monitoring Opportunities

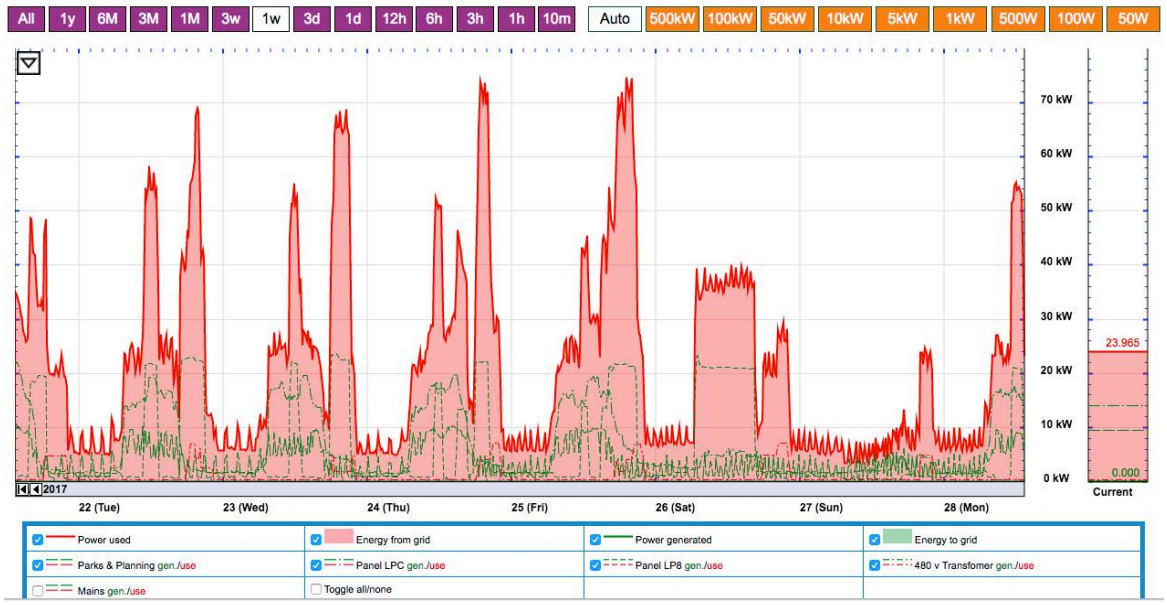
In order to better understand the energy use of the War Memorial Gym electrical meter the audit team installed an eGauge. This equipment monitors the energy use of different circuits through current transducers or CTs. As the equipment collects this data it calculates the usage and

then transmits it to an online database where the user can watch the energy use patterns in real time. This information can be very useful in analyzing opportunities with photovoltaic installations, proper scheduling of equipment, maintenance issues as well as identifying energy efficiency opportunities. The webpage can be accessed through the link bellow and a screen shot of the dashboard can be seen at the bottom or this section. The data can also be uploaded to an excel spreadsheet to manipulate and create graphs and charts if needed.

The graphs below show the total energy use of the circuits that have been monitored and the energy use of all of the individual circuits. All of the red shows total usage and each individual green line is separate circuits such as the parks and planning office, the gym lighting, the tennis court lighting and a sub panel that is believed to carry the majority of the air conditioning units.

This equipment can be set to send alerts to the facility maintenance teams if energy use goes above a certain threshold or shuts off completely. This can identify maintenance issues before they become more serious or can notify team members of equipment that has broken down.

Energy monitoring equipment is not always useful on every electrical meter. The electrical meters that have a minimal monthly energy use or have scheduled run times such as the football stadium and baseball stadium would not benefit from this technology. Electrical meters that have lots of mechanical equipment, varied usage and run times, load shifting opportunities or unidentified energy usage can benefit from energy monitoring by helping to identify the source of excess energy use. The meters that we would recommend using this technology on would be the gym meter #85111 and the aquatics and permitting office #82792.



16 Hawaii Energy Rebates

Hawaii Energy is a customer funded energy efficiency rebate program in the state of Hawaii that services all HECO, HELCO and MECO customers. The goal of Hawaii Energy is to make energy

efficiency retrofits more affordable to customers to incentivize moving forward with energy efficiency projects. Many of the recommendations in this report factor in Hawaii Energy rebates and all energy efficiency retrofits or services are recommended to consult with the local energy efficiency specialist, Walter Enomoto. The programs offered by Hawaii Energy are subject to change and throughout the year may run out of funding. It is important to confirm rebates with your local specialist as well as to note the rebates provided in these reports are estimates and are subject to change based on program adjustments.

For more information go to http://www.hawaiienergy.com

17 ACKNOWLEDGEMENTS

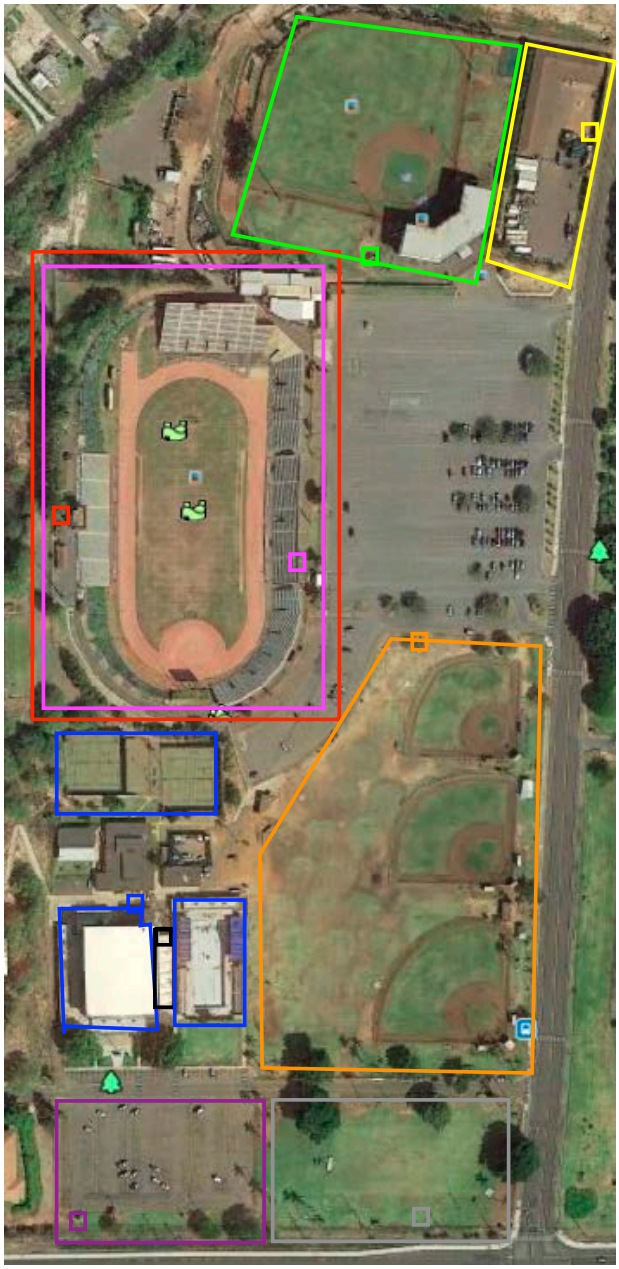
We would like to thank all of the employees at the War Memorial Complex who took the time out of their busy work schedule to provide us with billing information, access to different locations around the property and share first hand experience of how the buildings operate. An engaged operations team is the first step to a successful energy efficency project. Thank you Karla Peters and the rest of the team at the War Memorial Complex.

If you have any questions regarding the contents of this report, please do not hesitate to reach out to our team.

Info@greenbuildinghawaii.com

(808)873-2040

APPENDIX A-ELECTRICAL METER LOCATIONS AND AREAS SERVED



Electric Meters

- #82814
- #121727
- #115269
- #120347
- #85111
- #97424
- #65795
- #82792
- #97348

APPENDIX B-WATER METER AND PUMP LOCATIONS

APPENDIX C-STATEMENT OF ENERGY PERFORMANCE

ENERGY STAR® Statement of Energy Performance

LEARN MORE AT energystar.gov

N/A

ENERGY STAR® Score[1]

War Memorial Complex

Primary Property Type: Stadium (Open)
Gross Floor Area (ft²): 300,123
Built: 1963

For Year Ending: April 30, 2017
Date Generated: August 23, 2017

1. The ENERGY STAR score is a 1-100 assessment of a building's energy efficiency as compared with similar buildings nationwide, adjusting for climate and business activity.

Property & Contact Information

Property Address	Property Owner	Primary Contact
War Memorial Complex 1580 West Kaahumanu Ave Wailuku, Hawaii 96793	County of Maui 200 S. High Street Wailuku, HI 96793 (____)____-_____	Austin Van Heusen P.O. box 790-471 Paia, HI 96779 8082504439 austin@greenbuildinghawaii.com

Property ID: 6001714

Energy Consumption and Energy Use Intensity (EUI)

Site EUI
13.5 kBtu/ft²

Source EUI
35.5 kBtu/ft²

Annual Energy by Fuel	
Propane (kBtu)	962,136 (24%)
Electric - Grid (kBtu)	3,086,302 (76%)

National Median Comparison	
National Median Site EUI (kBtu/ft²)	32.3
National Median Source EUI (kBtu/ft²)	85.1
% Diff from National Median Source EUI	-58%
Annual Emissions	
Greenhouse Gas Emissions (Metric Tons CO2e/year)	451

Signature & Stamp of Verifying Professional

I _____ (Name) verify that the above information is true and correct to the best of my knowledge.

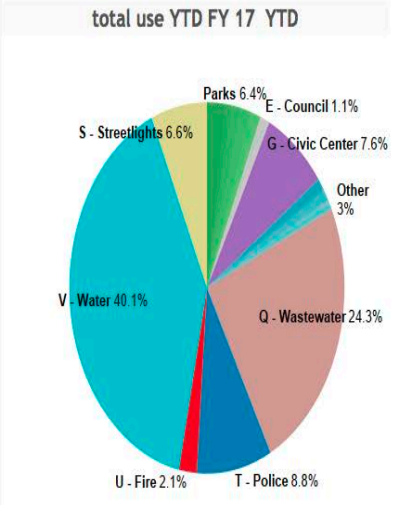
Signature: _____Date: _____

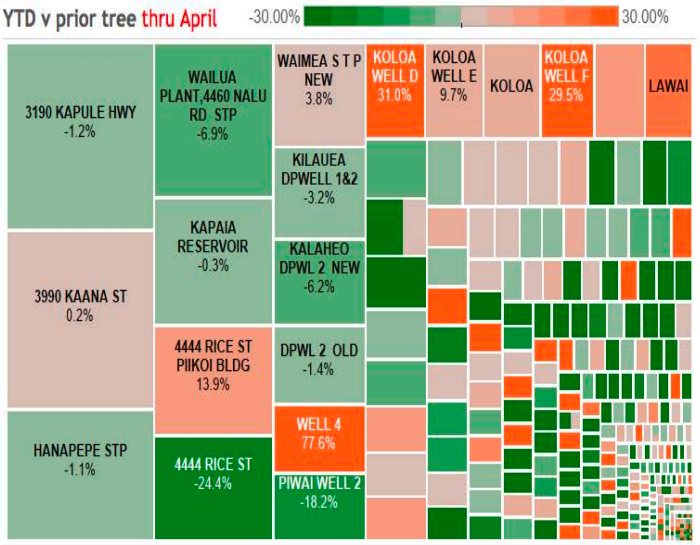
Licensed Professional

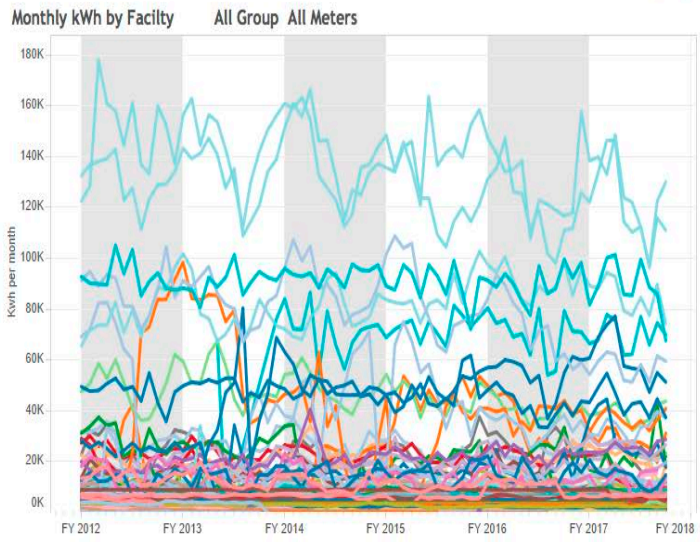
John Bendon
316 Paani Pl.
Paia, HI 96779
808-873-2040
john@greenbuildinghawaii.com

Professional Engineer Stamp (if applicable)

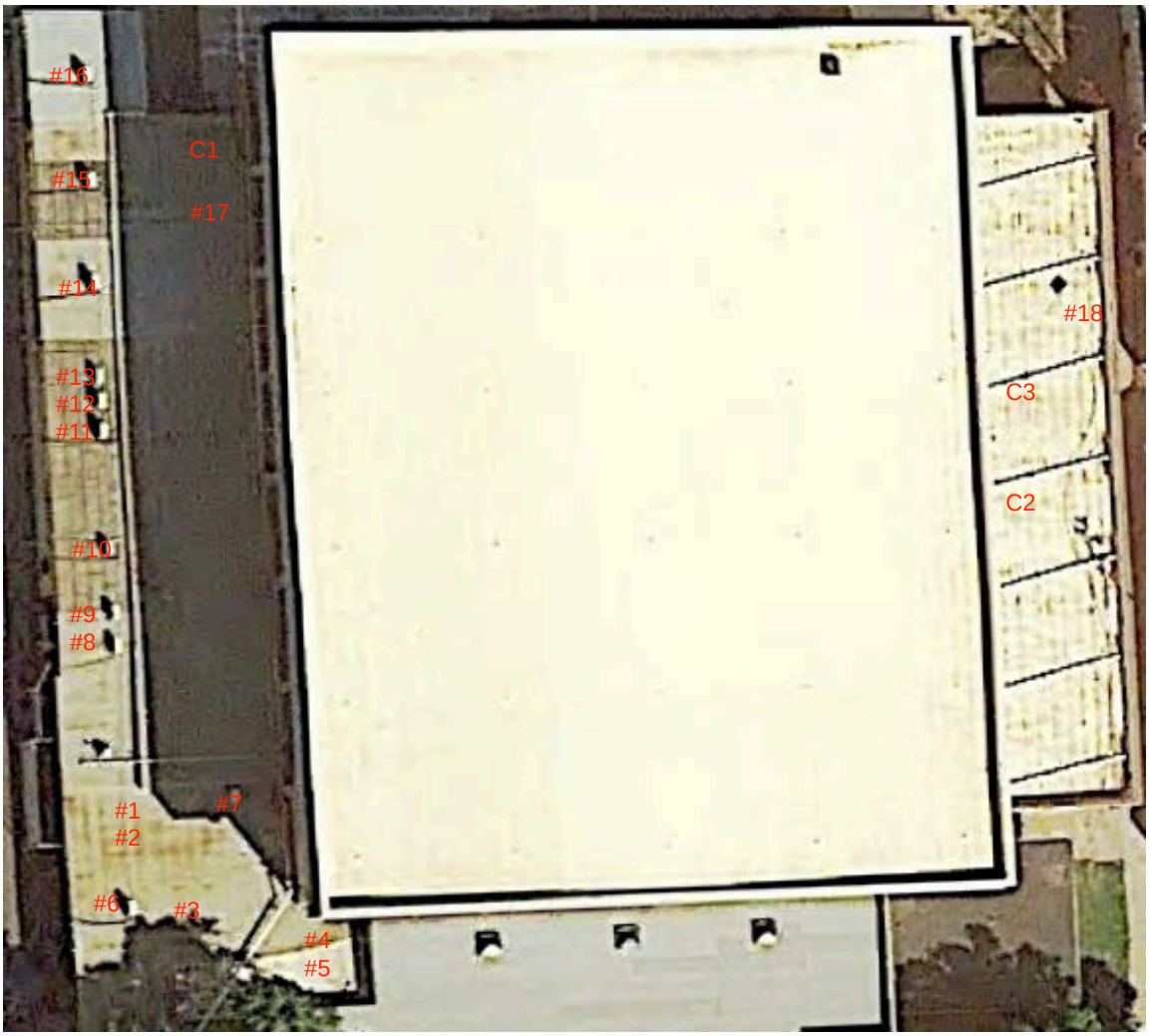
APPENDIX D-KAUAI UTILITY TRACKING DASHBOARD







APPENDIX E-PHYSICAL LOCATION OF AIR CONDITIONING UNITS



APPENDIX F-AIR CONDITIONING UNITS AND AREAS THEY SERVE