Characterization of Commercial Sites Selected for Energy Efficiency Monitoring

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Deliverable 3.5: 4) Report characterizing the commercial sites selected for energy efficiency monitoring

The County of Kauai is moving forward on its commitment to improve energy efficiency in its municipal facilities. Originally scoped in this project to conduct commercial building energy efficiency projects in two types of buildings on Kauai, the September 28, 2012 re-scoping of the HESP contract focused efforts on Kauai County municipal facilities. HNEI collaborated with energy professionals and the County to redefine Energy Service Performance Contracting (ESPC) criteria to support deep-dive audits and introduce advanced technologies. One objective of the ESPC criteria was to test and evaluate advanced energy efficient technologies used in institutional-scale buildings. The initial target locations at one time were the civic center and the police department facility, and included potential technologies such as solar thermal absorption chillers, building energy management systems, and advanced lighting. The two larger buildings were important to add square footage to an otherwise small municipal portfolio of buildings. Please see the table on Kauai County Facility ESCO Prioritization in the appendix.

Over the past year, the County has continued to develop its pilot Enterprise Energy and Carbon Management (EECM) system to track energy consumption of municipal buildings. The data is being used to establish baselines for comparison with future energy reductions. HNEI previously attempted to assist Kauai County with energy improvements to the Lihue Civic Center, and a performance contract was contemplated. Since that time, considerable uncertainty grew about the future use of portions of that facility, so the County determined that it was not in their interest to initiate energy improvements until the use was clarified. Since then, the County has obtained an architecture firm to plan an expansion/renovation of the Civic Center, and an audit and retro-commissioning of the entire facility will be part of that scope of work.

HNEI continues its support of the County by engaging in the evaluation of technologies, solutions, and mechanisms to optimize energy savings in the municipal facilities, specifically toward a major end–user, the Police facility. To achieve these savings, HNEI continues to support the County's developing partnership with the electric utility, Kauai Island Utility Cooperative (KIUC). Because of shared interests, opportunities and resources can be leveraged to maximize their value. A Memo of Understanding (MOU) between the County and KIUC was signed in August of 2013. The MOU resulted in a focus on the Police Station and County Civil Defense, a project currently dubbed the Ka'ana Street project, which includes exploring the following programs for their mutual benefit:

- Utilizing PV with battery backup as a source of utility reserves as well as firm backup power for the Police Department,
- Personal Comfort Pilot Program,
- Fast Demand Response Pilot,

- Utility Energy Services Pilot,
- Monitoring-based continuous commissioning programs utilizing EECMs that are being piloted by the County, and
- Appropriate ECMs such as HVAC upgrades, lighting and controls, and energy management controls.

While it is unlikely that KIUC and the County will agree to implement all of the programs, HNEI will continue to extend support to Kauai County by using internal and external expertise to evaluate and prioritize the elements of the joint strategy to the extent that they overlap with the evaluation of the Police department facility. It is not clear at this time what level of direct participation HNEI can offer over this larger and longer term partnership.

In an effort to meet program and HESP contract objectives, HNEI will report on the feasibility of these options identified for the Police facility and will make recommendations for the implementation of these technologies and solutions.

The following is a narrative of the energy assessment services to be provided by Loisos and Ubbelohde (L+U) in fulfilment of its role in the September 2012 rescoping.

For the purposes of this engagement with HNEI and the County of Kauai, Energy Services are defined as services related to retrofitting building components and or systems with the express aim to reduce energy use while either not changing or improving the functional and experiential aspects of the building. The project will involve multiple entities in addition to HNEI working together to achieve the goal of the project. While this conceptual scoping document will occasionally refer to other entities, it only covers the work that will be performed by L+U.

Traditional energy services contracts seek a particular type of energy retrofit. The combination of expediency, cost and accountability makes simple replacements the obvious way to effectively make a change that will result in reliable savings. An example of this is lamp retrofits, which is the process of changing an older lamp technology in an existing light fixture for a newer more efficient one. A drop in energy use due to the lamp for lamp replacement may make a good case. However, doing this may limit these savings, leaving larger potential savings on the table for the entire investment period, the time required to fully pay off the cost of the retrofit.

Using the above example, consider the following simple retrofit. Currently, institutional and commercial buildings have large numbers of two by four troffer lighting systems. Recently, Cree, a major LED manufacturer, produced a kit that allows the straight retrofit of T8 fluorescent lamps for tubes with LED lamps in them which mimic fluorescent lamps in form factor and light output. This yields 30% energy use improvements, which are respectable, but consider the following alternative. Existing troffer lighting systems are inherently inefficient, their optics are primitive and they were designed to handle a source, the fluorescent lamp, that indiscriminately emits light in a cylindrical fashion. LEDs are point sources that are designed to efficiently emit a cone of light well suited to superior optically designed fixtures. An LED retrofit may be expedient but it is using a highly efficient directable source by modifying it into an indiscriminate one to match the optics of what is a low-cost inefficient and usually glary source. An alternative to this is to change out the entire luminaire altogether, a more expensive retrofit, but one with the potential to reduce the energy use to a far lower level while at the same time

improving the lighting environment. Add to this modern controls and the energy use becomes a small fraction of what was expended before.

Hawaii's energy costs are very high. A solution, such as the one above can be effective over similar timelines as traditional retrofits, but after the investment period, the retrofit yields much higher returns. This is accomplished by expanding the area of concern from within the fixture to the actual space being lighted.

Similar savings can be had in the air conditioning and ventilating systems of the building. In addition, the investigation will also extend to other areas, such as window configurations, glass types, etc. The project will be organized as follows:

L+U will work with the local engineering entity that will perform the energy audit to understand the use of the spaces and the current energy consumption patterns. At that time, L+U will construct calibrated energy models of the building to fully explore and understand the patterns of energy use. That organization will then propose physical retrofits, test these with both energy and economic models and, if they meet stipulated requirements, L+U will propose, design them, have them reviewed, and then implement and measure their success.

Phase 1 Investigation
L+U proposes to use a high-level energy audit to understand what the energy use of individual systems of the spaces is. With this and current architectural drawings, they will build a calibrated energy model of the building. For this stage, a good quality weather station with the capacity to measure both direct and diffuse solar radiation will be installed.

Phase 2 Proposed Retrofits
This phase will include a design exercise to see how to simulate modern systems to reduce energy use while maintaining or improving space function, and a determination of whether these will fit within the investment proforma of the retrofit. The new retrofits must meet the economic thresholds to make them worthwhile.

Phase 3. Design
Loisos and Ubbelohde and the team will then design the systems, lighting and HVAC systems, and evaluate the design alternatives to optimize energy use, space utilization and human comfort. The designs will be developed with the client group and the contracting entity to ensure acceptance by the user, occupant owner group as well as the contracting entity to ensure that it can be constructed for the allocated budget.

Phase 4. Construction
In this phase, L+U will have a role limited to construction administration.

Phase 5. Evaluation
In this phase, real time monitoring will ensure that the performance of the system is operating within expected the performance parameters.

Appendix

(Source for all of the following material: County of Kauaʻi)

Ka’ana Street Facility Information

Table 1 Facility ESCO Prioritization

Figure 1 Kauai County Building Energy Consumption and Intensity

Figure 2 Hawaii Average Energy Utilization Index (EUI)

Monitoring Based Commissioning at the Ka’ana Street Facility

HVAC Retrofits

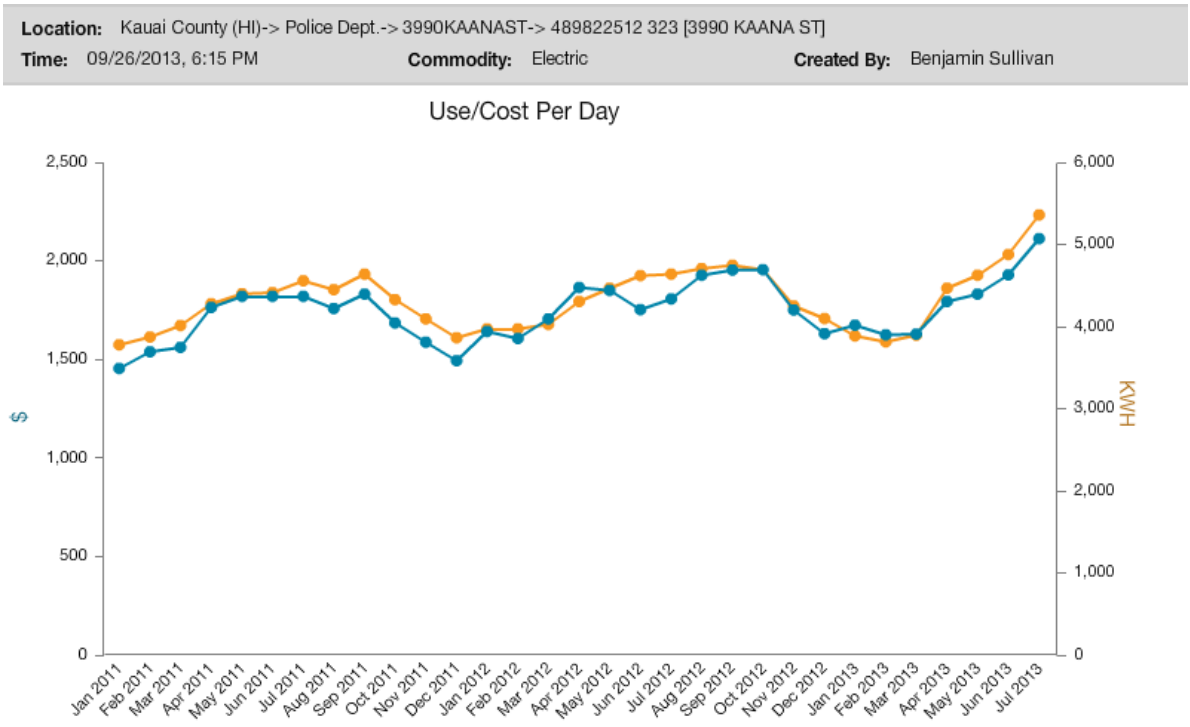
Ka'ana Street Facility Information

Facility Background

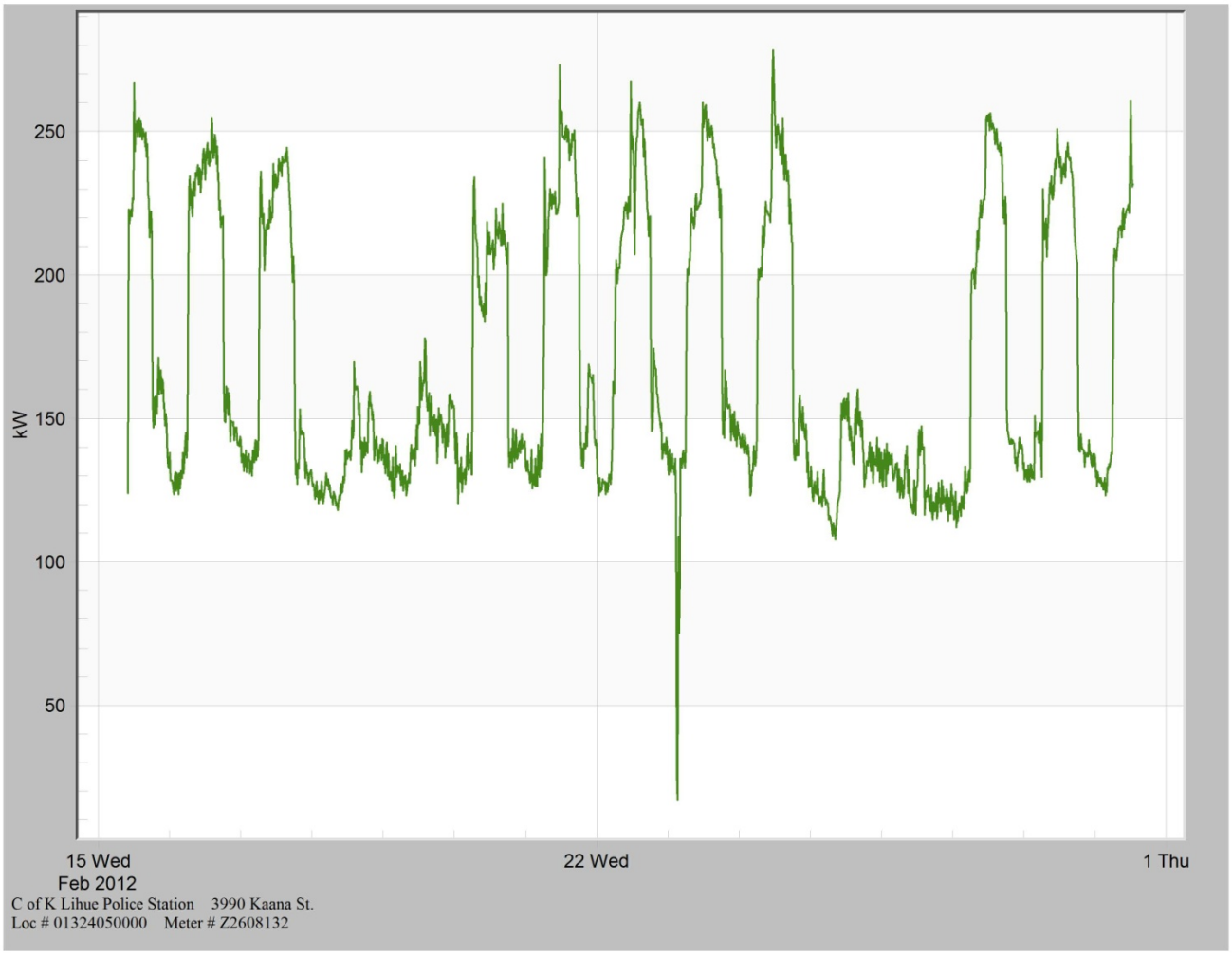
The Ka'ana Street Facility was constructed in 2001. It is a 2 story, 66,000 sf facility which houses Kauai Police, Kauai Civil Defense, and County Prosecutor's Office. A portion of the electric loads at the facility are critical loads which must be maintained during disasters and other emergencies so critical services can be provided to Kauai. For a photograph and site plan for the facility, see the two pages following the next page.

Month to Month Energy Use Trends

The Ka'ana Street facility has been trending towards its highest monthly energy usage since January 2011. The energy office is looking for assistance/info to determine the possible reasons for the increased consumption.



Typical Daily Load Profile



The above load profile shows an approximate doubling of energy use at the facility during normal business hours Monday through Friday.

PHOTOGRAPH OF KA'ANA STREET FACILITY

SITE PLAN FOR KA'ANA STREET FACILITY

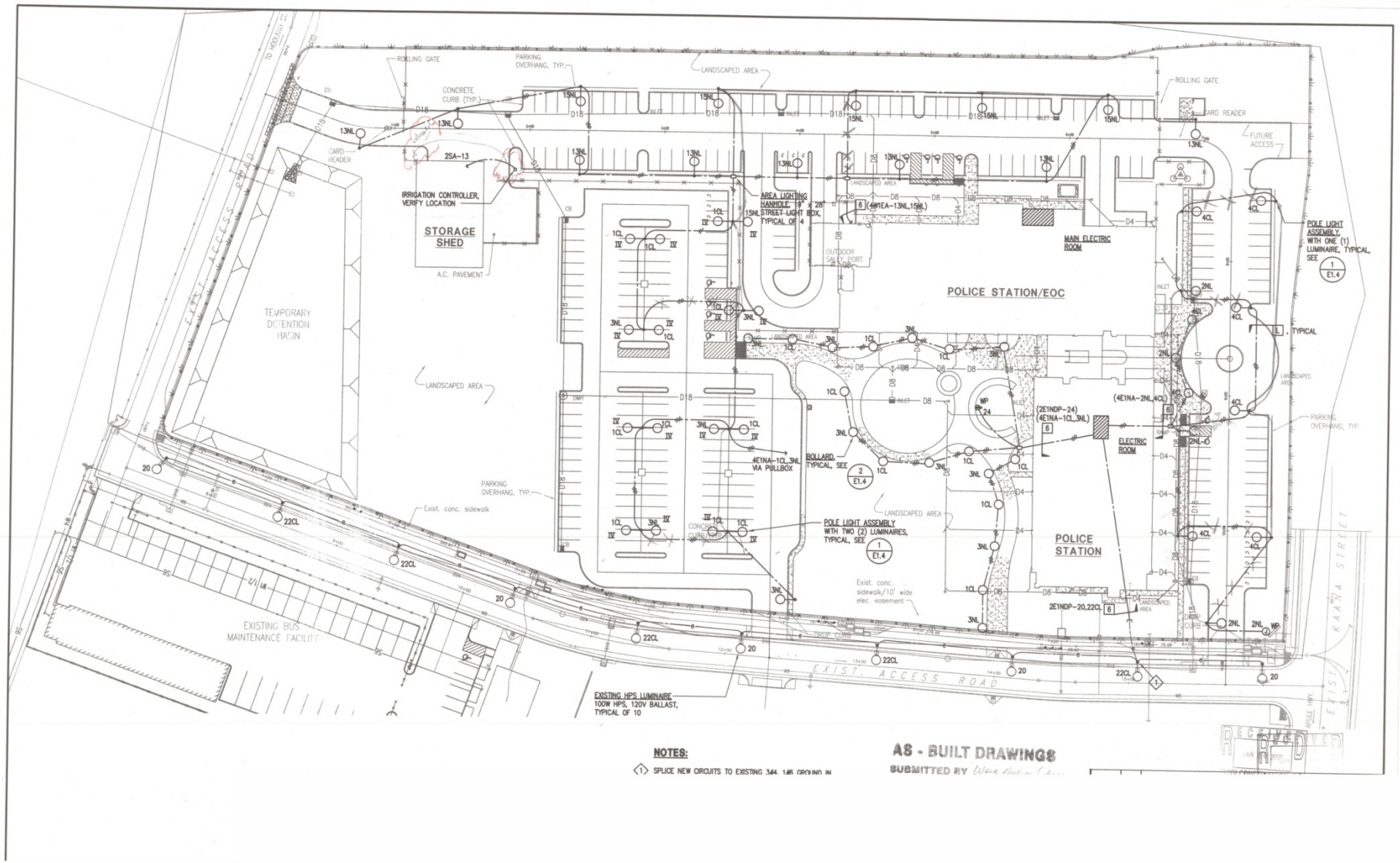


Table 1: Kauai County Facility ESCO Prioritization

parse by number of type, renovation priority, EUI, Gross Energy Use

Facility	Type	Last Renovated	Renovation Priority	Number	Area (sf)	Energy Use (kWh/year)	% of Total	EUI (kWh/sf)	Comments
Civic Center Bldgs	Office	2002	low?	3	150,000	1,700,000	30.9%	11.3	3 buildings
Police Facility	Police	2002	low?	1	70,000	1,500,000	27.3%	21.4	some 24-hr use; 10 years old
Parks Facilities	Miscl			69		441,000	8.0%		sport fileds, comfort stations, pavilions
Fire Stations	Fire Station			8		30-80,000 / station*	5.8%		age varies widely
Neighorhood Centers	Assembly			9		250,000	4.5%		
Police Substations	Police			6		250,000	4.5%		
Public Golf Course	Golf Course			1		239,000	4.3%		includes club house, maintenance, irrigation
Lihue Convention Hall	Convention			1	32,000	155,000	2.8%	4.8	intermittent use
Lihue Stadium	Stadium			1		58,000	1.1%		intermittent use
Transportation Agency	Office		low?	1		78,000	1.4%		newer facility
Auto Baseyards	Resource Recovery			3		172,000	3.1%		
Public Pool	Pool			2		116,000	2.1%		
Housing Agency	Housing					88,000	1.6%		housing common areas
Unaccounted						133,000	2.4%		
						5,500,000	100.0%		
						* calcs assume 40k/station			

Figure 1: Kauai County Building Energy Consumption and Intensity

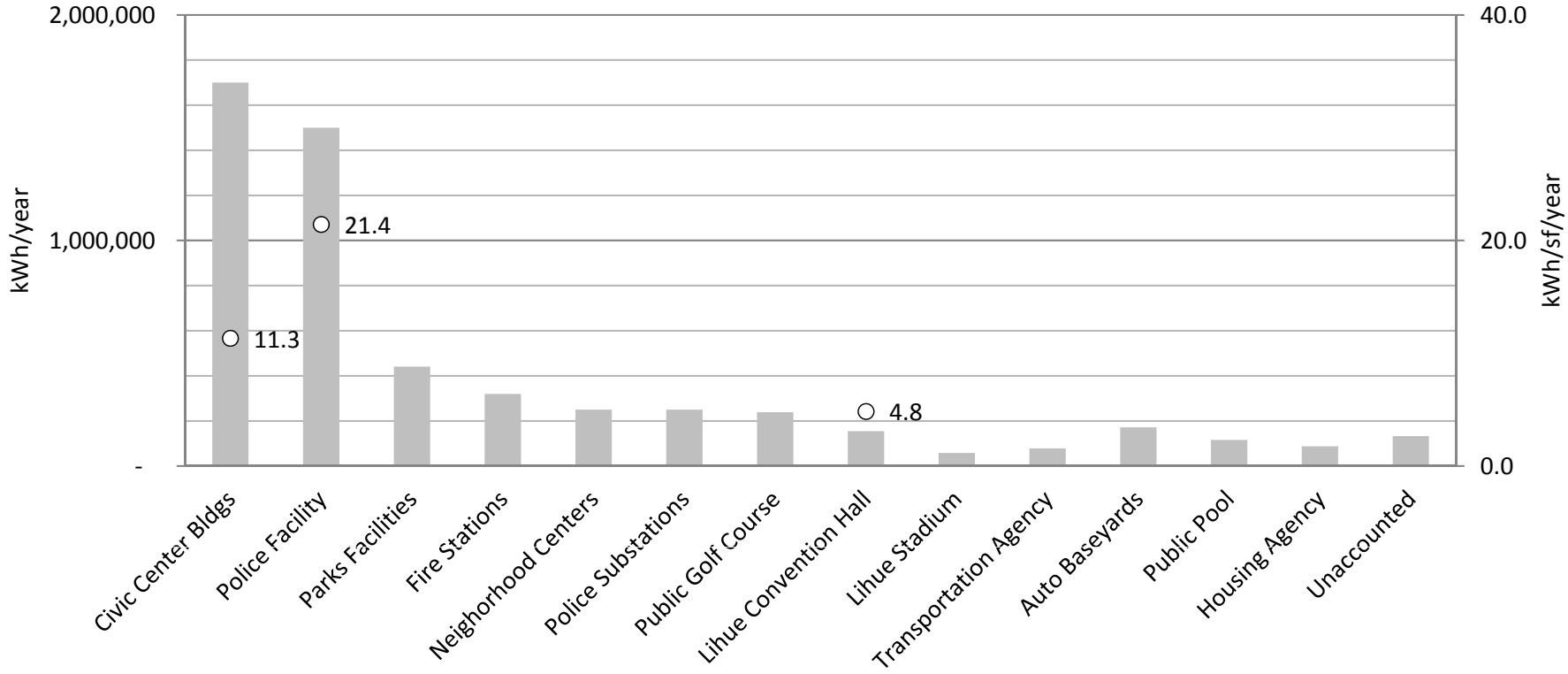
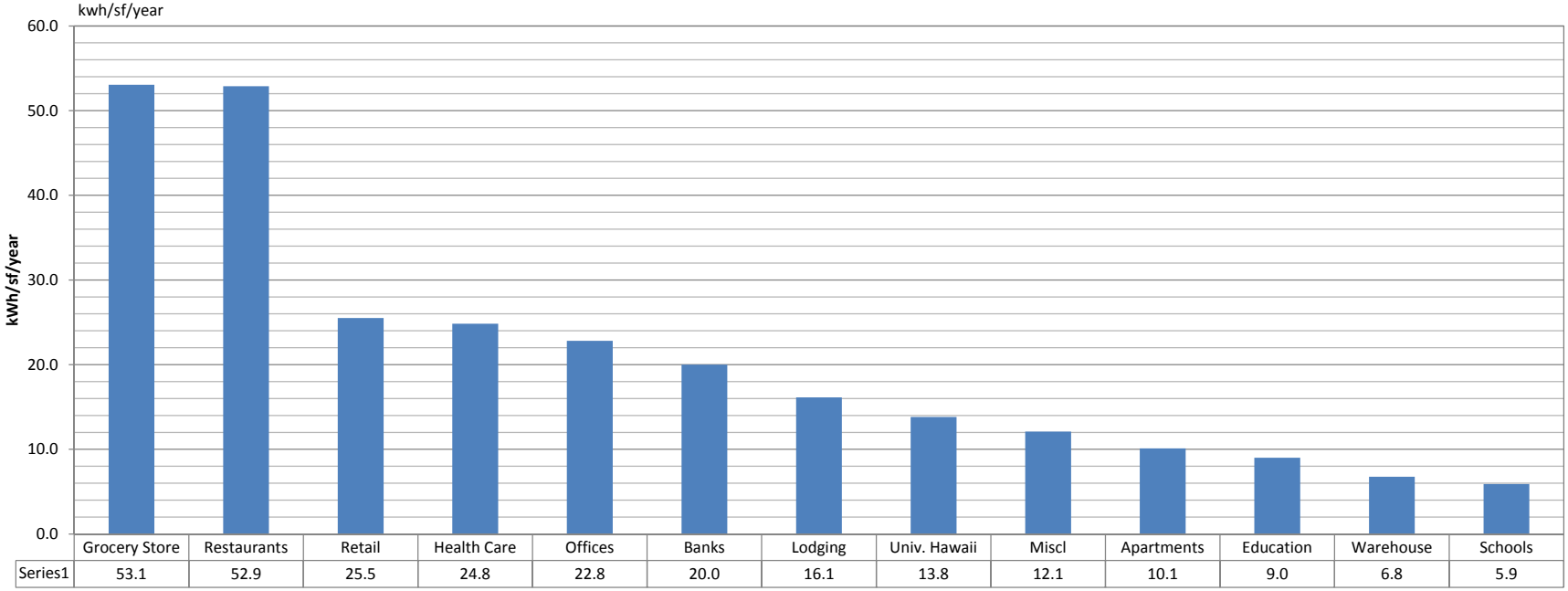


Figure 2: Hawaii Average Energy Utilization Index (EUI)



	Grocery Store	Restaurants	Retail	Health Care	Offices	Banks	Lodging	Univ. Hawaii	Miscl	Apartments	Education	Warehouse	Schools
Series1	53.1	52.9	25.5	24.8	22.8	20.0	16.1	13.8	12.1	10.1	9.0	6.8	5.9

Monitoring Based Commissioning at the Ka'ana Street Facility

Monitoring based commissioning (MBCx), or continuous commissioning, has progressed tremendously over the last several years. County of Kauai is interested in implementing Monitoring-Based Commissioning at major facilities, and in using the Ka'ana Street Facility as a pilot to test and learn about this approach. We are currently researching programs around the Country that use MBCx as a means of maximizing efficiency.

The police facility may be a good initial candidate for several reasons:

- No major building renovations are planned or anticipated for the near future.
- The building already has a functional BMS for the HVAC system in place (Trane Tracer).
- The facility is in use 24 hours due to the use (Police and Emergency Operations) and is one of the largest single loads within the County.
- Improved controls and monitoring at the facility may open other opportunities, such as fast DR or load shifting, which may increase the benefits of other project components as well.

One of the challenges to implementing an MBCx approach on Kauai is the relatively small size of facilities. Many MBCx programs implemented initially were at facilities with hundreds of thousands to millions of square feet.

County of Kauai anticipates hiring a commissioning agent in order to facilitate this project. We are currently reaching out to find out what other organizations in the State and beyond have successfully implemented MBCx at smaller facilities such as the ones operated by County.

Next steps to develop this concept:

1. Survey market for available MBCx systems specifically designed for smaller facilities
2. Procure professional services to evaluate opportunities at the facility related to MBCx

HVAC Retrofits

HVAC retrofits are a major opportunity to deliver energy savings in County Facilities. Public Works Building Division manages the existing systems and determines when major components should be replaced. Current capital expenditures at Ka'ana for HVAC:

1. Chiller Cooling coils currently being replaced.
2. Chillers may need replacement in 5 yrs +.

Some possible opportunities related to HVAC systems:

1. Improved Chiller Efficiency - Due to rising energy costs globally, significant technological improvements have been achieved in the past few years in terms of HVAC equipment. One example is in with Magnetic Bearing Chiller Compressors. The savings available by switching to these units is increased if compressors often run below full capacity due to variable A/C demand. (see slides below on Magnetic Bearing Chiller Compressors)

2. Load shifting - Because solar energy is substantially less expensive than other sources, it may become advantageous in the near future to have the ability to shift more electricity loads to times of the day when more solar energy is available (roughly 9am-3pm). An investigation of whether ice storage is a possible means to achieve this may be warranted. In a recent press release, KIUC suggested that they are considering time of use rates, which could come into effect as higher amounts of solar energy come onto the grid in a few years.