

**CASE STUDY**

**SAVED HOTEL \$510,000  
IN HVAC ENERGY IN ONE YEAR –  
APPROXIMATELY \$2.04 MILLION+ IN 4 YEARS**

**EXECUTIVE SUMMARY**

Eco-Enterprise HVAC experts implemented the HVAC Optimization service, in an effort to help correct the various issues causing the excessive energy consumption of the HVAC at two buildings in Hawaii, including the Mauna Kea and Hapuna plants.

**TOTAL ANNUAL SAVINGS: \$510,621**

**Mauna Kea Plant Annually Spend**  
**APPROXIMATE ANNUAL SAVINGS = \$182,909**

**Before HVAC Optimization**

- Annually 283 kW \* 8760 hours = 2,479,080 kWh  
2,479,080 kWh \* .29 cents per kWh = \$718,933

**After HVAC Optimization**

- 211 kW \* 8760 hours = 1,848,360 kWh  
1,848,360 kWh \* .29 cents per kWh = \$536,024

**Hapuna Plant Annually Spend**  
**APPROXIMATE ANNUAL SAVINGS = \$327,712**

**Before HVAC Optimization**

- Annually 255 kW \* 8760 hours = 2,233,800 kWh  
2,233,800 kWh \* .29 cents per kWh = \$647,802

**After HVAC Optimization**

- 126 kW \* 8760 hours = kWh 1,103,760 kWh \*  
.29 cents per kWh = \$320,090



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## IDENTIFYING THE PROBLEMS

- **480+ Hours to Identify Problems** - Eco-Enterprise engineers spent at least 40 hours per month for the better part of 12 months (480+ hours) working to identify problems and retro engineer solutions.
- **Quantified Exact Savings** - Overcoming these issues allowed Eco-Enterprise's HVAC experts to finally quantify the savings directly at the HVAC equipment opposed to trying to use the utility bills.
- **Equipment Assessment and Baseline Performance** - HVAC team Identified system architecture, specific equipment design and baseline operational performance demonstrating the operating costs for both plants as they were operating prior to HVAC Optimization.

## IMPLEMENTING SOLUTIONS

- **Remote Access to Energy Management System** - The engineering team was given remote access to the Automated Logic Energy Management control system.
- **Installing Forensic Measurement Equipment** - The team installed several equipment specific forensic measurement devices on a selection of equipment types to assist in determining the thermal and electrical performance of all HVAC equipment.
- **Replaced Faulty Equipment** - HVAC equipment fails to meet original operational sequences that govern and control the cost to operate while providing comfort cooling.
- **Repairs, Adjustments, Reprogramming, and Much More** - During the 12 months, the forensic engineering team provided the hotel engineering management staff with lists of needed physical repairs, adjustments, and revised temperature control system reprogramming so that Eco-Enterprise could utilize the aforementioned HVAC equipment and to provide revised operational control via the Automated Logic Energy Management system programming currently in place.
- **Revising System Programming and Extending Equipment Life** - The revised control system programming has resulted in daily routine operating changes that have been verified and tested to assure all HVAC systems compatibility within design while providing the guests with environmental comfort and improved air quality while reducing the cost to operate and extending the life cycle of all equipment.
- **Reduced KW Usage While Maintaining Guest Comfort** - All temperature and comfort processes met the level of comfort to guests and employees while reducing the kW usage as well as mechanical wear and tear.
- **Adjusted The Air and Water Flow** - The cooling towers and condenser water pumps in use at the Mauna Kea and Hapuna plants are capable of advanced thermally efficient operations. The tower fans and condenser pumps are equipped with electric variable speed controllers to provide the proper amount of air and water flow. Both sets of towers have been reprogrammed with specific wet bulb temperature control strategies to reduce fan speeds while reducing evaporation rates and chemical use. The condenser water pumps have been adjusted to provide variable performance that provides necessary condenser water flow to the chillers and towers.



## IMPLEMENTING SOLUTIONS CONT.

- **Reduced Fan speed from 100% to 64%** - Previously, the cooling towers and condenser water pumps were operating at 100% fan speed 24/7. After deploying the new strategies, the equipment is now operating at 64%, much lower speeds at significantly reduced energy consumption while maintaining the same comfort for guests. See Appendix A at the end of this report.
- **Discovered Failure of Chilled Water Bypass Valve and Control Sequence** - The chillers within the Mauna Kea and Hapuna plant were operating at a constant 44-degree F set point. The condenser and evaporator were operating with a constant water flow rate that was required as a result of the failure of the chilled water bypass valve at Mauna Kea and the control sequence in play at Hapuna.
- **Maintaining Variable Primary Chilled Water Flow Design** - The Automated Logic temperature control system is designed to be a primary variable flow design for both plants. The most important component of the ALC system is having the ability to control via a variable primary chilled water flow design.
- **Most Cost-Effective Way to Run the Chillers** - The engineering team examined all of the possibilities to deploy a cost effective and functional approach to operating the chillers while providing internal and external customers with reliable cost-effective comfort cooling.
- **Return To Efficient Operating Sequence** - Island Controls and Johnson Controls assisted in several areas to repair or replace key sectors of these facilities to allow it to be returned to an efficient type of operating sequence. We reengineered several control sequences and provided new programming parameters into the daily operation of both plants. The old leaving chilled water set point was a constant 44 degrees F, which wasted substantial energy.
- **Algorithm to Adjust Temperature based on Weather and Building Occupancy** - A new self-adjusting type of algorithm is in place to change the chilled water temperature when cooling loads are reduced due to weather and building occupancy. The average leaving chilled water temperature has increased from a constant 44 degrees F to a range consisting of 44 degrees F to 51 degrees F.
- **Increased Efficiency and Equipment Life** - Each degree of chilled water that we can reduce and continue to properly cool the facilities represents a 5% energy reduction in the cost to operate each plant while reducing the wear and tear on all associated equipment.

# ENERGY USAGE COMPARISONS DATA

Before HVAC Optimization = Baseline

After HVAC Optimization = Post

The data to the right was chosen under the criteria of comparing pre-pandemic levels of energy use in August of 2019 as compared to the same time this year in 2021 now that the resort is resumed to normal occupancy levels in 2021.

Only cooling equipment energy consumption was used, and temperature & humidity levels were very similar or slightly higher in the post period.

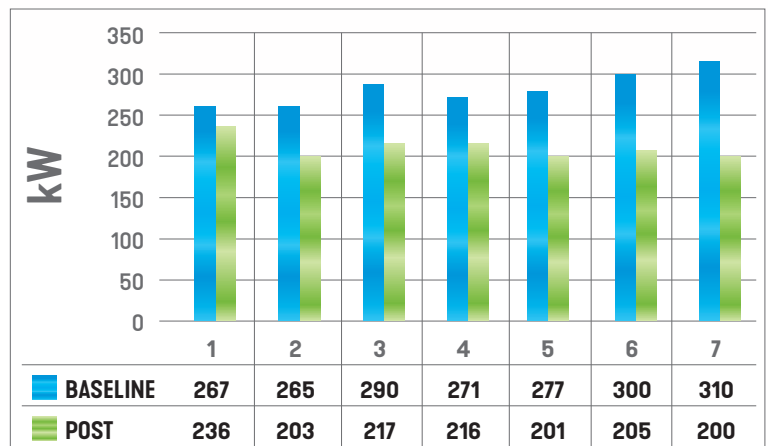
## MAUNA KEA EFFICIENCY RESULTS

### CHILLER PLANT TOTAL kW

DATES	BASELINE	DATES POST	POST
8/24/19	267	8/24/21	236
8/25/19	265	8/25/21	203
8/28/19	290	8/28/21	217
8/29/19	271	8/29/21	216
8/30/19	277	8/30/21	201
8/31/19	300	8/31/21	205
9/01/19	310	9/01/21	200
<b>AVERAGE</b>	<b>283</b>	<b>AVERAGE</b>	<b>211</b>

**REDUCTION% - 25.4%**

### TOTAL CHILLER PLANT kW DAILY AVERAGE



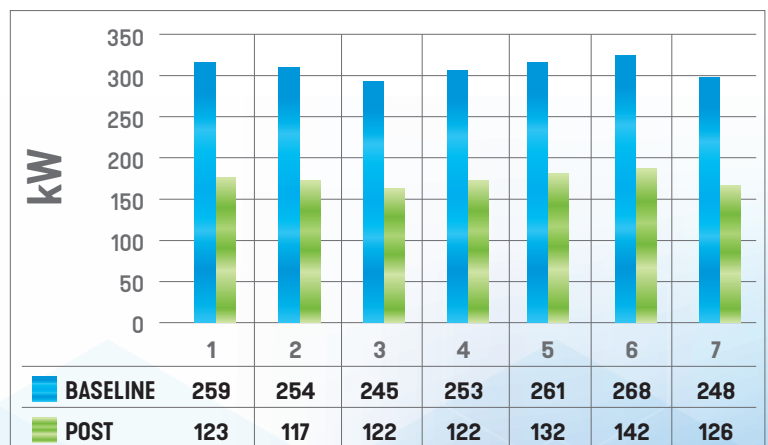
## HAPUNA EFFICIENCY RESULTS

### CHILLER PLANT TOTAL kW

DATES	BASELINE	DATES POST	POST
8/01/19	259	8/01/19	123
8/02/19	254	8/02/19	117
8/03/19	245	8/03/19	122
8/04/19	253	8/04/19	122
8/05/19	261	8/05/19	132
8/06/19	268	8/06/19	142
9/07/19	248	9/07/19	126
<b>AVERAGE</b>	<b>255</b>	<b>AVERAGE</b>	<b>126</b>

**REDUCTION% - 50.6%**

### TOTAL CHILLER PLANT kW DAILY AVERAGE



## NEXT STEP AN ADDITIONAL 8-11% ENERGY SAVINGS

The efficiency strategies implemented up to this point are only a portion of Eco-Enterprise's ongoing efforts to optimize the chiller plant.

The engineer will continue to go onsite to commission several components of the chiller plant.

The engineers estimate an additional 8-11% HVAC energy savings for the next phase.

The next procedures to be implemented at both plants are designed to drive HVAC energy usage levels even lower are as follows:

- Verify flow meters for accuracy and adjust accordingly
- Verify pump speeds in the VFDs and verify the output cards are accurate
- Target all large AHU's and commission (adjust water flows & face velocity)
- Bring heat pump chillers online with new piping configuration to reduce propane consumption along with less load on the chillers at Hapuna
- Train staff to manage all of the new setting/strategies put in place to maintain savings
- Ongoing consulting and monitoring (included in the service already) for the duration of the contract

Note that currently the condenser water pump serving these chillers are locked in the full speed mode which is causing some plant energy issues and should be released to operate in the automatic mode so the Eco-Enterprise engineering team can develop a change in programming as was accomplished with the chilled water architecture. This request has been presented to the Mauna Kea engineering staff and will soon become an additional reduction of energy consumption beyond the current reductions.

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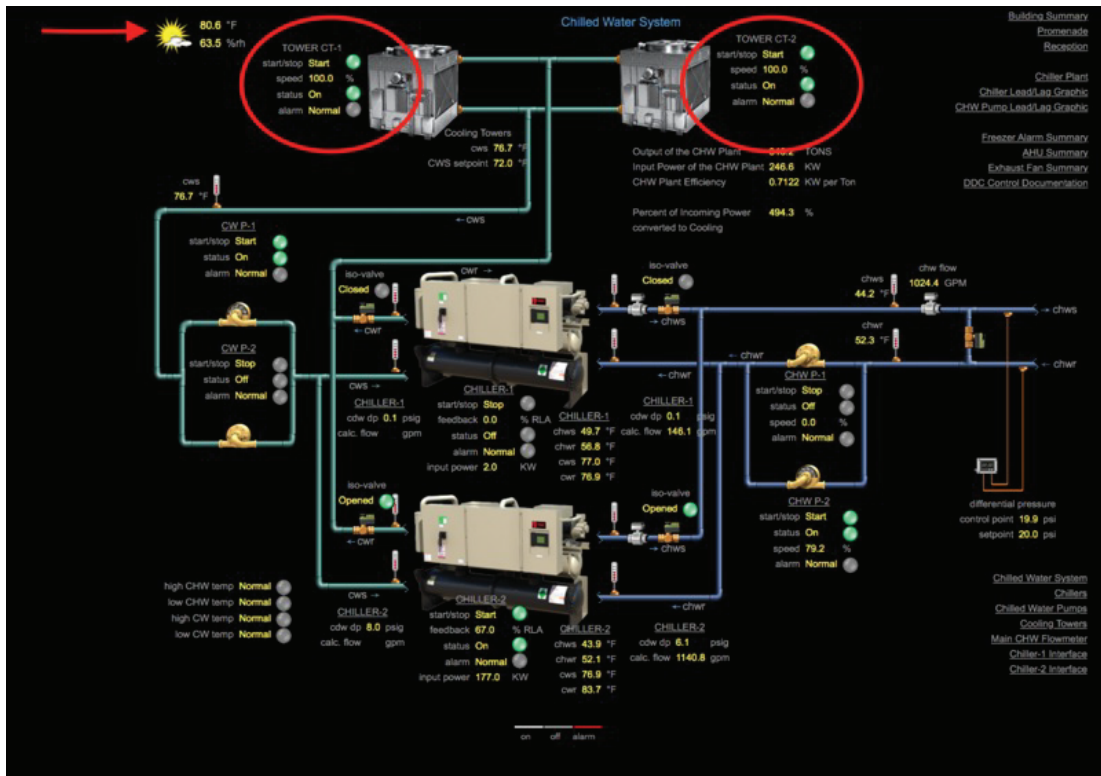
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# APPENDIX A

## Before HVAC Optimization Implementation



## After HVAC Optimization Implementation

