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OPERATIONS & ENERGY MANAGEMENT

SiteWatch Sample Report

Typical Energy Review for a Hospital located in Philadelphia PA

Summary

A Channel Partner, supported by SiteWatch, provides energy monitoring using Panoramic Power[1] sensors and data support services for a hospital located in Philadelphia, PA. The hospital provides vital services to the region, requiring continuous operation (24/7/365). The energy monitoring system covers equipment grouped into the following types:

- Air handlers
- Boilers
- Chillers
- Condensers (cooling towers)
- Heating elements
- Water pumps
- Air compressors

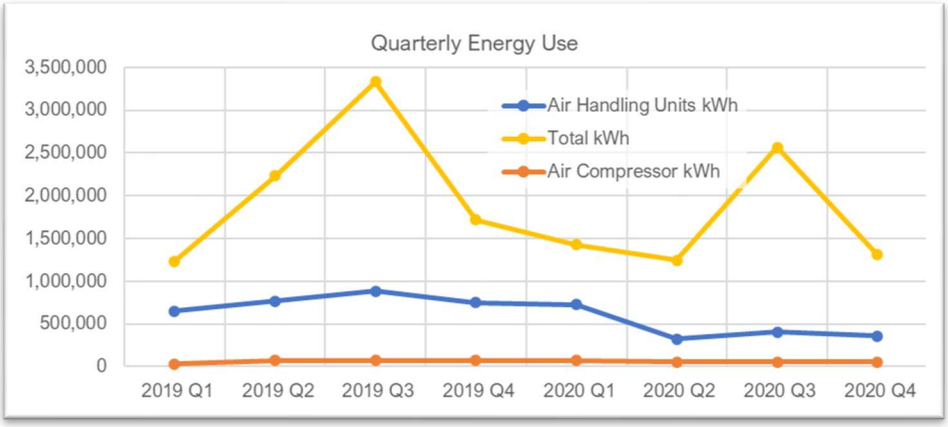
Benchmarking

As part of the ongoing support service, the hospital requested benchmarking on a quarterly basis. This benchmarking tracks total energy use, total energy use vs. building area, energy use versus ambient conditions (degree days), and energy use by individual equipment types. Energy use by type (heating, cooling, or air handling units) can be summarized by quarter and year. Increases or savings in energy usage, and thus cost, are quantified through this review process, allowing the site to understand how equipment impacts operating costs related to electrical energy use.

Energy Use by Quarter – Tracking energy use by quarter may an effective assessment, depending on the variability of weather and the monitored equipment's dependence on ambient conditions (i.e., outside air temperature). For example, cooling HVAC equipment operates more during hot weather, so presenting quarterly energy use without accounting for changing conditions may not present an accurate picture. Systems without weather dependence, such as lighting, plug loads, elevators, or server rooms, may be compared more simply as their operations are likely more consistent regardless of season. Air handling units may operate based on time-of-day controls with more limited impacts from ambient conditions:

[1] Panoramic Power and PowerRadar are registered trademarks of Panoramic Power Ltd in the United Kingdom and United States of America

Figure 1: Energy Use by Quarter, Overall and for Select Equipment Types[2]



Energy Use Intensity by Area – Energy use intensity (EUI) is present as kWh per square foot of building area. This value can be used to compare between similarly operated sites/building types, or benchmark energy use over time even with expansions in building area. If total building usage is tracked, SiteWatch can compare kWh per square foot to national databases, helping a site understand how their building operates versus peers throughout the country (and whether more drastic action is required to bring a building into alignment with peer buildings). SiteWatch helps determine and maintain these values over time, not only for the total building, but for specific equipment types, and with only partial data sets.

Table 1: Energy Use by Equipment Type, Overall and per Square Foot of Building Area

Total Energy

Period	Total Energy Use	kWh per Sq Ft
2019 Total	8,521,350	13.11
2020 Total	6,551,448	10.08 ↓

Cooling-Related HVAC

Period	Total Energy Use	kWh per Sq Ft
2019 Total	4,995,542	7.69
2020 Total	4,313,802	6.64 ↓

Heating-Related HVAC

Period	Total Energy Use	kWh per Sq Ft
2019 Total	224,002	0.34
2020 Total	184,432	0.28 ↓

Air Handling Units

Period	Total Energy Use	kWh per Sq Ft
2019 Total	3,054,189	4.70
2020 Total	1,816,063	2.79 ↓

Air Compressors

Period	Total Energy Use	kWh per Sq Ft
2019 Total	247,616	0.38
2020 Total	237,150	0.36 ↓

[2] View from Power Radar. Panoramic Power and PowerRadar are registered trademarks of Panoramic Power Ltd in the United Kingdom and United States of America.

Annual Energy Use by Type – Annual energy use is a summary that can be compared between years, accounting for typical seasonality in weather conditions, operations, and other routine events. Comparing by equipment types allows a customer to differentiate how changes in energy use year-over-year can be attributed to a single type of usage (for instance, lighting), or show if different types of energy using equipment changed in different ways (for instance, a decrease in cooling tower energy led to an increase in chiller energy):

Figure 2: Annual Energy Use by Equipment Type

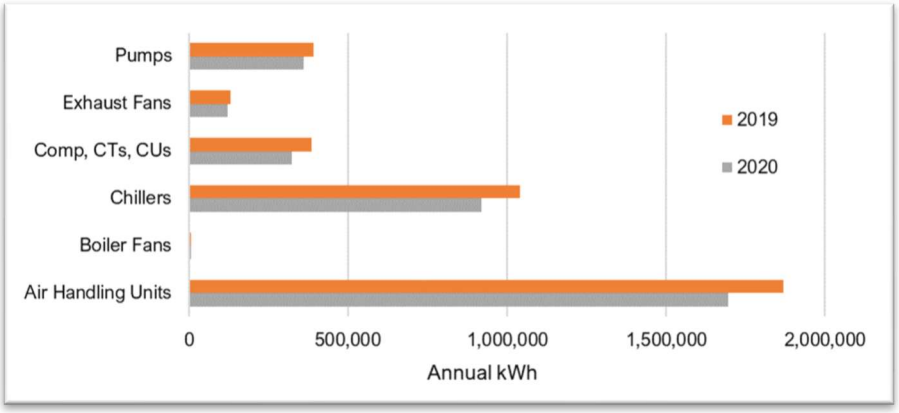


Table 2: Annual Energy Use by Equipment Type

Total kWh

Usage Type	2019	2020	
Air Handling Units	1,868,711	1,692,955	↓
Boiler Fans	8,092	7,921	↓
Chillers	1,040,517	919,684	↓
Comp, CTs, CUs	384,111	322,444	↓
Exhaust Fans	130,462	121,259	↓
Pumps	392,896	361,391	↓

As demonstrated in the table and figure above, this site reduced electrical consumption between 2019 and 2020 for all usage groups.

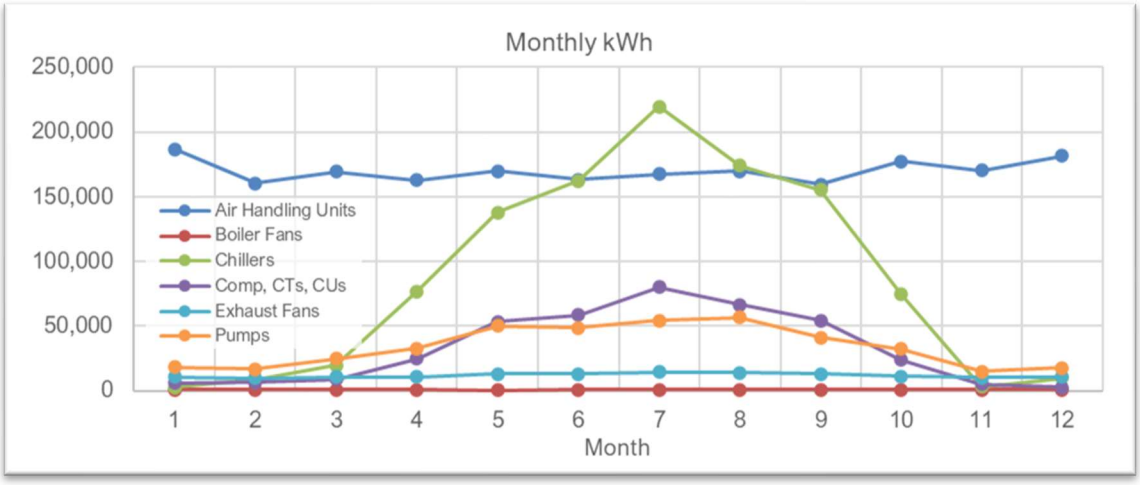
Energy Use Per Cooling-Degree or Heating-Degree Day – Cooling and heating degrees are standard measures of how many hours a building will spend heating or cooling itself, and are calculated from local temperature readings. Degree days are standard meaasurements use for normalizing energy use, and help energy specialists normalize equipment operations between years, even if one year was hotter or cooler compared to another. For example, if the heating degree days (HDD) are lower from one year to another, the year with fewer HDD required less heating, likely leading to a reduction in energy required to heat a building. Likewise for cooling degree days (CDD), a reduction in CDD from one year to the next means the more recent year was cooler, so less cooling energy is expected.

Table 3: Degree Days by Year

	2019 Total	2020 Total	
Cooling Degree Days	1,950	1,946	↔
Heating Degree Days	4,064	3,677	↓

For this site there was no difference in cooling degree days between 2019 and 2020, and a 10% drop in heating degree days. This reduction meant 2020 had a warmer winter than 2019. To start this comparison, each type of equipment's monthly energy use is viewed over a year to see if and when energy use increased. In the figure below, chillers, condensing units, and pumps saw increased usage in summer months, meaning each is used for cooling and should be compared year-over-year using kWh per CDD.

Figure 3: Monthly kWh by Usage Type



No equipment has increased during the winter, so there is no relationship between HDD and electrical energy use for monitored equipment.

Table 4: Energy Use per Degree Day by Equipment Type

kWh per CDD

Usage Type	2019	2020	
Chillers	534	472	↓
Comp, CTs, CUs	197	166	↓
Pumps	201	186	↓

When accounting for weather, each usage group with CDD dependence saw a decrease in energy use per degree day. This means the reductions in usage for these types of equipment were real savings, not due to less of a need for cooling in 2020.

Proposed Energy Saving Strategies

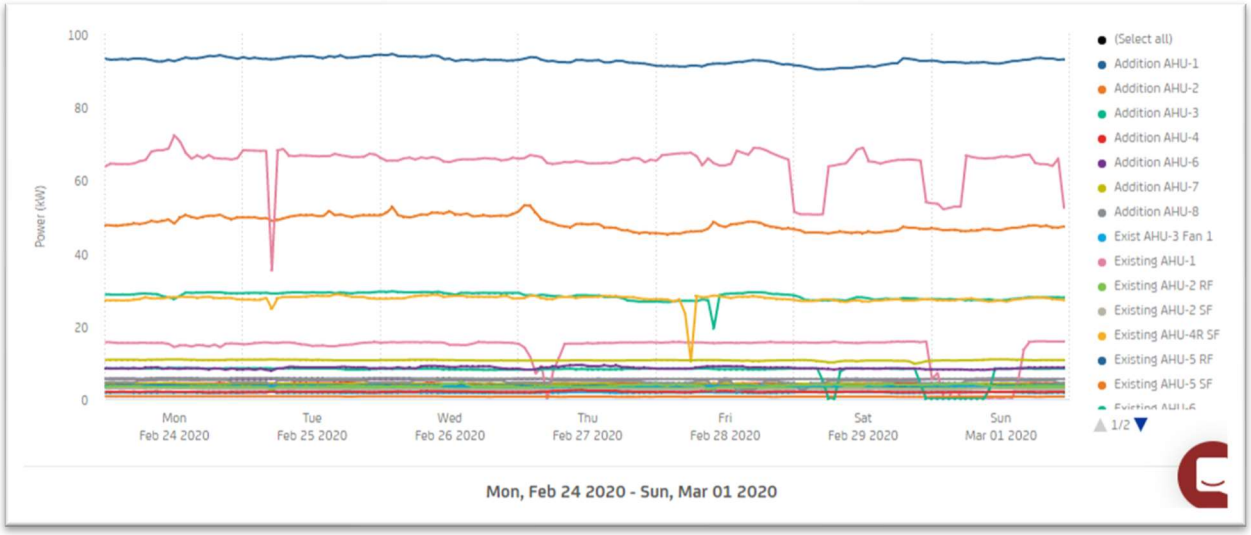
Steps for reducing energy use for individual machines and equipment types are discussed with the site on an ongoing basis. SiteWatch supports the site by identifying atypical or unexpected equipment operations based on historical trending, survey of site personnel, and engineering knowledge for similar system types in other healthcare facilities. Assuming conservative savings estimates for each device category based on a review of operating data, understanding of the facility functions, and engineering experience, this site can save more than $56,000 per year by implementing low or no cost changes to existing equipment.

Table 5: Impact of No- or Low-Cost Controls Recommendations vs. SiteWatch Cost

Monitored Device Annual kWh	8,521,351
Potential Savings kWh	561,102
Percent kWh Savings	7%
Potential $ Savings	$56,110
Annual SW Cost	$9,360
ROI vs. SW Cost (years)	0.16

Air Handling Units - The site monitors 22 air handling units (AHUs). All monitored AHUs have shown some energy use within the past three months, though several units have been offline since mid-March, coinciding with the start of COVID-19 stay-at-home orders[3]. Prior to the start of stay-at-home orders, all monitored units operated continuously throughout the week and did not set back during typical "unoccupied" hours (weeknights after 6 PM, weekends, holidays).

Figure 4: All AHU Typical Weekly Load Profile (pre-COVID 19)



SiteWatch Recommendations: The site should identify AHUs serving areas that are not occupied continuously. Implementing fan setback schedules for AHUs with limited off-hour occupancy can reduce the cost of operating equipment during those hours. *SiteWatch can establish operating schedules unit by unit to assist with reporting and to identify potential savings.*

Boilers – The site monitors boiler fans which operate when boilers are in combustion mode (air required). There are 4 boilers monitored. These boiler fans all run during a typical week, though several only cycle for several minutes before shutting off again.

[3] This Case Study is based on a customer support sent to the site in the Fall of 2020.

Figure 5: All Boiler Fan Usage (October 2019 – June 2020)

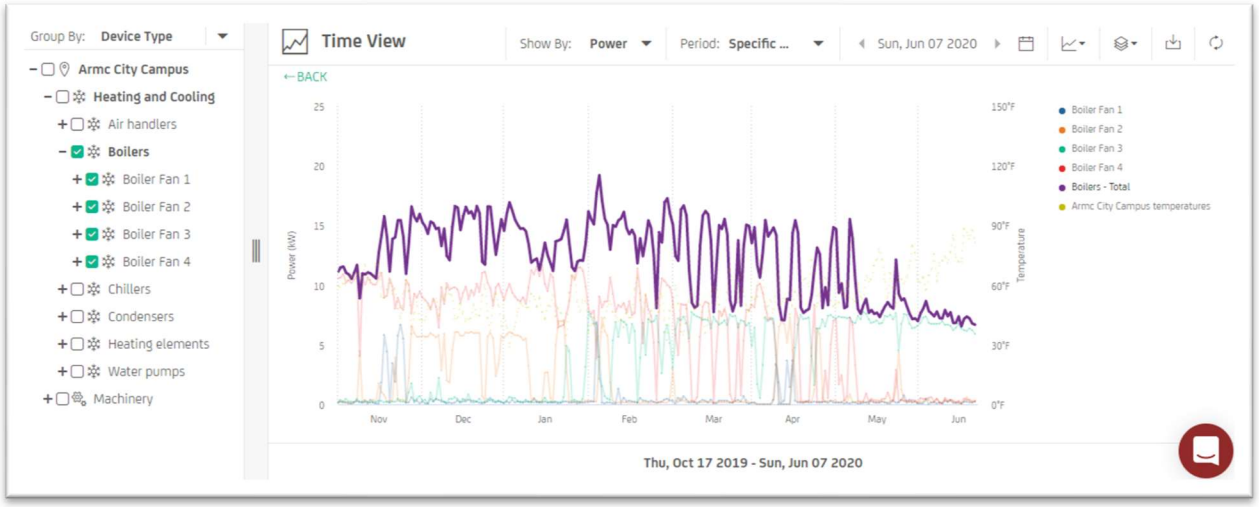
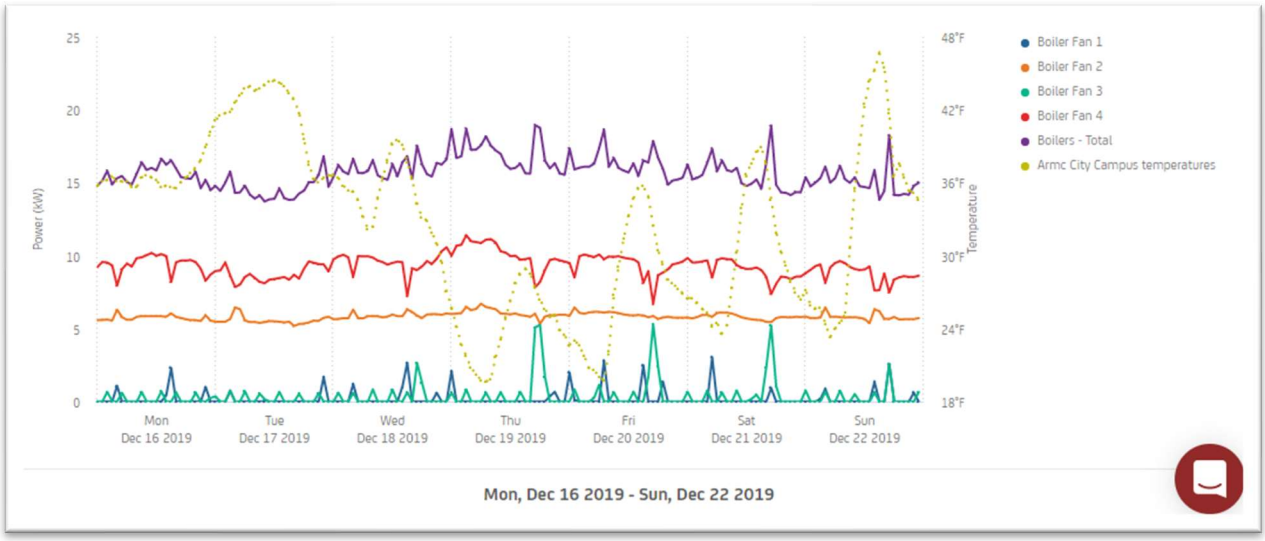


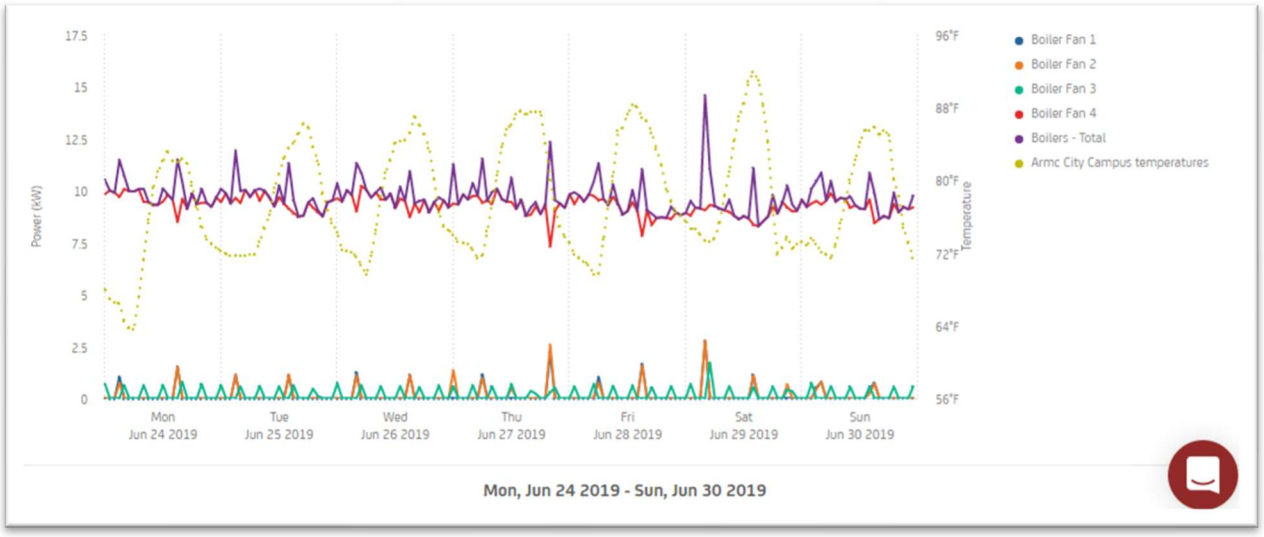
Figure 6: Heating Season Boiler Fan Typical Week (December 2019)



During the heating season, the site uses two boilers on a continuous basis while two boilers remain on standby, indicated by quick fan cycling as burners are fired to maintain temperature within the boiler. The site relied on three boilers for short periods of time to provide heating, though the periods with three boilers operating did not correspond to when additional heating capacity is normally required such as during morning warm-up or coldest hours, though all did occur during winter months.

The lead boiler is not changed on a regular basis. During 2019, Boiler-4 remained the lead boiler for nearly the entire year. Since the start of 2020, the lead boiler has been updated to Boiler-3.

Figure 7: Cooling Season Boiler Fan Typical Week (June 2019)



A single boiler appears to meet summer reheat load, though all 4 boilers showed evidence of cycling during summer months period. This additional cycling and keeping boilers on full standby results in significant unnecessary heating fuel usage.

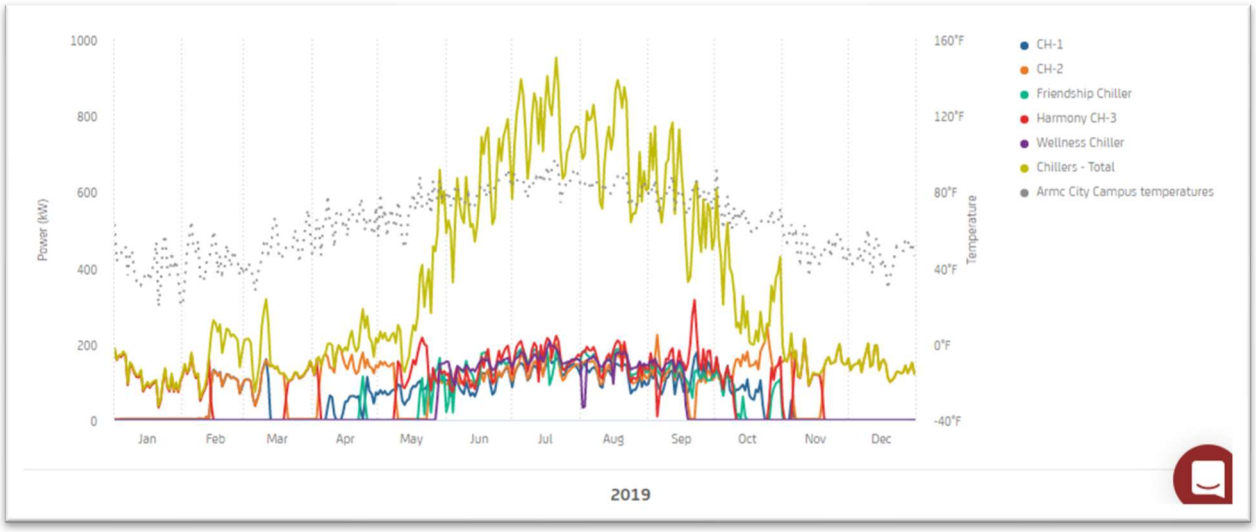
SiteWatch Recommendations: The site can either program a control strategy through existing BMS controls, or manually shut off boilers to ensure unused boilers are not cycling unnecessarily. This update will save heating fuel with little or no additional capital investment. Other strategies include:

- More frequent switching of the "lead" boiler, especially during the cooling season when there is limited load, to extend boiler life.
- Allow unused boilers to fully cycle off. A single boiler appears to meet the full reheat load required during summer/cooling months, while no more than (3) boilers are loaded during the heating season. Allowing unused boilers to fully cycle off will reduce standby losses, resulting in 1-5% savings on annual heating fuel consumption, along with electrical savings from reduced pump and boiler fan operations.
- The site may add a smaller boiler for summer/cooling season reheat load. Additional information would be required to understand the capacity needed for such a system.

If requested, SiteWatch will provide detailed cost savings calculations (baseline versus post-installation/post-period) to determine the impact of changes made to boiler controls.

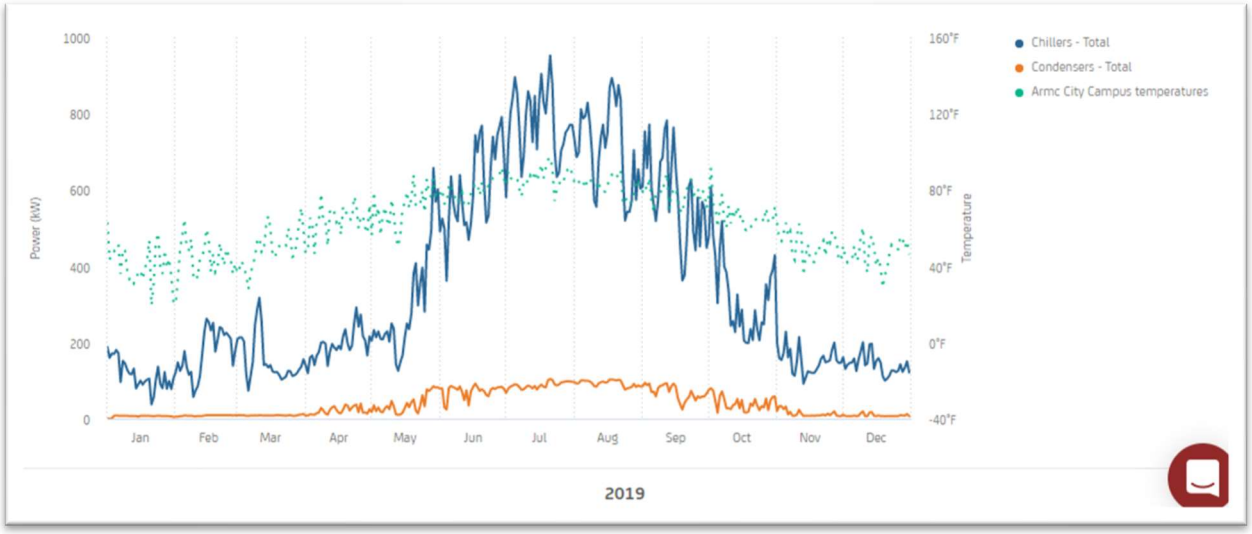
Chillers and Cooling Towers - The site monitors 5 chillers and 7 cooling towers. Chiller and cooling tower operations follow typical load profiles for the application (higher during summer, lower during winter), with some chiller operation through the year. Cooling tower fans do not operate during the winter months.

Figure 8: Individual and Total Chiller kW through 2019



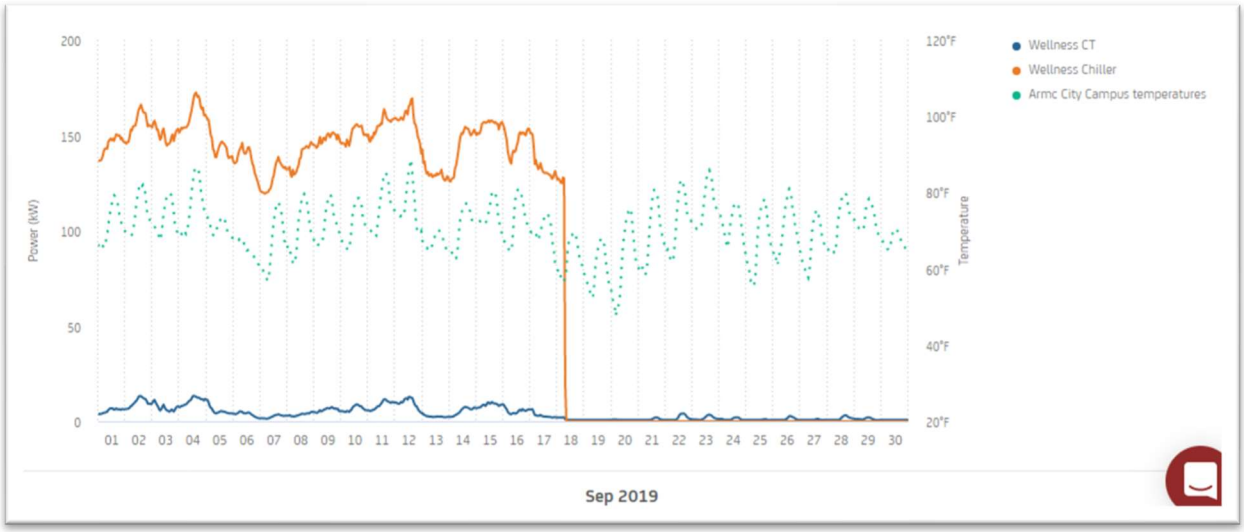
Cooling tower energy use follows chiller energy use, except as noted for winter months.

Figure 9: Total Chiller kW vs. Total Cooling Tower kW through 2019



Chillers appeared to operate through automated controls rather than manual lockouts. The exception is the Wellness Chiller, which has distinct ON/OFF dates. The cooling tower associated with this chiller may not have been shut off at the same time, leading to some usage past the OFF date in 2019:

Figure 10: Wellness Chiller and Cooling Tower kW for September 2019



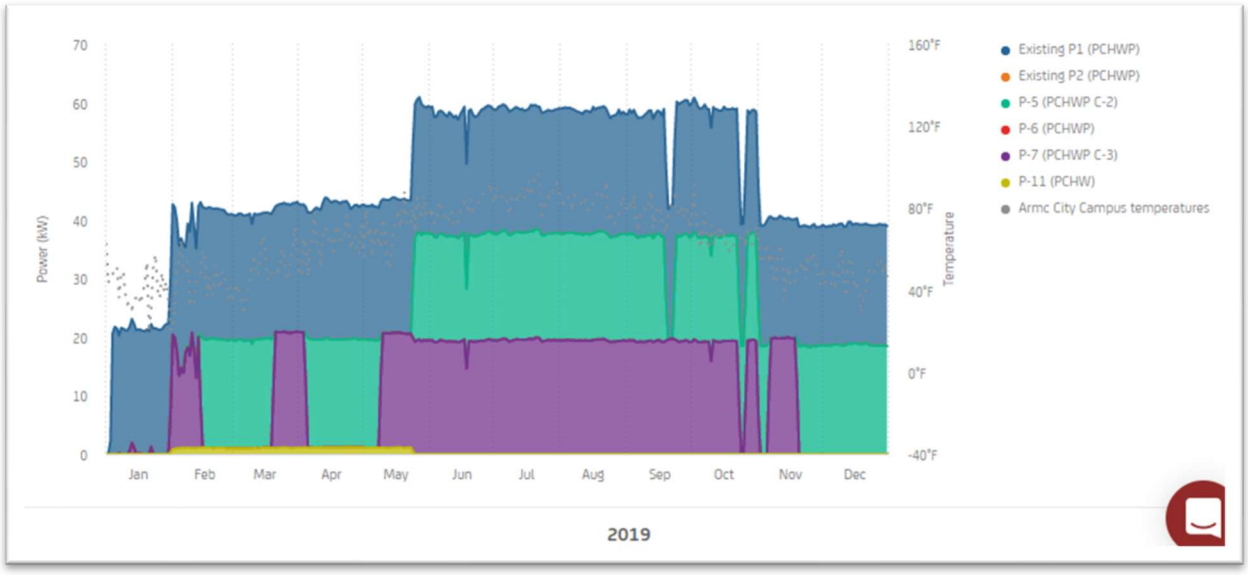
SiteWatch Recommendations: The site routinely cycles chillers, spreading run hours between devices to ensure equal loading. The system is fully loaded during summer months with a peak kW near 1 MW. Winter hourly kW varies from ~100 kW to ~300 kW. The periods of winter usage need investigation to ensure simultaneous heating and cooling does not result in wasted energy.

Water Pumps - The site monitors energy use on 34 pumps covering the following applications:

- Chilled water primary, secondary, and AHU pumps
- Condenser water pumps
- Hot water pumps

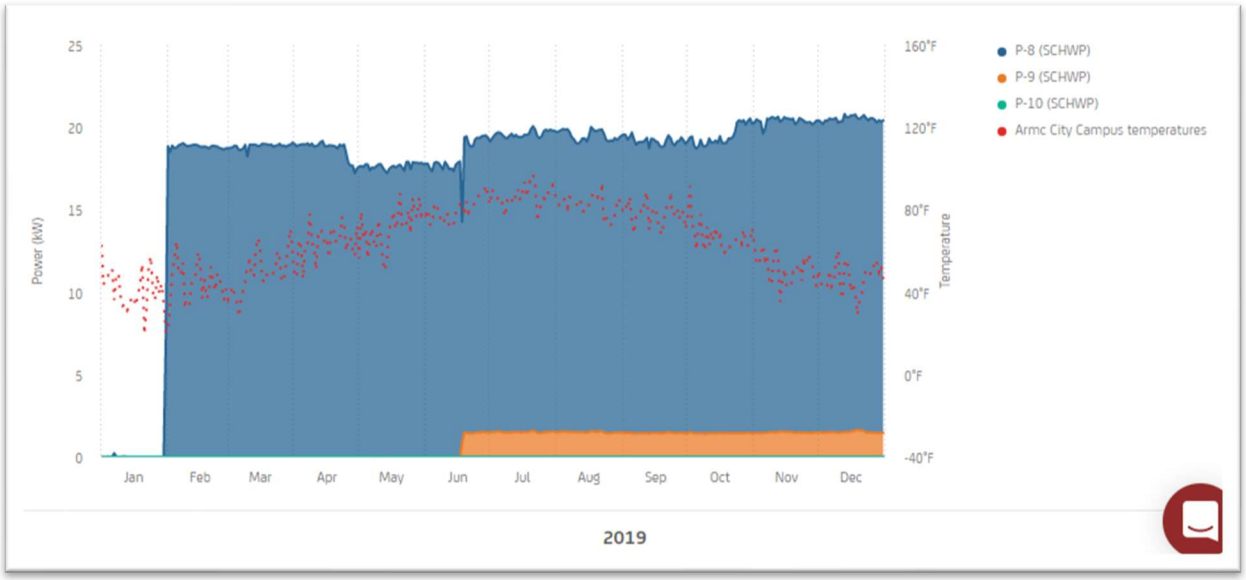
Primary chilled water pump operation follow chiller and cooling season loads. For the most recent summer, all three primary pumps operated fully loaded through the entire cooling season. There is very little time of only one primary chilled water pump operating.

Figure 11: Primary Chilled Water Pump kW through 2019



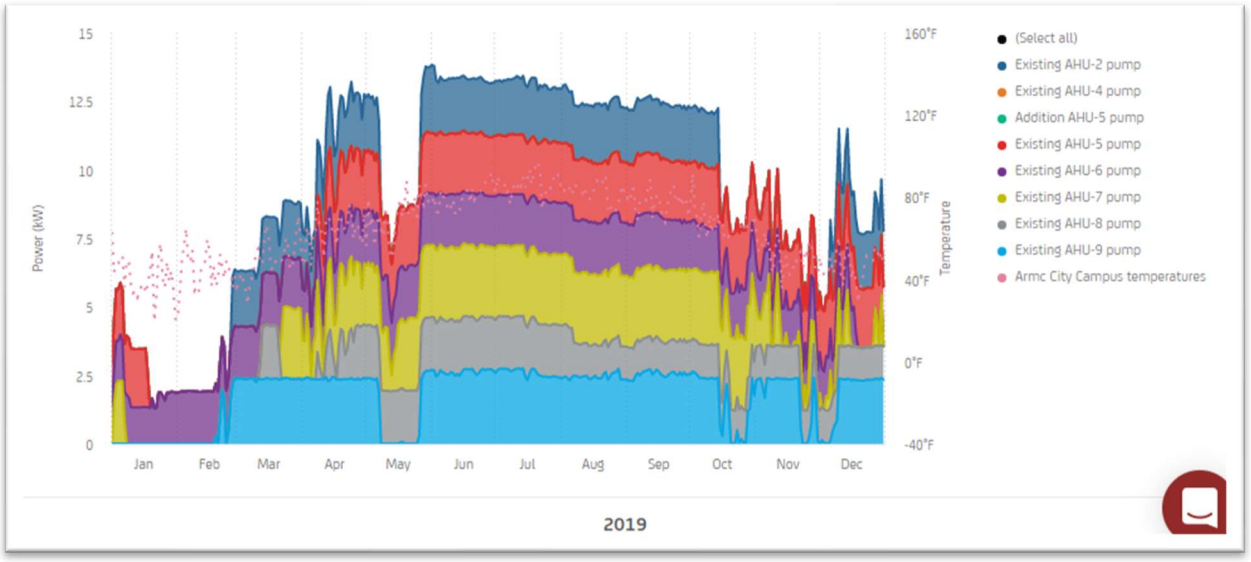
There are three secondary chilled water pumps being monitored. A single secondary pump operates during most operating hours, with very little variation in energy use.

Figure 12: Secondary Chilled Water Pump kW through 2019



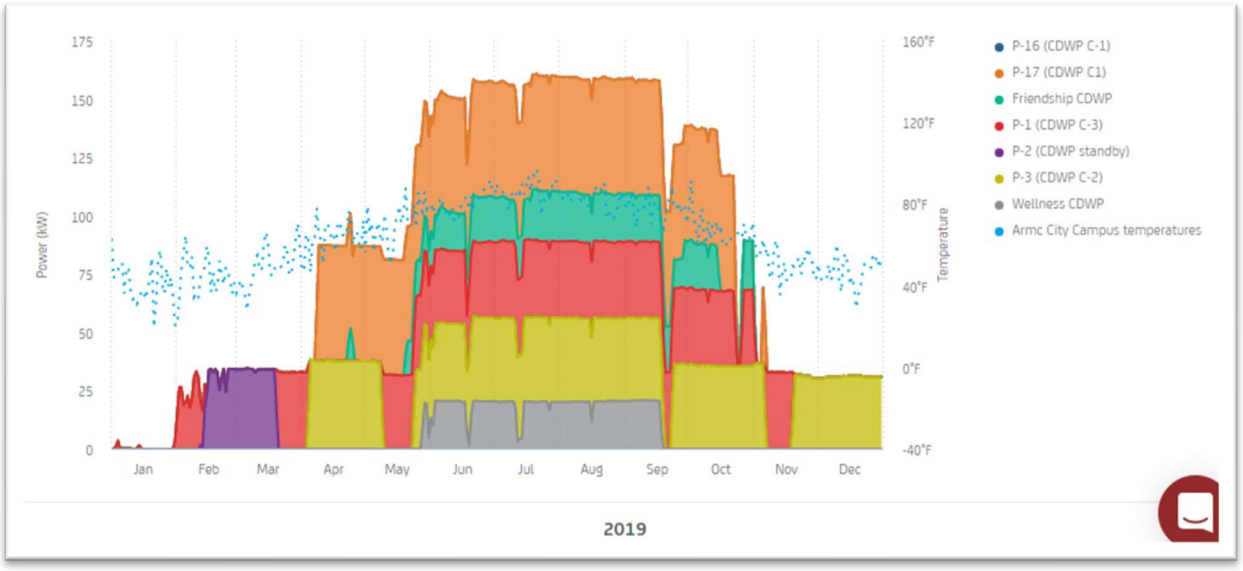
The site is monitoring pumps serving individual AHU cooling coils, with pump energy following an expected usage profile matching the cooling season, though there is also significant usage during the heating season.

Figure 13: AHU Chilled Water Pump kW through 2019



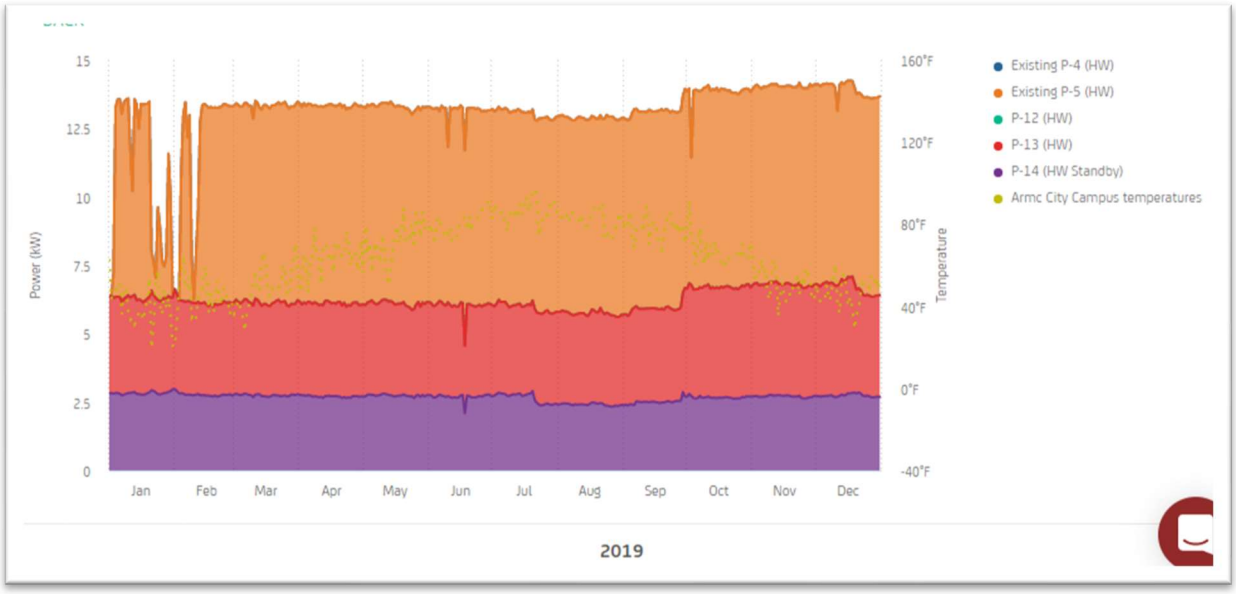
Condenser water pump operation generally follows chiller and cooling tower use.

Figure 14: Condenser Water Pump kW through 2019



There are 5hot water pumps (HWPs) being monitored, with (3) pumps running continuously through the year. Several monitored HWPs did not show any use during the monitoring period.

Figure 15: Hot Water Pump kW through 2019



SiteWatch Recommendations: The site monitors a range of pump applications, with each group of pumps generally following the expected usage profile. Monitored pumps appear to be constant speed.

- Primary chilled water pump energy exceeds expected usage, and pumps assigned to CH-1 and CH-2 operate even when those chillers are not running. *Confirm with the site that the primary chilled water pumps are not operating excessively*.
- There is significant AHU pump usage during winter months. *Confirm with the site that units with airside economizers are operational, as mechanical cooling may not be required through the heating season when cooler outside air is available.*

Additional Recommendations

- Setting up schedules and alerts on air handling units to track off-hour usage
- Enable weekly and monthly usage reports to track departures in energy use for major equipment
- Continue downloading short-interval data to support measurement and verification activities for energy efficiency measures as needed

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