vybeenergy

AI-DRIVEN ENERGY OPTIMIZATION

CAMPUS CHILLER PLANT

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INTRODUCTION

Vybe Energy's **AI-Driven Energy Management Solution (EMS)** turns your facility into a "smart" building by managing all energy usage, generation, and batteries (energy storage) under a single master controller. Our patented software:

- uses machine learning (ML) algorithms that allow for dynamic predictive modeling of building load; on-site energy production; and battery charge and discharge.
- takes into consideration the prevalent time-of-use rates to maximize demand reduction and utility savings, while reducing greenhouse gas emissions
- generates additional revenue streams from participation in utility programs and wholesale energy markets
- monitors and controls all systems under a "single-pane-of-glass" dashboard.

Our technology solution is comprised of two components: a cloud-based software and site-level hardware controller that communicate with each other. The software provides the optimized setpoints for energy assets, while the site controller integrates energy systems within the building.

This paper summarizes the positive results of the pilot of Vybe Energy's innovative solution at Oklahoma Panhandle State University (OPSU) that commenced in June 2024. Specifically, Vybe optimized the performance of the chiller plant on campus that provides cooling to 26 buildings on campus.

Our technology uses machine learning algorithms to predict outside air temperature over a 24-hour period and specifies temperature setpoints that maximize energy cost savings. The model adapts and continuously trains itself based on new data from the site.

BACKGROUND

The largest energy user at Oklahoma Panhandle State University (OPSU) is the Physical Plant Building that supplies cooling to 26 buildings on campus. The Plant houses a centrifugal chiller system that turns on when the outside air temperatures (OAT) is above 60 ºF; the system turns off when the OAT drops below 55 ºF. The university's go-to strategy was to set the chilled water temperature setpoint (aka "leaving water temperature") to 42 ºF year-round. Once the system turns on, water is chilled and makes it journey to all 26 buildings on campus. When the water enters a building, electric air handlers and pumps heat up the resulting air flow to the desired temperature of 70 or 72 ºF. The water is then recycled from the building back to the chiller. Due to the OAT, the water will be above 42 ºF so the water is chilled back to 42 ºF before making its roundtrip journey back to the buildings. The plant typically operates for eight months (April to November) of the year when temperatures tend to exceed 60 ºF.

METHODOLOGY

Vybe's solution is multiple steps beyond the "set-it-and-forget-it" approach. Specifically, Vybe uses historical OAT to predict the OAT over the following 24-hour period. We use this information to schedule the operation of the chiller for the entire day. The chiller manufacturer recommends the chiller be set between the range 42 ºF to 48 ºF. The optimization finds the chilled water setpoint within the range that results in the lowest energy consumption (kWh) by the plant. That is driven by the difference between the entering water temperature and leaving water temperature. The lower the difference between those two variables, the lower the energy consumption. As the real time values catch up to the values forecast for the day, the machine learning algorithm continuously adapts the model to achieve optimal results.

We built our chiller energy use model based on actual chiller energy data that we have been collecting since October 2023.

Our solution has been operational at OPSU since June 2024. We are continuing to adjust and update our model to improve its predictive capability.

KEY FINDINGS

KEY FINDINGS #1

Energy kWh savings of approximately 23% when comparing optimized result to business-as-usual "set-it-and-forget-it" approach. Indicative savings over the course of two months are shown below.

	kWh Savings	Dollar Savings
June 2024 (24 days)	17,900	$1,540
July 2024 (23 days)	20,900	$1,800
Total	**38,800**	**$3,340**

1. Chiller was down for a few days each month for maintenance
2. Energy cost per kWh: $0.086
3. Demand was not impacted by this optimization (see Savings Potential #1 on Page 8)

KEY FINDINGS #2

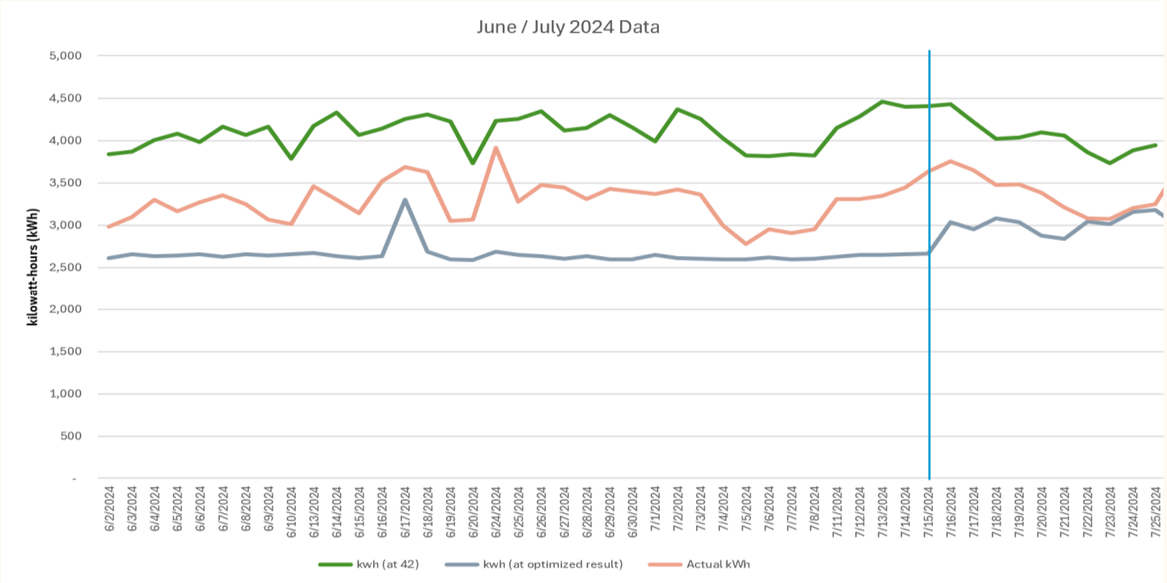
Optimization solution does **not** require changes to occupant comfort, i.e., we did not have to change the building thermostat settings.

KEY FINDINGS #3

Our cloud-based software was able to establish communications with the site hardware with minimum upgrades to the existing site-level control system.

VISUAL DATA

The graph below shows the predicted kilowatt-hour (kWh) consumption at the optimized temperature setpoint determined by Vybe's algorithm (shown in gray); the actual kWh consumption by the chiller at the optimized setpoint (in orange); and the predicted kwh consumption under the BAU scenario of 42 ºF (in green).



The difference between the gray and orange lines on the graph can be explained by the following: a) Vybe did not have access to the chiller specifications and therefore, we based our calculations on a more generic chiller energy use equation; b) the actual consumption includes energy use of the condenser water pumps, cooling tower fans and the primary and secondary chilled water pumps, which is not considered in Vybe's energy use calculations.

After analyzing the June results, Vybe made some updates to the ML model to improve its predictive capability. On July 15 (see blue vertical line), we implemented a code change, the results of which show much closer tracking between the gray and orange lines.

ADDITIONAL SAVINGS POTENTIAL

SAVINGS POTENTIAL #1

Centrifugal chillers have solid state starters that do not decrease *inrush* current. In other words, each time the chiller turns on, there is a jump in energy demand that cannot be regulated, which results in higher demand charges for OPSU. This older technology could be replaced with variable frequency drives and OPEN chiller controls to reduce the demand peaks most prevalent in the Summer.

SAVINGS POTENTIAL #2

The results presented in this paper are compelling considering that Oklahoma is a low energy cost state. If we were to apply this optimization in a high energy cost state with time-of-use (TOU) states, such as NY, CA or MA, the resulting dollar savings would be significant.

SAVINGS POTENTIAL #3

The optimization logic is capable of taking into consideration other variables, such as thermostat settings, in order to reach the most optimal chilled water setpoint that maximizes energy savings and meets the comfort of users.

CONCLUSION

Most chiller systems in the US are old and tend to operate under a rules-based approach with minimal interference from building energy managers. Therefore, the opportunity for savings are significant with optimization.

TAKEAWAY #1

OPSU realized energy savings of approximately 23% in June and July 2024 compared to business-as-usual.

TAKEAWAY #2

Optimization of chillers can be done without impacting comfort and without occupants' knowledge.

TAKEAWAY #3

If savings such as what was demonstrated is possible in a low electricity cost state like Oklahoma, the cost savings in a high cost of electricity state would be significant.