

Abstract

A significant portion of the campus’ building electric consumption occurs overnight when the spaces are generally unoccupied. In the case of office and academic buildings, these overnight loads can be potentially minimized in periods of vacancy. This is a study on the nature of the overnight loads in these buildings and the potential savings associated with reducing these loads during periods of high confidence of vacancy. We assess the impacts of Audio-Visual (AV) and Information and Technology (IT) equipment in Giedt Hall and the Annual Fund Trailer (AFT) as well as propose a control mechanism, the Vacancy Inference Engine (VIE), as a possible method of turning down these loads using a building’s incumbent infrastructure and sensor networks. The VIE receives inputs from these systems to calculate a confidence interval of vacancy which can be used to turn down and minimize building demand.

Background

The 2 buildings that were the focus of this study:

Giedt Hall:

Total Area:
15,540 sqft
Hours of Occupancy:
M-F, 5am - 11pm;
Sat-Sun, 6:45am- 11pm
Primary Use:
Instructional, consisting of lecture halls and classrooms



Annual Fund Trailer:

Total Area:
2,200 sqft
Hours of Occupancy:
Sun-Th, 1:00 pm - 10pm;
Fri-Sat, Closed
Primary Use:
Office building, used primarily as a call center



Objectives

The objective of the projects were to:

- Determine the energy consumption during unoccupied periods
- Determine signals that could be used in the vacancy inference engine
- Evaluate financial benefits and operational risks associated with including a vacancy mode in buildings

Methodology

A three-part approach was taken to investigate the feasibility of putting buildings to sleep:

1. Literature Review

- Review prior work related to occupancy and vacancy detection
- Identify key parameters that could be easily measured as inputs to the vacancy inference platform

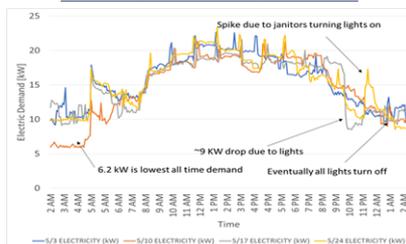
2. Field Inspections

- Estimate vacancy periods for the Annual Fund Trailer and Giedt hall
- Perform after hours energy audit to record equipment that is still on
- Determine sensors in the buildings that could be used for vacancy inference

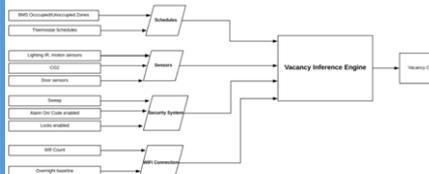
3. Calculations

- Match the audit results to the load data
- Infer the possible energy savings available

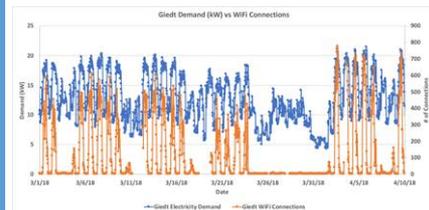
Electrical Load Behaviour of Giedt Hall



Vacancy Inference Engine for Buildings



Wifi Connections for Vacancy Detection



Summary of Results

Annual Fund Trailer

- Estimate average 1 kW of demand while unoccupied
- 46% of energy consumption due to energy use while unoccupied
- Air Conditioner and server were observed to be running while unoccupied
- Desktops are on during unoccupied hours of week (38 w/ standby power of 15 W each)

Giedt Hall

- 91 A/V devices in building
- A/V devices including a projector were on after hours
- Combined demand of 27.1 kW
- Night time demand of 6.2 kW to 9 kW
- Night time demand is 23% to 33% of nominal power rating of A/V equipment

Potential Savings

Giedt Hall’s Average Overnight Load: ~ 9 kW

Overnight EUI of Giedt Hall: 0.58W/sqft
Total Maintained Gross Square Feet of Classroom buildings: 1,025,141 sqft
Total Average Overnight Load: ~530 kW

Potential Annual Overnight Consumption Savings*:
~530,000 kWh / ~\$37,000

*Assuming 1 kW EUI load for vital equipment, 2h/wd, 5h/we, using \$0.0699/kWh

Conclusion and Future Work

There are significant savings from nighttime shut off of buildings. There is \$37,000 potential savings from turning off unused devices after hours. Lighting and HVAC schedules can be changed from the originals for specific events, however there is no reminder nor incentive to switch back to the original schedules.

Next steps include:

1. Changing the AV equipment schedules to reduce load upon vacancy
2. Checking the lighting/HVAC schedules across campus to ensure they are running as required by the building, only during operational hours.
3. Implementation and testing of Vacancy Inference Engine with IT Services.

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