

A Methodology for Reducing Building Energy Usage

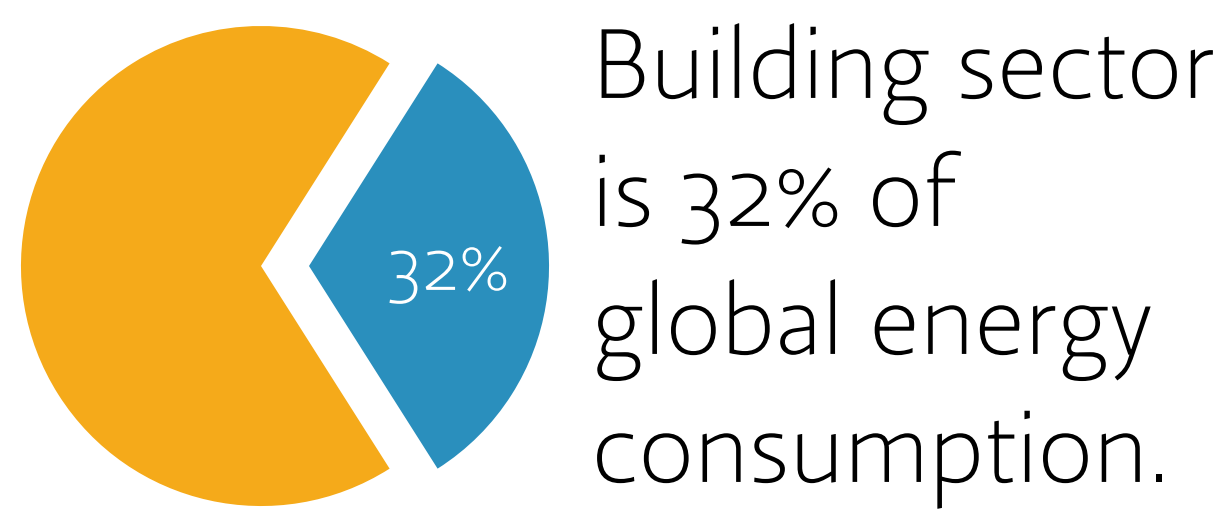
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Introduction

This research outlines a methodology for reducing building energy usage and improving operational efficiency. A study of Cooper Union's engineering building, 41 Cooper Sq, shows significant laboratory ventilation and a high base load during unoccupied hours. A comparison of academic facilities and analysis of energy profiles reveals significant potential savings if HVAC usage is aligned with thermal load and occupancy.

Motivation



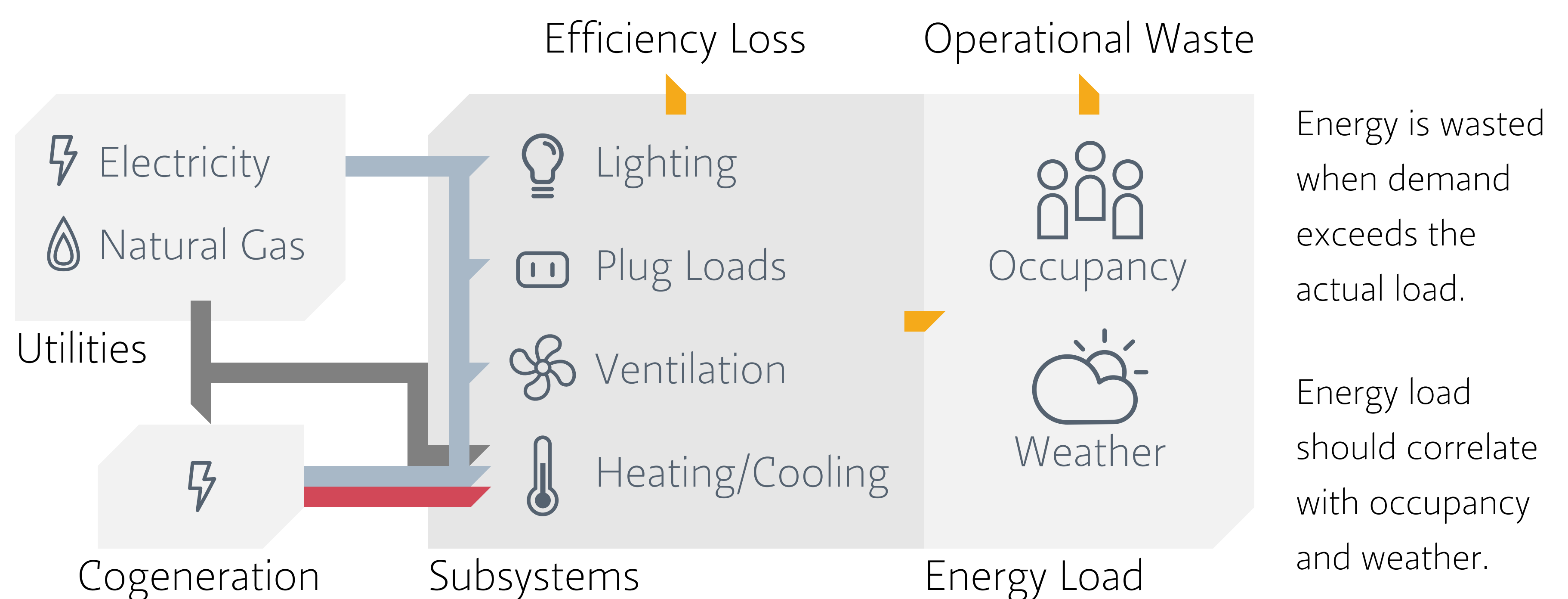
LEED certification, a rating system for green construction, does not account for actual performance after completion.

Energy Star, a benchmark to assess energy efficiency, does not address differences between buildings within a single property type.

41 Cooper Square

Constructed in 2009, 41 Cooper Square is a 175,000 square foot academic and laboratory building on Cooper Union's campus. Certified LEED Platinum, a state of the art building management system (BMS) operates the various subsystems. The building is cooled electrically and heated using natural gas, supplemented with a cogeneration plant producing 250 kW of electricity and 450 kW in thermal energy.

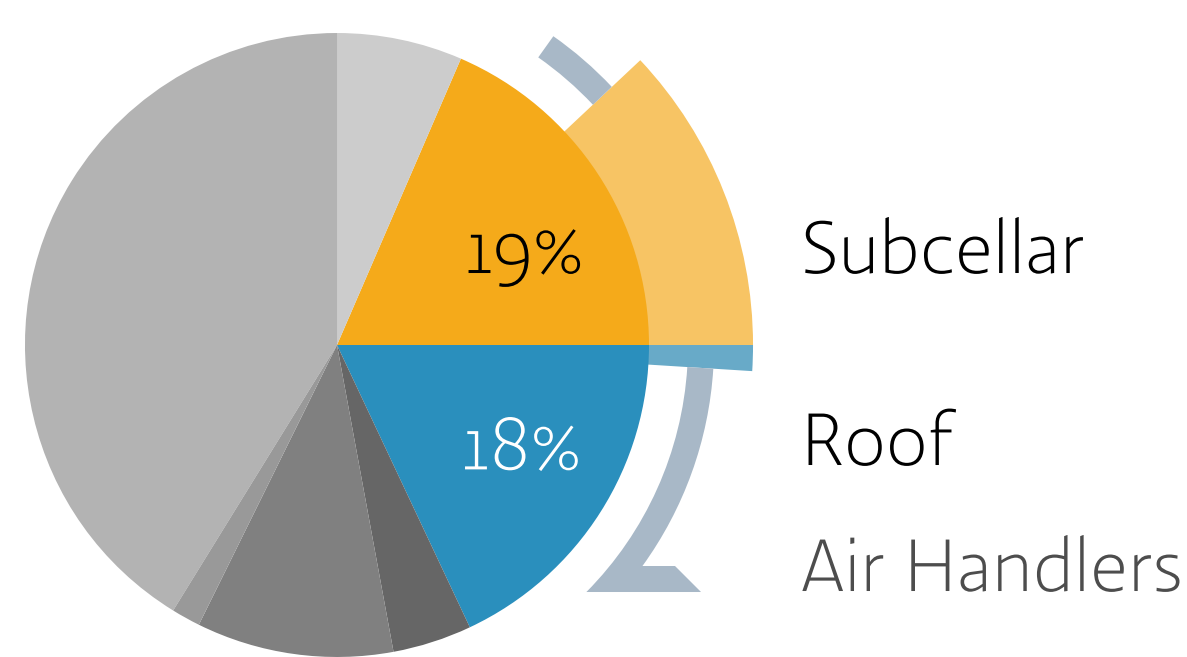
Energy Flow



Methodology

Summarize Energy Consumption

Capture utilization of the entire building and compare to similar properties.



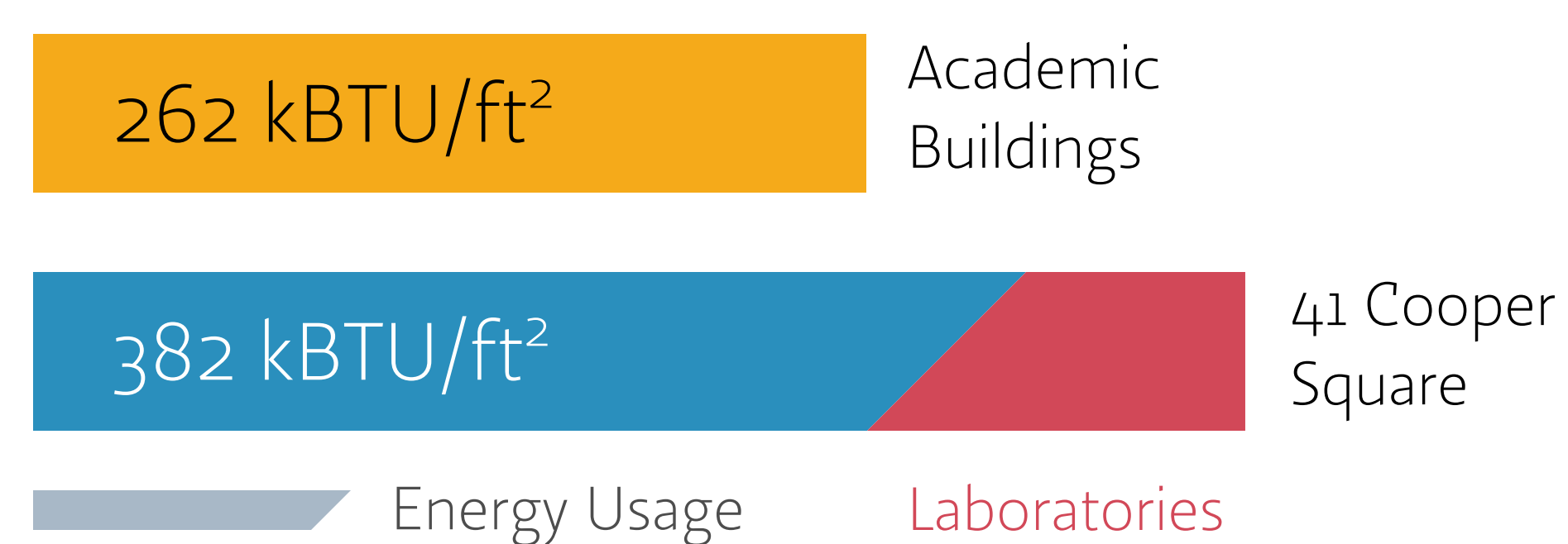
Energy Breakdown by Location

A large portion of energy usage goes to the air handlers located in the subcellar and on the roof.

Additional energy is spent on conditioning outside air.

Source Energy Use Intensity (EUI)

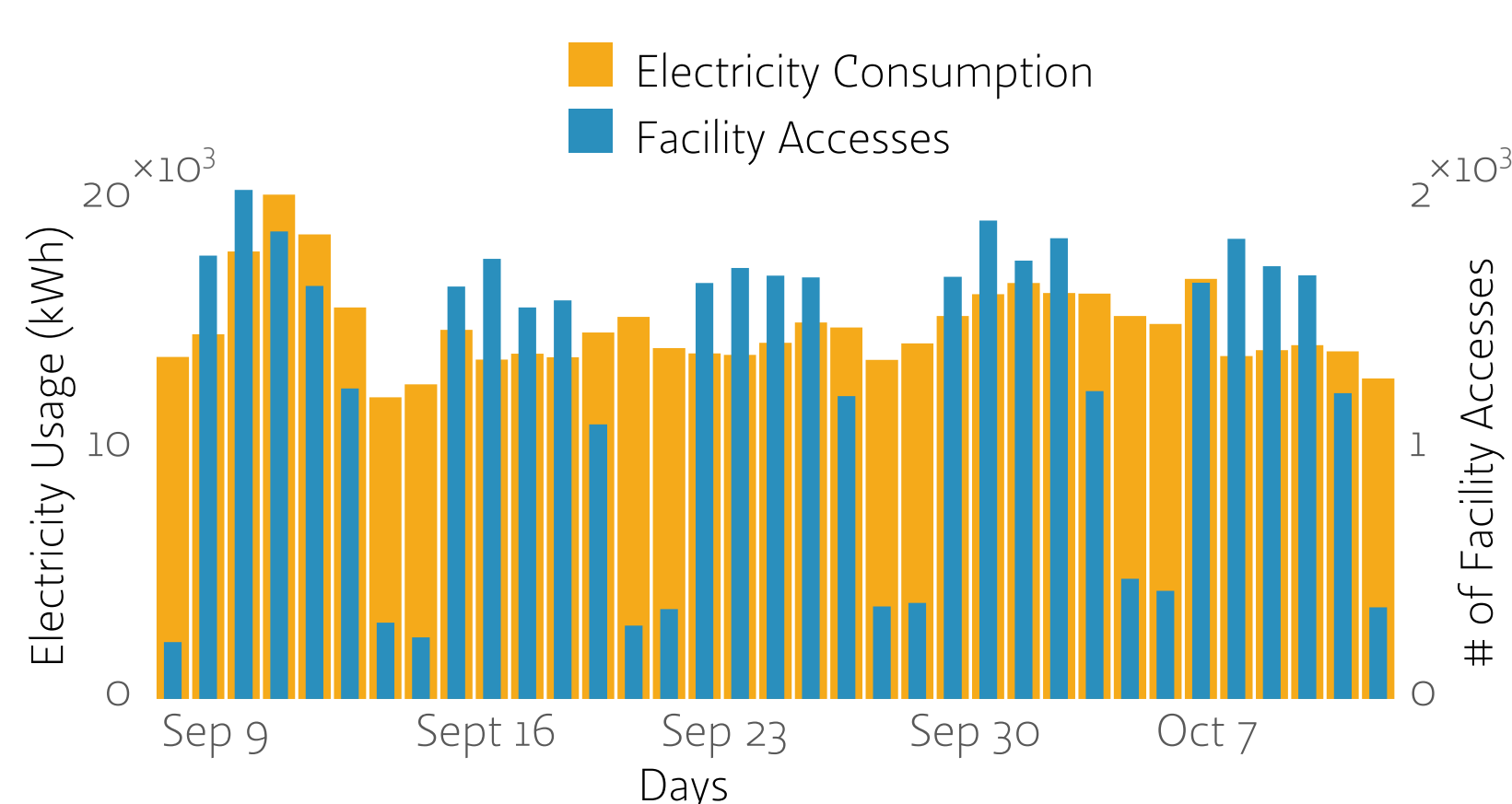
Annual energy usage per square foot, adjusted for raw fuel type.



The higher source EUI is possibly due to high ventilation requirements in laboratories.

Inspect Energy Profiles

Normalize energy consumption for occupancy and temperature.



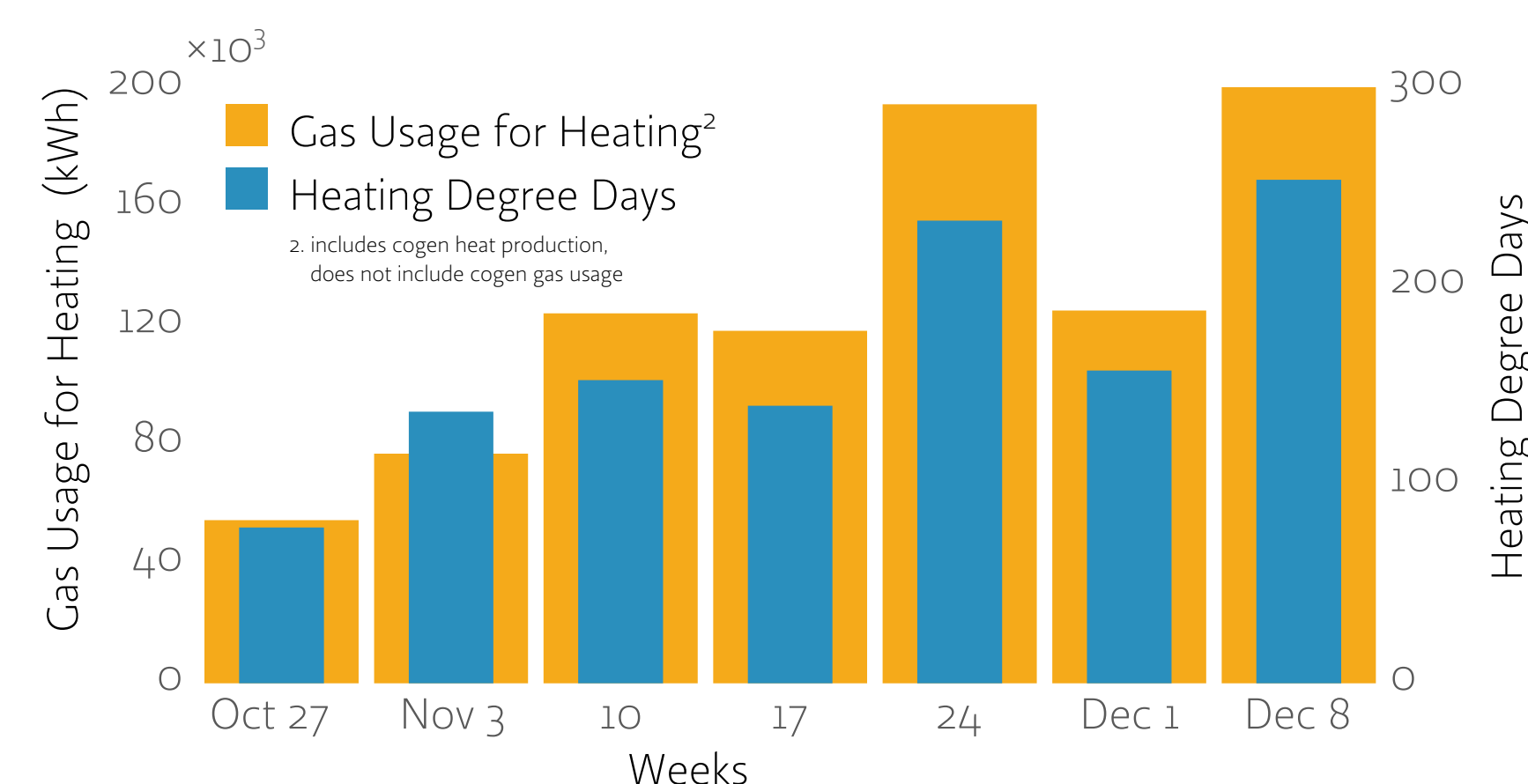
Electricity usage only weakly correlates with occupancy.

Weekend usage is high, but occupancy is low.

Heating Degree Days

1 Degree Day for each degree difference between the setpoint and outside in one day.

Measures thermal load due to temperature variation over a given period of time.

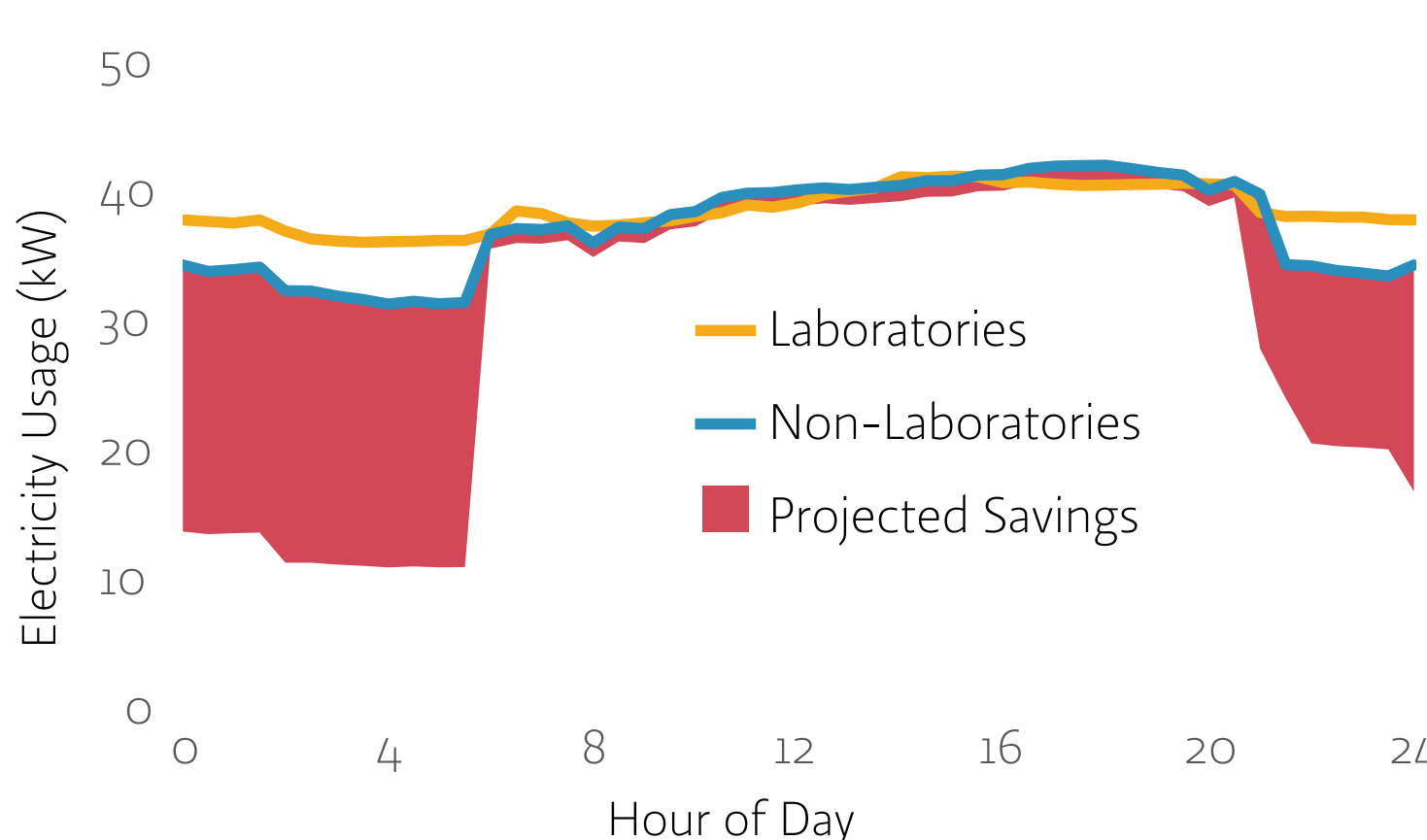


Gas usage correlates well with thermal load.

Weekly analysis is appropriate for seasonal trends.

Investigate Individual Subsystems

Correlate energy consumption from ventilation with building hours.



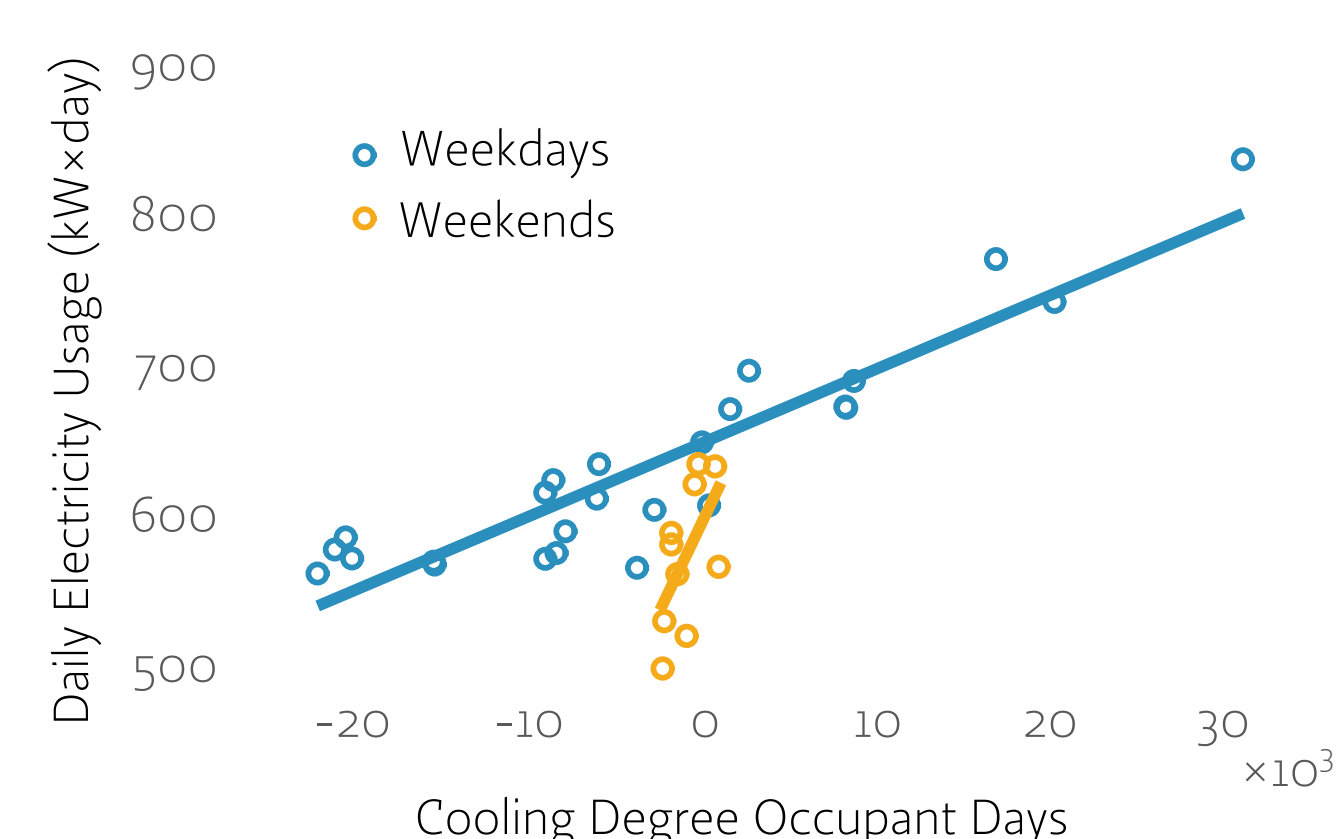
Laboratories have higher ventilation requirements independent of occupancy.

Weekday profile reveals constant energy usage even when building is closed.

Degree Occupant Days

1 Degree Day × 1 Occupant higher occupancy and temperature increases load.

Simultaneously account for both thermal and occupant loads.



Better daily electricity usage correlation than degree-days.

More electricity is used per degree per occupant on weekends than weekdays. A few occupants are distributed throughout the building.

Building energy usage can be reduced by at least 25%.

Recommendations

- Reclassify spaces that are not utilized as laboratories.
- Adjust setpoints during nights and weekends.
- Recommission building to meet design intent.