Building User Audit
Capturing Behavior, Energy & Culture

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UNIVERSITY OF WASHINGTON
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Building User Audit Goals

Project

- Develop a building user audit tool for campus buildings
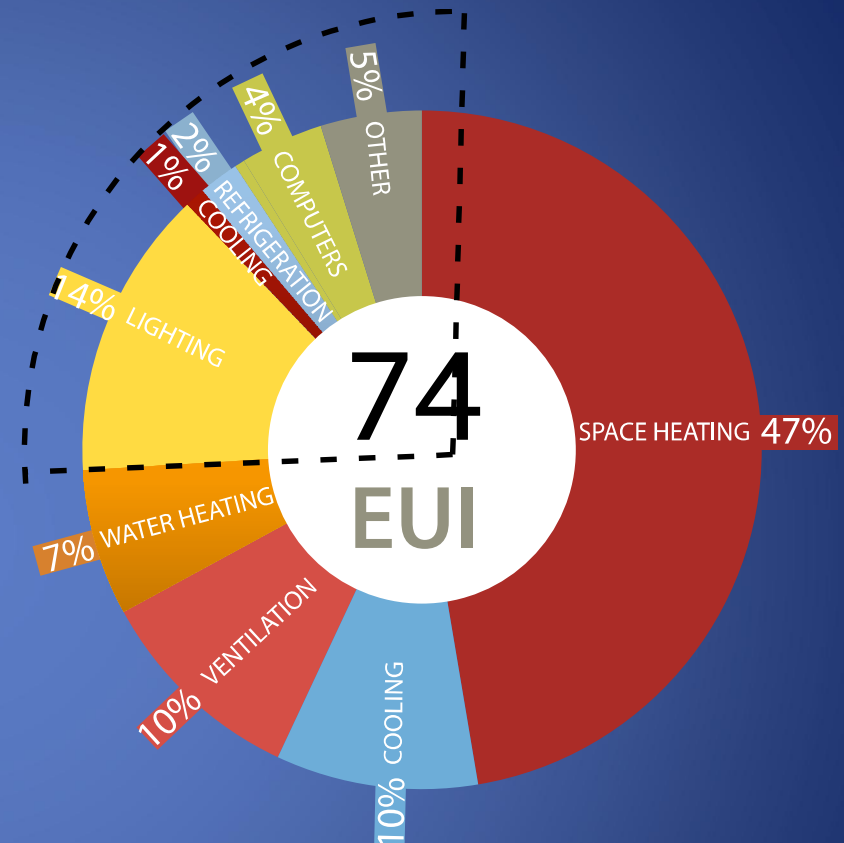- Transferable to other buildings & campuses

Tool

- Establish a baseline for behaviors that affect energy use
- Determine people's perceived and actual energy related behaviors
- Use the results to inform future behavior interventions
- Serve as a benchmark for new building design

Building Users

People influence about 25% of the energy in typical educational buildings.

The audit tool is used to give researchers and designers a holistic understanding of how energy is used by people (building users) in relation to their actual use, their perceptions of use and their values.
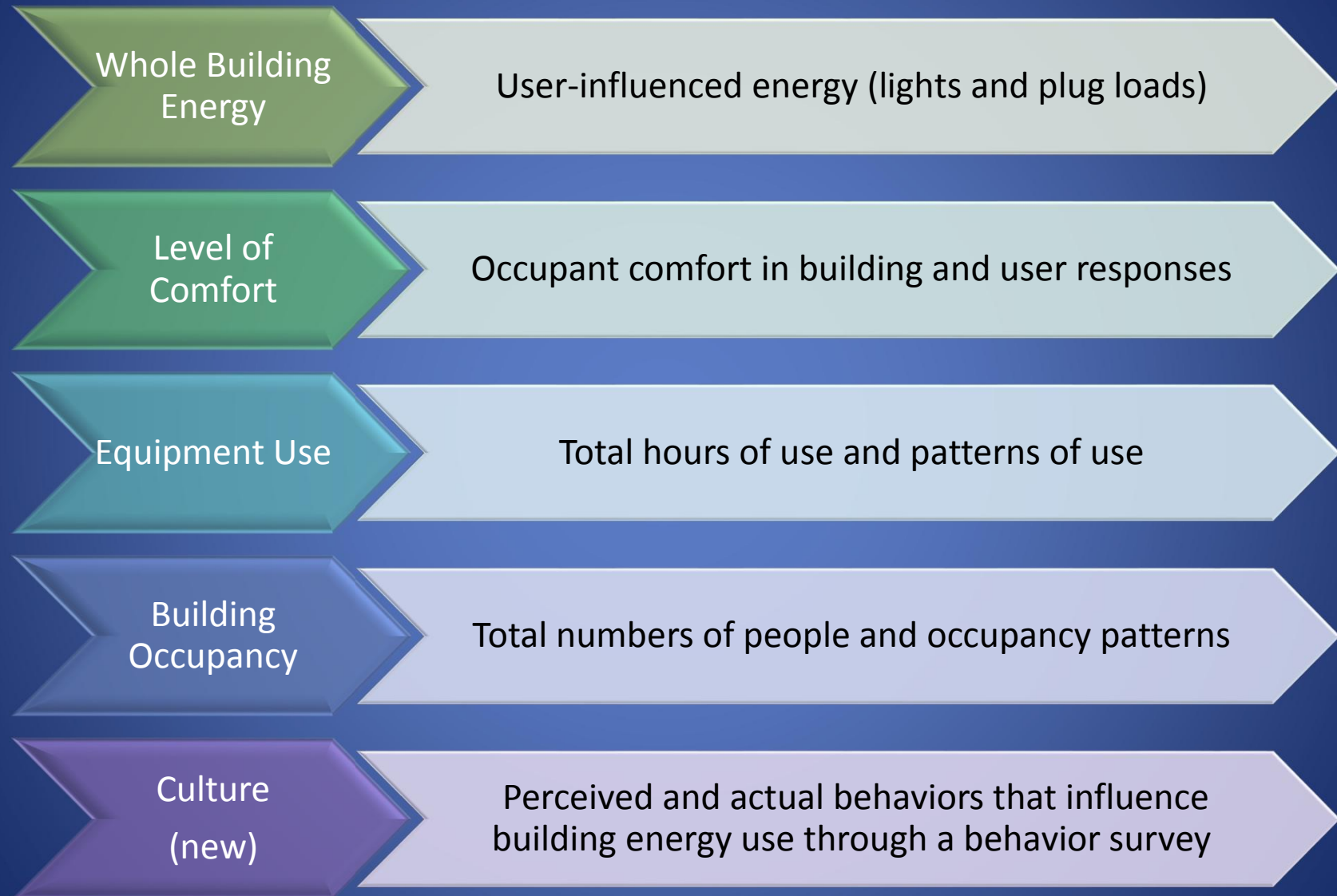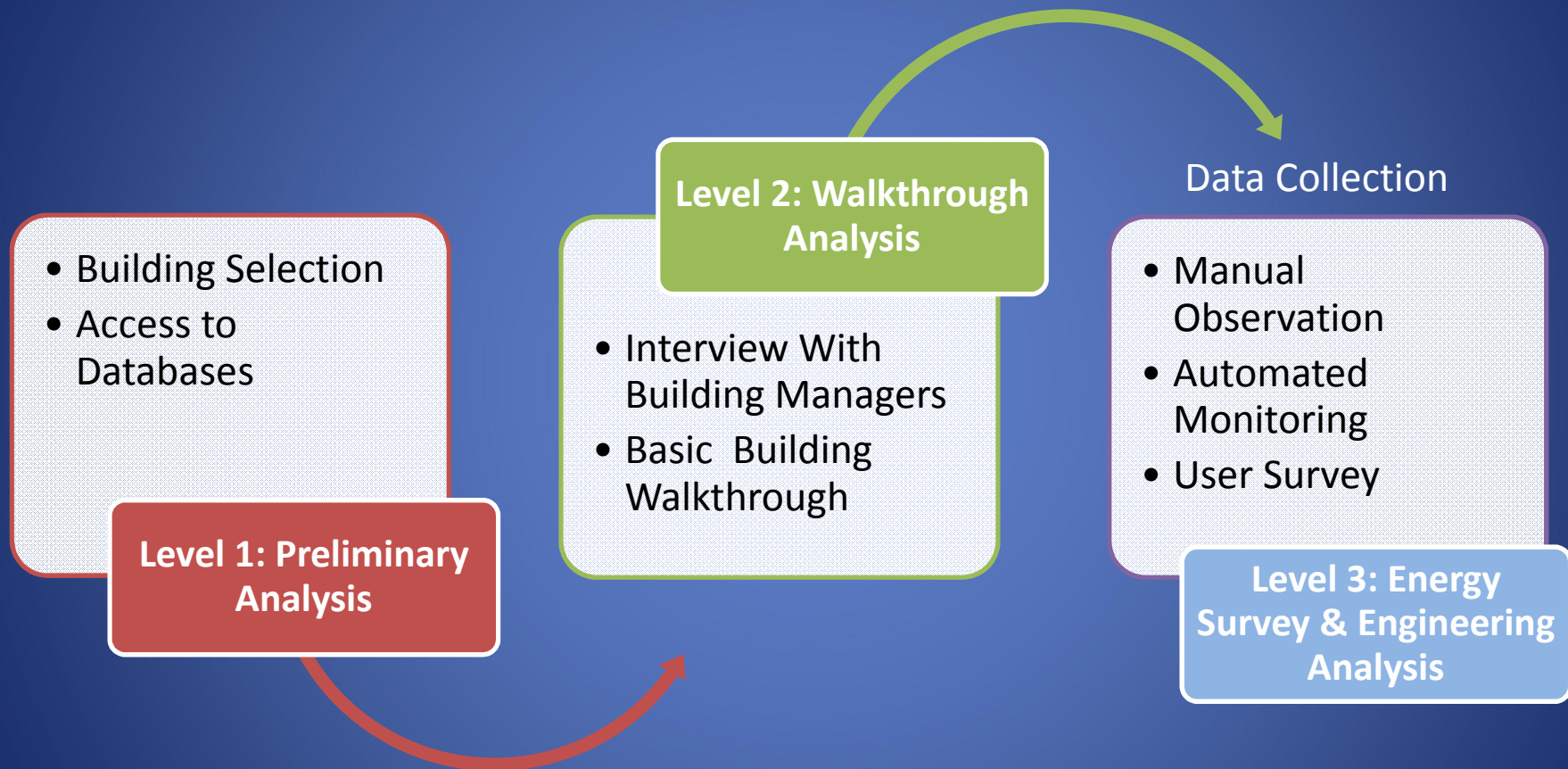

74 EUI

- SPACE HEATING 47%
- 10% COOLING
- 10% VENTILATION
- 7% WATER HEATING
- 14% LIGHTING
- 1% COOLING
- 2% REFRIGERATION
- 4% COMPUTERS
- 5% OTHER

TYPICAL "EDUCATION" BUILDING

- - - Indicates User-Influenced Energy End Use

Data Categories

Whole Building Energy	User-influenced energy (lights and plug loads)
Level of Comfort	Occupant comfort in building and user responses
Equipment Use	Total hours of use and patterns of use
Building Occupancy	Total numbers of people and occupancy patterns
Culture (new)	Perceived and actual behaviors that influence building energy use through a behavior survey

Building User Audit Process (BUAP)

Level 1: Preliminary Analysis

- Building Selection
- Access to Databases

Level 2: Walkthrough Analysis

- Interview With Building Managers
- Basic Building Walkthrough

Data Collection

- Manual Observation
- Automated Monitoring
- User Survey

Level 3: Energy Survey & Engineering Analysis

Data Collection Systems

Automated Monitoring

- Room's Average Relative Humidity
- Duration of Lighting
- Duration of Occupancy/ People Counting
- Room's Average Temperature
- Amount of Electricity Used

Manual Observation

- Number of Laptops Present/Plugged In
- Number of Desktops In Use
- Number of Projectors In Use
- Number of Rooms With Light On
- Number of TVs In Use
- Number of People Present
- Number of Windows/ Blinds Open

Behavioral Survey

- Building Use
- MELs Equipment Inventory
- Climate Change Beliefs
- CAP Related Items
- Energy Related Intentions & Behaviors
- Occupant Thermal Comfort
- Socio-Demographic Measures
- Inherent Value Orientations

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Automated Monitoring

Data captured in selected rooms at 15 min intervals, 24 / 7

- Lights on (HOBO UX90)
- Room occupied (HOBO UX90)
- Average room temperature (HOBO UX100)
- Average room humidity (HOBO UX100)
- Work station energy usage (WattsUp)
- Occupant movement (People Counter)

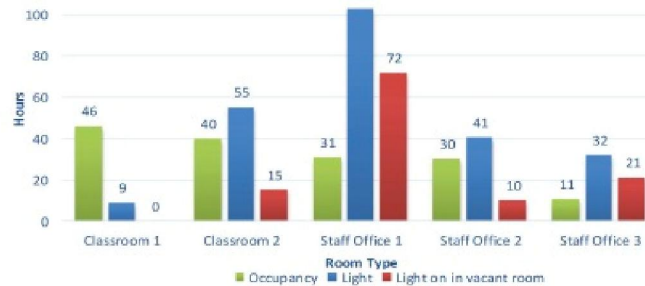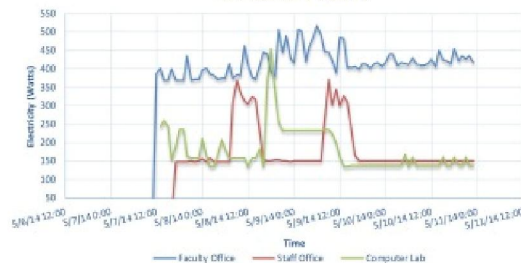People Counter   Watts Up   HOBO UX100 & UX90

Automated Monitoring Results
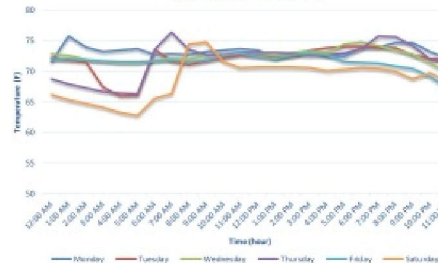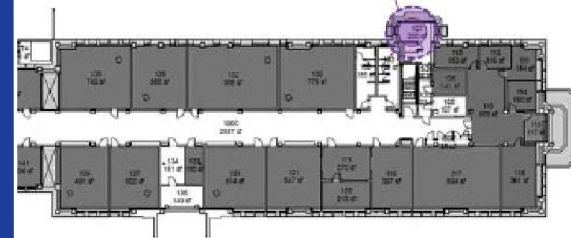
Manual Observation

Direct observation of the building spaces

- Occupancy (number of people in room)
- Lights on/off
- Windows open/closed
- Blinds/drapes open/closed
- Number of desktops in use
- Number of laptops
- Number of laptops plugged in
- Other plug loads (cell phones,
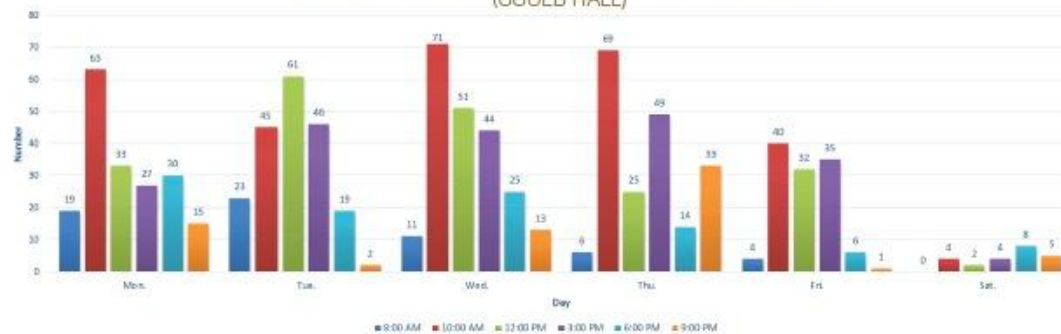- desk lamps, projectors, etc.)
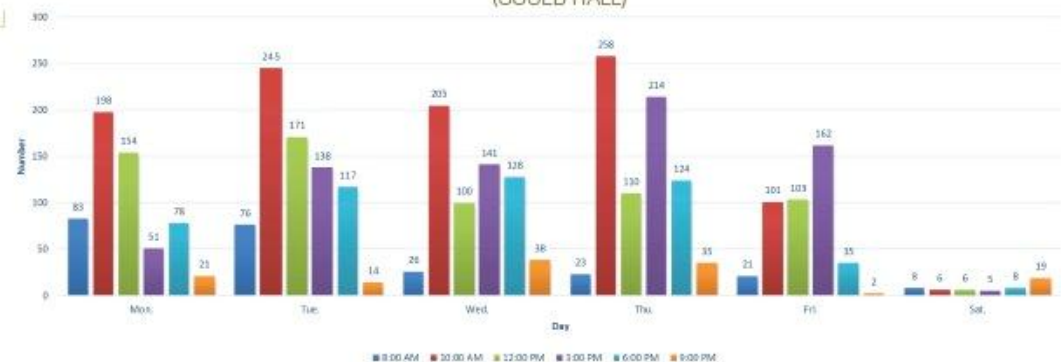
Manual Observation Results

Behavior Survey Results

SURVEY

- Building Use
- MELs Equipment Inventory
- Climate Change Beliefs
- CAP Related Items
- Energy Related Intentions & Behaviors
- Occupant Thermal Comfort
- Socio-Demographic Measures
- Inherent Value Orientations

50% of respondents are concerned with climate change

60% of respondents reported they "almost always" conserve energy by turning off lights

GAP between values, beliefs, and actions is revealed when cross referenced with measured lighting use data

PERCEIVED AND ACTUAL ENERGY USE

Monitoring: turn off lights
- Gould Hall 38%
- Savery Hall 43%
- Dempsey Hall 51%

Survey report: turn off lights
- Gould Hall 58%
- Savery Hall 63%
- Dempsey Hall 65%

Analysis Outcomes: Data alone

Major Findings from Manual and Automated Observation

1. Peak energy use is between 10 am and 3 pm
2. 25% of users bring laptops and 50% of those are plugged in
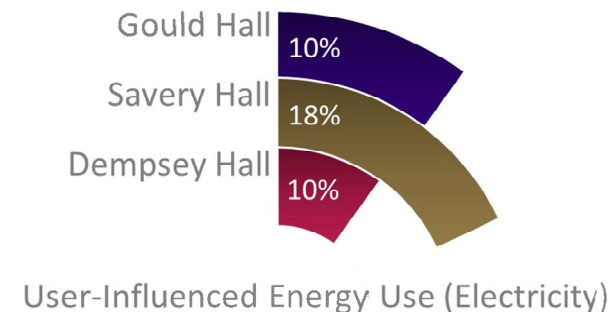3. Occupants use natural lighting and ventilation much less than reported and expected.
4. After hours building use was higher than expected for buildings with restricted access.

*Of the three buildings studies, Savery Hall
Stands out with the highest use of energy use yet this building was recently remodeled

Gould Hall 10%
Savery Hall 18%
Dempsey Hall 10%

User-Influenced Energy Use (Electricity)

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Analysis Outcomes + Behavior Survey

1. "Office" uses in social or common spaces suggests the need to capture MEL's (miscellaneous electric loads) of computers, tablets and cell phone charging in future audits.
2. 60% of those surveyed report that they turn off lights yet the energy audits found that 40 to 50% of the time in vacant offices, lights were left on suggesting a gap between perceived behavior and actual behavior.
3. There is a lack of awareness of University's Climate Action Plan suggesting a campaign to help user's understand the issues and motivate actions related to energy is needed.
4. Over 40% of building users (mainly faculty and staff) believe that acting pro-environmentally is an important part of who they are yet less than one third believe that they can do something about climate change revealing an incongruity between values and actions.
5. The environmental values section of the survey predicts that building occupants are very likely to engage in pro-environmental behaviors (PEB) suggesting that this population would be receptive to intervention campaigns to foster PEB actions to reduce energy consumption.

Project Team

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