

Figure 1: McKinstry's Cycle of Services



## Background

**McKinstry Construction Engineering Co.** serves building owners, occupants, and operators by providing well-designed, easy-to-maintain buildings that work at peak levels of performance and economy for their clients.

**Design | Construction | Operation | Maintenance**

## Problem



- The UW consumes **295 million kWh** electricity per year at a **cost of \$15M**
- McKinstry** has access to the HVAC performance data from the UW, though it goes largely unused... **How can we unlock this data?**

## Project Goal Statement

To support McKinstry's Cycle of Services by providing accessible visualizations of HVAC systems using the company's built environment data.

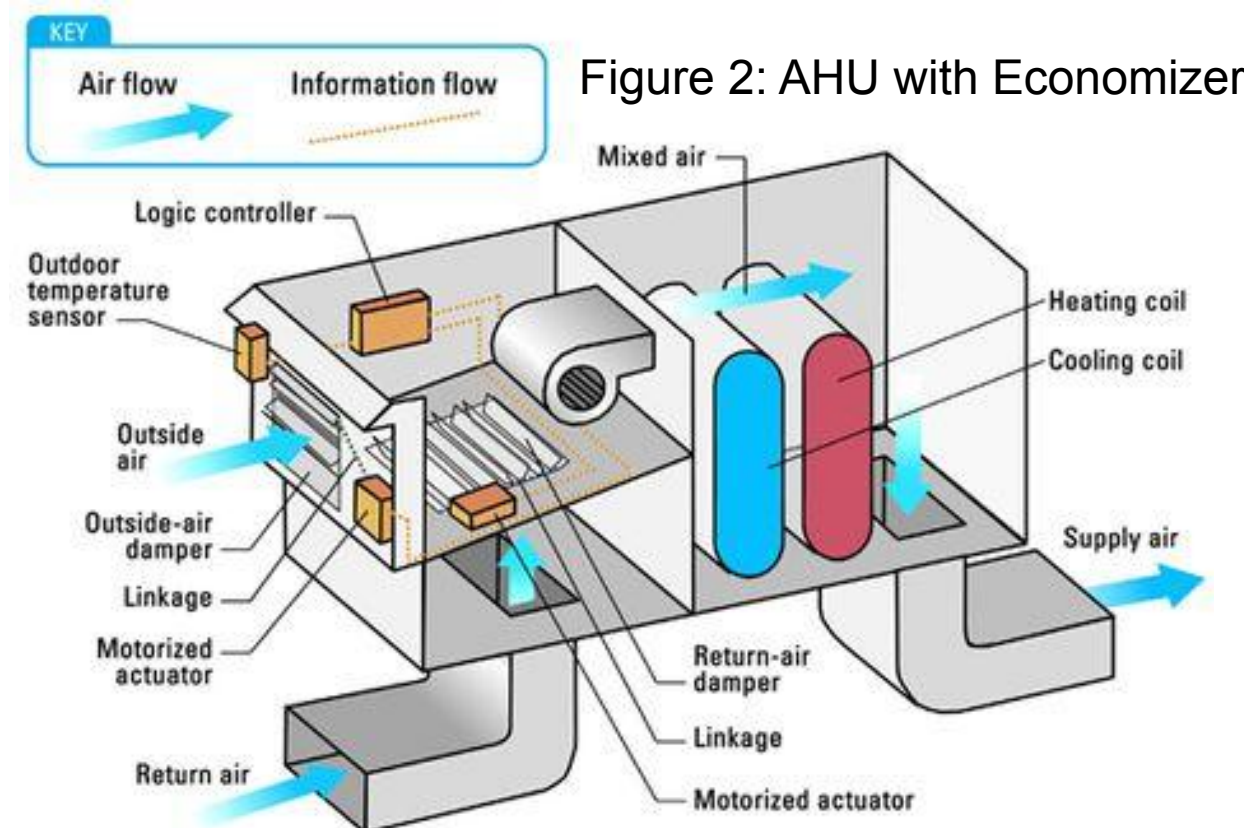
### Deliverables include:

- A dashboard** that produces visualizations of HVAC sensors within Gowen Hall
- Recommendations** to improve energy usage on dashboard visualizations

## Gowen Systems

- Three air handling units**
  - Mechanical heating
  - No mechanical cooling
- Hot Water System**
- Electric Meters**

**100 Unique Sensors** help to efficiently heat and cool the building as well as report values to McKinstry's Database



## HVAC Data

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/Gowen/BacnetNetwork_k_1201_GOWENS2eHWS2e0AS2dFLOW,7052617,1,0,{ok},1/1/2018 12:45:00 AM,0,{ },1150.478515625
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```

## Requirements

Our dashboard shall..



## Dashboard Creation

All development was done using **R Shiny and MySQL**.  
The open source packages provide an *elegant* and *powerful* framework for web apps



### Feedback

How can we improve upon what we have designed? What additional needs can be identified?

### Test & Evaluation

Do functionalities work as expected? Do they work efficiently?

### Design & Development

What is the duration of design sprint? How can we support holistic dashboard experience?

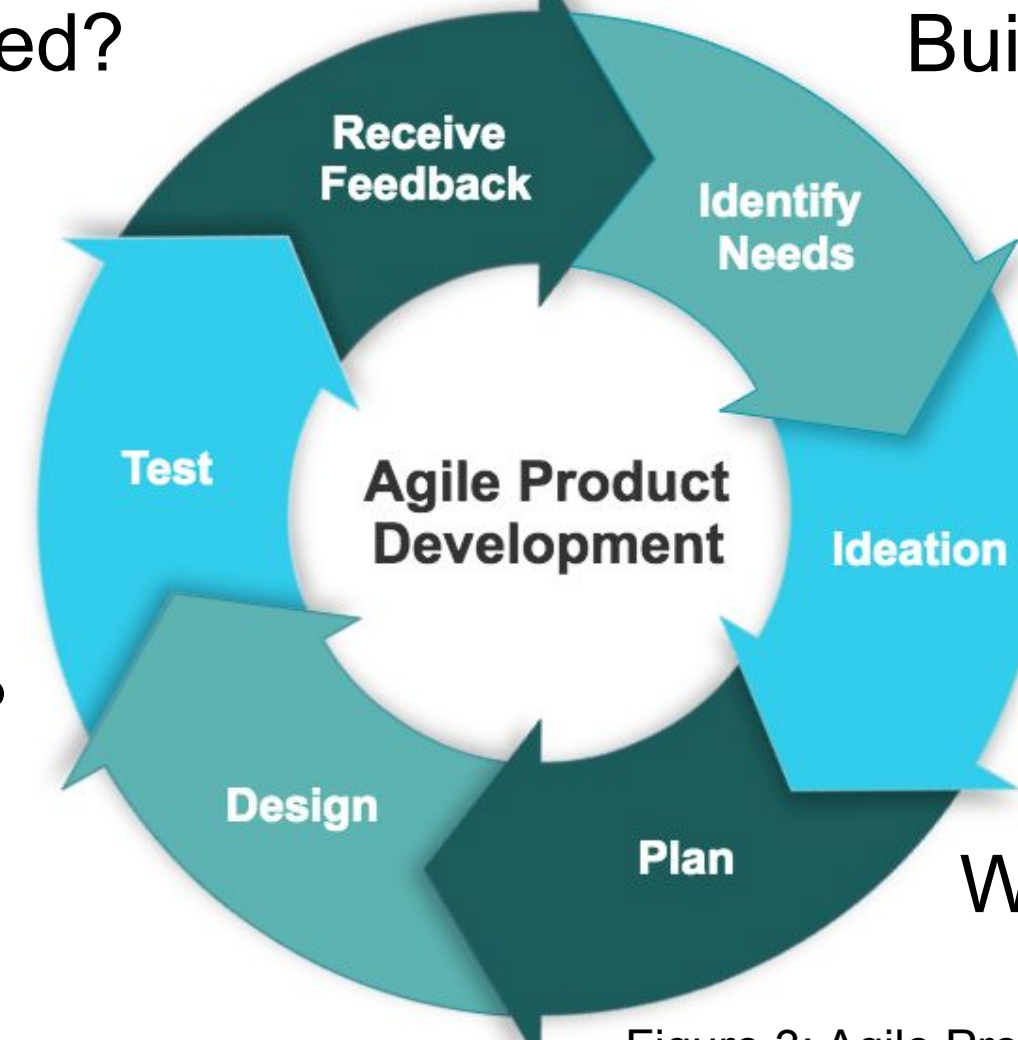


Figure 3: Agile Product Development Cycle

### Identifying Requirements

What functions best serve the needs of McKinstry? Building Operators, and Project Sponsors?

### Ideation & Benefit Analysis

What functions must be prioritized? What are our constraints?

### Planning & Scheduling

What are roles of each team-member? What are our next scheduled milestones?

Each cycle represents an iteration to the dashboard whose requirements and solutions have evolved through the **collaborative effort of our cross-functional team and our end user.**

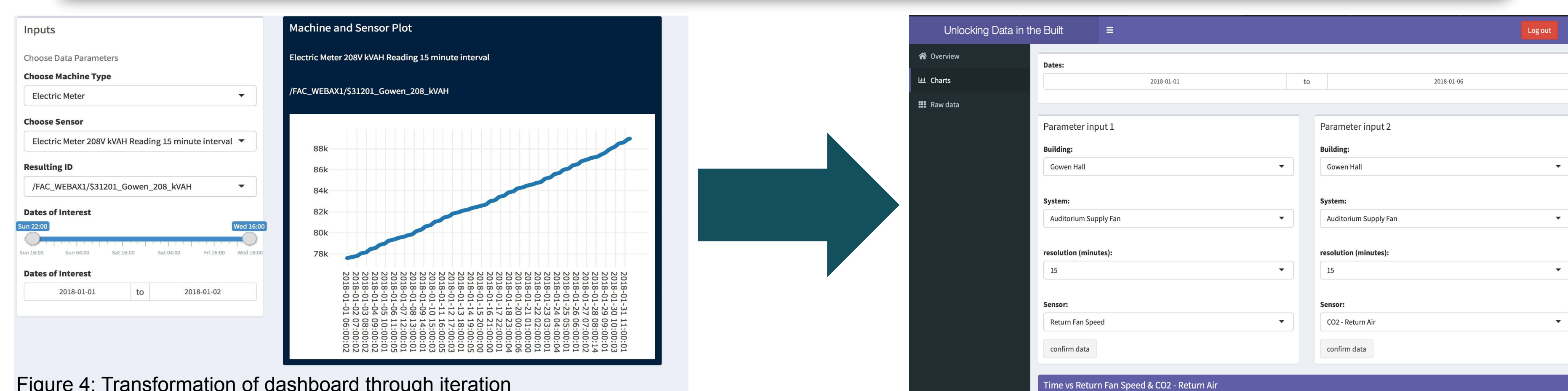


Figure 4: Transformation of dashboard through iteration

## Backend Development

- Dashboard **must be efficient** when retrieving data
  - Smallest amount of filtered data returned to R
- Improve speed with keys and indices
- Manage number of connections with pool object

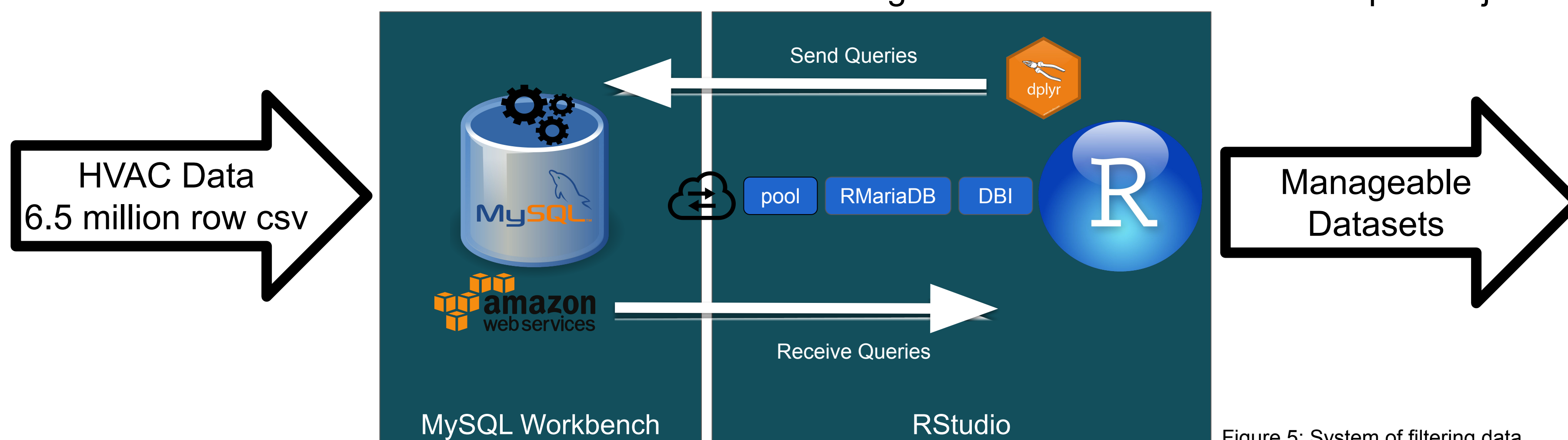


Figure 5: System of filtering data

## Findings

Gowen is being heated over the winter holiday...



Figure 6: Visual of building heating

From the relational plots created using our dashboard, we can see that heat is being supplied to the building throughout December.

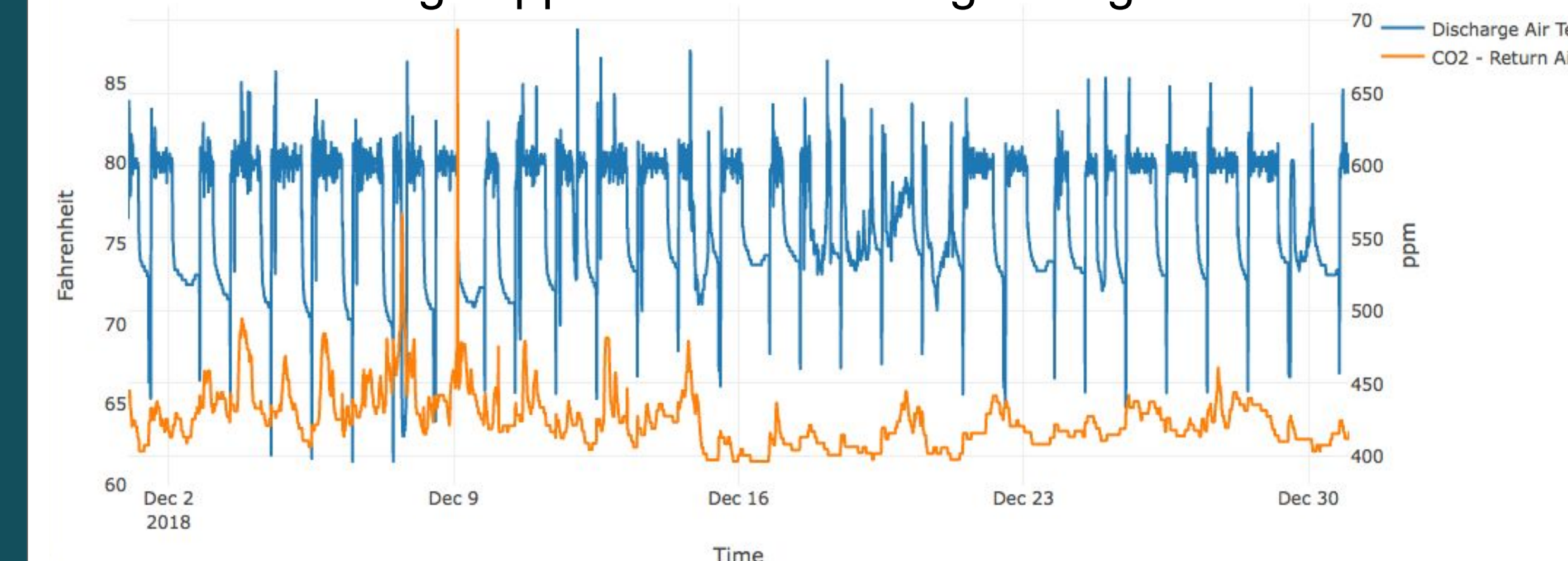


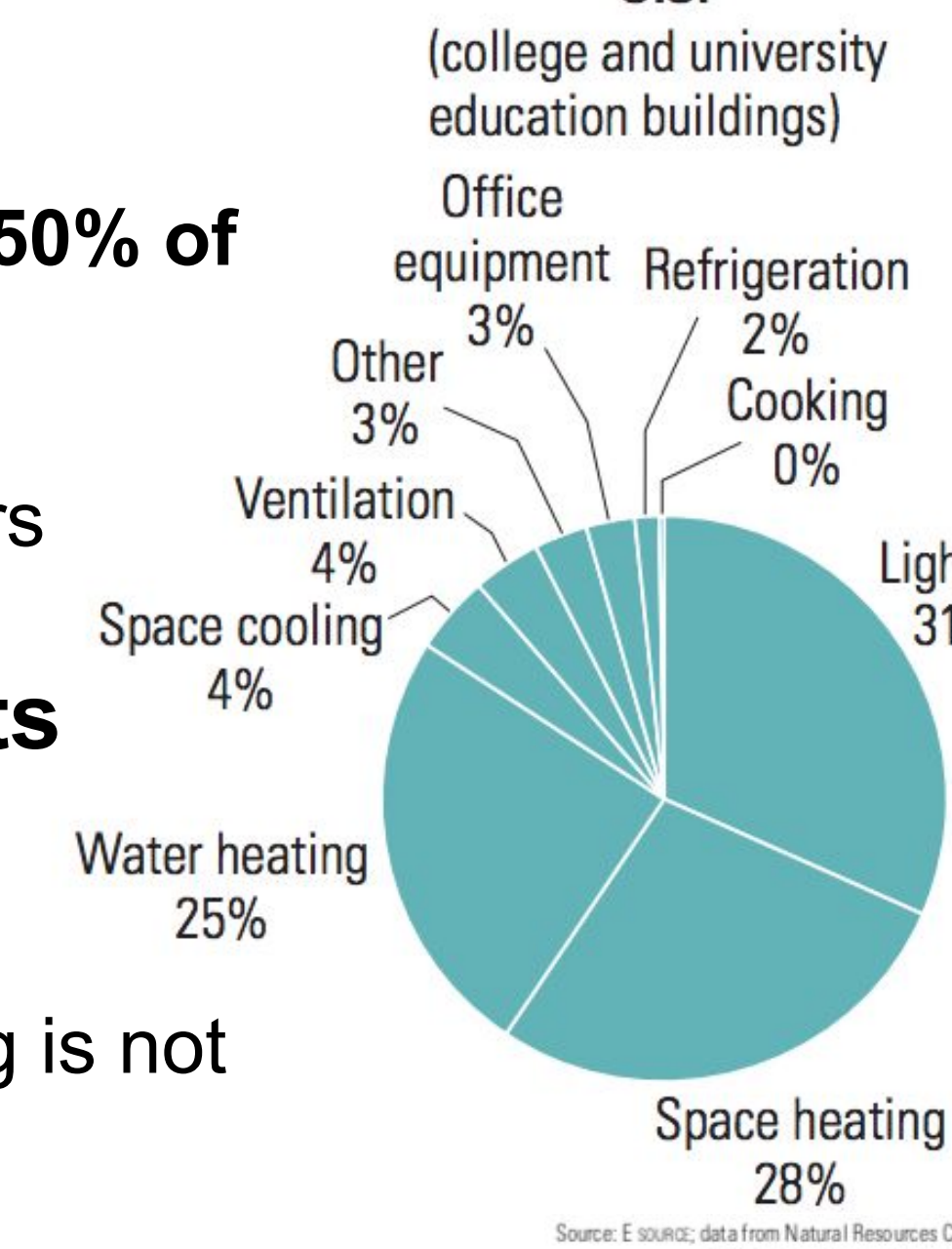
Figure 7: Visual of building heating and occupancy

The CO2 levels confirm our findings since CO2 gives us an approximation of the occupancy in the auditorium space

## Impact

- Lighting and heating account for **50% of energy consumption**
- Energy reduction of a few percent means hundreds of thousands of dollars in savings
- Therefore, **variable set-points must be enabled** based on the building's expected occupancy
  - Avoid heating costs when building is not occupied

Figure 8: Energy consumption by end use U.S.



Additionally, **McKinstry must deploy our tool on their active energy management jobs**  
Our tool will...  
 → Enhance capabilities over existing projects  
 → Enable active use of HVAC data to provide real-time insight for building systems

## Acknowledgements

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