

Energy Analytics: Identifying Anomalies in Campus Energy Usage Data

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Comps 2022
Carleton College

Overview

- Introduction
- Energy Analytics 4
- Conclusion



Overview

- **Introduction**
 - Motivation
 - Key Terms
 - Previous Work
- Energy Analytics 4
- Conclusion



Introduction

- Motivation
- Key Terms
- Previous Work



Introduction

- **Motivation**
 - Goal
 - Impact
- Key Terms
- Previous Work

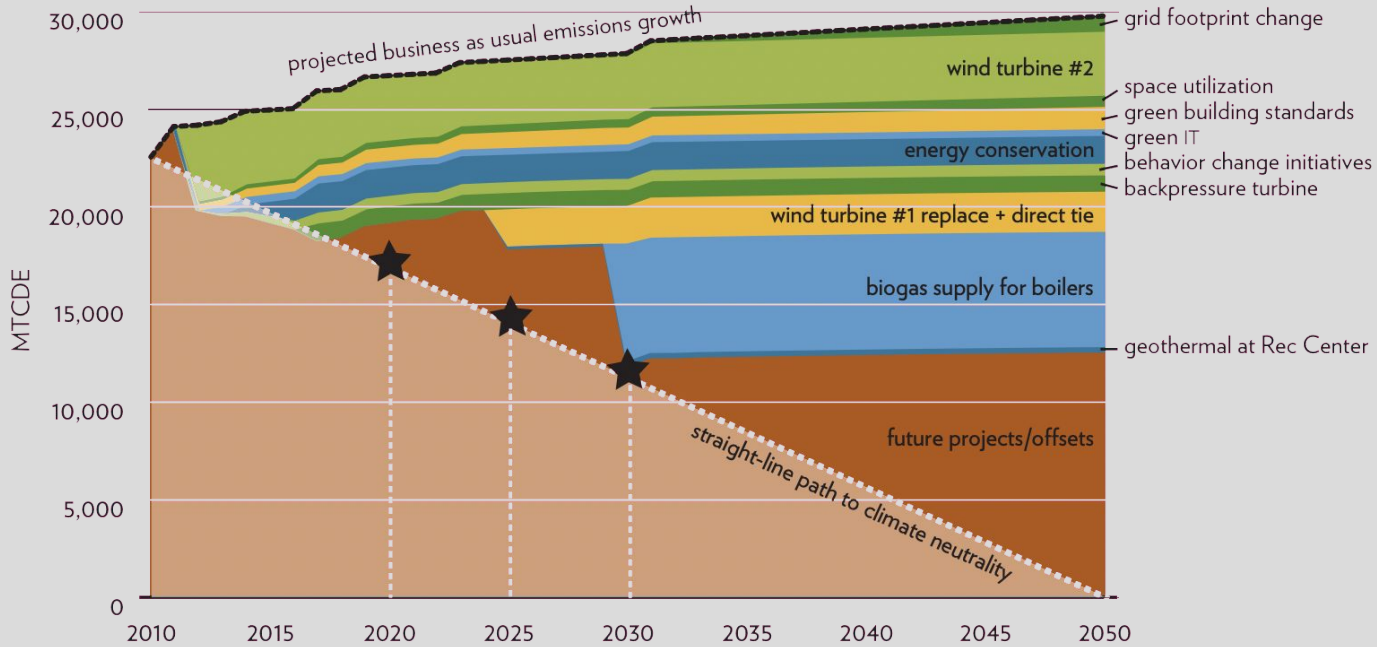


Goal

- **Task:** Develop a web-tool for identifying anomalous data in Carleton's energy system
 - Long term goal of EA Comps
- Importance & relevance of the project
 - Carleton's 2011 Climate Action Plan
 - Net zero GHG emissions by 2050
 - "Energy audits, Green IT" (2010-2025)
 - Financial consequences
 - Wasted energy costs
 - Money that isn't going 'green'



Impact



★ interim net GHG emissions targets:
17,000 MTCDE by 2020; 14,000 MTCDE by 2025; 11,000 MTCDE by 2030

Figure 1: Timeline for GHG emission targets & reductions

Introduction

- Motivation
- **Key Terms**
 - Energy Analytics
 - Points
- Previous Work



Energy Analytics: definition

- “The process of collecting electrical data and applying sophisticated analytical software and algorithms to deliver insights around consumption and time of use reductions”
- Key factors in *Energy Analytics*
 - Energy used
 - Cost
 - Detecting anomalies (eg, room is too cold)
 - Automation

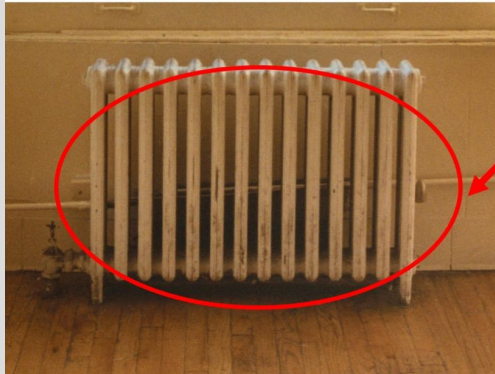
Points - Devices



Thermostat



VAV Box



Radiators



Air handling unit

Points

- What are they?

Points

- What are they?
 - Room Temperature

Points

- What are they?
 - Room Temperature
 - Room Set Temperature

Points

- What are they?
 - Room Temperature
 - Room Set Temperature
 - Air Vent Percentage Open

Points

- What are they?
 - Room Temperature
 - Room Set Temperature
 - Air Vent Percentage Open
 - Wind Speed

Points

- What are they?
 - Room Temperature
 - Room Set Temperature
 - Air Vent Percentage Open
 - Wind Speed
 - Wind Direction

Points

- What are they?
 - Current Room Temperature
 - Temperature Set Point
 - Air Vent Percentage Open
 - Wind Speed
 - Wind Direction
- Tons of points!

Points

- Naming

EV.RM102.RT

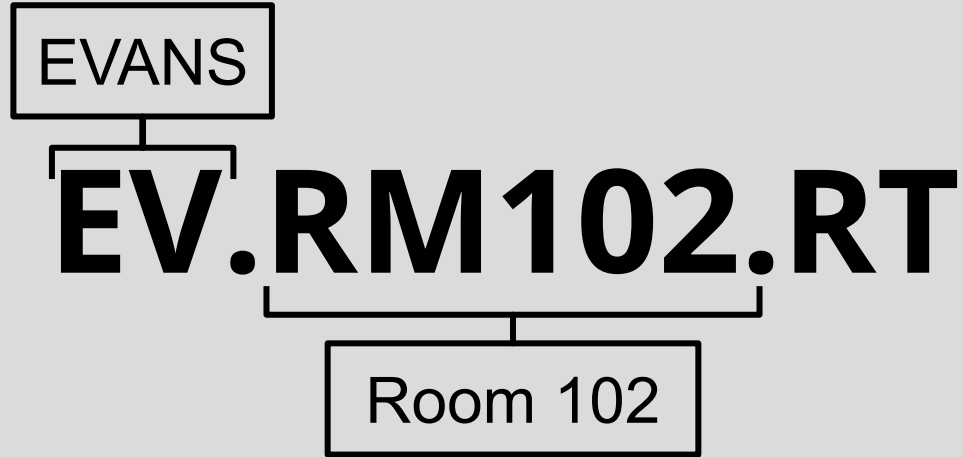
Points

- Naming



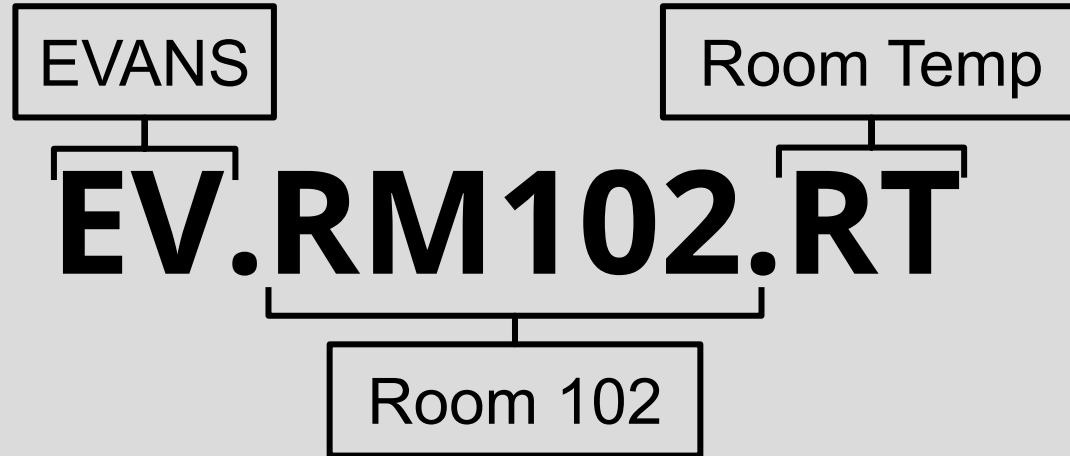
Points

- Naming



Points

- Naming



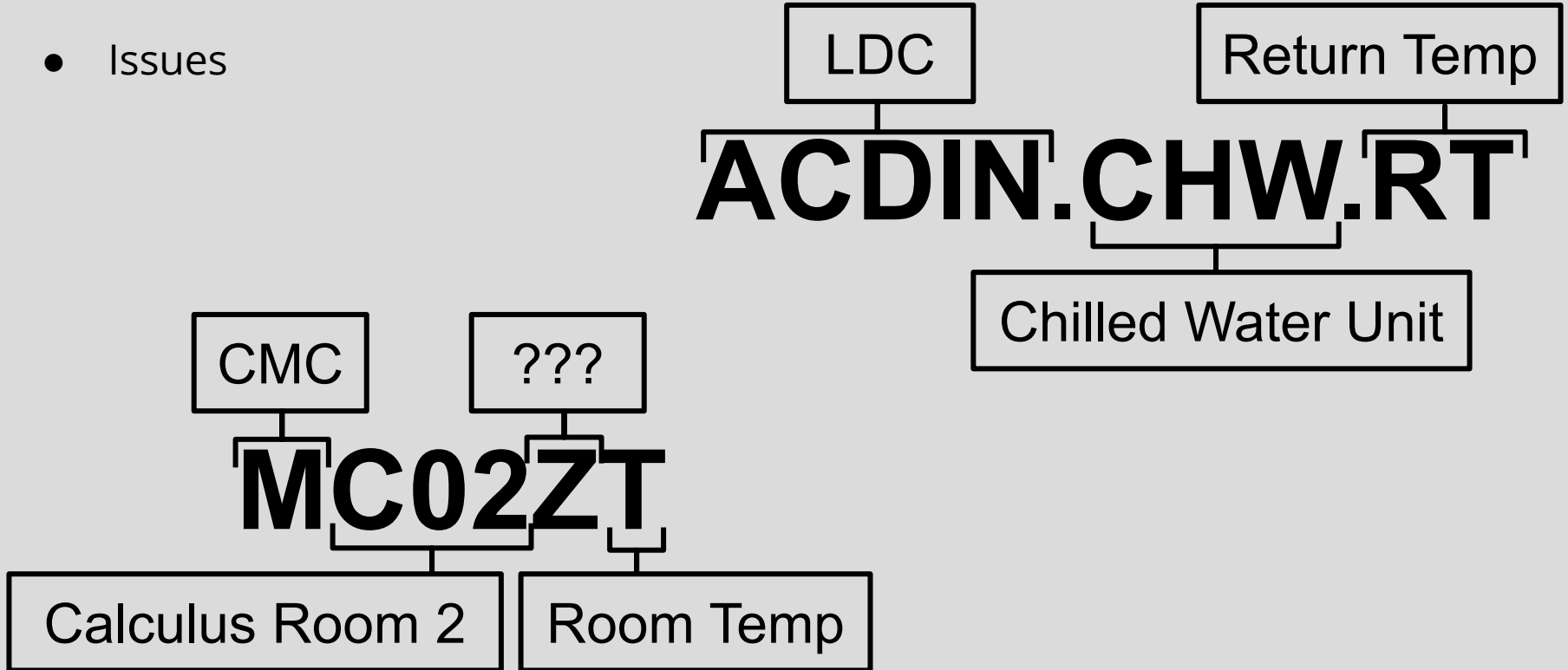
Points

- Issues



Points

- Issues



Introduction

- Motivation
- Key Terms
- **Previous Work**
 - Value pipeline
 - API
 - Point graph
 - Search feature
 - Machine learning algorithms



Previous Work

- **Value Pipeline**
 - Importer script to collect data from points
 - Rube Goldberg machine of automated scripts
 - Data goes straight to us
 - No disrupting production server

Previous Work

- Value Pipeline
- **API**
 - API endpoints to search database

GET Point IDs

```
http://energycomps.its.carleton.edu/api/points/ids?search=<search_request>
```

Returns the point_id's that follow the specified search parameters

GET Point by ID

```
http://energycomps.its.carleton.edu/api/point/:id
```

Gets a point by its point_id

Previous Work

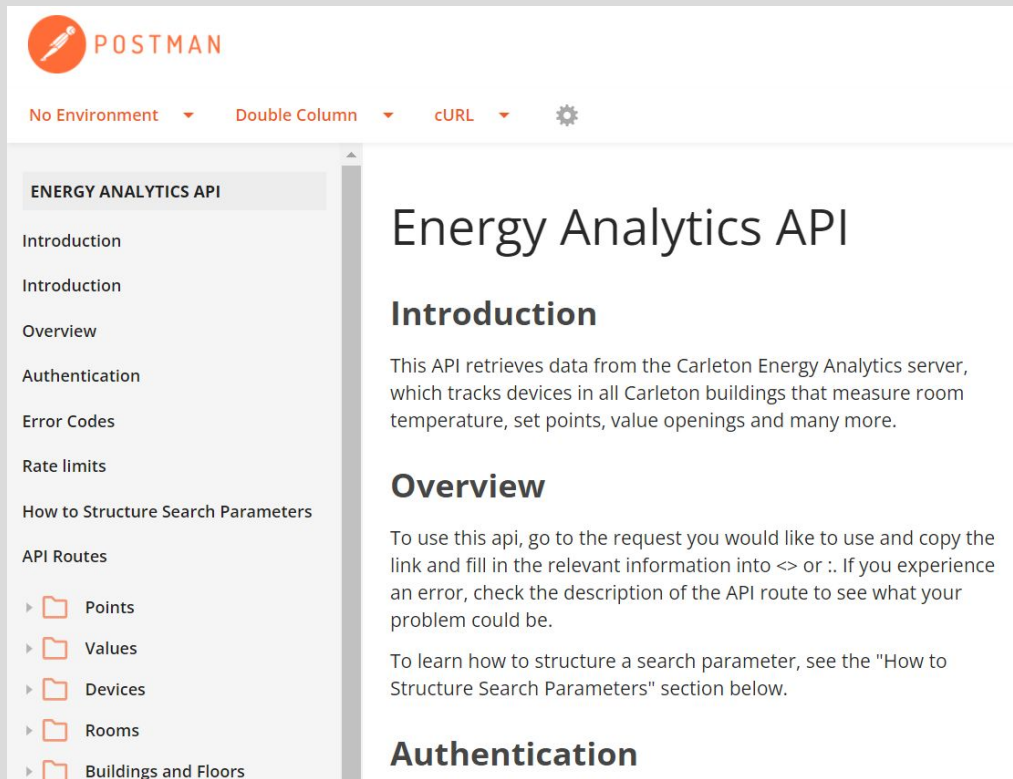
- Value Pipeline

- **API**

- API endpoints to

search database

- Postman documentation



The screenshot shows the Postman interface for the Energy Analytics API. The top bar includes the Postman logo, environment settings (No Environment), view settings (Double Column), and format settings (cURL). The left sidebar lists the API documentation sections: Introduction, Overview, Authentication, Error Codes, Rate limits, How to Structure Search Parameters, and API Routes. The API Routes section is expanded to show folders for Points, Values, Devices, Rooms, and Buildings and Floors. The main content area displays the 'Energy Analytics API' title, followed by an 'Introduction' section with a paragraph describing the API's purpose and an 'Overview' section with instructions on how to use the API and a warning about error handling. The 'Authentication' section is also visible at the bottom.

Previous Work

- Value Pipeline
- API
- **Point Graph**

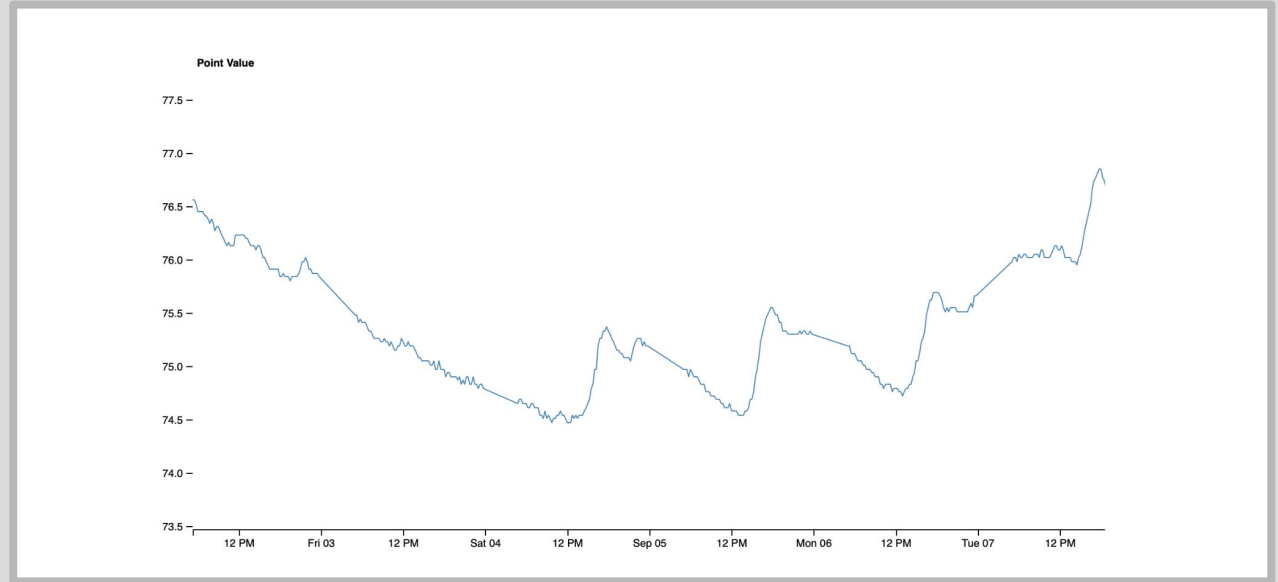


Figure 1: Evans 106 room temperature from Sept 1st to Sept 8th, 2021

Previous Work

- Value Pipeline
- API
- Point Graph
- **Search Feature**

Point Selector

The screenshot shows a 'Point Selector' interface with four main columns: Building, Floor, Room, and Point. The 'Building' column has a dropdown menu with 'Boliou' selected. The 'Floor' column has a dropdown menu with '0' selected. The 'Room' column has a dropdown menu with '158' selected, and the text 'UnID'd Room in Boliou' is visible below the list. The 'Point' column shows a list of points, with 'BO.1.RM158A:CTL STPT' selected. Below the columns, there is a date range selector showing '2/20 12:00 AM - 2/20 12:00 AM', a 'Graph' button, a 'Reset' button, and the text '29 points found'.

Building	Floor	Room	Point
All Buildings	All Floors	153	All Points
Boliou	0	155	BO.1.RM158A:AIR VOLUM
Evans	1	156	BO.1.RM158A:AUX TEMP
UnID'd Building	null	157	BO.1.RM158A:CLG FLOW
Hulings		158	BO.1.RM158A:CLG FLOW
Townhouses		160	BO.1.RM158A:CLG LOOPC
Weitz		161	BO.1.RM158A:CTL FLOW M
Cassat		163	BO.1.RM158A:CTL FLOW M
			BO.1.RM158A:CTL STPT

2/20 12:00 AM - 2/20 12:00 AM Graph Reset 29 points found

Previous Work

- Value Pipeline
- API
- Point Graph
- Search feature
- **Machine learning algorithms**
 - To find energy usage problems, devices problems, etc.
 - K-Means
 - STL or Seasonal-Trend decomposition using LOESS
 - Isolation Forests

Energy Analytics: at Carleton

- Reduce costs by:
 - Improving energy efficiency
 - Not relying on a third-party to process our data
- Try to be even more environmental friendly
- Carleton's climate goals from 2030 to 2050 (and their current reliance on “unknown tech”) – Climate action plan (2030 to 2050), Utility master plan (done last year)

Overview

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- Energy Analytics 4
- Conclusion



Overview

- Introduction
- **Energy Analytics 4**
 - Energy data
 - Data Management
 - Anomaly algorithms
 - Heuristics approach
 - API
 - Website interface
- Conclusion



Energy Analytics 4

Energy Analytics
./energy-analytics-4

- Energy data



Energy Analytics 4

- Energy data
- Data Management



Energy Analytics 4

- Energy data
- Data Management
- Anomaly algorithms



Energy Analytics 4

- Energy data
- Data Management
- Anomaly algorithms
- Heuristics approach



Energy Analytics 4

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- API



Energy Analytics 4

- Energy data
- Data Management
- Anomaly algorithms
- Heuristics approach
- API
- Website interface



Energy Analytics 4

- **Energy data**
- Data Management
- Anomaly algorithms
- Heuristics approach
- API
- Website interface



Energy Analytics 4

- **Energy data**
 - What we have
 - Difficulties
- Data Management
- Anomaly algorithms
- Heuristics approach
- API
- Website interface



Carleton's Energy Data

- What we have now:

Carleton's Energy Data

- What we have now:
 - Each building's energy use - hour to hour

Carleton's Energy Data

- What we have now:
 - Each building's energy use - hour to hour
 - Can be useful for large issues

Carleton's Energy Data

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 - Whole building data visualizations

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- What's hard to do:

Carleton's Energy Data

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 - Compare buildings side-by-side

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 - Identify single rooms with problems

Carleton's Energy Data

- What we have now:
 - Each building's energy use - hour to hour
 - Can be useful for large issues
 - Whole building data visualizations
- What's hard to do:
 - Compare buildings side-by-side
 - Identify single rooms with problems
 - Automate identification of problems

Carleton's Energy Data

- Examples of problems:
 - Finding open windows in the winter

Carleton's Energy Data

- Examples of problems:
 - Finding open windows in the winter
 - Locating a stuck vent

Carleton's Energy Data

- Examples of problems:
 - Finding open windows in the winter
 - Locating a stuck vent
 - Discovering that a floor is leaking energy

Energy Analytics 4

- Energy data
- **Data Management**
 - ALC and Siemens
 - Database
 - Compression and backup
- Anomaly algorithms
- Heuristics approach
- API
- Website interface



Data Management

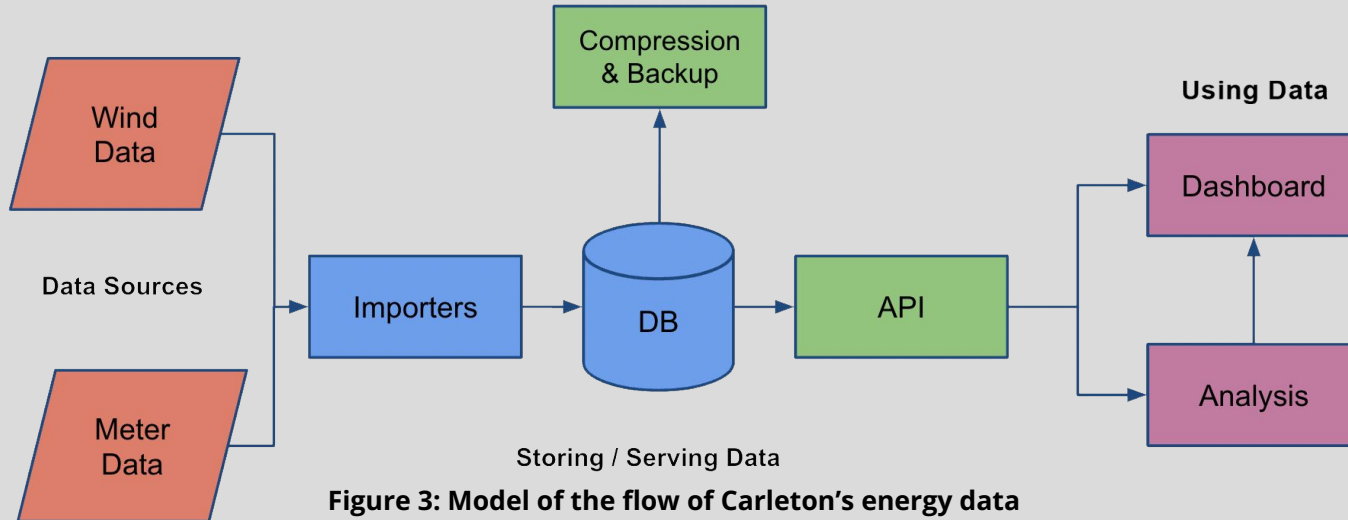


Figure 3: Model of the flow of Carleton's energy data

Data Management

- ALC & Siemens
 - Value pipeline to database

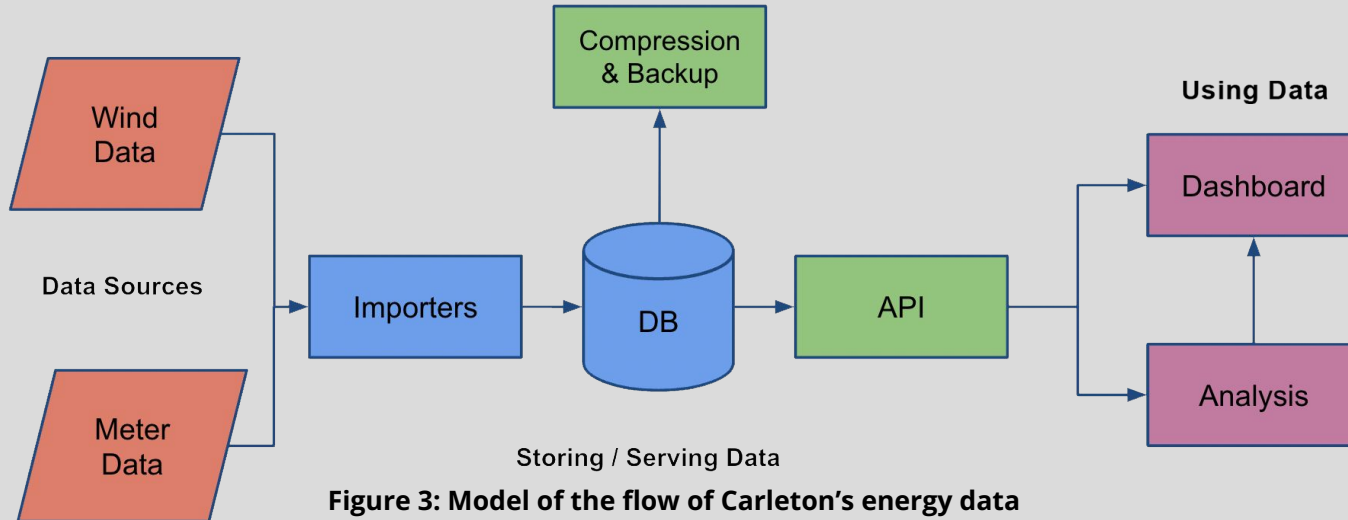


Figure 3: Model of the flow of Carleton's energy data

Data Management

- ALC & Siemens
 - Value pipeline to database
 - Difficulties with ALC data

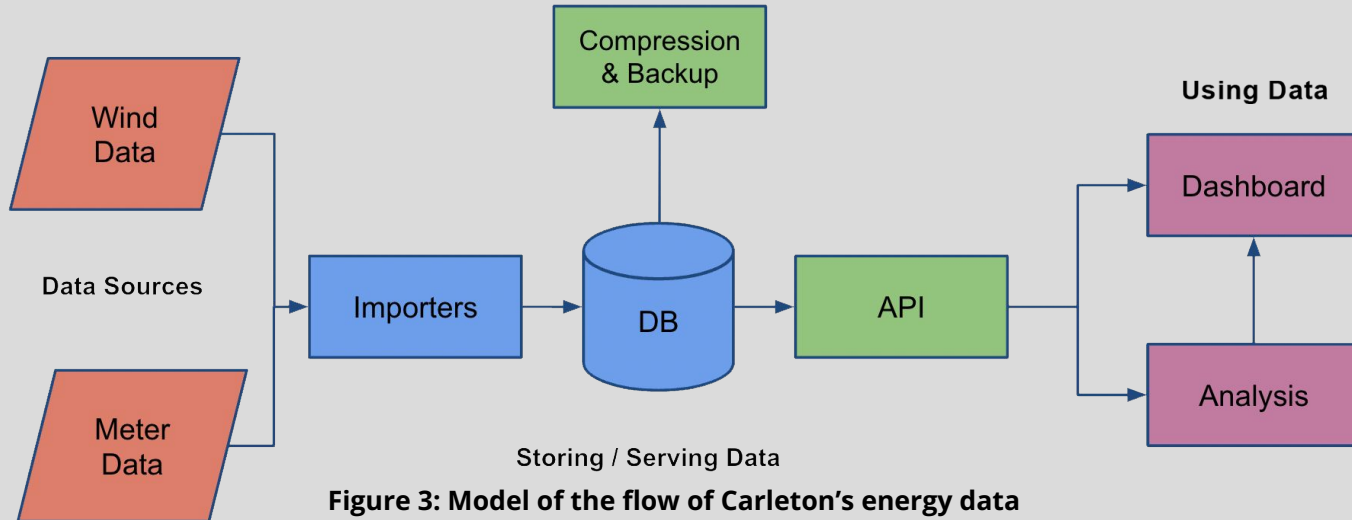


Figure 3: Model of the flow of Carleton's energy data

Data Management

- ALC & Siemens
 - Value pipeline to database
 - Difficulties with ALC data
- Creating an automated compression & backup system for the database
 - .CSV file format clean-up

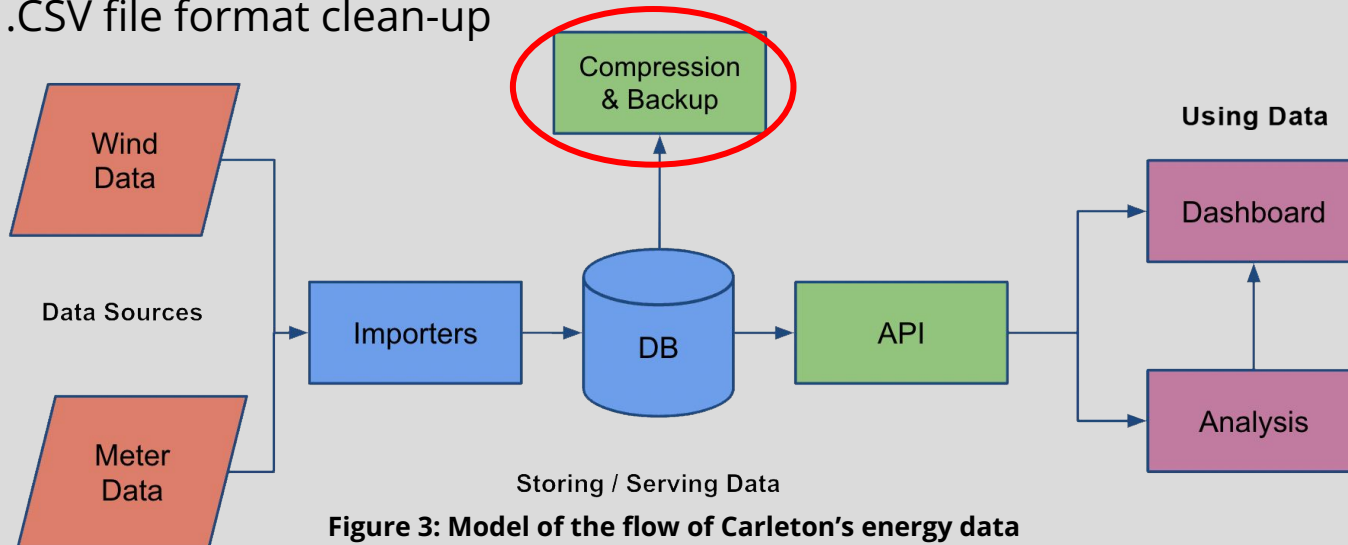


Figure 3: Model of the flow of Carleton's energy data

Data Management

- Data was originally all dumped into one place with no organization

`bolliou1_10-21-21_04-30.csv`

Data Management

- Data was originally all dumped into one place with no organization
 - Naming conventions made the data impossible to sort

```
bolliou1_10-21-21_04-30.csv
```

Data Management

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 - Naming conventions made the data impossible to sort

boliou1_10-21-21_04-30.csv



2021-10-21-boliou1-04-30.csv

Data Management

- Data was originally all dumped into one place with no organization
 - Naming conventions made the data impossible to sort
- Next group by buildings

`boliou1_10-21-21_04-30.csv`



`2021-10-21-boliou1-04-30.csv`



`2021-10-boliou`

Data Management

- Data was originally all dumped into one place with no organization
 - Naming conventions made the data impossible to sort
- Next group by buildings
- Finally, combine into one file and compress

`bolliou1_10-21-21_04-30.csv`



`2021-10-21-bolliou1-04-30.csv`



`2021-10-bolliou`



`2021-10-bolliou.tar.gz`

Data Management

- Created 3 bins:

Data Management

- Created 3 bins:
 - Failed to import

Data Management

- Created 3 bins:
 - Failed to import
 - Ready to archive

Data Management

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 - Uploads

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 - Successful processing entailed tar and zip

Data Management

- Created 3 bins:
 - Failed to import
 - Ready to archive
 - Uploads
- Movement through bins automated with a cronjob
 - Runs bash scripts daily
 - Successful processing entailed tar and zip
 - After a month's collection of data

Energy Analytics 4

- Energy data
- Data Management
- **Anomaly algorithms**
 - K-means
 - STL
- Heuristics approach
- API
- Website interface



Anomaly Algorithms

- K-Means & STL (Seasonal Trend Decomposition with Loess)

Anomaly Algorithms

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Anomaly Algorithms

- K-Means & STL (Seasonal Trend Decomposition with Loess)
 - Two anomaly algorithms previously investigated by EA Comps groups
 - K-Means good at analyzing multivariate data
 - STL especially sensitive to identifying anomalies associated with seasonal changes

Anomaly Algorithms

- K-means not what we needed
 - Conflated high positive rate
 - Computationally expensive
 - Results not as interpretable

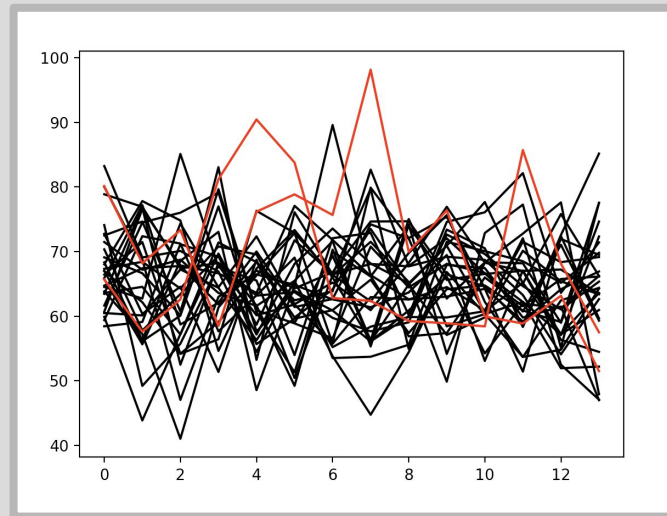


Figure 1: K-means anomaly detection algorithm run on test data

Anomaly Algorithms

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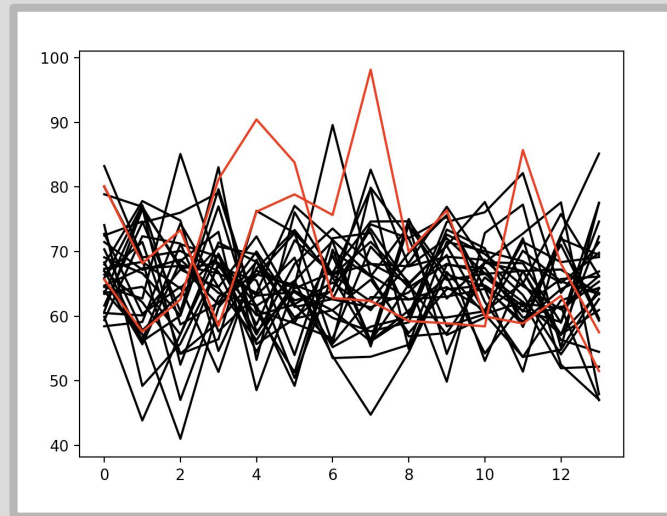


Figure 1: K-means anomaly detection algorithm run on test data

Anomaly Algorithms

- K-means not what we needed
 - Conflated high positive rate
 - Computationally expensive
 - Results not as interpretable
- STL
 - Very slow
- Promising in the long term, and merits further research
 - Decided to focus on tools that allowed for higher interactivity

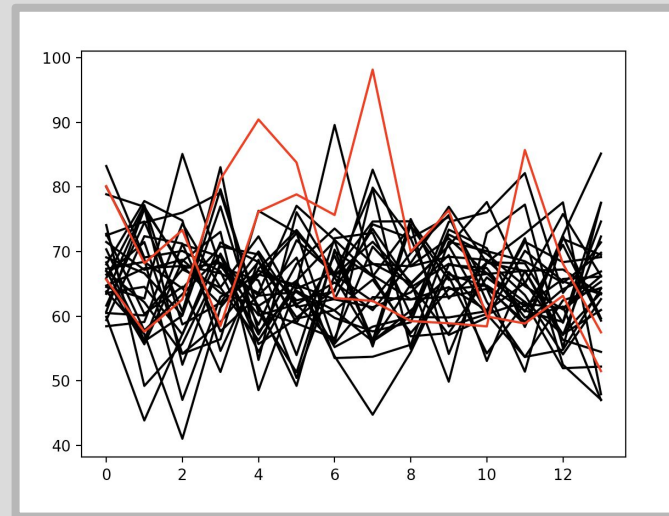


Figure 1: K-means anomaly detection algorithm run on test data

Energy Analytics 4

- Energy data
- Data Management
- Anomaly algorithms
- **Heuristics approach**
 - Idea
 - Example
- API
- Website interface



Heuristics Approach

- Short term over long term

Heuristics Approach

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- Finds data points in range of parameters for *combination of points* selected by user

Heuristics Approach

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- UI catered towards facility staff
 - Intent to make identifying broken points easier

Heuristics Approach

- Short term over long term
- Finds data points in range of parameters for *combination of points* selected by user
- UI catered towards facility staff
 - Intent to make identifying broken points easier
- Interpretable presentation of identified points

Heuristics Approach

Example: Using *Room Temperature* and *Damper Percentage*

- High RT, low DP
 - Stuck vent



Heuristics Approach

Example: Using *Room Temperature* and *Damper Percentage*

- High RT, low DP
 - Stuck vent
- Low RT, high DP
 - Stuck vent



Energy Analytics 4

- Energy data
- Data Management
- Anomaly algorithms
- Heuristics approach
- **API**
 - Explanation
 - Implementation
- Website interface



API

- Previous comps groups developed an API that allowed for the extraction of values from one specific point over time

API

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 - Highly granular, very targeted querying of the database

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In practice:

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 - Zoomed out API endpoints

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 - Room level data

API

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In practice:

- More than any one particular point value, it was *the combination of point values within a given room* that signaled to facilities that a problem had arose
 - Zoomed out API endpoints
 - Room level data
 - Multiple point value readings at the same time

API

/anomalies/vent-and-temp

Parameters: start time, end time, vent, temp

API

/anomalies/vent-and-temp

Parameters: start time, end time, vent, temp

Big idea: “Show me all of the rooms on campus within a given time frame, where the temperature is greater than a particular threshold, but the vent isn’t opening wide enough to try and cool it down”

API

/anomalies/vent-and-temp

Parameters: start time, end time, vent, temp

Big idea: “Show me all of the rooms on campus within a given time frame, where the temperature is greater than a particular threshold, but the vent isn’t opening wide enough to try and cool it down”

Context: Facilities and directory of sustainability have identified this type of “vent/temp mismatch” as a common problem, one they’d like to be able to spot quickly

API

Energy Analytics
./energy-analytics-4/api

/anomalies/vent-and-temp?start_time=1636478378
&end_time=1636564778&vent=30&temp=75

API

```
/anomalies/vent-and-temp?start_time=1636478378  
&end_time=1636564778&vent=30&temp=75
```

“Show me all of the rooms that had a temperature greater than 75 and a vent angle of less than 30, between November 9th and November 10th, 2021”

API

/anomalies/vent-and-temp?start_time=1636478378
&end_time=1636564778&vent=30&temp=75

“Show me all of the rooms that had a temperature greater than 75 and a vent angle of less than 30, between November 9th and November 10th, 2021”

```
{
  "Boliou 140": {
    "damper_name": "BO.1.RM140:DMPR COMD",
    "temp_name": "BO.1.RM140:ROOM TEMP",
    "values": {
      "temp": [
        75.75, 76.25, 76.25, 76.50, 76.50, 76.50, 76.00, 75.50,
        75.25, 75.25, 75.25, 75.25, 75.25, 75.25, 75.25, 75.25,
        75.25, 75.25, 75.25, 75.25, 75.25, 75.25, 75.25, 75.75,
        75.25, 75.25, 75.25, 75.25, 75.25, 75.25, 75.75, 76.25,
        76.25
      ],
      "timestamp": [
        1636479000, 1636479900, 1636480800, 1636481700, 1636482600,
        1636483500, 1636484400, 1636485300, 1636533000, 1636533900,
        1636534800, 1636535700, 1636536600, 1636537500, 1636538400,
        1636539300, 1636540200, 1636541100, 1636542000, 1636542900,
        1636543800, 1636544700, 1636545600, 1636546500, 1636547400,
        1636548300, 1636549200, 1636550100, 1636551000, 1636561800,
        1636562700, 1636563600, 1636564500
      ],
      "vent": [
        0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
        0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0
      ]
    }
  }
}
```

Figure 4: JSON data returned by API heuristic query

Energy Analytics 4

- Energy data
- Data Management
- Anomaly algorithms
- Heuristics approach
- API
- **Website interface**
 - Dashboard
 - Heuristics



Website Interface

- Dashboard
 -

- Heuristics
 -

Website Interface

- Dashboard
 - Seamless, automated display of most important information

- Heuristics
 -

Website Interface

- Dashboard
 - Seamless, automated display of most important information

- Heuristics
 - In depth interactivity and experimentation

Website Interface - Heuristics

- Heuristics

Website Interface - Heuristics

- Heuristics
 - Simple heuristics: Finding points easier and quicker than anomaly search algorithms

Website Interface - Heuristics

- Heuristics
 - Simple heuristics: Finding points easier and quicker than anomaly search algorithms
 - Allowing facilities to play with data

Website Interface - Heuristics

- Heuristics
 - Simple heuristics: Finding points easier and quicker than anomaly search algorithms
 - Allowing facilities to play with data
 - Finding open windows

Website Interface - Heuristics

- Heuristics
 - Simple heuristics: Finding points easier and quicker than anomaly search algorithms
 - Allowing facilities to play with data
 - Finding open windows
 - Broken devices

Room temperature & Damper %

The screenshot shows a search interface with the following elements:

- Room Temperature:** A filter set to '> 68'. A red box highlights this filter, with a callout pointing to it that reads 'search for rooms with high temperature'.
- Damper %:** A filter set to '< 50'.
- Building:** A dropdown menu set to 'All Buildings'.
- Search:** A button labeled 'Search'.
- Date Range:** A date range selector showing '2/13 12:00 AM - 2/16 12:00 AM'.

Room temperature & Damper %

The screenshot shows a search interface with several input fields. A red box highlights the 'Room Temperature' field, which contains a greater-than sign and a dropdown arrow, followed by a text input containing the number '68'. A blue box highlights the 'Damper %' field, which contains a less-than sign and a dropdown arrow, followed by a text input containing the number '50'. To the right of these fields is a 'Building' dropdown menu set to 'All Buildings' and a 'Search' button. Below the search fields is a date range selector with a calendar icon and the text '2/13 12:00 AM - 2/16 12:00 AM'. Two callout lines originate from the red and blue boxes: a red line points to the text 'search for rooms with high temperature' and a blue line points to the text 'search for rooms with low damper %'.

Room Temperature > ▾ 68

Damper % < ▾ 50

Building All Buildings ▾

Search

2/13 12:00 AM - 2/16 12:00 AM

search for rooms with high temperature

search for rooms with low damper %

Room temperature & Damper %

The screenshot shows a search interface with three main filter sections: Room Temperature, Damper %, and Building. A date range filter is also present below the Damper % section. A 'Search' button is located to the right of the Building filter. Three callouts with colored lines point to the filters: a red callout for Room Temperature, a blue callout for Damper %, and a yellow callout for Building.

Room Temperature > 68

Damper % < 50

Building All Buildings

Search

2/13 12:00 AM - 2/16 12:00 AM

search for rooms with high temperature

search for rooms with low damper %

search by building

Room temperature & Damper %

The screenshot shows a search interface with four main components highlighted by colored boxes and lines pointing to explanatory text:

- Room Temperature:** A red box highlights the 'Room Temperature' field with a dropdown arrow and the value '68'. A red line points to the text: "search for rooms with high temperature".
- Damper %:** A blue box highlights the 'Damper %' field with a dropdown arrow and the value '50'. A blue line points to the text: "search for rooms with low damper %".
- Building:** A yellow box highlights the 'Building' dropdown menu with the value 'All Buildings'. A yellow line points to the text: "search by building".
- Time Frame:** A green box highlights the date and time range '2/13 12:00 AM - 2/16 12:00 AM'. A green line points to the text: "search by time frame".

A 'Search' button is located to the right of the 'Building' dropdown.

Room temperature & Damper %

Energy Analytics
./energy-analytics-4/website-interface

Carleton Energy Dashboard

Dashboard
Search
Anomaly Heuristics
About

Heuristics Search

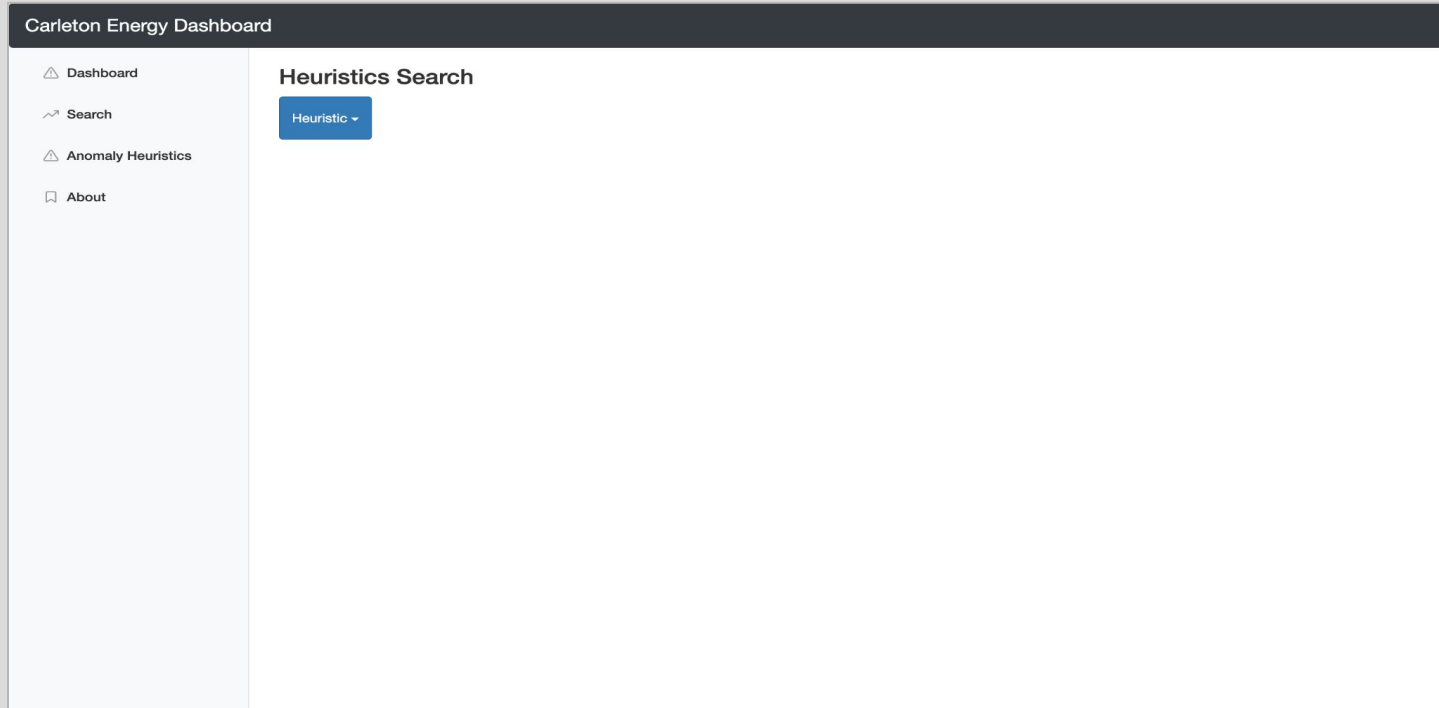
Room Temperature/Vent

Room Temperature > 75 Damper % < 30 Building All Buildings Search

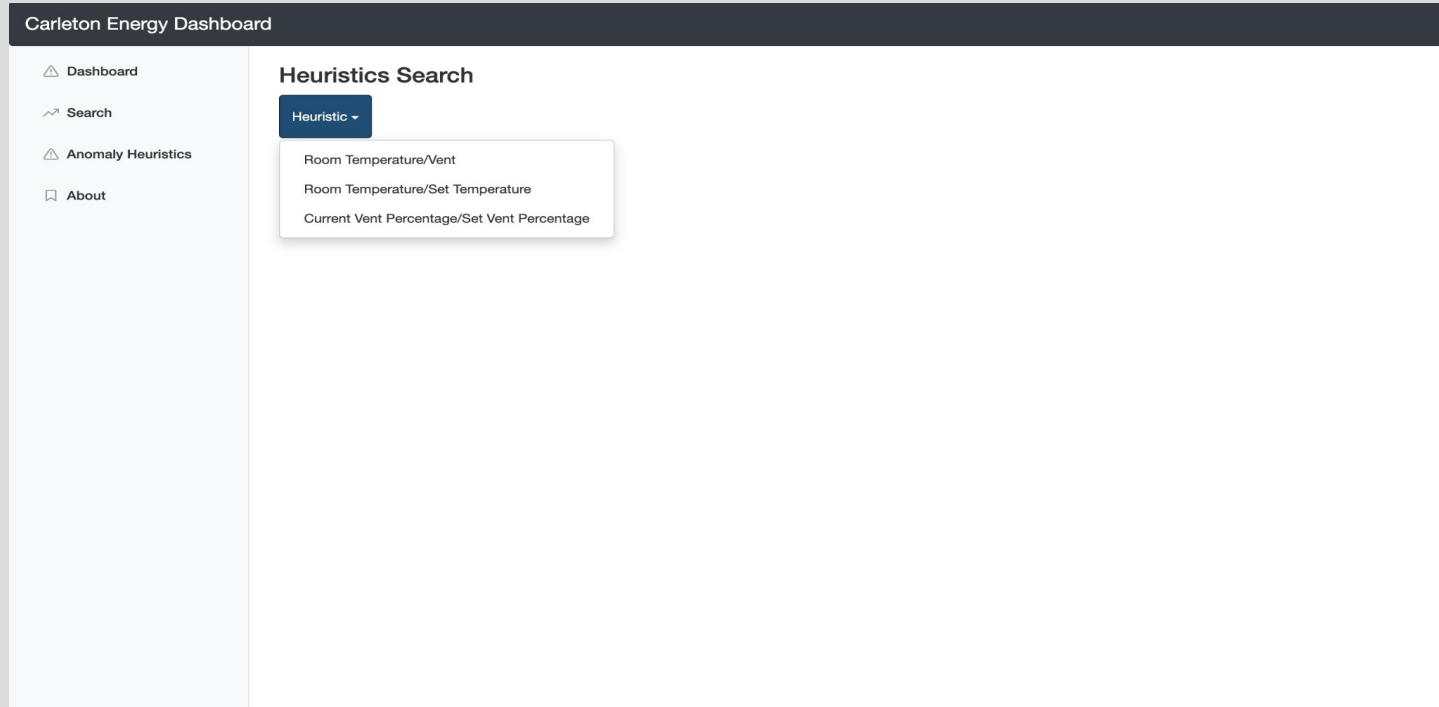
9/01 12:00 AM - 9/17 12:00 AM

Building & Room	Room Temperature	Damper Percentage	Date & Time
Boliou 020	76.5	0	Oct 01 2021 12:15 AM
Boliou 031	75.5	0	Oct 06 2021 05:15 PM
Boliou 032	75.75	0	Oct 16 2021 12:30 AM
Boliou 042	76.5	0	Oct 01 2021 12:15 AM
Boliou 044	78.25	0	Oct 01 2021 12:15 AM
Boliou 046	75.5	28.8	Oct 07 2021 10:00 PM
Boliou 047	75.5	0	Oct 11 2021 08:00 PM
Boliou 050	75.5	0	Oct 14 2021 01:45 AM
Boliou 055	75.75	0	Oct 06 2021 04:15 AM
Boliou 140	79.5	0	Oct 02 2021 06:15 AM
Boliou 142	80	0	Oct 02 2021 12:15 AM
Boliou 144	81.5	0	Oct 01 2021 12:15 AM
Boliou 145	79.25	0	Oct 01 2021 12:15 AM

Heuristics: Functionality



Heuristics: Functionality



Heuristics: Functionality

Carleton Energy Dashboard

- Dashboard
- Search
- Anomaly Heuristics
- About

Heuristics Search

Room Temperature/Vent

Room Temperature > 68 Damper % < 50 Building All Buildings Search

2/20 12:00 AM - 2/20 12:00 AM

Heuristics: Functionality

The screenshot displays the 'Carleton Energy Dashboard' with a sidebar on the left containing navigation links: 'Dashboard', 'Search', 'Anomaly Heuristics', and 'About'. The main content area is titled 'Heuristics Search' and features a blue dropdown menu currently set to 'Room Temperature/Vent'. Below this, there are three search criteria: 'Room Temperature' with a greater-than sign and a value of 78; 'Damper %' with a less-than sign and a value of 30; and 'Building' with a dropdown menu set to 'All Buildings'. A 'Search' button is positioned to the right of these criteria. At the bottom, a date range selector is set to '2/20 12:00 AM - 2/20 12:00 AM'.

Heuristics: Functionality

The screenshot shows the 'Carleton Energy Dashboard' with a sidebar on the left containing navigation links: Dashboard, Search, Anomaly Heuristics, and About. The main content area is titled 'Heuristics Search' and features a blue button labeled 'Room Temperature/Vent'. Below this, there are three search criteria: 'Room Temperature' with a dropdown arrow and a value of 78; 'Damper %' with a dropdown arrow and a value of 30; and 'Building' with a dropdown menu open showing options: All Buildings (checked), Evans, Hulings, Townhouses, Weitz, Cassat, and Boliou. A date range selector shows '2/20 12:00 AM - 2'. A 'Search' button is located to the right of the building dropdown.

Heuristics: Functionality

Carleton Energy Dashboard

- Dashboard
- Search
- Anomaly Heuristics
- About

Heuristics Search

Room Temperature/Vent

Room Temperature > 78 Damper % < 30 Building Boliou Search

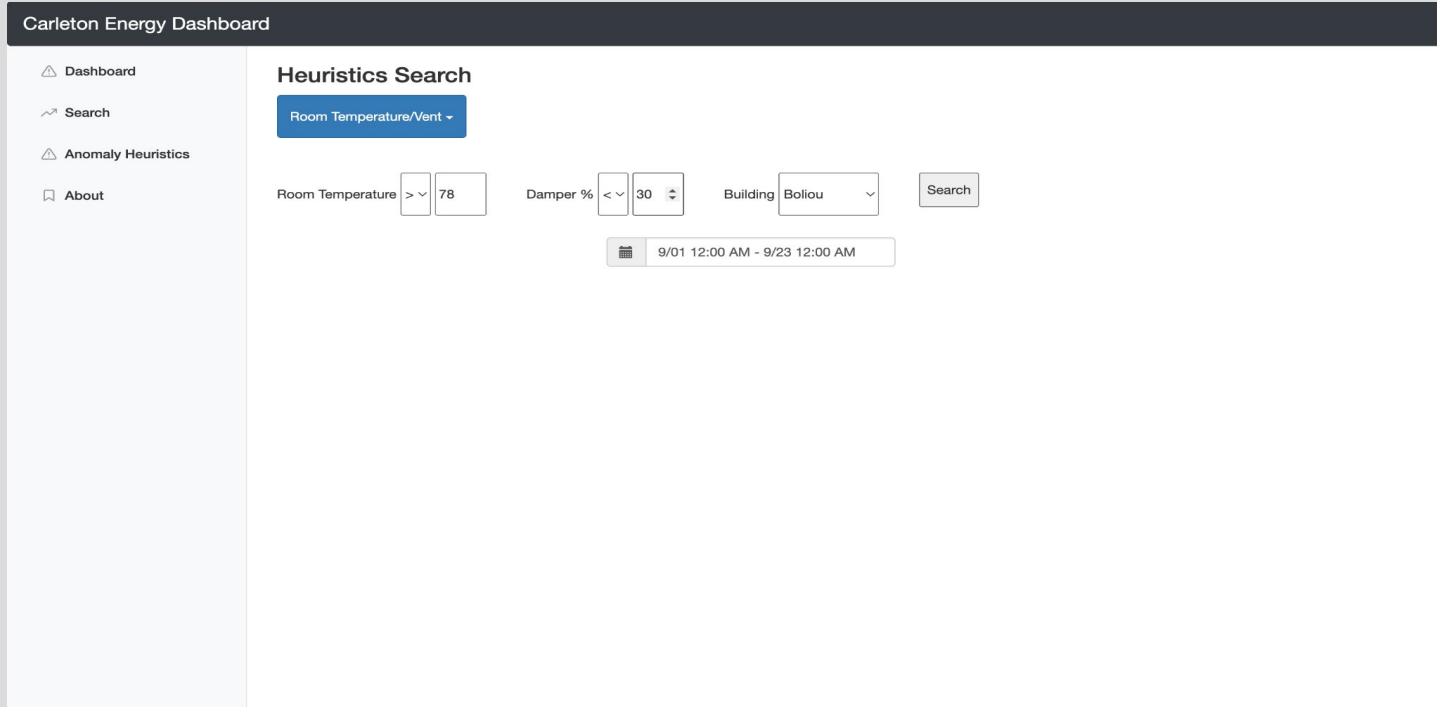
2/20 12:00 AM - 2/20 12:00 AM

Sep 2021							Oct 2021						
Su	Mo	Tu	We	Th	Fr	Sa	Su	Mo	Tu	We	Th	Fr	Sa
29	30	31	1	2	3	4	26	27	28	29	30	1	2
5	6	7	8	9	10	11	3	4	5	6	7	8	9
12	13	14	15	16	17	18	10	11	12	13	14	15	16
19	20	21	22	23	24	25	17	18	19	20	21	22	23
26	27	28	29	30	1	2	24	25	26	27	28	29	30
3	4	5	6	7	8	9	31	1	2	3	4	5	6

12 : 00 AM

9/01 12:00 AM - 9/23 12:00 AM Cancel Apply

Heuristics: Functionality



Heuristics: Functionality

Carleton Energy Dashboard

Dashboard
Search
Anomaly Heuristics
About

Heuristics Search

Room Temperature/Vent

Room Temperature > 78 Damper % < 30 Building Boliou Search

9/01 12:00 AM - 9/23 12:00 AM

Building & Room	Room Temperature	Damper Percentage	Date & Time
Boliou 042	79.75	0	Oct 18 2021 10:30 PM
Boliou 044	78.25	0	Oct 16 2021 01:15 PM
Boliou 046	78.5	0	Oct 19 2021 01:15 PM
Boliou 140	82	0	Oct 11 2021 01:30 PM
Boliou 142	82.75	0	Oct 05 2021 03:00 PM
Boliou 144	82.25	0	Oct 04 2021 03:45 PM
Boliou 145	80	0	Oct 11 2021 03:45 PM
Boliou 146	81.5	0	Oct 05 2021 04:45 PM
Boliou 148	80.5	0	Oct 05 2021 08:15 PM
Boliou 149	81	0	Oct 05 2021 01:15 PM
Boliou 151	80.75	0	Oct 05 2021 03:30 PM
Boliou 152	81.5	0	Oct 19 2021 02:15 PM
Boliou 155	78.25	15.2	Oct 20 2021 07:45 AM

Website Interface - Heuristics

- Functionality of heuristics page
 - Limitations of data and current heuristics
 - Potential of current heuristics
 - Future heuristics and their value

Website Interface - Dashboard

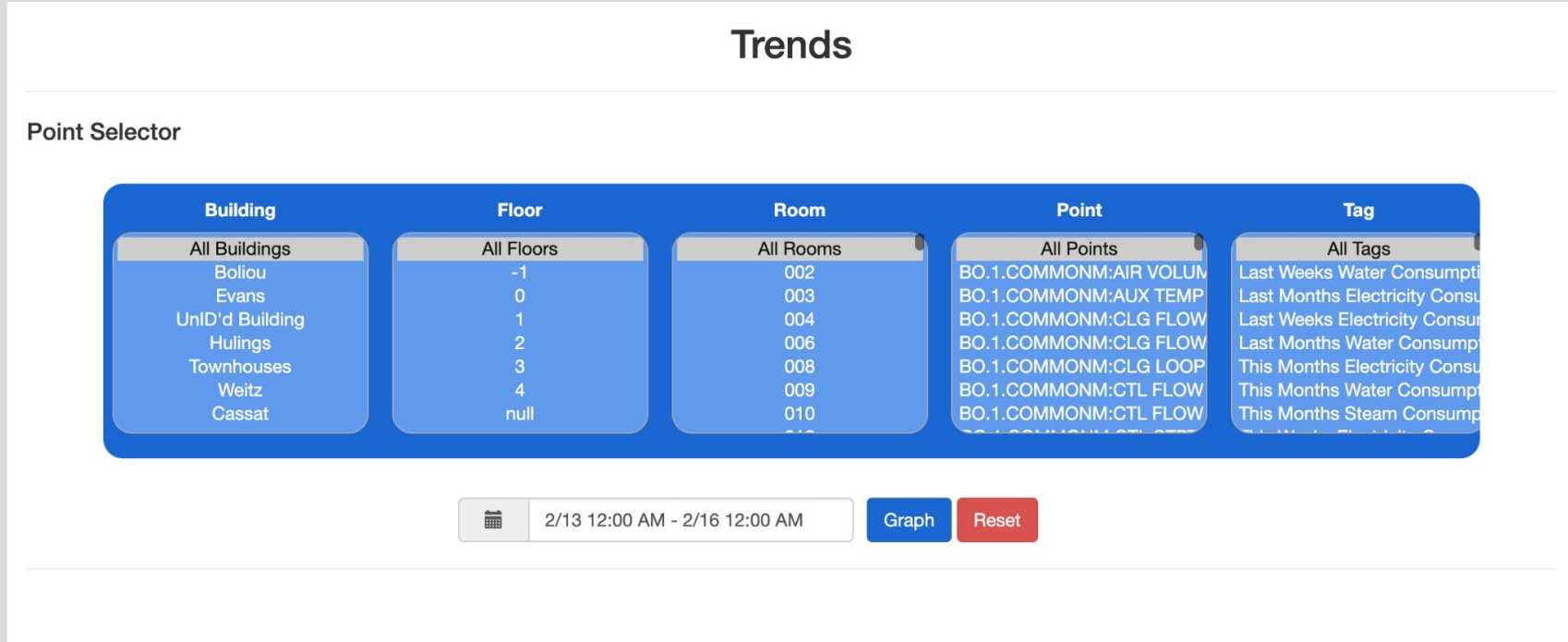


Figure 6: Point search tool

Website Interface - Dashboard

Potential Problems

Temp/Vent Mismatches (T > 75°, V < 30%)

Room	Date & Time	Room Temperature	Damper Percentage
Boliou 140	11:30 Nov 9	75.75°	0%
	11:15 Nov 10	76.25°	0%
Boliou 142	11:30 Nov 9	76.25°	0%
	11:15 Nov 10	76.75°	0%
Boliou 155	5:30 Nov 10	75.25°	10.4%
	9:45 Nov 10	75.5°	14.4%

Figure 7: Dashboard populated by potentially anomalous rooms

Overview

- Introduction
- Energy Analytics 4
- Conclusion



Overview

- Introduction
- Energy Analytics 4
- **Conclusion**
 - Challenges
 - Our work
 - Moving Forward
 - Acknowledgements



Conclusion

- Challenges
- Our work
- Moving Forward
- Acknowledgements



Conclusion

- **Challenges**
 - Legacy code
 - Data standardization & pipeline
 - API Documentation
 - Data Access
- Our work
- Moving Forward
- Acknowledgements



Challenges

- Legacy code
- Data standardization & pipeline
- API Documentation
- Data Access

Challenges

- **Legacy code**
- Data standardization & pipeline
- API Documentation
- Data Access

Legacy code

- Working but not fully documented
- Incomplete & didn't work (STL)
- Irrelevant or with unclear purpose

Challenges

- Legacy code
- **Data standardization & pipeline**
- API Documentation
- Data Access

Data & pipeline

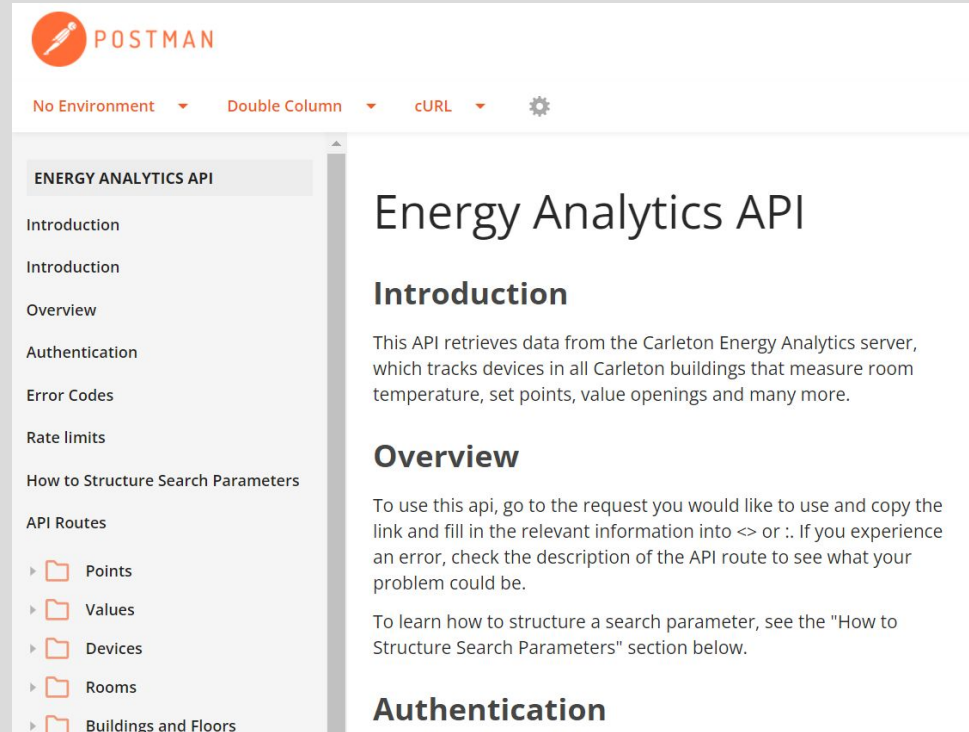
- Missing data
 - ALC, Wind, Windows upgrade
- Data integration
 - Siemens, ALC, Wind different formatting
- Ownership/Permissions
 - Automation didn't go through, files couldn't run, data unmovable

Challenges

- Legacy code
- Data standardization & pipeline
- **API Documentation**
- Data Access

API documentation

- No access to edit
- Incomplete sections



The screenshot shows the Postman interface for the Energy Analytics API. The top navigation bar includes the Postman logo, "No Environment", "Double Column", "cURL", and a settings gear. The left sidebar lists the API sections: Introduction, Overview, Authentication, Error Codes, Rate limits, How to Structure Search Parameters, and API Routes. The API Routes section is expanded to show folders for Points, Values, Devices, Rooms, and Buildings and Floors. The main content area displays the "Energy Analytics API" title, followed by an "Introduction" section with a paragraph describing the API's purpose and an "Overview" section with instructions on how to use the API and a link to the "How to Structure Search Parameters" section. The "Authentication" section is also visible at the bottom.

Challenges

- Legacy code
- Data standardization & pipeline
- API Documentation
- **Data Access**

Data access

- No access to data from the points

Conclusion

- Challenges
- **Key takeaways**
 - Standardization and compression
 - User-friendly web interface
 - Dynamic heuristics concept
- Moving Forward
- Acknowledgements



Key takeaways

- Data standardization and compression system

`bolliou1_10-21-21_04-30.csv`



`2021-10-21-bolliou1-04-30.csv`



`2021-10-bolliou`



`2021-10-bolliou.tar.gz`

Key takeaways

- Data standardization and compression system
- User-friendly Dashboard and Heuristics page

The screenshot displays the 'Carleton Energy Dashboard' with a sidebar on the left containing navigation links: 'Dashboard', 'Search', 'Anomaly Heuristics', and 'About'. The main content area is titled 'Heuristics Search' and features a dropdown menu currently set to 'Room Temperature/Vent'. Below this, there are input fields for 'Room Temperature' (set to 78), 'Damper %' (set to 30), and 'Building' (set to 'Bollou'). A 'Search' button is positioned to the right of these fields. A date range selector is set to '2/20 12:00 AM - 2/20 12:00 AM'. Below the date selector are two calendar views for 'Sep 2021' and 'Oct 2021'. The 'Sep 2021' calendar has the 1st, 23rd, and 24th highlighted. The 'Oct 2021' calendar has the 1st, 2nd, 3rd, 4th, 5th, and 6th highlighted. At the bottom of the interface, there are time range selectors for '12 : 00 AM' and '12 : 00 AM', and a final date range selector set to '9/01 12:00 AM - 9/23 12:00 AM' with 'Cancel' and 'Apply' buttons.

Key takeaways

- Data standardization and compression system
- User-friendly Dashboard and Heuristics page
- Heuristics concept robust for further development
 - Room temp vs. set temp
 - Vent angle vs. set vent angle

Conclusion

- Challenges
- Key takeaways
- **Moving Forward**
 - More heuristics
 - Machine learning algorithms
 - Data integration
- Acknowledgements



Moving forward

- Further implementation of heuristics
 - Room temp vs. set temp
 - Vent angle vs. set vent angle

Moving forward

- Further implementation of heuristics
 - Room temp vs. set temp
 - Vent angle vs. set vent angle
- Machine learning algorithms
 - K-means
 - Isolation forests

Moving forward

- Further implementation of heuristics
 - Room temp vs. set temp
 - Vent angle vs. set vent angle
- Machine learning algorithms
 - K-means
 - Isolation forests
- Data integration
 - Siemens and ALC
 - Wind Turbine data

Conclusion

- Challenges
- Key takeaways
- Moving Forward
- **Acknowledgements**



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Questions

Energy Analytics
./questions