Diagnostic Visualisation of *Building Management System* Energy Data

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IODiCUS
Interoperable Open Digital Control Unit System

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Background

- Local Energy Systems management – campus scale
  - e.g. Overall energy & peak demand reduction and demand shifting/balancing with renewable generation and storage
- University of Bristol campus
  - Large estate of buildings, ranging from offices and student halls to state-of-the-art research labs and light industrial buildings, …
- Large volumes of rich Building Management System (BMS) data
- Difficult for facilities/energy managers to make practical use of …
  - High-level aggregated data (e.g. half hourly meter, aggregate BMS state)
  - Low level sensor or BMS ‘node’ level

Working with Facilities/Energy Managers

- Key Needs Identified
  - Obtaining an overview of energy use and energy using behaviours across various timescales, device types, site & building structural scales, etc.
  - Patterns and variations in behaviours of buildings and residents
  - Evaluation of existing and pilot energy management initiatives
  - Spotting anomalies, such as areas of high or low energy use that might require further investigation, sensor errors, etc.

BMS Data – Typical Example

- *Prefect* BMS over electrical heating systems in student halls
- BMS has 100s of ‘nodes’ (combined sensor/actuator)
  - Each node is sampled for state data approx. every 300 seconds
  - **Sensor data per sample**: node ID, date-time, temperature, thermostat set-point, power relay status (on-off), energy management program in operation, temperature manually adjusted, …
  - **Metadata**: power rating of node device (Watts), type of node (water heater, corridor heater, room heater, etc.), building, building story, etc.
- Sense of “… drowning in data”

Prototype Analytical Interface

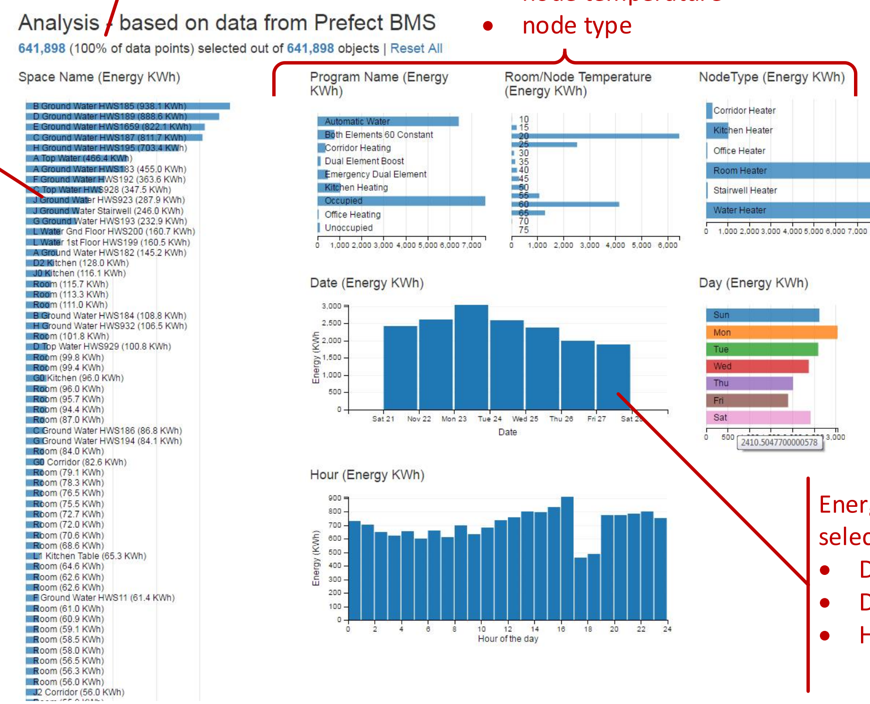
- Sensor and metadata combined

- Calculate/estimate energy use (relay time on * power rating)
- Choose interesting 'dimensions'
- Sum energy for dimensions
- Interactively filter data
- Open source libraries*

Number and % of data points selected

Energy use (kWh) of selection by
- operational 'program'
- node temperature
- node type

Energy use (kWh) of each 'node'* for given filters

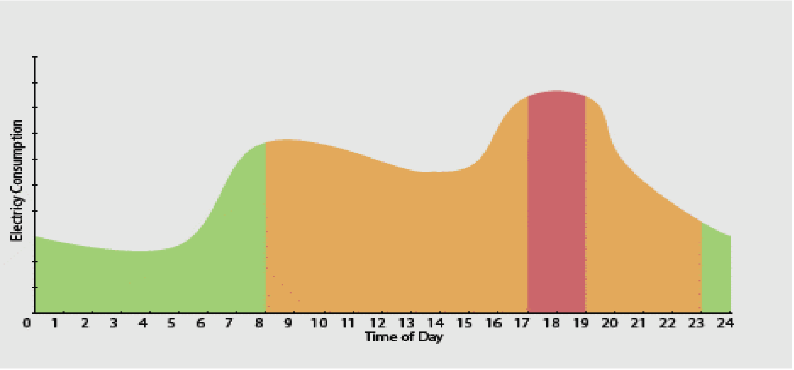


Energy use (kWh) of selected data by:
- Date
- Day of the week
- Hour of the day

Demo

- IODiCUS → Evaluate effectiveness of BMS energy use reduction programmes to:

  ‘avoid red-DUoS (peak) electricity cost charges between 5-7pm on weekdays’



Enhancements - examples

- Configure for other 'dimensions' e.g. temperature adjusted by resident, building structure (building, storey), room orientation (study solar gain), …
- Other core metrics kWh → count of samples, £ and kgCO_2(e)
- Other types of chart (d3.js javascript library very rich in options)
- Other kinds of linked interactive 'drill down' and analytical interfaces

Limitations – examples

- Slow to load and sluggish on date-time dimensions with large datasets > 500k rows
- 700,000 to 1,400,000 samples practical limit
  - Means one week whole site *or* months for a block, …
  - Possible solutions
    - aggregating data-points, dynamic pre-filtering of data, exploring ways to support more data points, …
- BMS sensor and configuration errors – leads to under and over estimation of energy use (values indicative only)
- Uses BMS state data but some BMSs supply event (state change) data

Questions?

Thank you