ContextViz: Making Context and Systems Knowledge Visible in Non-Domestic Energy Demand Dashboards

Christian Remy[1,*], Oliver Bates[1] and Adrian Friday[1]

[1]School of Computing and Communications, Lancaster University, UK

Abstract

Dashboards are omnipresent in energy management environments to visualise energy data, aiding non-domestic energy demand reduction. Through the design and live deployment of ContextViz in an campus energy management setting, our demo presents our investigation of how the analysis and visualisation of energy data can be made more insightful for energy stakeholders (e.g., facilitates managers) and support organisational decision making for carbon reduction. Our research highlights two primary reasons for the current limitations in the effectiveness of energy demand dashboards: 1) broken data pipelines; and, 2) and a lack context and system knowledge being made visible at the point of decision making. Supplementing our live demo, we share our insights from user studies and experiences of including stakeholders in the design process.

Keywords

Energy Dashboard, Context, Systems Knowledge, User Centred Design, Energy Data, Net Zero,

1. Introduction

Non-domestic energy management has access to a growing volume of data made possible by more affordable sensors, cloud data services, and an increased level of integration of ubiquitous technologies embedded in modern buildings and energy systems. However, this growing volume of 'available' data does not automatically translate into more useful insights and sustainable energy practices. Anomalies and errors often hide in the granular details of this increasing volume of data, confounding analysis of energy savings, and compounding the need for already overlooked resources and tools that clean and error-check to generate usable and impactful insights.

In this demonstration we will report on our experiences as part of the NetZeroInsights (net0i) project, of designing and building ContextViz, a mixed-methods energy dashboard deployed to support facilities management stakeholders (e.g., energy mangers, facilities managers, energy analysts) working at the Lancaster University campus. This project is the culmination of a decades' experience working to support facilities management with the development of digital interventions that bridge the gap between stakeholder needs and commercial building and energy ICT services, i.e. Building Management Systems (BMS) and Energy Monitoring Systems (EMS) [1, 2, 3]. The goal of the project was to develop tools (e.g., dashboards, code libraries) for energy management stakeholders, enabling decision making for Net Zero and decarbonisation through novel analytical tools that provide actionable insights grounded in commercial energy data.

2. ContextViz: Design and implementation

Following an iterative User Centred Design process we have developed a custom energy dashboard, ContextViz. The dashboard (see Figure ??) runs on an on-premises server on the university campus drawing data from an time-series Influx database into a Python flask API. Metadata is stored in an Apache Jena ontology supplemented by information in local CSV files. The front-end UI runs the same Python flask instance and utilises lightweight JavaScript libraries: datatables, plotlyjs and Mazemap. A preliminary limited version of the code base is available from github as well as a public demo utilising

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*Corresponding author.

c.remy@lancaster.ac.uk (C. Remy); o.bates@lancaster.ac.uk (O. Bates); a.friday@lancaster.ac.uk (A. Friday)

historic energy data. Due to the commercial sensitivity of real-world commercial data used in this project, we will be demoing the public version at the conference.

Figure 1 shows the first implemented prototype that was the first request our main stakeholder group wanted. It was inspired by facilities department vision of a map view as a starting page, and draws on other similar public designs, such as the Stony Brook University and UC Davis CEED energy dashboards[1] [2]. User tests monitoring the interactions of energy stakeholders with the map interface, have since revealed that such a mapping feature looks great for a demo or for public communication, but is not effective when trying to practically evaluate energy efficiency across the estate or find erroneous data. In fact, this view could be said to have acted as a barrier to energy management practice. In response to energy managers normative practice, data can be explored in lists, tables and graphs such as bar charts of energy intensity, comparisons with normative demand for a given building type, and data quality. Through the design process it became apparent that a plethora of undocumented and unknown errors in the data streams were a key barrier that we needed to help the stakeholders surface to contractors in order to effect repair and maintenance of the energy data infrastructure. The data quality pipeline, system knowledge and ontology capturing this, are all critical to enable effective further analysis of such data.

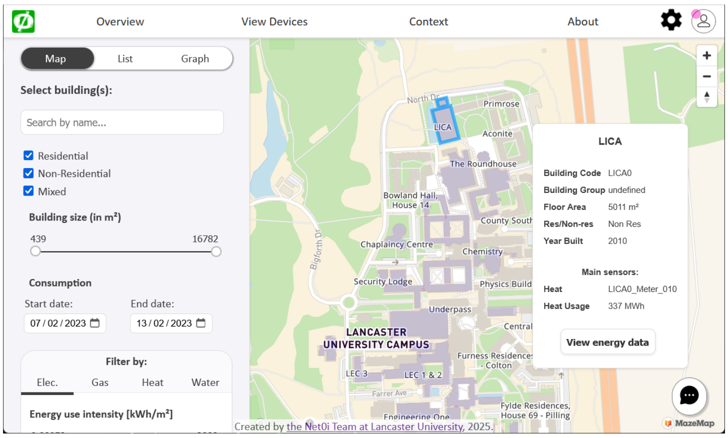

Figure 1: An energy map of campus.

3. Data error handling

There is a plethora of tools to visualise and analyse data, however, data streams 'in the real world' are rarely fit to be used in those tools without extensive preprocessing. This pipeline includes removing outliers, recognising faulty readings, misconfigurations, or simply stripping series of zero data that are not supposed to be returning zero. 'Off-the-shelf' dashboards do not provide the tools for such data processing because there is no one-size-fits-all approach as every data environment is unique. In our case, for example, we identified different cases of zeros: absent data, zero readings that should not be zero (such as in cumulative meters), zeroes because of an issue in the pipeline (such as the intermediate API or network failures), or true zeroes

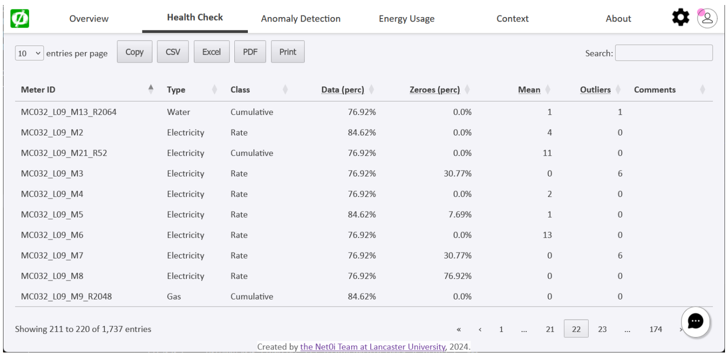

Figure 2: Data Health Check View

[1] Stony Brook University Energy Dashboard
[2] UC Davis CEED Energy Dashboard

(where no energy has been used for a energy rate meter) – with only the latter needing to be kept.

In several iterations and collaboration with statisticians and mathematicians we arrived at a health check tool displayed in Figure 2 that provides a list of all meters along with several statistical analyses over a fixed period of time. This resulted in energy management being able to pinpoint which meters were truly broken and needed further investigation which need to be monitored and which meters are fit for analysis in more sophisticated dashboards. We are in constant exchange with energy management to refine the analysis, in an attempt to reduce the burden for detecting broken or sub-optimal energy use patterns.

4. Context and Systems Knowledge in dashboards

From our initial engagements with energy stakeholders strongly grounded in our prior mixed-methods energy demand research [4, 3, 2] and critiques of contemporary dashboard design [5] our primary design goals for usable energy dashboards was finding ways to embed contextual and systems knowledge throughout the tools we were designing.

This can be seen in Figure 2 in the context column on the right, but also in the bottom right corner of Figure 1. Clicking 'on the speech bubble' will open a context dialogue allowing the user to input a comment connected to a meter and optionally timestamp or time frame. This context can then be displayed anywhere in the dashboard where data from this meter is being used to inform users of the dashboard of potential errors, important information regarding a meter, or special exceptions such as a one time event that affected a series of data. An example of the context dialogue can be seen in Figure 3.

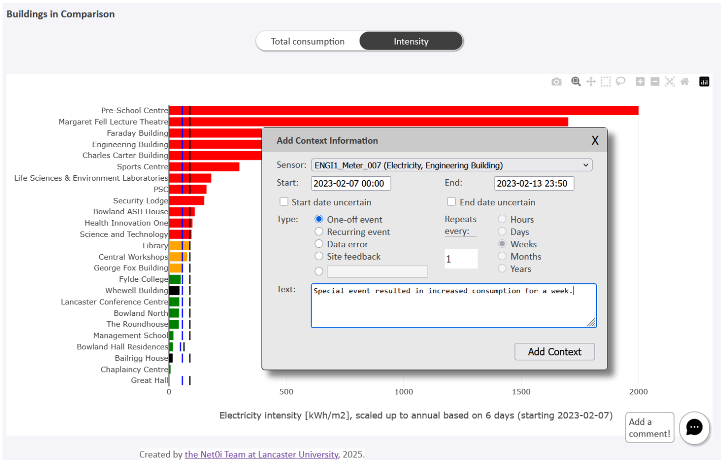

Figure 3: Surfacing Contextual data and Systems Knowledge

We believe this context and systems knowledge *is the single most important* aspect to truly unravel the full complexity of energy data and energy demand reduction in complex non-domestic settings using dashboards and similar digital analytics tools. While statistical analysis *can* provide crucial insights such as change points or anomalies, it is often outliers and events that provide insights into potential for energy savings. Without the transparent and documented process to make information about interventions changes and infrastructure or one of events transparent, a dashboard might lead to misinterpretation or loss of insight.

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