Session 4
Macquarie University Energy Audits - Using Big Data
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Shane is a Director with Umow Lai and Principal of Umow Lai's specialist Sustainability group. Shane is one of Australia's leading sustainability consultants having pioneered the integration of many sustainability principles to the built environment in Australia and overseas. Shane's has worked on some of the world's leading sustainable buildings, particularly within the University and Education sectors. A key focus of Shane's recent work is on improving building performance through the harnessing of big data.

Conducting energy audits on an individual building basis is a well understood and practiced science following a relatively straight forward sequence of events:
1. Review the energy consumption
2. Inspect the building and talk to the occupants
3. Analyse the results
4. Consider how the building could be cost effectively improved
5. Recommend upgrades and behaviour changes as necessary

However, when multiplying out this process across dozens of buildings, such as a University campus, this process can become incredibly time consuming and, consequently, *expensive*.

Additionally the amount of report documentation and results can be overwhelming and difficult to manage with a lot of the information represented qualitatively within reports.

The result is often a simplified overview with 'blanket' upgrades being proposed, which do not reflect the rigour and the detail of the work undertaken and has limited value, unless the client is willing and able to dissect the reports themselves.

The Umow Lai Way
When Umow Lai approached the University of Macquarie's Sydney Campus, which consists of over 200,000sqm of occupied floor area across 60 buildings, we wanted to address this issue in a 21st Century fashion. We set about creating a reporting methodology that quantified all aspects of the building and formed a database of building attributes and building upgrades.

This process enabled us to powerfully interpret, explore and present the results from our audits succinctly at both a building and site-wide level.

Desktop analysis of the campus metered data using 'Big Data' analysis software to crunch millions of rows of electricity data at 15 minute intervals across a year and perform detailed analysis including energy consumption, greenhouse gas emissions, peak and off-peak costs, demand charges, overnight loads, peak loads, power factors, weekends, holidays, response to ambient temperatures etc.

This analysis is a product of our research and development work around what we can do with smart meter data which is rapidly being rolled out across Australia. The insights are remarkable compared to simple analysis of energy bills and the data is routinely accessible.
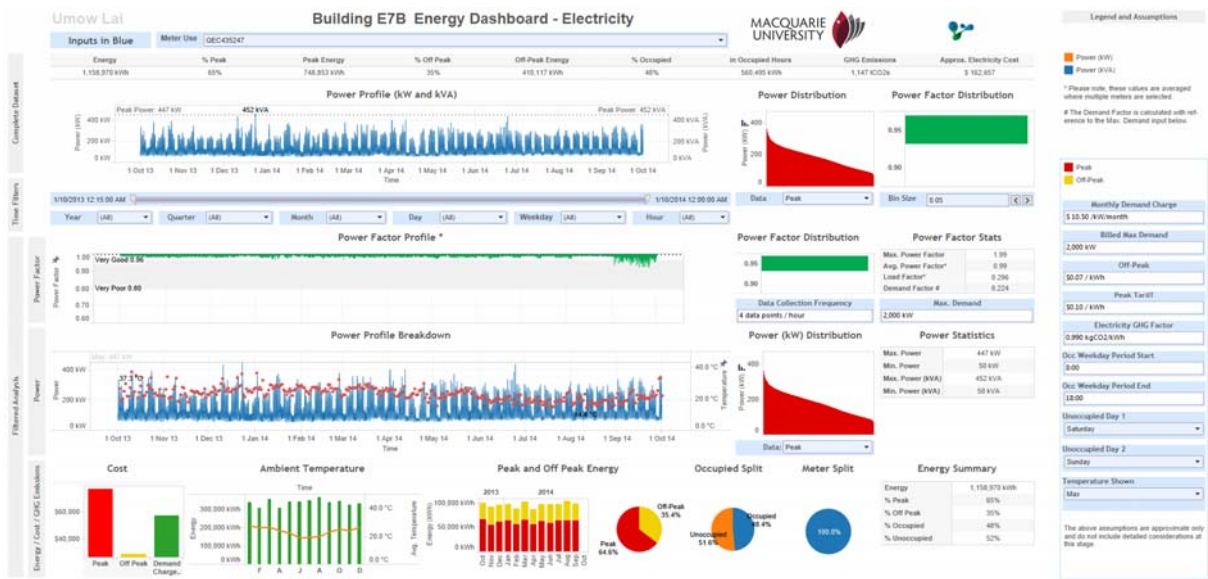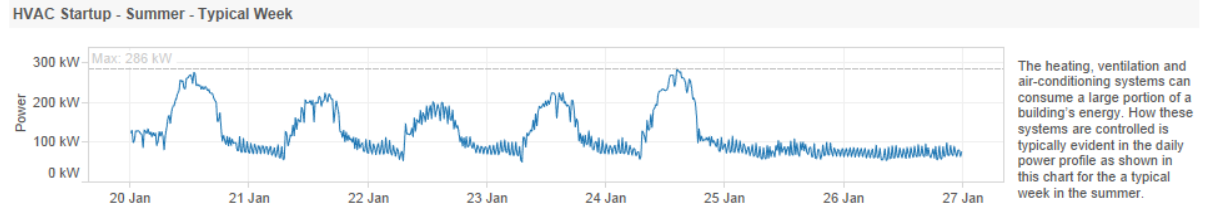
Figure 1 - Electricity Metering Analysis Dashboard

Figure 2 - Example of Detail that can be extracted

On-site inspections were undertaken for all buildings on-site and unfortunately there is little opportunity for saving time here! We recognise the importance of getting on-site and talking to occupants as they can offer very interesting insights whilst also potentially revealing some of their bad habits.

As most existing buildings are not extensively sub-metered, we estimated the breakdown of energy consumption across the HVAC, Lighting, Equipment and other uses through detailed consideration of the building space types, usage and energy mix with an additional adjustment on the basis of our scoring system.
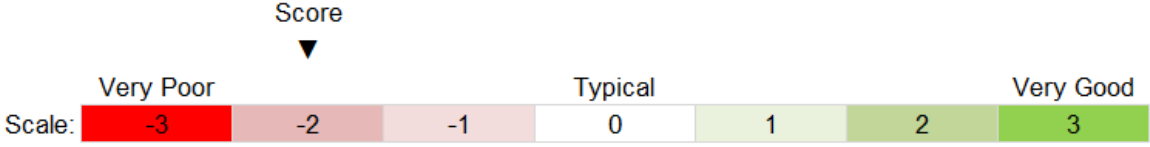

Figure 3 - Traffic Light Scoring System

This -3 to +3 or "traffic light" scoring system applied to all aspects of the building including the fabric, ventilation and various controls which also acted as a quantifiable grade.

Back at the office, working with engineers from various disciplines, we identified and costed upgrades to enable the building to achieve an improved score across each category which in turn was used to estimate energy savings, payback and greenhouse gas reductions.

The results from the energy meter analysis were also quantified using a traffic light system and fed into the building report.

The fully customised reporting process was heavily automated on the basis of a myriad of carefully selected inputs following a series of reviews with Macquarie University's Sustainability and Facilities Management teams.
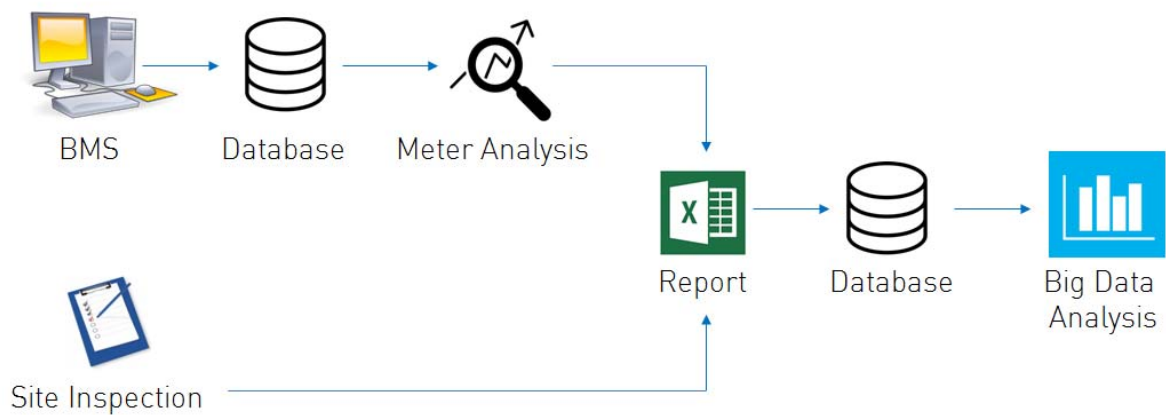
Figure 4 - Process Diagram

This process produced a database of all of the results that we could analyse using the latest technology and data analytics techniques.

Exploring the results led to many interesting insights into the University's existing building stock performance, such as:

- Identification of low cost and cost effective upgrades for each and every building, the 'low-hanging fruit'.
- Mapping allocated scores for various indicators across the campus.
- Performance analysis of the University's various district energy network systems.
- Marginal Abatement Cost (MAC) Curve analysis simultaneously assessing GHG and Payback across the existing building stock.
- Site-wide PV opportunity assessment.
- Analysis of building age vs building performance.
- Determining the 'Big Bad Buildings' in order to identify which to focus on.
- Comparison to COAG Typical University Building Benchmarks.
- Analysis of potential GHG reductions and comparisons to the Universities 50% 2030 target.

The work is currently in the final stages and the Client has been very impressed with the delivery of a wealth of accessible, concise and well presented results enabling them to take a clear and informed direction with their future upgrade works.

Figure 5 - Mapped Data: Can be explored using filters and menus

Figure 6 - Building Upgrade Analysis - all upgrades, all buildings