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Integrating building services data for energy efficiency and cost saving investment

Glasgow City Council

Background

Working in partnership with the Scottish Government, IES was commissioned by Glasgow City Council to carry out a one year Proof of Concept study to investigate building optimisation opportunities through the analysis of data gathered from a number of sources and a range of buildings. These data sources included Automatic Meter Reading (AMR), Building Management Systems (BMS), sub-metering, building schematics and schedules. The project began in July 2013 and was completed in August 2014.

Motivation

The main purpose of the project was to explore how analysis of data already available could be used to refine Glasgow City Council's building management and energy investment strategies and Return on Investment (ROI) targets. Buildings selected for the project included:

- Glasgow City Chambers
- Exchange House
- Collegelands
- Riverside Primary School

The selection criteria allowed for a broad variety of construction styles, ages and operational functions, so that lessons learned could be applied across a wide range of the Council's estate; while clustered regions were also chosen specifically to review what district heating opportunities could be explored further.

Glasgow City Council full building

IES Virtual Environment (IESVE) software models were created to run scenarios comparing early stage design with daily operation, incorporating AMR and BMS data from the selected buildings.

Development

Data availability was an initial obstacle in this project, with 90% of available data coming from AMR sources and only 10% from BMS sources. While good quality half hourly AMR records existed, some going back ten years, these tended to be for electricity alone, as gas AMR technology had only been fitted relatively recently (sometimes just six months previous to project set up). Data gaps also existed, particularly where the utility provider had changed.

To overcome these issues, project consultants had to fill the AMR data gaps with suitable data, i.e. data from the same month but from the previous or subsequent year. AMR data was extracted from the utilities companies' platforms and uploaded into the IES SCAN technology. BMS data collection from a variety of applicable makes, models and software types also made interrogation challenging, particularly as there tended to only two forms of sensor: IAQ (Indoor Air Quality) and MEP (Mechanical & Electrical Processes). In addition, BMS data stores tended

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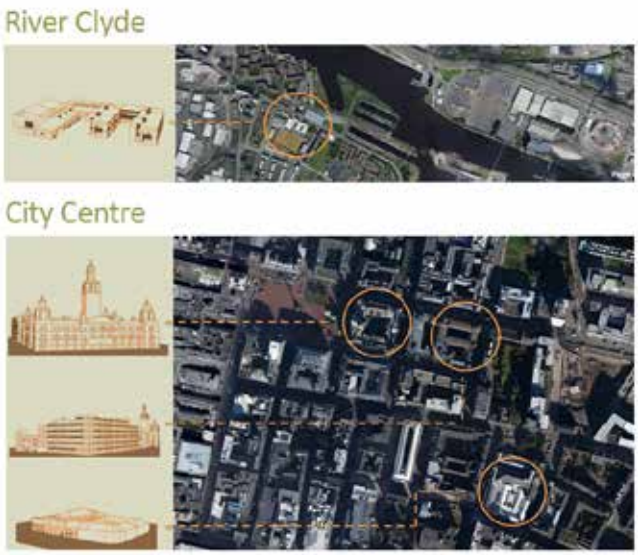
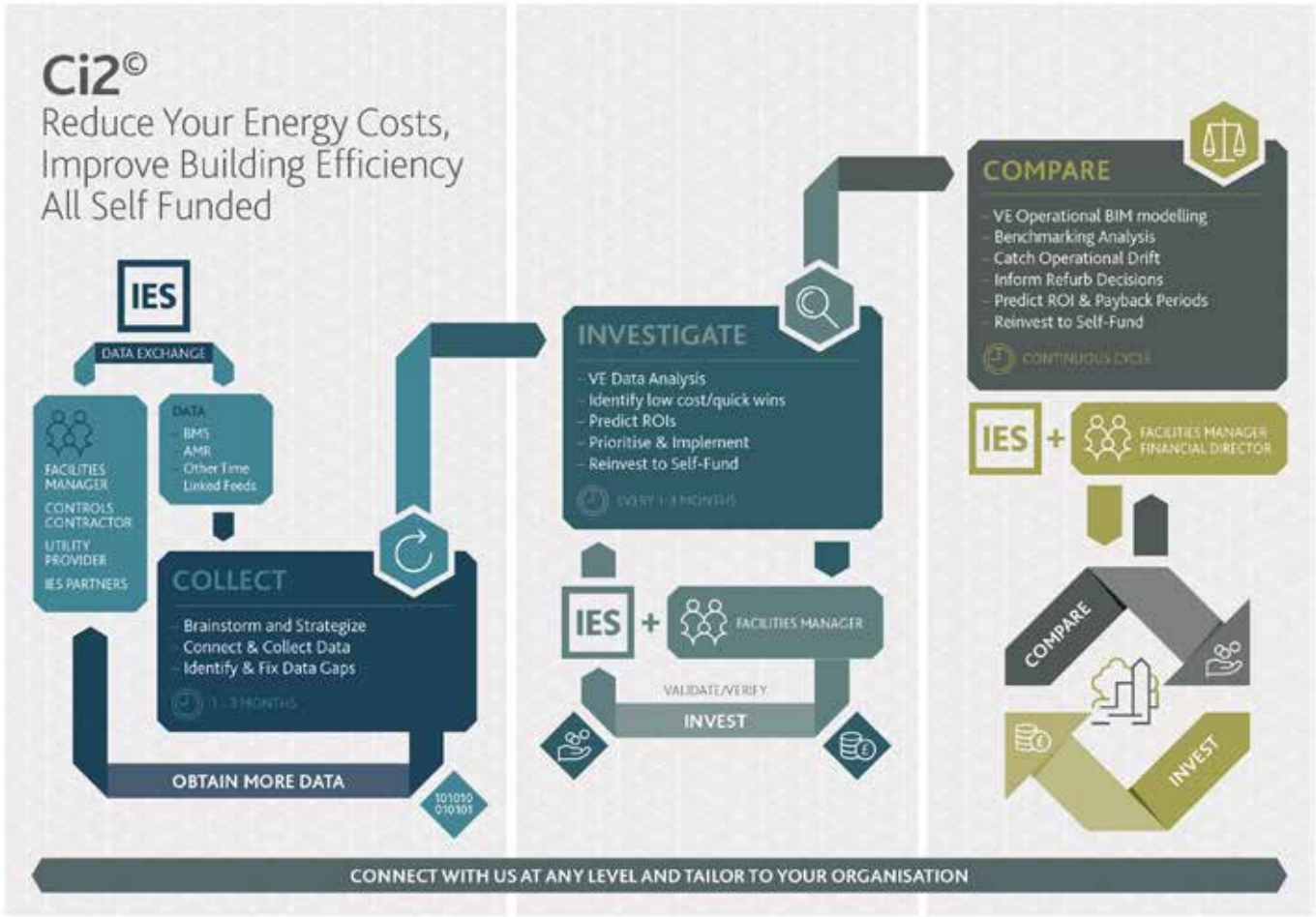
at best to only cover seven to ten days' worth of data, and even then data was only typically logged from a tiny fraction of the thousands of sensors found in the estate.

To work around these challenges, a recording system was set up for the BMS data – this capability was installed onsite to mitigate concerns over internet connectivity for streaming the data online. One of the biggest tasks once data had been collected and stored, was taking all of the raw data and converting it into a consistent universal format that 'ironed out' inconsistencies across time steps, frequency, data gaps, naming conventions and units, etc. Proprietary algorithms and IES SCAN technology were deployed to achieve this.

Finally, the project consultants undertook a metadata tagging process, which involved intelligently annotating the data feeds with information about what sensor it came from, where it was located and whether the location was suitable etc. By describing both the **contents and context of data files**, the usefulness of the original data was greatly increased.



Buildings reviewed during the project



IES Ci2 Full Chart

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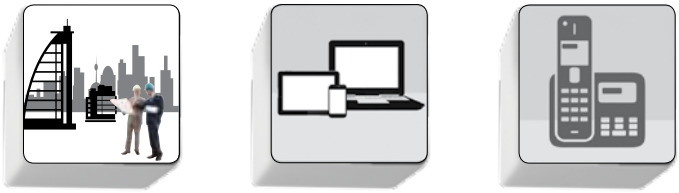

Table 1: Energy Investment Strategy and ROI Results

GCC PoC Building	Target %	Annual Cost Saving £	CapEx Budget @ x3 year ROI	CapEx Budget @ x5 year ROI
City Chambers	10.0%	£ 30 k	£ 90 k	£ 150 k
Riverside Primary School	10.0%	£ 10 k	£ 30 k	£ 50 k
Exchange House	10.0%	£ 15 k	£ 45 k	£ 75 k
Collegelands	15.0%	£ 30 k	£ 90 k	£ 150 k
Total		**£ 85 k**	**£ 255 k**	**£ 425 k**

Results

A key finding of this project was that the BMS installations are being massively under-utilised by building owners, with most BMS systems primarily being used for plant control and basic fault detection. As this project showed, much more detailed and useful data was available but it was either not being logged at all, not stored for a suitable period of time, or not being used for analysis.

The project demonstrated how powerful data could be where there is a robust framework of data collection upon which advanced analytics can be performed, in an integrated fashion. The project team were able to demonstrate how data could be used to support an energy investment strategy and ROI targets, as identified in Table 1, with a potential for significant annual cost savings for this group of buildings readily allowing for a three to five year payback.

Given that Glasgow City Council has an estate of over 300 buildings, if these appropriate strategies were applied to all viable buildings, the annual cost savings could be vastly increased and the payback period accelerated.

In addition, conceptual analysis of a regional district heating scheme using a visual 'heat map' of energy demand showed that rather than each building utilising its own boiler plant, a single central District Energy System (DES) could allow for more efficient handling of load, lower energy costs, lower maintenance costs and lower capital expenditure.

Next Steps

This project show that there is great opportunity for improving the management of legacy building systems, particularly as the rate of building refurbishment is much slower than development of data-driven systems and technology. The potential for data collection, analysis and use extends across the building systems functionality, including relationships between indoor conditions and equipment performance, occupancy periods and seasonal weather variations.

One key recommendation for improvement arising from the project, would be to ensure that there is interdisciplinary cooperation at the specification and hand-over stage for buildings to ensure that sensors are appropriately positioned, labelled, meta-tagged and that suitable logging is set up in the BMS or equivalent systems.

IES Consulting recommended that more extensive data-logging of BMS data could be undertaken on all of these buildings, with potential follow-on projects including a review of BMS specification within both a new-build and refurbishment project; as well as a high level AMR study in the education estate to support development of a better integrated BMS strategy.

Acknowledgement

Mark Gifford is a specialist in low-energy sustainable design and an expert in thermal simulation of high-performance buildings and HVAC systems. He has been extensively involved in cutting-edge research on calibrating and comparing simulation results against BMS data, developing smart metering infrastructure and implementing predictive data analytics. His experience covers advanced LEED energy modelling, involvement in a long-term high-efficiency store project undertaken with Wal-Mart and Building Information Modelling (BIM) technologies and processes.