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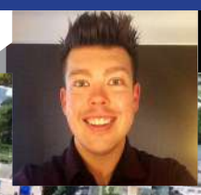

A Six Step Approach to Energy Management in Buildings

I was brought into the organisation about 2.5 years ago to report on energy usage and reduce where possible. The first step of the process was for me to gather as much information as I could about the portfolio which consists of approximately 100 buildings spread across the U.K. The Science and Technology Facilities Council (STFC) has 5 main sites, located in Abingdon, Didcot, Chilbolton, Warrington and Edinburgh and an annual energy budget of approx. £12 million. All five sites serve different purposes and have holistically grown over time to support the scientific research which is conducted by our world leading scientists.

1. Understanding buildings – construction type/use etc.

To say STFC has a unique portfolio may be an understatement. Our oldest buildings (in Edinburgh) date back to 1896 and to this day the sites are still expanding with construction of the Higgs Building (of Higgs Boson fame) in Edinburgh and the new RAL (Rutherford Appleton Laboratory) Space building at the main site just outside of Didcot, Oxfordshire to name but a few. So the portfolio is greatly varied and comprises of:

- Further education facilities
- Hotels
- Restaurants
- Office Accommodation
- Small Scale Scientific Experimental areas (for example, clean rooms)
- Medium Scale Scientific Experimental areas (for example, laser labs)
- Large Scale Scientific Experimental areas (for example, a synchrotron – particle accelerator)

With the diversity and scale of this organisation, we are by default a large user of electricity – last year for example we used 138,400 mWh of electricity across the portfolio. We have now collected key information to help us manage the portfolio and plan for the future. This information includes:

- The portfolio of STFC buildings
- When they were built
- How they were built
- The area of these buildings (and separate areas down to room level within the building)
- Who uses these buildings
- In general, how they are used and who by

The above forms the basis of the living document that is the STFC Energy Strategy. The occupants and assets are as varied as the buildings themselves ranging from 'The Crawford Collection' (a selection of documents and artefacts in Edinburgh from great scholars such as Copernicus and Galileo as well as a Victorian copy of Sir Isaac Newton's death mask) to Petawatt (1 billion watt) lasers.

2. Collecting and understanding the general consumption data – kWh usage at high level and techniques to use when this is where the data ends

In an ideal world every building would have a single gas, electricity and water meter serving only the building in question and all rooms and experiments would be

submetered to the 'nth' degree. However, as mentioned the sites have grown organically over the last 100 or so years so things are not as simple as they may appear.

Serving our 100 or so buildings we have a grand total of 12 half hourly electricity meters, 5 small scale non half hourly meters and approx. 15 main gas meters. Each site has its own water supply, with most benefiting from a few water meters (to confuse matters slightly).

The first step for me as National Energy Manager (and one of my key requirements for Energy Management) was to have AMR (Automatic Meter Readers) installed on all fiscal meters.

This has helped in a number of ways to achieve:

- Financial control of invoices
- High level data analysis
- Identification of wastage
- Profiling of the portfolio

The AMRs have now been installed for over 12 months which means STFC now has a data set to work with which is great. Unfortunately for STFC, and for many other organisations, this is where the data story ends. There is still value in analysing the available data; some of the great benefits we have had are:

- A level of understanding around the out of hour usage
- Some key data to base business cases on – leading to energy efficiency being brought to the forefront of the organisation
- ASC (Available Supply Capacity) analysis – potential of cost saving
- Data for degree day analysis
- A 'kWh/m^2' figure which we can base calculations on

The last point above is both a blessing and a curse. We have two buildings in the portfolio which have a sole gas and electrical supply, which have fiscal meters. These buildings act as our baseline for future development.

The remaining buildings can have a kWh/m^2 rate applied to them based on the information we do have about them, however this has to be adjusted and taken as a discussion point only as it is based on the area of the building. So while the biggest building in our portfolio does happen to be one of the most energy intensive (the particle accelerator), the second or third building may be a warehouse for storage. In which case the kWh/m^2 rate has to be taken with a pinch of salt and manually adjusted based on experience.

3. Understanding and planning of further consumption information – sub metering at building level and what can be done with this?

Sub metering at a building level. The 'golden goose', the gift that keeps on giving, at least this is what I hope for STFC. Sub metering at a building (or beyond) level is the ideal scenario for anyone involved in Energy Management. In the world of Energy, data is king! However when trying to get sub metering installed on a large and complex portfolio there is a large stumbling block – the capital cost and the forever question payback or ROI.

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Now for STFC (and my role), based on the analysis of the available half hourly AMR data, sub metering was a must, however it is still extremely difficult to prove a payback without the granularity of the data – which is delivered by sub metering. A never ending debate, however STFC have progressed the idea and are mere weeks away from having a fully operational sub metering system – at a building level.

Perhaps in time, a follow up piece will be done on how effective this has been.

Certainly the plan for the sub metering system (when operational) is:

- To develop profiles and baselines for each individual building
- Use the data to target out of hour wastage
- Use the data to build in depth business cases for energy efficiency measures
- Develop league tables to have each building trying to compete to be the most efficient

4. Reviewing, expanding and understanding through BMS

So how did STFC piece together a business case for a full sub metering solution? Well STFC also has separate BMS systems running at all different sites and thus no one platform to view key information on (can be done at site level). With a cohesive line of thinking from an energy, operational and maintenance stand point an open protocol system was selected to collect all information from all BMS's onto one platform which could be monitored by our helpdesk staff.

This open protocol system will provide a dashboard for each of the buildings from an energy standpoint but also from an asset monitoring standpoint. The thought process is that this will lead to cost savings in Energy and also in maintenance costs as each asset is monitored and alarmed so any issues will be flagged prior to them becoming a major concern.

At present, the simple tasks performed using the BMS were:

- A review of the current sub metering capabilities (which highlighted that yes there was some form of sub metering, however it was programmed to overwrite every day)
- A review of the building set points (which should be primarily set at 19-21ºC as per CIBSE

guidance)
- A review of the heating profile of the buildings

The review of the current set up did highlight some issues, however once again any data is useful in the realms of energy management.

5. Improving and planning - projects – from the simple to the complex – what we have in the pipeline

Being one of seven research councils within the U.K. we at STFC are working on some truly fascinating things. These, by their very nature are energy intensive although ironically a lot of the research is looking in to the energy sources of the future.

We have examined multiple projects, and many are awaiting funding however the active projects we do have are:

- Full sub-metering solution and asset monitoring system
- 30kW PV install with 50kW Battery Storage system
- Boiler/Chiller replacements
- Demand Side Response G59 upgrades

The first project on this list will hopefully lead to many more projects, and for me it is the key project moving forward as it will inform all future decisions.

I am looking forward to the trial of the battery storage system as I truly believe that PV arrays with battery storage will play a key part in the Energy landscape moving forward.

6. Identifying and overcoming barriers

Science. Comes. First. This is the mantra which runs through The Science and Technology and Facilities Council, and rightly so. There are hundreds of ground breaking experiments going on across all of the sites in the fields of:

- Lasers & Plasma Physics
- Astronomy and Space Science
- Particle Physics and Particle Astrophysics
- Energy (Laser Fusion, Hydrogen Storage, Fuel Cells)
- Environment
- Medicine, Health & Bio Science
- Chemistry
- Physics and material science
- Engineering & enabling technologies
- Accelerator science
- Computational science

Working with so many highly skilled individuals drives the need for accurate business cases even in the earliest stage of discussion.

Scientists by nature question everything and are obviously very protective of their working environments and equipment (again rightly so, a lot of the equipment is custom built to very exact specifications). This makes the project timeline for anything STFC tries to accomplish somewhat extended. This means that when projects do begin STFC is hopefully getting exactly what is required with no negative outcomes. Some of the barriers I have had to try and overcome so far are:

- When attempting to install a PV array and battery storage solution on site scientists were concerned over the impact of the invertors on the equipment – a solution was to install the invertors in a faraday cage to eliminate certain risks. Further concerns were discussed surrounding the reflection from the PV array on readings taken by the satellite at this site. Unfortunately, due to time constraints, STFC had to move the project to another site, although when this is operational we fully intend allowing our scientists to run experiments to satisfy any concerns.

- As part of my interview with STFC I commented on the lack of visible renewables. At the interview I was told that wind turbines could not be installed due to the vibrations interfering with laser experiments on site. I have yet to challenge this statement as no formal report was written, however we are in the process of adding more renewables to the portfolio.

- Voltage Optimisation. We have been working on installing voltage optimisation for some time, however due to the sensitive nature (age – some of the scientific equipment i.e. the syncatron is 1960's technology and size/scale of 4-5 mW base load) the feasibility stage of the project is still on going.

Author's profile:
Following graduation Craig worked as a Quantity Survey for approx. 6 months before making the shift in to energy. His first energy role was as an Energy Technician within the third largest Local Authority in Scotland. The role involved managing a portfolio of thousands of accounts and an energy spend of approx. £10 million per annum. After two years of making substantial savings from mainly desk top studies (limited capital budget) he joined the Science and Technology Facilities Council as the National Energy Manager.