Marks & Spencer Cheshire Oaks Store

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Innovate UK project number	450109
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Report date	2014
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Building sector	**Location**	**Form of contract**	**Opened**
Retail	Cheshire Oaks	Design and build	2012
Floor area (TFA sales)	**Storeys**	**EPC / DEC**	**BREEAM rating**
14,915 m^2	2	N/A / N/A	Excellent

Purpose of evaluation

The Cheshire Oaks store was the third Marks & Spencer's 'sustainable learning store'. The aim of sustainable learning stores was to provide a bank of knowledge and experience in the sustainable practices surrounding the design, construction, commissioning and operation of buildings.

Design energy assessment	**In-use energy assessment**	**Electrical sub-meter breakdown**
Yes	Yes	Yes

Electricity 193.9 kWh/m² per annum (design 243 kWh/m² per annum), thermal (fossil fuel) 17 kWh/m² per annum. The Cheshire Oaks store was said to perform well against benchmarks both in terms of thermal fuel and electricity due mainly to better insulation and greater air tightness on the thermal fuel side, and more efficient building services and refrigeration on the electricity side. Gas was the primary heat source for the front of house heating systems and therefore represented the majority of the heat input into the building. It was also used for the generation of domestic hot water. The use of daylight also helped to reduce the artificial lighting load, which was the single largest energy consuming system in the store.

Occupant survey	**Survey sample**	**Response rate**
BUS paper survey	81	40%

73 customers were surveyed at the Cheshire Oaks store, while feedback from the building occupants was obtained using the BUS survey and from two focus group sessions over the course of the year. The first session was held in April 2013 after the store had been opened for a full seven months. The customer feedback survey contained a strong focus on how customers viewed the sustainable features implemented in the building.

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This report template has been used by BPE teams to draw together the findings of the entire BPE process and to record findings and conclusions, as specified in the Building Performance Evaluation - Guidance for Project Execution (for domestic buildings) and the Building Performance Evaluation - Technical Guidance (for non-domestic buildings). It was designed to assist in prompting the project team to cover certain minimum specific aspects of the reporting process. Where further details were recorded in other reports it was expected these would be referred to in this document and included as appendices.

The reader should note that to in order to avoid issues relating to privacy and commercial sensitivity, some appendix documents are excluded from this public report.

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1 Introduction and overview

Cheshire Oaks is Marks & Spencer's second largest premier store, carrying the full product catalogue including women's and men's wear, foods, home and furniture, along with two cafes all arranged over two floors. The site is located on Longlooms Road, Cheshire Oaks, north of Chester and adjacent to the Cheshire Oaks Designer Centre. The closest conurbation is Ellesmere Port, which is situated on the Wirral peninsula, south of the Mersey estuary. The store has parking for 949 cars and provides secure bicycle storage. A site plan and floor plan for the store is included in the Appendix of this report.

Figure 1 Ariel view of the Cheshire Oaks store

The Cheshire Oaks store is the third Marks & Spencer's 'sustainable learning store'. The aim of sustainable learning stores is to provide a bank of knowledge and experience in the sustainable practices surrounding the design, construction, commissioning and operation of buildings. The sustainability features designed into the store include:

- Heat reclaim technology from refrigeration plant used for building heating. The refrigeration plant itself uses CO_2 as the working refrigerant.
- Hemclad® panels in the external walls. These are a pre-fabricated wall panels that uses a lime based binder and hemp. The panels have a U value of 0.12, and have a relatively low embodied carbon footprint compared to traditional wall construction types. (Marks and Spencer have undertaken an independent study of the projects embodied carbon through Deloitte)
- 100% FSC glulam timber frame roof, which is the first of its kind used in retail. The roof itself is made from 100% recycled aluminium painted white to reflect heat, plus the insulation contains recycled post consumer waste.
- Rainwater harvesting is used for toilets and irrigation. In order to facilitate this, an 80,000 litre underground storage tank has been provided.

- A wood pellet fired biomass boiler is used to meet part of the winter heating load. The combined heat input from the biomass boilers and the heat reclaim system has been designed to provide approximately 70% of the building's heat demand.

- A 300 m² living wall runs along the side of the car park structure and contains 30 different plant species. The watering is provided automatically through the rainwater harvesting systems.

- During construction 100% of the construction waste was diverted from landfill. 54,000 tonnes of quality soils and clay from the initial bulk excavation works was used in projects such as capping a contaminated quarry and developing a local Moto-X park.

- LED lighting is used in the car park and other external areas. Inside the building a daylight sensing control system is used to dim the lights when there is sufficient sunlight provided thorough the widows and roof lights.

- A brise soleil is used to reduce the solar gains from the high summer sun whilst allowing the low winter sun through.

- The sales floor is heated, cooled and ventilated via displacement air ventilation columns. Each one is connected to 2 m diameter, below ground, earth ducts and the system is capable of providing free cooling in the appropriate conditions.

- A total of 9 swift boxes, designed for mating swifts, have been embedded in the building's wall above the service yard entrance. In addition to this a further 6 bird boxes have been added to the perimeter hedgerows.

- Enhancement of the site biodiversity through the planting of over thirty different plant species, and the creation of wildlife garden, and nature pond

- The store has extensive sub-metering allowing most of the energy-using systems to be monitored in real time. A monitoring and targeting system is in place to provide feedback on performance and to track improvements to the systems.

The store opened on the 27th August 2012 and has attached visitors from all over the North West of England and Wales. There are regular tours provided for local people and coach parties. During the tour they are shown many of the sustainable features of the store.

2 Details of the building, its design, and its delivery

2.1 Overview of building details

The store is built on a 57,022 m² site. It has a Gross Floor Area of 19,401 m², of which 14,915 m² is sales area split over two levels. The land it has been built on was formerly a greenfield site. The construction activities included the provision of a new store shell; a two storey car park and associated infrastructure works; and the full fit out of the shell. The main store is a timber frame building, with predominantly hemp and lime clad walls and an aluminium roof. The use of daylight is facilitated through the use of North lights in the roof and extensive glazing throughout.

The store has good transport links to the local towns of Ellesmere Port and Chester. Being located close to the M53 and M56 motorways means it is very accessible from Warrington, Liverpool and other towns in the North West of England and North Wales. Some of the main roads leading up to the store were widened as part of the project and a number of cycle lanes were added. A new bus route from Chester to the store has been provided and Marks & Spencer fund a bus to take shoppers to and from the adjacent outlet shopping centre.

2.2 Design requirements

The Cheshire Oaks store was designed and constructed in line with the principles set out in the Marks & Spencer Sustainable Construction Manual a subset of the 'Plan A'. The broad aim of the Sustainable Construction Manual is to move to a position where Marks & Spencer can realise their ambition of being the world's most sustainable major retailer. The details of the manual put a strong emphasis on the importance of designing and specifying materials and systems with low embodied and operational carbon as well as other sustainability requirements (FSC timber for example). The designers were given a target of reducing the operational energy use by 30% and carbon emissions by 35% compared to a peer store. These figures were decided upon by assessing the success of energy saving measures implemented at other Marks & Spencer stores. A number of sustainability features were investigated before the final design was produced. Some of the features considered, and ultimately rejected, included the installation of a wind turbine and the provision of a green roof.

The client's requirements for the building, as described in the Building Log Book, are as follows:

Environmental Requirements:

A key objective of Marks & Spencer is the efficient use of energy, natural resources and to be carbon neutral in accordance with a commitment to the highest environmental standards as follows:

The shell building shall maximise the BREEAM credits awardable, which, together with the Fit Out works, will achieve an "Excellent" rating.

All primary building elements shall be 'A Rated' in accordance with the current BRE Green Guide or alternatively be sourced from natural materials.

Marks & Spencer shall expect that the building design, construction and maintenance shall minimise waste, conserve resources, use recycled materials appropriately and where economically practical to meet the requirements of the specification, and encourage suppliers to reflect company policies.

Thermal Requirements:

The maximum thermal permitted transmittance (U-value) for the various areas of the works shall be as follows:

i) The area weighted average U-value for the external walls shall be 0.18 W/m²K or better.

ii) The area weighted average U-value for solid panels, metal cladding and metal spandrel panels shall be 0.27 W/m²K or better.

iii) The area weighted average U-value for the works (double glazed vision area and frames) shall be 1.65 W/m²K or better.

iv) The area weighted average U-value for horizontal roof lights (double glazed vision area and frames) shall be 1.88 W/m²K or better.

v) The area weighted average U Value for roof shall be 0.18 W/m²K or better.

2.3 Project timeline

The land for the store was initially identified in 2004 and the original plan was that Marks & Spencer would be tenants and the Church Commission, who owned the land, would be the landlords. Eventually it was agreed that Marks & Spencer would take a 100 year leasehold of the land and that they would be owner/occupiers of the building. A number of administrative issues held up the project, including a change in local authority boundaries and the 2007 – 2008 financial crisis. Planning was submitted in June 2008. The project was given Secretary of State approval in October 2009. There was an 18 month period of newt trapping on the greenfield site before work commenced. The enabling works took two months and sod cutting started in October 2010. The building topping out was completed in May 2011 and fit out started in October 2011. The practical completion date was 7th August 2012, and the store opened three weeks later.

This is a different approach to that typically taken by Marks & Spencer in that they usually occupy a developer's shell and are tenants to a landlord.

2.4 Construction Phase

The procurement route for the building was through a two stage competitive tendering process. The main contractor, Simons, was appointed by tender submission of prelims/OH&P and initial manager's proposal of the preferred contractor from the Marks & Spencer supply base. Sub-contractors were appointed by competitive tendering of the individual work packages.

Figure 2 shows the organisational structure adopted by the construction team.

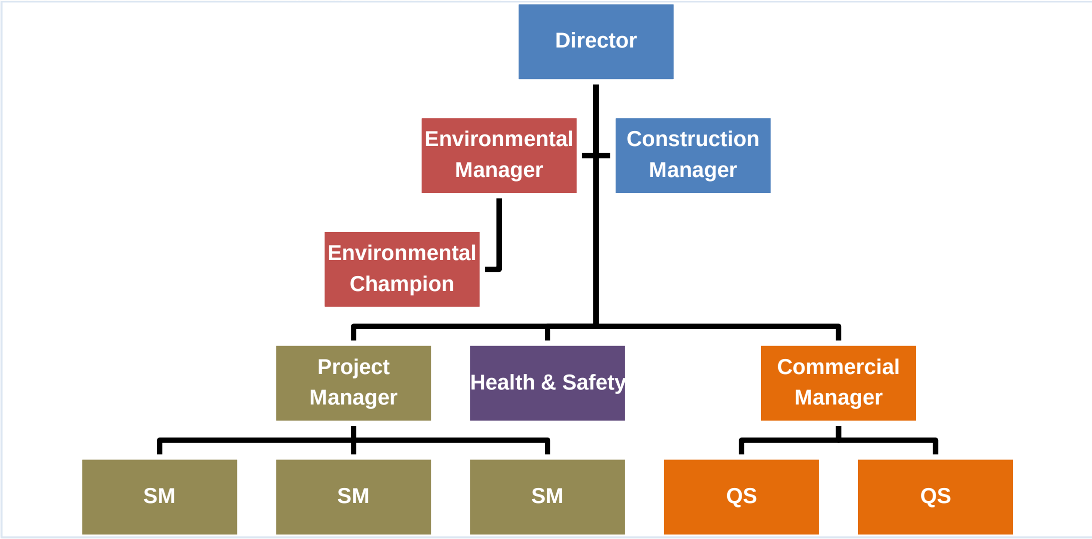


Figure 2 –Organisational structure of the construction team

In a traditional construction team the environmental manager and environmental champion report to the project manager, however in this team they reported directly to the project director. This meant that sustainability was part of every decision made, and the principles set out in the Marks & Spencer Sustainable Construction Manual were implemented throughout the construction process. This organisational structure allowed the environmental team to influence the project in ways that would have been difficult if they were reporting directly to the project manager, as demonstrated in the following examples:

- Due to a miscommunication between a number of sub-contractors, the enclosures for the displacement ventilation system were initially fabricated from oak and not FSC certified timber as specified. The environmental team was able to over-rule the project manger's decision to keep the oak enclosures. The supplier was able to reuse the oak rejected from site on other projects.

- The construction of the store created some strong, polarising views from the local community. The environmental team were able to organise over 100 hours of tours of the construction site to allow the local community to properly understand the project. These tours had cost, programme and health & safety implications for the project, which the project manager was not keen to take on board.

- The environmental team wanted to allow local people to take away left over wood and other reusable construction waste for free. The project manager was resistant to this idea due to the health and safety implications of allowing the general public on site. In order to facilitate this, a gate controlled 'safe zone' was created on the site where local people could bring their cars and trained members of the construction team would help them to load up any of the waste wood or other materials they wanted.

During the construction phase, none of the construction waste was sent to landfill and as much as possible was recycled. The cheapest way to dispose of waste is to use a 40yd mixed waste skip so as to minimise the number of skip movements. This however increases the risk of entire waste consignments going directly to landfill. To reduce this risk the waste needs to be segregated. Waste segregation requires a larger number of skip types, which in turn increases the costs associated with waste disposal as the number of skip movements increases. The waste budget was doubled due to the extensive onsite segregation, which was around 90% upon completion of the building. The waste was segregated on site and the skip compound was operated with strict opening hours. The waste being put into the skips was closely monitored and a 'carrot and stick' approach was taken to encourage good practice with regards to recycling. For example, personal commendations and gift vouchers were awarded to people who showed a strong commitment to segregating waste, and yellow and red cards were issued for bad practice.

The choice to use FSC certified timber throughout presented challenges to overcome. Not only was the timber used in the building fabric FSC certified but so was the timber used in the construction, including the shuttering and the furniture in the site cabins. Checking the timber deliveries for the correct certification and paperwork became part of the induction process, and deliveries were regularly turned away. Some of the larger timber sections, such as those used in the wooden curtain wall and the brise soleil, proved difficult to source. The timber also needed to be stored, handled and installed with a greater degree of care than other building materials which presented an additional degree of complexity to the construction.

Although FSC certified glulam is increasingly being used in the construction of buildings, there were only a limited number of contractors available to meet the quantity and specification required. Also there is not a very wide breadth of understanding in industry of how to use glulam as a structural element. As a result, a significant amount of steel bolt reinforcements were added to the frame in the ceiling in order to satisfy the building insurers that it was structurally sound. This had an impact on the programme, which would not have been incurred with a traditional steel frame building. It was also found that the glulam deflected to a greater extent than the designers' predicted, resulting in the first floor screed cracking and a more flexible grout was required. This deflection was not related to the number of steel bolts in the ceiling.

The decision to use hemp and lime panels for the walls was taken at the detailed design stage as it has good thermal insulation properties and low embodied carbon. Also hemp has a rapid growing material and so crops can be refreshed quickly. A company called Lime Technology was selected to provide the hemp and lime panels as they had strong expertise in this new technology. At that point Lime Technology were a relatively new company but had provided their products on a number of smaller buildings, such as the Adnams brewery in 2006. Marks & Spencer worked with them to bring them up to a position where they could produce panels on the scale required and also assisted with getting them FSC certified. The panels were partly fabricated off site, then finished with a natural render on site. Using a natural render resulted in different colours being produced with every different batch mixed. To overcome this, the building was finished with a render wash which provided a consistent colour throughout.

Initially the displacement ventilation earth pipes were to be constructed from precast concrete tubes, as the thermal mass of the concrete would assist with the free cooling process. As the design and construction progressed it became clear that pressure exerted from the loads above the pipes would cause them to crack and leak. Therefore the concrete pipes were replaced with plastic piping which has more freedom to flex under pressure, but this also meant that the system was no longer able to take advantage of the thermal mass of the buried pipes.

The installation of the 80,000 litre rainwater harvesting tank required the closure of the main haul road onto site for two weeks. The installation itself proved challenging as there were a significant number of clashes in the ground and the drainage system required was fairly complicated.

2.5 Handover

Simons provided two weeks of training to the Marks & Spencer facilities staff between the practical completion process and the opening of the store. The training covered all the operational and maintenance information required to keep the building's systems operating as designed. In addition to the training, a very comprehensive technical training manual was provided. The manual provides all the training materials for the facilities staff to refer to as and when required.

A soft landings process has not been undertaken at the store; however Simons have been available to answer queries when necessary.

Feedback given at the POE Quarter 1 workshop meeting was that the handover and O&M/training was exemplary, incredibly thorough and straight forward.

2.6 Conclusions and key findings for this section

The store is well located close to a popular outlet shopping mall and has good transport links to a number of large towns and cities in the North East of England and North Wales.

The Marks & Spencer Sustainable Construction Manual played a key role in communicating the core sustainable principles to all parties involved in the design, construction, commissioning and operation of the store. It gave a mandate to the onsite environmental team to ensure that sustainability issues were considered at all stages of the construction. This was also helped by the management structure adopted onsite which allowed decisions to be taken on sustainability issues more easily.

A strong culture of sustainability good practice was developed on site. This process started through good site inductions that explained the reasoning behind the sustainable construction practices. This was reinforced through the active recognition of those people who repeatedly demonstrated good practice.

The contractor provided comprehensive training to the Marks & Spencer facilities staff on how to operate the building in the correct manner before the store opened and also provided a detailed training manual.

3 Review of building services and energy systems.

3.1 Overview

The energy demand for the building can be split into the following broad categories:

- HVAC
- Lighting
- Refrigeration
- Catering
- Small power
- Manual handling
- Other support systems

The following section provides a basic review of each of these systems detailing how, why and when each consumes energy.

3.2 HVAC

For the purpose of heating, cooling and ventilation, the sales floor is split into five discrete zones, each of which is served by its own individual air handling unit. Each air handling unit is controlled to provide air to the sales floor at 19°C throughout the store's opening hours. To facilitate this, the air handling units are provided with a DX type cooling system and natural gas heating system. The air is provided to the sales floor from the air handling units via underground 2 m diameter earth ducts. Conditioned air from the earth ducts is then fed up through 18 separate displacement ventilation outlets built around the roof support columns. Dampers in the displacement ventilation columns control the flow of air into the building, which is dictated by an adjustable set point in the BMS.

Air is extracted from the sales floor through high level ducts which deliver the air back to the air handling units where it is either re-circulated or exhausted to atmosphere. The rate of recirculation and exhaust is controlled by a set point on the BMS. When the system is run in full fresh air mode there is no heat recovery.

In addition to the main air handling units, there are an additional three smaller air handling units. One of which supplies the staff cafe and the other two supply the staff quarters, lockers room, offices and toilets. Air is extracted from these areas and fed back to the air handling units, where it is either re-circulated or exhausted to atmosphere as dictated by the BMS. These air handling units have heating coils, but no cooling facilities. The heating coils are fed via the LTHW circuit connected to the biomass boilers.

There are area specific make up air and extract ventilation systems fitted to a number of areas including staff offices, staff catering areas, toilets, and stock rooms. The air is supplied and discharged via roof level inlets/plenums. The customer first floor cafe and deli are provided with their own extract ventilation systems with roof mounted extract fans. All the extract ventilation systems are provided with motorised dampers that shut upon cessation of operation.

There is a 200 kW packaged chiller plant in the upper plant area. The purpose of the chiller is to provide chilled water at 6°C to chilled water cassette units located throughout the store. The return water temperature for the system is 12°C. The chilled water circuit has a 300l buffer tank which is provided within the chilled water circuit to act as a thermal store and lessen the cycling of the chiller's compressor. The chilled water cassettes are provided in staff areas on the first floor, the food preparation areas, fitting areas and the food hall.

The chiller is operated continuously to provide chilled water at the required temperature. It is not clear if the chillers had the facility to operate in a free cooling cycle.

Heating

There is a 320kW biomass boiler which provides water in to a variable flow heating system. The system is designed to operate on 80°C - 60°C flow and return temperatures. The hot water is provided to the back of house room heaters, fan coil units, radiators and first floor trenches.

A separate 285kW gas boiler is used to provide hot water to the summer variable flow heating circuit. Like the biomass boiler, the system is designed to operate on 80°C - 60°C flow and return temperatures. The hot water for heating is provided to the following areas:

- Foods area CWC units, foods areas entrance unit heater and fan coil units
- Stairway 6 area radiators
- Foods area trench heating

The domestic hot water is generated in a hot water calorifier, which is fed from the summer variable flow heating circuit. The domestic hot water is supplied to the catering facilities, toilets, showers, stock room and cleaning facilities.

The boilers are controlled to maintain a constant flow temperature into the heating circuit during working hours. The heating system distribution pump speeds are controlled to maintain the requisite pressure within the system. The various terminal units are provided with control valves to maintain the preset temperature within the room it is located.

In the food hall, under-case warm air heating is provided on the refrigerated food aisles utilising heat reclaimed from the refrigeration plant.

3.3 Lighting

The lighting strategy used in the Cheshire Oaks store is designed to provide a comfortable atmosphere for the shoppers, whilst showing off the products. This has resulted in a wide variety of lighting types being employed throughout the store.

In the general mid floor areas, food halls and cafes the lighting is provided by track mounted T5 fluorescent lamps with integrated metal halide spot lamps. These have been chosen for their energy efficiency as they provide relatively high lamp lumens per circuit watt, with excellent colour rendering. More specific lighting is used in certain areas around the store for the purpose of highlighting products, task lighting or for aesthetic reasons. These lights tend to be compact fluorescents, LED spot lights, T5 fluorescents and metal halides.

These lamps are controlled via a daylight sensing dimming system used together with a front of house lighting control system. The front of house control system provides simple 'on/off' controls for the lights based on timers. The dimming system is able to reduce the light output of the main track mounted lights on the first floor and those adjacent to the windows on the ground floor. For the purpose of dimming the store is split into a number or discrete lighting zones, each with a pre-defined required lux level. This means that the amount of dimming can vary from one area to another, but on the whole the store's lighting level is consistent throughout. Both the dimming system and the front of house lighting control system are monitored via the BMS.

The back of house lighting is primarily provided by T5 fluorescent lamps in the larger rooms or compact fluorescents in the smaller rooms.

External lighting

Lighting is used externally to illuminate the car park and signage. The car park lights use LED lamps and the lights on the upper car park deck have daylight sensors to switch them off when they are not required. The controls for the external lights are provided via the front of house lighting system and is timer based.

3.4 Refrigeration

Refrigeration plant is used in the store to provide cooling for the food in the shop floor cabinets and the back of house coldrooms. The refrigeration plant uses propane as the primary refrigerant in a high temperature circuit and CO_2 in the secondary low temperature system. The CO_2 is distributed directly to the coldrooms and shop floor cabinets.

The refrigeration plant comprises two packaged chiller plants with air cooled condensers, and two CO_2 DX cascade units all located in the refrigeration compound. There are six roof mounted evaporators in the cold rooms, a bakery refrigerator and 7 food cabinets in the food hall which are all provided with CO_2. In addition to this there are a number of mobile electric refrigerator cabinets and an electric cold storage cabinet in the deli area.

The refrigeration plant is operated continuously to provide cooling as demanded by the system. The operation of the plant is monitored via the BMS.

The heat rejected by the refrigeration plant is reclaimed in a hot water system. The hot water is used to provide the heating for the under cabinet warm air heaters.

3.5 Catering

The store contains a large cafe on the first floor, a smaller cafe on the ground floor and a staff cafe. All three of the cafes provide hot and cold food and drinks. As such each is provided with a wide range of energy using products including dish and glass washers, pasta cookers, steamers, soup kettles, ovens, microwaves and coffee machines. They also have their own refrigerators.

All the plant is manually operated and the use is based on the in-store demand.

3.6 Small Power

There are a number of small power outlets provided throughout the store which are used for cleaning equipment, displays and other small devices. Each plant item is controlled locally at the source.

The small power system also includes an electric car charging point.

3.7 Manual handling

The manual handling facilities in the store comprise four escalators, three customer lifts and a goods lift. The escalators are 15.2 m long and provide a 5.5 m rise. They are operated continuously throughout the opening hours. The operation of the lifts is dependent on the in store demand. There are no speed control functions provided to reduce the energy consumption during low load conditions.

3.8 Other systems

In addition to the systems described above there are the following power using systems:

- Emergency lights
- Fire alarms
- Security system
- ICT
- Refrigeration leak detection
- Trace heating
- Voice communications
- Signage
- AV equipment
- Water pumping
- Sprinkler system

These systems all add to the power demand for the building, but the total power demand is small compared to the main energy using systems.

3.9 Conclusions and key findings for this section

The building uses energy in a diverse range of ways. A number of features have been built into the design to reduce energy consumption where possible. These include the provision of a biomass boiler, automatic dimming systems for the lights, heat recovery from the refrigeration plant and a displacement ventilation system.

All the main control systems are connected to the BMS which provides a single point of access for monitoring their operation. This allows issues to be identified quickly before they result in excessive energy wastage.

4 Key findings from occupant survey

4.1 Overview

The feedback from the building occupants was obtained in two sessions over the course of the year. The first session was held in April 2013 after the store had been opened for a full seven months. It took the form of a customer feedback survey which contained a strong focus on how customers viewed the sustainable features implemented in the building. The survey questions were also asked at the large M&S store in Warrington, known as Gemini, in order to understand how the Cheshire Oaks store compared to a traditional store. The details of this feedback session are given in Section 4.2. The Warrington Gemini store is a traditional, steel framed, windowless retail unit, located on a retail park on the outskirts of town, close to the M6. Its net sales area is 30% smaller than Cheshire Oaks, however the Gemini food hall is approximately 25% larger. It also provides the same range of products and services.

The second session of feedback focused on the views of the shop floor staff and the facilities staff and took place after the store had been opened for one year.

4.2 Initial customer survey

73 customers were surveyed at Cheshire Oaks store and 76 at Warrington Gemini. The days were cool and overcast and it rained in the afternoon of the 11th April 2013. The mean external temperature was 6°C.

The survey questions asked were the same as those used on a previous post occupancy evaluation study produced for M&S's 'Sustainable Learning Stores' at Ecclesall Road in Sheffield. The Ecclesall Road store is a much smaller store which only sells food and so cannot be directly compared with Cheshire Oaks, however it does incorporate some sustainable features, such as a green wall. Therefore, where relevant, the responses to the questions given at the Eccelsall Road store have been compared to the responses from Cheshire Oaks in this study.

Lighting

Customers in the Cheshire Oaks and Warrington stores were asked whether they found the lighting levels satisfactory in their respective stores. Survey results in the stores found that around 87% of customers found the lighting levels satisfactory throughout – slightly more than 84% of customers who found the lighting to be satisfactory throughout in Warrington. This was not unexpected, as whilst natural lighting was absent in Warrington, the artificial light was well designed and provided a good environment for viewing the products.

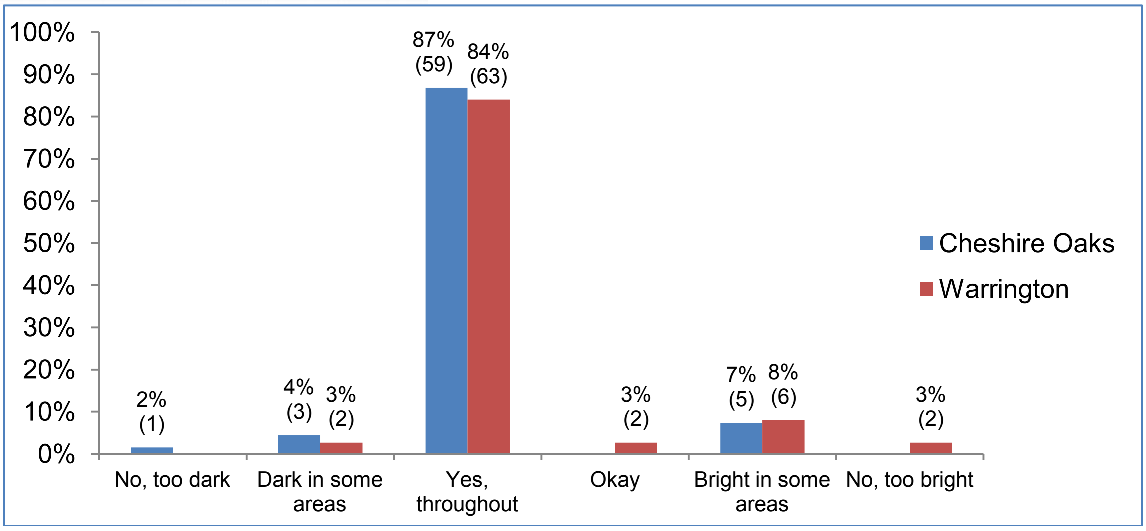


Figure 3 Response to: Were the artificial light levels satisfactory?

Great efforts have been made at Cheshire Oaks to maximise the amount of natural daylight used in the store through the use of roof lights and extensive glazed facades. The automatic dimming system attempts to provide a consistent level of light throughout the day. This use of daylight does appear to be appreciated by the customers as 84% found there to be good daylight, with only 9% wishing there was more. Some shoppers commented that natural light was the ideal environment to buy clothes as they know what the colours will look like when worn outside negating the need to take clothing outside to test the colours. A number of customers also noted that they preferred the first floor to the ground floor because of the high ceilings and additional daylight.

The use of large areas of glazing did cause some problems with glare, especially in the winter when the sun is low in the morning and evening. This issue was raised during one of the post occupancy evaluation workshops and adjustable blinds have been proposed as a potential solution.

The Warrington store does not use any daylight, but there did not appear to be any significant demand for it as there was good quality artificial light.

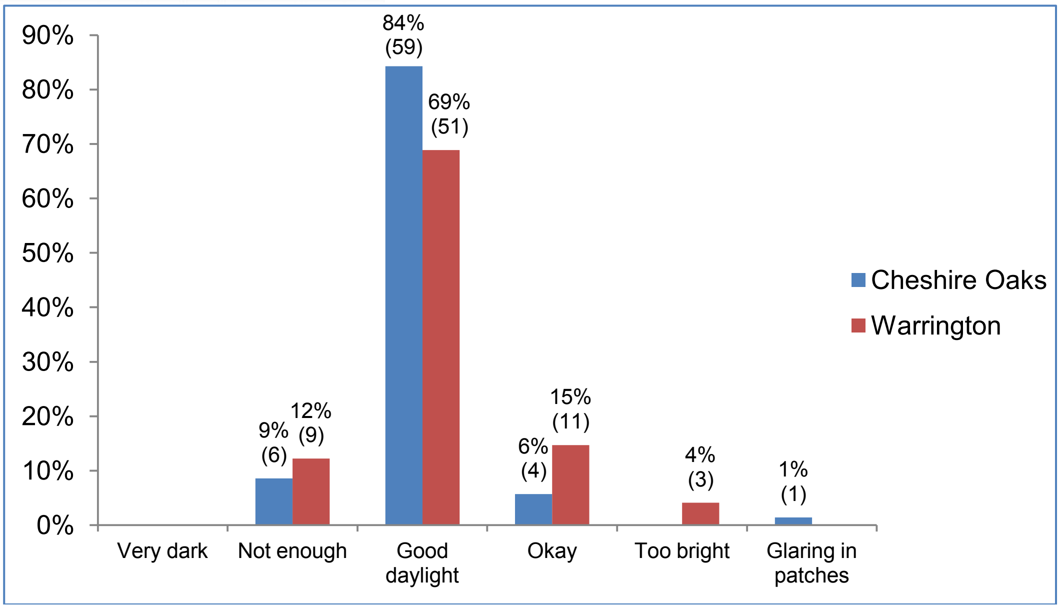


Figure 4 Response to: How did you find the daylight levels in the store?

A low level of awareness of sustainable features related to lighting was found. Maximised natural light was noticed by only 8%, daylight-controlled lighting by 3%, and LED lighting by 1% of those surveyed in the Cheshire Oaks store. It could be argued that low awareness of these features are a good thing, as they do not distract from the customer's shopping experience.

Temperature

Customers were asked whether they found the temperature in their respective store comfortable. 85% of customers answering 'Yes, throughout'. Only 6% answered that the temperature was not comfortable in some form or another. Overall the customer satisfaction to temperature in the Cheshire Oaks was good. This can mainly be attributed to the consistent and relatively even temperature on the sales floor provided by the displacement ventilation system in conjunction with the open plan sales floor, meaning that there are not localised hot or cold pockets.

The food hall, which traditionally can be found to be too cold, was also found to be of an acceptable temperature. Many of the chilled food cabinets on the shop floor use a direct expansion CO_2 refrigerant system where the compressor and condenser is located outside the building and the waste heat is supplied to the aisles in a controlled manner. Traditional chilled food cabinets have the compressor and condenser integrated into the cabinet themselves and so there is much less control as to how the waste heat is pushed out into the shop floor, making the shop floor temperature much less consistent. This was reflected in the feedback from customers at the Warrington store who commented that the temperature around the chilled food cabinets in the food hall was particularly cold. Where traditional chilled food cabinets are used there is a good case for installing doors on them, both from an energy efficiency point of view and for reasons of comfort.

This cold temperature could possibly be attributed to the fact that fridge doors are not incorporated into the refrigeration equipment design, however a member of M&S management also identified that there was a known problem with both boilers and cold aisle retrieval at the store.

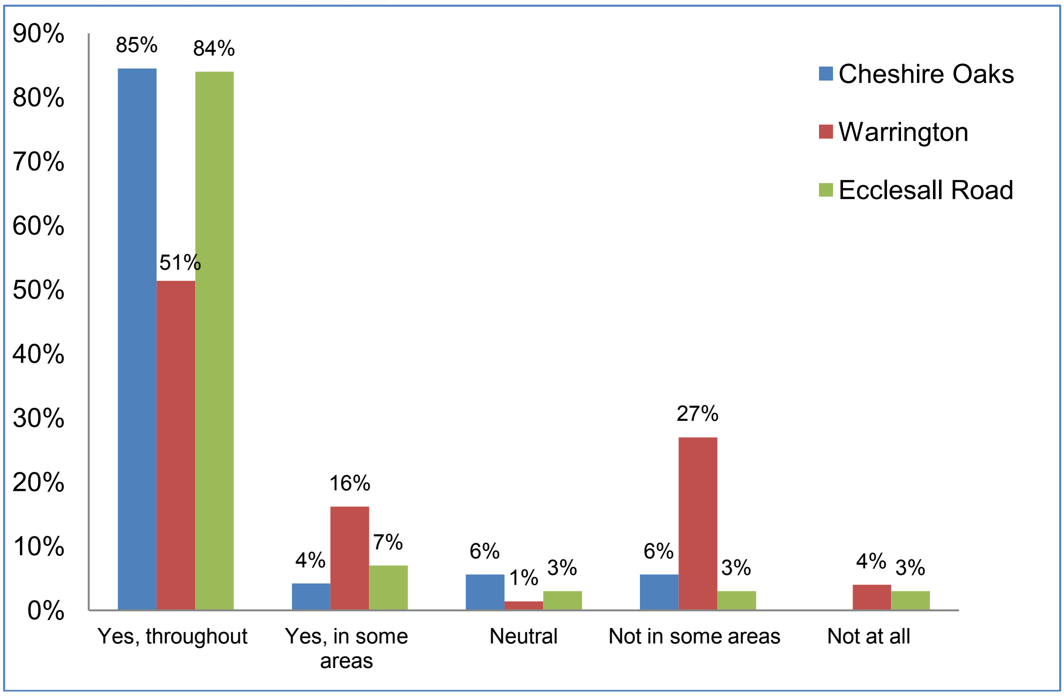


Figure 5 Response to: Was the temperature of the store comfortable?

Those customers who said that aspects like lighting and temperature affect their choice of stores mostly focused around temperature considerations. 22% of all customers surveyed commented that they disliked hot stores and some identified that they disliked having to carry their coats around the store when the temperature inside was hot. Cold changing rooms were also identified as being disliked by 3% of customers. Customers at the Warrington store answered similarly to those at the Cheshire Oaks store.

Travel and access

Customer travel to Cheshire Oaks and Warrington is overwhelmingly by car, which is not unexpected given their 'out of town' locations. Ecclesall Road, which is in a busy street in Sheffield has a greater number of people visiting on foot.

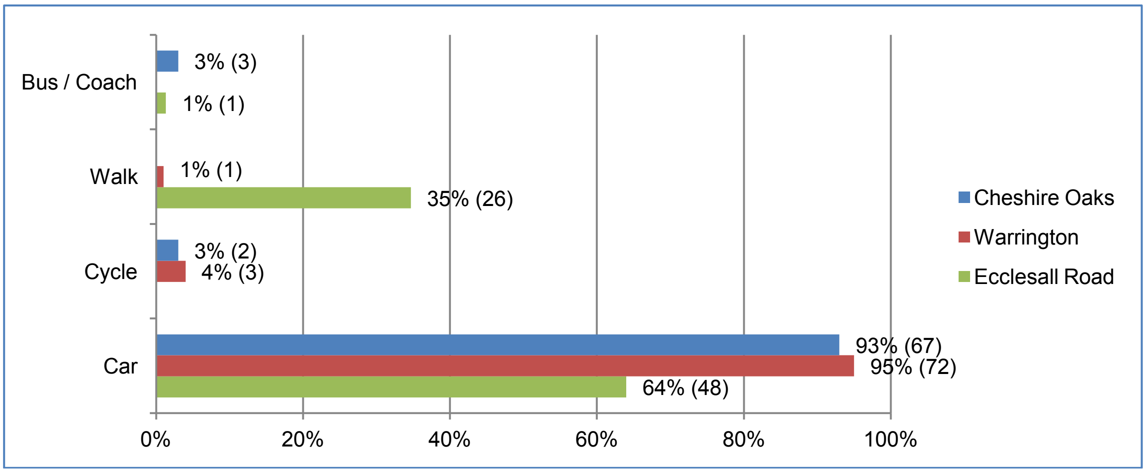


Figure 6 - Travel to store

The prominent use of cars is reflected in the importance with which the parking facilities are considered at both Cheshire Oaks and Warrington. Several customers identified that they really liked the parking facilities provided, and at both Cheshire Oaks and Warrington 15% and 21% respectively commented that really liked the convenient parking and easy access. Free parking is especially popular with customers at Cheshire Oaks (cited specifically to be 11%) – due in part to the high cost of parking in nearby Chester town centre.

Car parking was also liked in the Ecclesall Road store, although some customers commented that they disliked having to pay for parking.

Electric car charging points were incorporated at both the Cheshire Oaks and Ecclesall Road stores. Customer awareness of this feature was better at the Cheshire Oaks store with 18% (13) noticing the charging points compared with only 5% (6) at Ecclesall Road. In Cheshire Oaks the Electric car charging points are located in a highly visible area in the main car park, where at Ecclesall Road the charging points were placed at the store rear to avoid occupying highly desired parking spaces, and were not reported to be greatly visible. In addition, charging points at Cheshire Oaks are accompanied by printed sustainability messages to raise awareness of them, whereas the points at Ecclesall Road are not believed to be well signed.

The Cheshire Oaks and Ecclesall Road stores both display travel information. The information is intended for use by customers and staff to help them plan their journeys better and encourage the use of public transport. However the quality of information provided at these stores varies.

The Cheshire Oaks store only displays standard printed timetables whereas the Ecclesall Road store information screen delivers live public transport times and updates.

Customers in both stores were asked if they knew about the travel information screens in their respective stores. In the Ecclesall Road store customers showed greater awareness of the travel information screens with 33% of customers answering that they knew about them. In the Cheshire Oaks store only 12% of customers were aware of the travel information screens. No customers at Cheshire Oaks said they have, or would, use the Travel information board.

Sustainable Features

Customers were asked to identify any sustainable features that they had noticed at Cheshire Oaks.

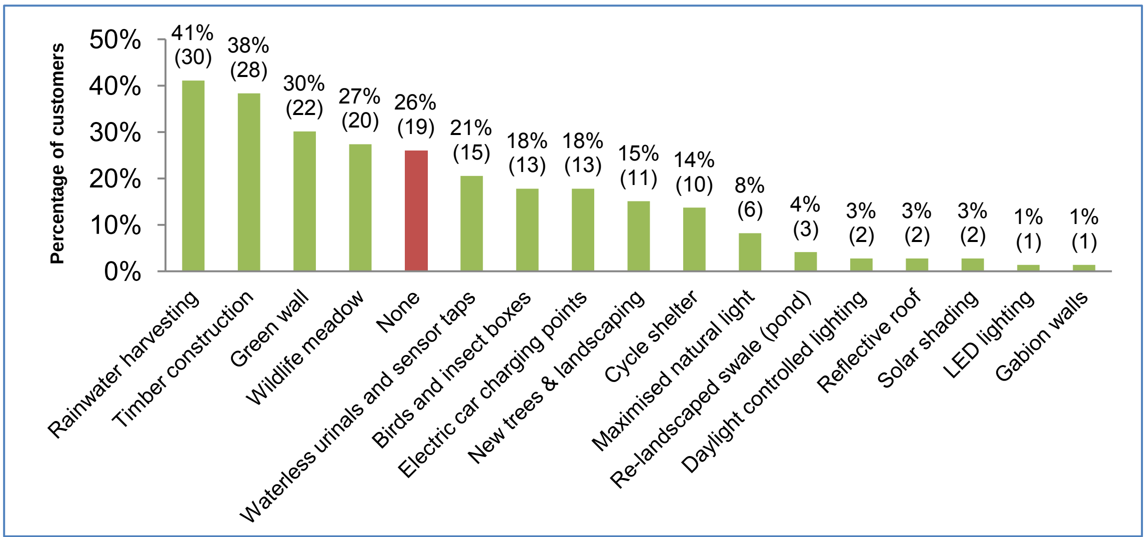


Figure 7 - Customer awareness of *sustainable* features at Cheshire Oaks

At Cheshire Oaks, rainwater harvesting and the timber construction were the most noticed features with 41% (30) and 38% (28) of customers respectively noticing them. The high level of customer awareness towards rainwater harvesting can be attributed to the printed sustainability messages displayed in the store – especially in the toilet areas. Awareness of the store timber construction is due to the intricate and exposed roof on the 1st floor. Customers commented on the ceiling saying they "liked the look". Some customers commented that they had read about the sustainability features in promotional literature before coming to the store and that had helped them to identifying the features within the store. Sustainable features were not noticed by 26% (19) of the customers and a couple of customers also commented that they did not read the printed sustainability messages or had no interest in them.

Overall the sustainability features were well received in the Cheshire Oaks store and customers displayed a better level of awareness of their presence than at Ecclesall Road. When customers were asked what they liked about the building six people commented that they particularly liked the "green features".

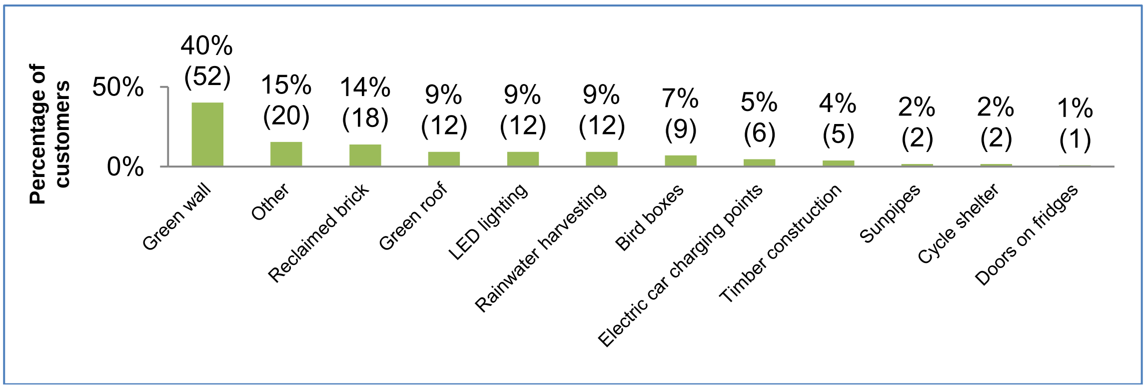


Figure 8 - Customer awareness of sustainable features at Ecclesall Road

In comparison in the Ecclesall Road store only 9% of surveyed customers were aware of the rainwater harvesting system. Given the low visibility of the system the difference in customer awareness here may be attributed to varying levels and locations of the printed messages about the store or promotional literature. The main feature at Ecclesall Road of which customers were aware was the green wall with 40% (52) of customers noticing it.

Customers in the Cheshire Oaks store were also asked to identify which printed messages about the sustainable features they had noticed. 47% of the customers noticed none of the printed messages. The printed messages displayed in the toilet areas were noticed by the most customers – with 30% (22) noticing the rainwater harvesting printed messages and 14% (10) noticing the waterless urinals and sensor taps printed messages. Timber construction, electric car charging points, green wall and bird boxes printed messages received moderate levels of awareness with approximately 10% of customers noticing them. Customers showed little awareness of the remaining printed messages with only 3-4% of customers noticing them.

The location of the printed messages has the greatest effect on its effectiveness – clearly demonstrated by the low awareness of the store's hemp walls, and the display being somewhat hidden by the 1st floor elevators.

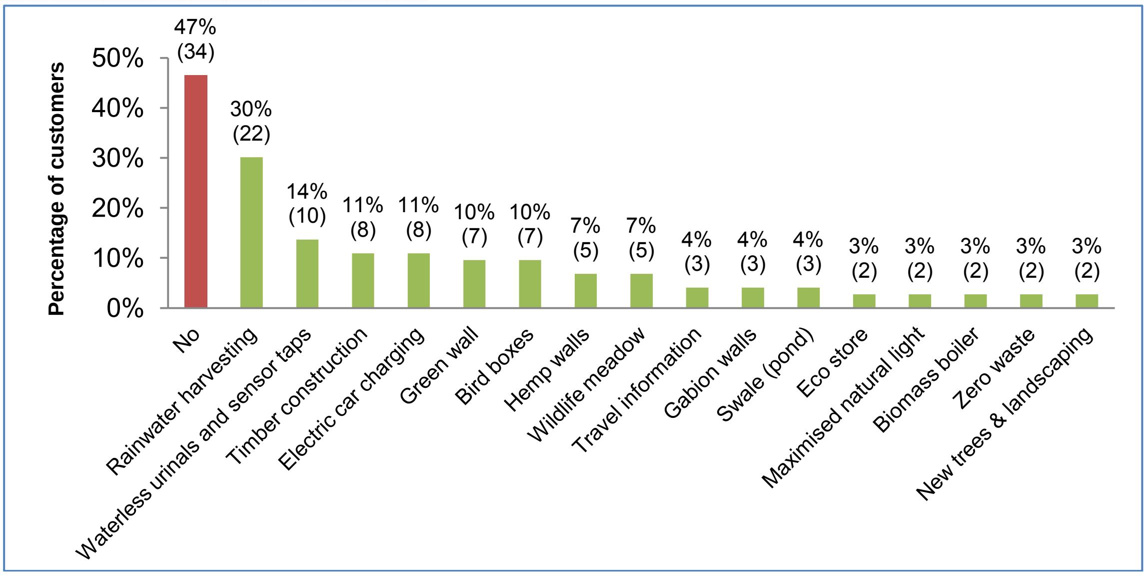


Figure 9 - Customer awareness of printed *messages* about the sustainable features in the store at Cheshire Oaks

QR codes are located around the Cheshire Oaks store to allow customers to receive additional information about specific areas. Customers were asked whether they knew what a QR code was (and if not by name, it was subsequently described to them) and if they used them. No customer asked knew what a QR code was, or said they used or would use them.

Cheshire Oaks customers were also asked if they thought the store had had any impact on the local community. 46% did not have a view. No customers thought that the store had had a significant negative impact on the local community, though around 25% believed the store would have brought jobs and new visitors to the area.

Exterior

The Ecclesall Road store received the most positive feedback when its customers were asked what they thought about the look of the store outside – only 8% answered that they were 'Neutral' and the remaining 92% answered that they 'Really liked it' or 'Liked it'. Cheshire Oaks received similar positive feedback with no negative responses, except with more 'neutral' responses. Customers at Warrington were less positive, but still without negative feedback.

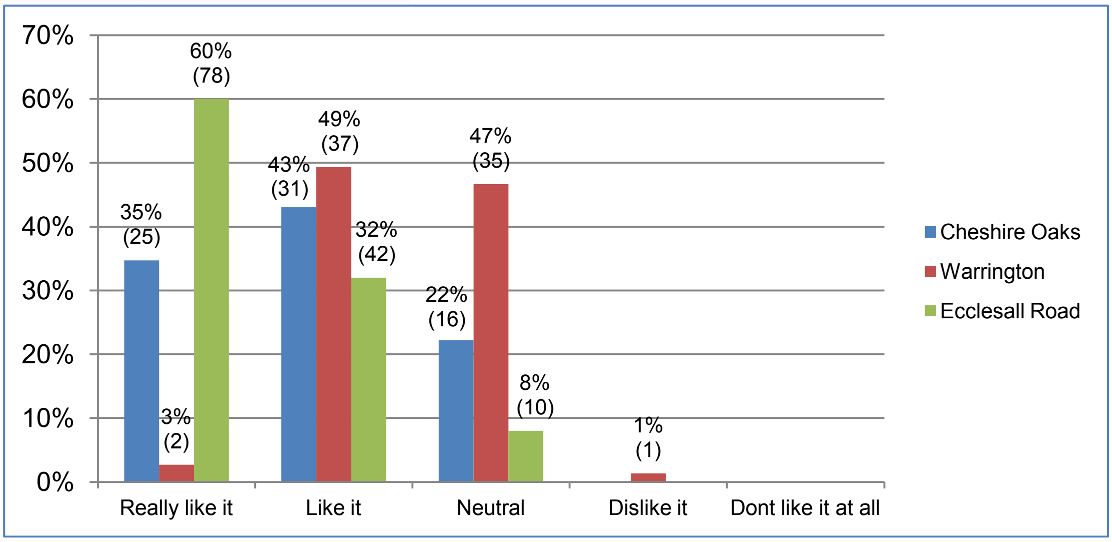
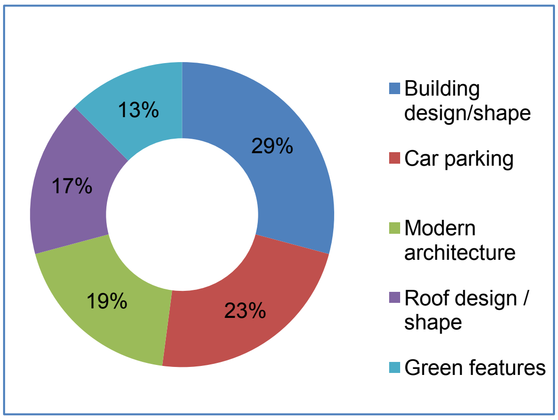


Figure 10 - Response to: What do you *think* of the look of the store outside?

When customers were asked what they liked best about the look of the store outside, respondents from the eco-stores answered positively towards the sustainable features. At Ecclesall Road the green wall was the most popular with 55% of people saying that they liked it best. At Cheshire Oaks 'Green features' were what 13% liked best about the store exterior.

The building design, modern architecture and roof shape were popular with customers at Cheshire Oaks – however some displeasure with the "warehouse look" from the rear (the first view when arriving) was expressed. Modern architecture was also popular in the Ecclesall Road store with 30% of customers saying that they liked it best.



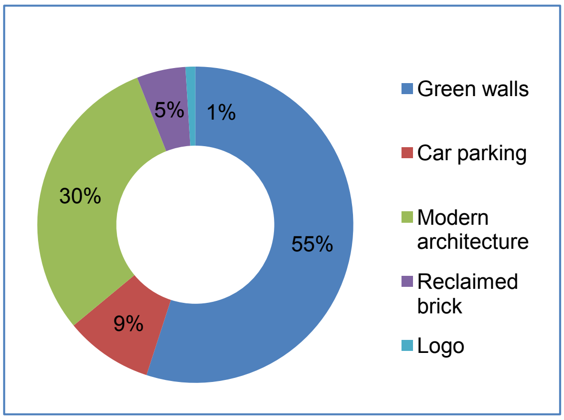


Figure 11 Response to: What do you like best about the outside of the store? L: *Cheshire* Oaks, R: Ecclesall Road.

Car parking featured strongly in customer responses in all of the stores and this gives an indication as to how strongly car parking facilities influence customer decisions to use a store. A shortage of disabled parking was identified by 4% of customers in Cheshire Oaks, whilst 10% of customers in the Ecclesall Road store commented that they disliked 'Access – car park too small'.

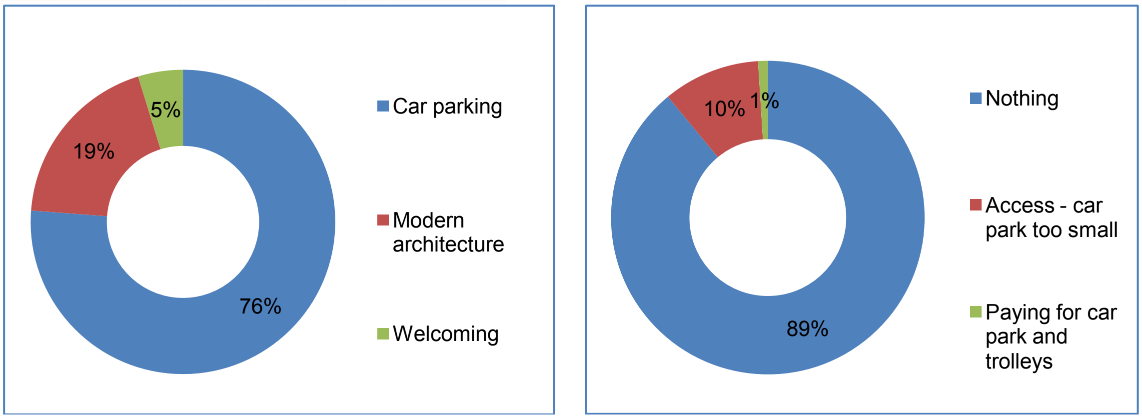


Figure 12 L: Warrington *Gemini*, Response to: What do you like best about the outside of the store? R: Ecclesall Road, Response to: What don't you like *about* the outside of the store?

Interior

Customers in the Cheshire Oaks and Ecclesall Road stores gave very positive feedback towards the interior of their respective stores. At Cheshire Oaks 80% either ‘Really like it’ or ‘Like it’ and at Ecclesall Road 84% said the same. Responses in the Warrington store are distinctly different yet positive. No customers answered that they disliked the store’s interior, but 32% said they felt neutral about it and 64% ‘Liked it’. This could reasonably also be interpreted as a neutral response, with only 4% saying they ‘Really liked it’.

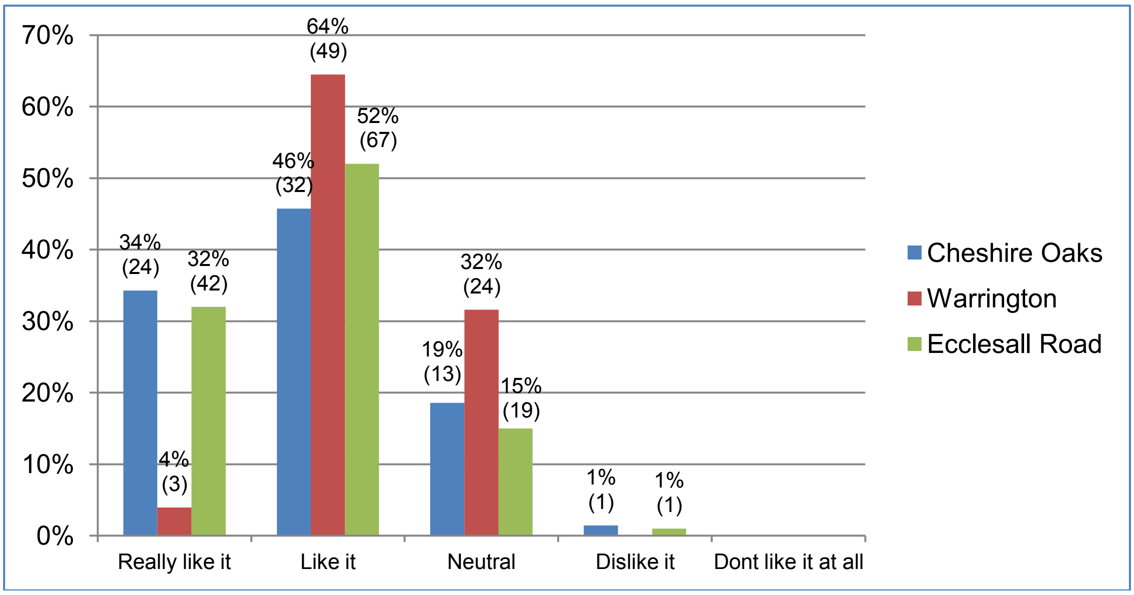


Figure 13 - Response *to*: What do you think of the interior of the store?

Customers were then asked what they did and did not like about the interior of the store. Spaciousness, large size, wide aisles, and a good layout were most commonly appreciated in the stores. Most customers did not dislike any aspects of the store interiors, though a dislike for changing layouts and having to re-learn where goods are displayed was voiced by some at each store. 21% of customers at Ecclesall Road disliked the exposed pipe work inside the store.

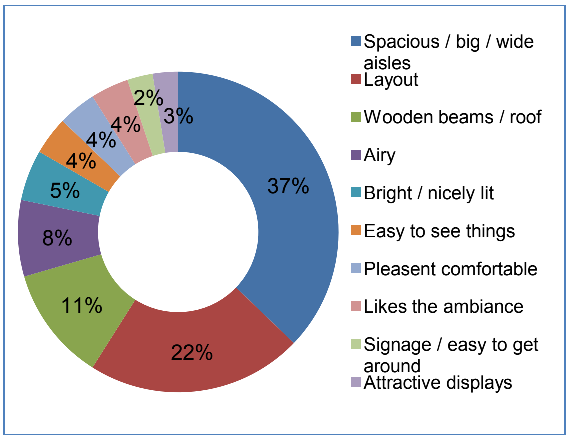


Figure 14 - Cheshire Oaks, Response to: What do you like best *about* the interior of the store?

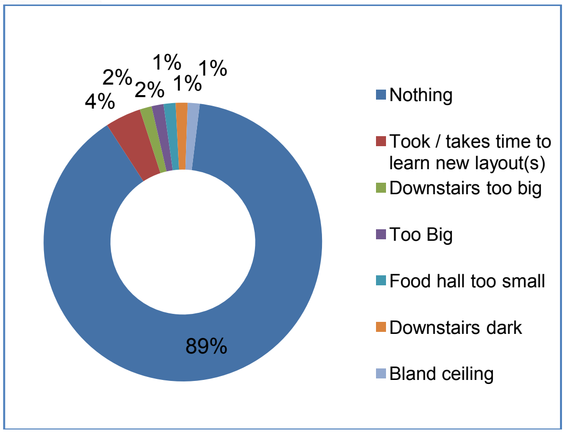


Figure 15 - Cheshire Oaks, Response to: What don't you like *about* the interior of the store?

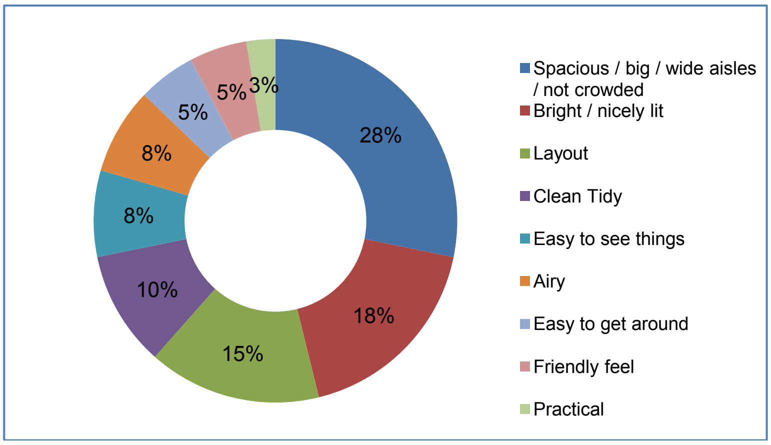


Figure 16 - Response to: What do you like best about the interior of the store? at Warrington Gemini

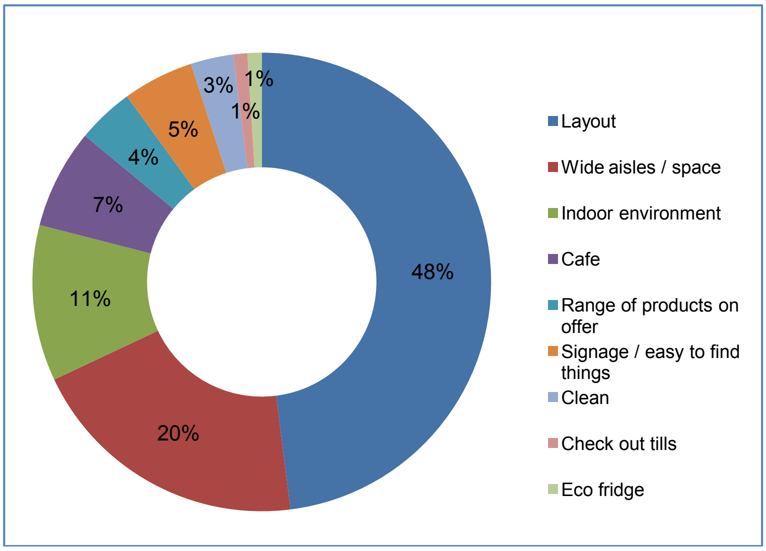


Figure 17 - Response *to*: What do you like best about the interior of the store? at Ecclesall Road

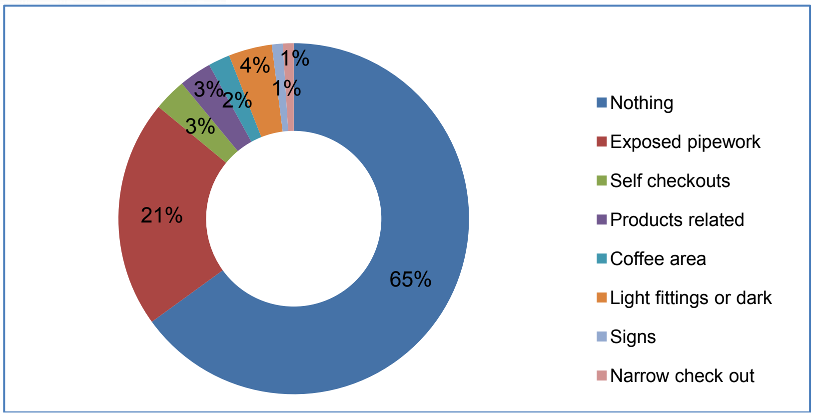


Figure 18 - Response to: What don't you like about the interior of the store? at Ecclesall Road

In conlusion

Customers in the Cheshire Oaks and Warrington store were overall very happy with their shopping experience in their respective stores. When the customers were asked to rate their experience compared to other stores, no negative comments were received. Customers at Cheshire Oaks were especially enthusiastic about their shopping experience.

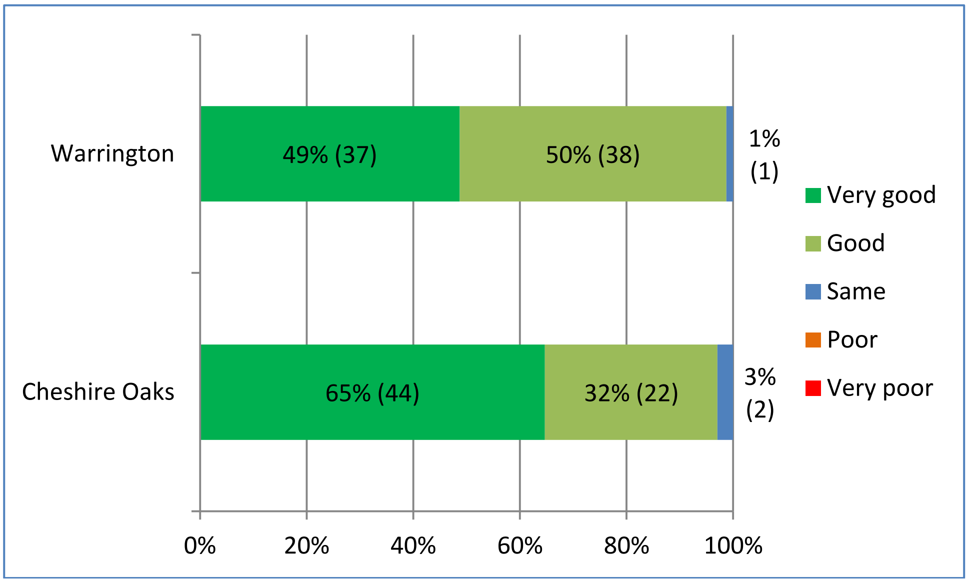


Figure 19 - Response to: How would you rate your shopping experience here compared to other stores?

Customers at Cheshire Oaks were on the whole satisfied with conditions in the store. Temperature and daylight were considered adequate by the vast majority of customers. The majority of customers arrived by car, and found the car parking to be attractive and convenient.

Whilst it could be considered that the sustainable features were not as prominent a consideration for customers as they might be, two considerations should be noted. Firstly, the time of year the survey was taken means that the gardens and green wall were not as prominent as they will be later in the year. Secondly, and importantly, many of the sustainable features will contribute to the very positive customer experience at Cheshire Oaks though they may not be immediately obvious whilst shopping.

4.3 Year one building user feedback results

The shopfloor staff, facilities staff, customers and the local community were all consulted after the store had been opened for one year to obtain their feedback on the building. This feedback was obtained through a combination of focus groups and the use of a BUS survey. The process was repeated at the local Warrington Gemini store to allow the results from Cheshire Oaks to be benchmarked fairly. The whole process was carried out by a team of building use specialists from University College London. They produced a detailed report with all the findings and analysis of their investigation entitled “Cheshire Oaks Soft Analysis Report 2013 v5”. This report is included as one of the deliverables in the overall TSB Building Performance Evaluation project for Cheshire Oaks. The main findings from the UCL report are replicated in this section for completeness.

The survey work was conducted during the first week of September 2013, after the hottest summer for 6 years in the UK. The winter of 2012/13 was also colder than the 20 year average.

We received 81 and 94 completed BUS surveys from Cheshire Oaks and Warrington Gemini respectively, corresponding to a response rate of around 40% for each store. In total, 35 and 34 participants took part in 6 focus groups in each of Cheshire Oaks and Warrington Gemini stores.

Main survey results

The results from the BUS survey for Cheshire Oaks, placed it very highly compared to all the buildings surveyed using the BUS method. The score for "overall summary index" for the Cheshire Oaks store, puts the building in the top 5% of all buildings surveyed, the "comfort score" is in the top 11%, the "satisfaction index" is in the top 2%, and the "forgiveness index" is in the top 26% of all surveyed. Given that the building is very large and is mechanically ventilated, these results indicate the building is performing extremely well. All of the "overall" variables are better than or very close to benchmark. Of all 48 individual variables only 7 are below benchmark values, with 5 of these relating to user control of their environment, the other 2 are speed of response to requests for changes, and effectiveness of response to request for changes.

The focus groups allowed more detailed insight to be gained about each store than was possible with the BUS survey. The feedback from the focus groups in Cheshire Oaks demonstrated very high approval from almost all of the participants. The main positive points across the groups were that the building was light and airy and the aesthetics were well appreciated, with several mentioning that it was like a cathedral. The environment was comfortable in terms of temperature, noise and light levels to make it an enjoyable shopping experience that people would spend several hours in. The sustainable features, such as the living wall, landscaping, rain water harvesting and low energy ventilation systems were enjoyed by staff, customers and the local community. There were only a few negative points; a lack of customer seating in the ground floor, not enough food hall area, and the large distances involved in shopping being the main ones. Also, some customers questioned whether the downstairs cafe was needed as the upstairs one was excellent. Staff also found the distances walked to be significant and when taking a break it could take them a long time if they were approached by customers on their way to the staff canteen, or staff toilets.

The BUS "index" scores from Warrington Gemini are not available; however, of the 48 individual variable scores from the BUS survey of Warrington Gemini all but 8 are less positive than those from Cheshire Oaks, with 19 being less than the benchmark. Of the 8, some are related to office environments, so Cheshire Oaks has "too little" outside noise compared with Warrington Gemini, no natural light glare problems (due to far fewer windows), and more "fresh air" (related to the cold temperatures within Warrington Gemini). None of the 8 variables relate to store design. The Warrington Gemini store has a very cold environment within the large food hall section, the BUS survey reflects this with temperature scores all scoring poorly.

The focus groups provided further detailed insight regarding this issue in Warrington Gemini. In the food hall, staff wear gloves, and pyjamas under their uniform, and customers wear coats. There is a flower sales area just outside the food hall, that customers thought was too warm, though this could have been in comparison with the food hall. Customers were appreciative of the general shopping environment in terms of light levels and space but did not like that there were no ground floor toilets, as in Cheshire Oaks there was a shortage of seating in the shopping area. Some mentioned that the fitting rooms were too warm. In Warrington Gemini, staff were very unhappy about the lack of storage space: following the refurbishment the store increased in retail floor area by ~20% with no increase in storage area. Customers appreciated the free parking compared to city centre shopping.

The customers from both stores were in general incredibly loyal to the M&S brand; they repeatedly came to buy the products they liked. For Cheshire Oaks they thought the range was good, the quality good and the price "wasn't too bad" either. For Warrington Gemini they thought the range looked dated and had the impression that Cheshire Oaks received the better lines earlier. The customers of Cheshire Oaks liked the shop very much and enjoyed the whole shopping experience, including the parking facilities and the café. Warrington Gemini customers seemed to put up with the extreme cold of the food hall but some were definitely put off by the temperatures and curtailed their shopping because of it. M&S service scores for both Cheshire Oaks and Warrington Gemini show customer complaints are higher at Warrington Gemini than at Cheshire Oaks.

The local community at Cheshire Oaks had changed from resenting the store's arrival in their neighbourhood to treating it as their "local corner shop". The local traffic in the area had also improved due to improvements made as part of the development. They enjoyed visiting the store frequently and like to keep an eye on the ecological features such as swifts nesting and bees. Surprisingly, they now thought that M&S should market the store better to encourage more people to see what a great building they thought it was.

The staff of Cheshire Oaks often said that they were "proud" to work there, (BUS score for "needs" variable of 6.88/7 compared to benchmark of 4.88), one said, 'I do enjoy working here, I do enjoy coming in this store', the Warrington Gemini staff did not use the word proud in focus groups, but were in general satisfied with the building (BUS "needs" variable 4.99/7). The absenteeism rates are likely to reflect this over time but Cheshire Oaks hasn't been open long enough to have enough data for a reliable comparison.

Overall footfall data for each store is very similar with around 4% more in Cheshire Oaks than in Warrington Gemini, possibly reflecting the excitement generating large crowds at the time of the store opening in late 2012. When looking in more detail footfall numbers are very similar.

Considering sales for each store, General Merchandising sales are almost identical for both stores, with weekly peaks closely following each other, over the past year Cheshire Oaks sold 0.1% more than Warrington Gemini. Food sales follow a similar pattern but Warrington Gemini sells almost 40% more food than Cheshire Oaks each week. Overall sales are 13% higher for Warrington Gemini because of this. The focus groups mentioned that the food hall was too small at Cheshire Oaks, no such comments were received at Warrington Gemini.

The focus groups for staff at both stores clearly demonstrated a difference in attitude with those at Cheshire Oaks using far more positive statements about their working environment than those at Warrington Gemini.

It is worth mentioning energy consumption figures for both stores, Cheshire Oaks uses 40% less energy than Warrington Gemini, and has much better thermal environment in the whole store in both summer and in winter. Cheshire Oaks has high levels of natural lighting and good artificial lighting, with similar or better approval ratings from both focus groups and BUS survey results when compared with Warrington Gemini.

Staff, customers and community in general were highly impressed with the store. They liked the environment within the store and the ecological landscaping outside of the store. There were a few customers from Warrington Gemini who would go to Cheshire Oaks for the experience, but the main reason for customers visiting both stores was clearly that they liked M&S products. The challenge is then to get more customers into the store, improve the products, make the store easier to move about in for the less mobile, and keep them there longer.

One participants response might sum it up, they said "well done you've done an amazing job on this".

4.4 Conclusions and key findings for this section

M&S Cheshire Oaks is assessed as being one of the top buildings in the country based on an objective staff questionnaire survey (Building Use Survey). From this, workers rated that the environmental conditions in the building increased their productivity. They rated the image that the building presents to visitors was very high and they were very happy with the design of the building.

M&S Cheshire Oaks ranks far higher than a peer store in terms of customer satisfaction with the shopping experience, with quotes such as “I think anybody coming here for the first time is like ‘wow’”. Customers love the design of the store with the sustainable features ranking highly, “I think ecologically they’ve done really well”. An interesting point that came out of the customer interviews was that in general they felt that the merchandise at Warrington were dated and needed refreshing, and that Cheshire Oaks had better ranges. In reality both stores carried the same range, which suggests that the customer’s perception of the products was influenced by the building they are in.

Local community representatives living near Cheshire Oaks have moved from a position of not wanting the store to be built to it becoming their corner shop, the sustainable features outside the store led them to visit more often, “looking up at that roof it’s like a cathedral: St Marks it should be called”.

Shop floor staff at Cheshire Oaks express high levels of satisfaction working in the store with the design of the store contributing strongly to these feelings, “It must be one of the nicest places in the country to work ‐ ‐ not just Marks and Spencer’s but generally”.

5 Details of aftercare, operation, maintenance & management

5.1 Aftercare

As a mandatory part of the Practical Completion process, the Principle Contractor provided a detailed handover manual to Marks & Spencer. The manual has been used to assist Marks & Spencer in the training of the facilities staff who are involved in the day to day operation of the new equipment and systems.

The manual covers all likely systems and equipment associated with the Fire, Health and Safety matters associated with the building. The manual is broken down into the following systems:

- Utilities
- Loading bay
- People movement
- Controls
- Mechanical
- Refrigeration
- Electrical
- Store systems
- Sprinklers
- Swale area

The manual provides both a description and photographs of all of these systems, highlighting where all of the main plant items and their controls are located. Instructions for the safe start up, operation and shutdown of each system is provided in a clear step by step format. In addition to this it contains details on how to operate the building in the event of a power failure. The maintenance team were provided with all the appropriate training before the handover of the store.

In addition to the handover manual, the project Health & Safety file contains detailed descriptions on all aspects of the building's systems, including as built drawings, system overviews, plant schedules, manufacturers' data sheets, risk registers, maintenance instructions and control philosophies.

5.2 Operations

As described in previous sections, the facilities staff were fully trained before the store was opened in an intensive two week training period provided by the contractor. The facilities staff had all previously worked at others Marks & Spencer stores, and were already familiar with Marks & Spencer procedures. The two systems which were new to the staff were the biomass boilers and the rainwater harvesting system. Initial teething problems have been experienced with both of these system, however the contractor has been on call to resolve these issues as and when they have been found.

Details of the electricity consumption in each area of the store are provided through the use of extensive sub-metering. Information from these sub-meters are used to provide a breakdown of the energy used by the following systems:

- Lighting

- Heating
- Air conditioning
- Ventilation
- Refrigeration
- Small power
- IT / Communications
- Mechanical services
- Catering

These sub-meters are connected to an automatic monitoring and targeting system which can be accessed through a web portal called 'MS Energy'. The biomass consumption information is not collect via this system, but is recorded manually.

The MS Energy system has a web interface that allows users to view and download consumption data from any Marks & Spencer store. Figure 20 shows an example of the type of information available through Marks & Spencer Energy.

Figure 20 - Example of the data available from 'MS Energy'

As well as providing monthly summaries for the electricity, gas and water consumption, MS Energy is used to provide hourly consumption data from the sub-meters. An example of the level of detail available from the sub-meters is shown in Figure 21.

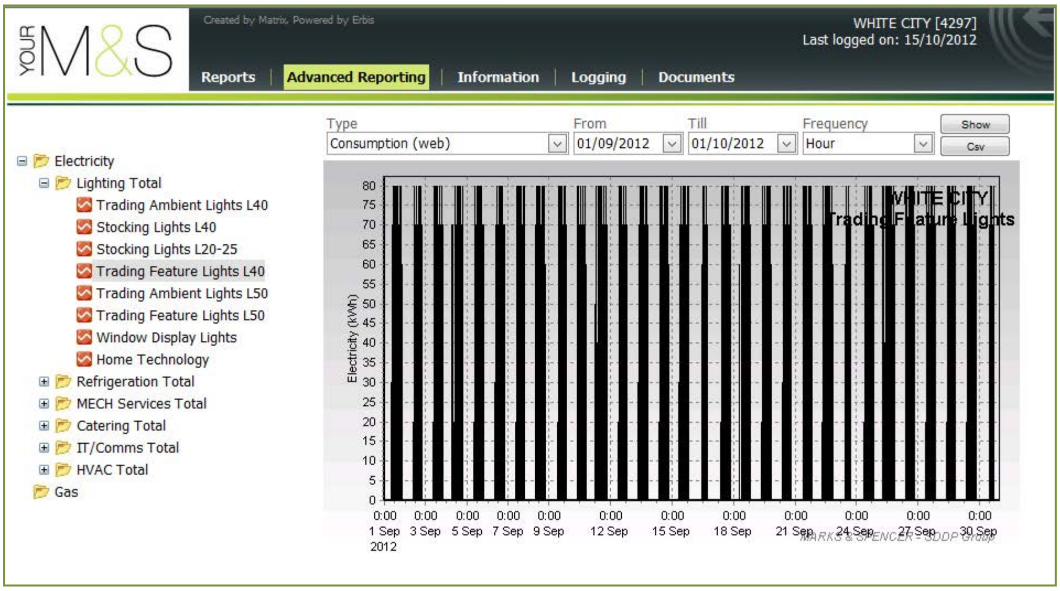


Figure 21 – Example of the sub-metering data available on MS Energy

5.3 Maintenance and Management

The store has an extensive BMS system which provides operational data on the heating plant, ventilation systems, lighting, cooling plant, refrigeration systems and in store temperature sensors. The BMS is provided with a web based interface which shows the current operation of these systems and also allows historic performance data to be interrogated.

The BMS is monitored remotely by a third party energy management bureau. The energy management bureau has a remit to monitor the energy use in the store and identify any systems which are using more energy than expected. If they see a parameter go outside normal operating parameters they inform the Marks & Spencer facilities staff. The facilities staff are then responsible for identifying and rectifying any issues. This pro-active monitoring of the BMS can help identify issues with the building services as soon as they occur and allows early maintenance to be focused in the appropriate areas.

The energy management bureau has full remote control over the HVAC and lighting systems in the store. The onsite facilities staff do not have the ability to switch the store lights on and off or adjust any of the heating and cooling set points. This can occasionally lead to issues when out of hours working is required, as permission needs to be sought from the energy management bureau to keep the heating systems on.

Set points on the BMS for the HVAC and lighting system can only be changed once permission has been granted by one of the two authorised senior engineering managers, based in the Marks & Spencer head office. Once a set point has been changed, the system is monitored for a period of time to assess the overall impact of the change. The energy management bureau keep records of the changes made to the systems.

5.4 Conclusions and key findings for this section

The contractor has been available to provide aftercare to support in addressing teething issues that have arisen in the first months of operation. Also the supporting documents provided on the operation of the store are very clear and comprehensive.

The facilities staff were fully trained and up to speed on the building services before the store opened, which helped to ensure its smooth operation.

Having an energy management bureau continually monitor the BMS ensures that pro-active maintenance can be undertaken before any serious issues develop.

6 Energy use by source

6.1 Overview of Electricity Consumption Data

The electricity data for the store is measured through a main meter which is supplemented by an additional 51 sub-meters. The sub-meters have been grouped together into the following categories in the MSEnergy portal, (described in Section 5.2), to allow for easier reading of the actual consumption.

- Trade lighting (the lights that are on during store opening hours)
- Stock lighting (the lights that are on during staff working hours, these are longer than opening hours)
- Other lighting (typically local lighting used to provide a specific atmosphere around a particular sales area)
- External lighting
- Refrigeration
- HVAC
- Mechanical handling
- Catering
- IT/Comms
- General power

In general these map well to the end use categories used in the TM22 analysis, which allows for fast comparison between the two systems. The output from the Simple Assessment in TM22 for the building for the period 01/11/12 to 31/10/13 is shown in Table 1, Figure 22 and Figure 23

Table 1 – Simple Analysis table from TM22

Absolute values	Energy supplied (kWh)		Carbon dioxide emissions (kg CO_2)		
	Fuel/thermal	Electricity	Fuel/thermal	Electricity	TOTAL
Supplied	330,561	3,765,830	69,112	2,071,207	2,140,319
Exported CHP	0		0		

Unit values	Energy supplied (kWh/m² GIA)		Carbon dioxide emissions (kg CO_2/m² GIA)		
	Fuel/thermal	Electricity	Fuel/thermal	Electricity	TOTAL
Supplied	17.0	193.9	3.6	106.7	110.2
Exported CHP	0.0		0.0		
Raw TM46	171.2	89.5	33.2	49.2	82.4
User Specified	89.0	360.0	17.3	198.0	215.3
Benchmark from DEC	0.0	0.0	0.0	0.0	0.0

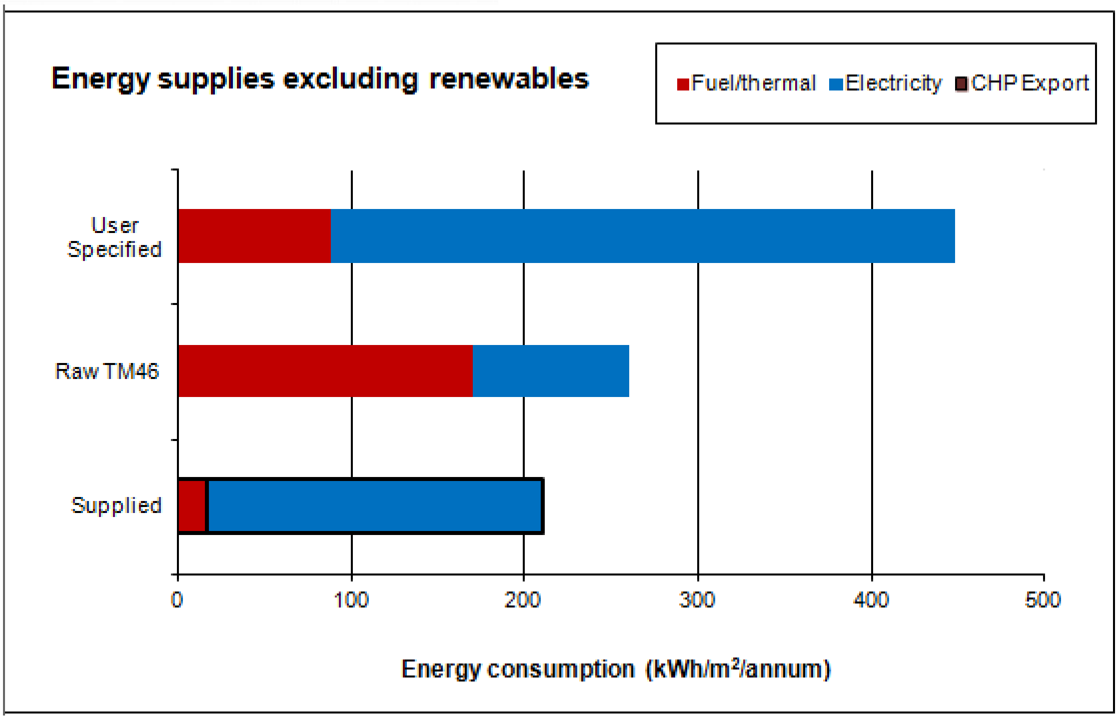
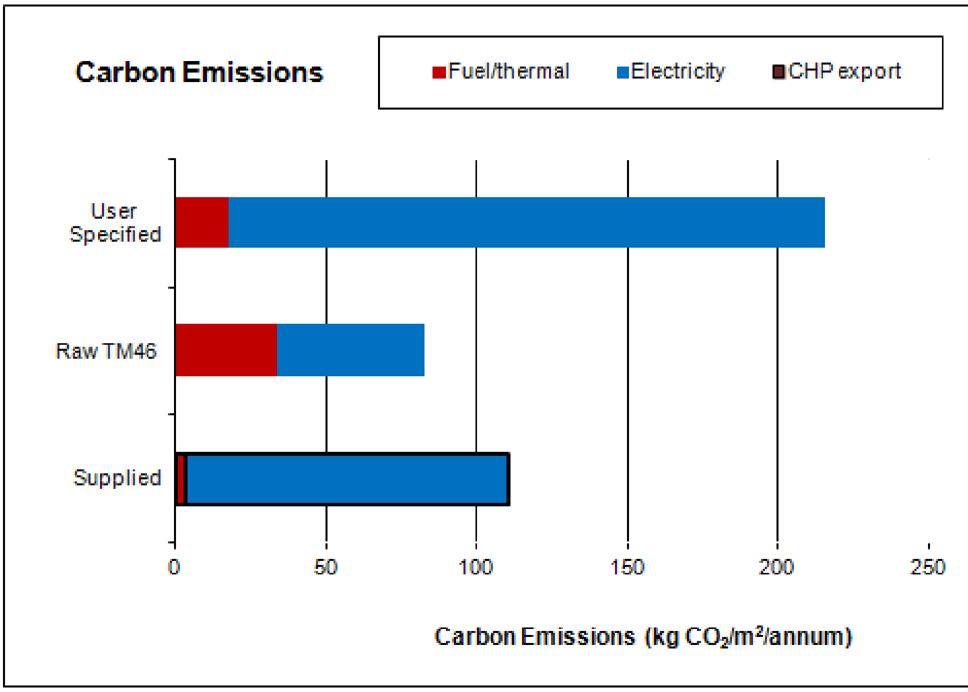


Figure 22 – Energy consumption from the Simple Assessment in TM22



CO_2 factors used in assessment:	kg CO_2 /kWh
Electricity (grid)	0.55
Natural gas	0.194
Biofuels	0.025
Waste heat on-site	0

Benchmark CO_2 factors:	kg CO_2 /kWh
Electricity (grid)	0.55
Gas	0.194

Figure 23 – Carbon emissions from the Simple Assessment in TM22

In these charts, the “User Specified” thermal fuel and electricity is based on the benchmarks derived from the energy consumption from other similar sized M&S stores. It is clear the Cheshire Oaks is performing well ahead of these user benchmarks both in terms of thermal fuel and electricity. The reasons for this is mainly due to better insulation and greater air tightness on the thermal fuel side, and more efficient building services and refrigeration on the electricity side. The use of daylight also helps to reduce the artificial lighting load, which is the single largest energy consuming system in the store.

The TM46 comparison should only be seen as a very rough approximation to the Cheshire Oaks store. This is because the Cheshire Oaks store is a mixture of food retail, clothing, homeware, cafes and backstage storage, which is hard to compare with the reference building types used in TM46. Nevertheless, an attempt has been made to split the store into discreet areas of “Large Non-food shop”, “Large food store” and “Storage facility” in the TM22 to allow this simple comparison to be undertaken. Note that there is no DEC available for the building and so no comparison with it can be undertaken.

The MSEnergy portal has been used to obtain energy consumption figures for other “premier” style M&S stores over the same period. The results are shown in Figure 24.

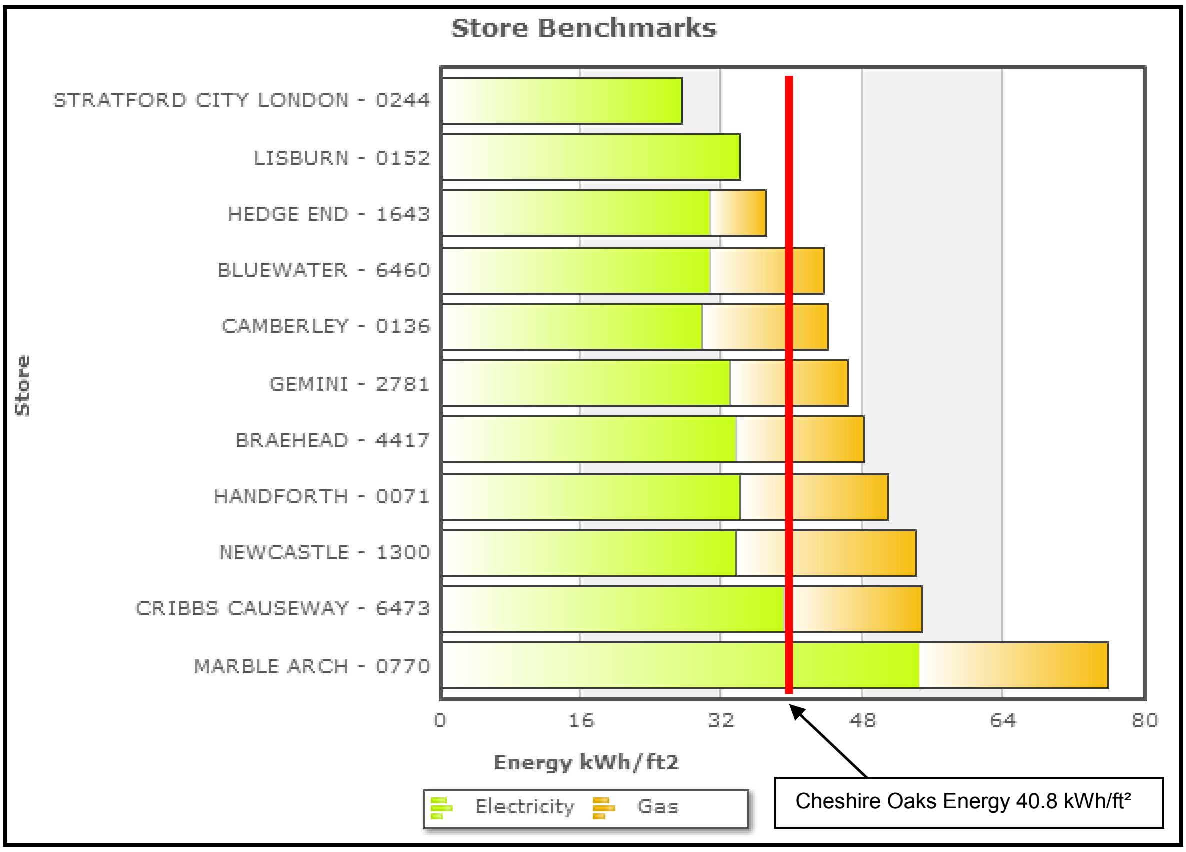


Figure 24 – 12 month energy consumption benchmarks (kWh/sales floor area) for other Premier M&S stores

It is important to note:

- The **Stratford City** figures do not include the heating or the chiller loads.
- **Lisburn** is heated by fuel oil which is not included in the figures.
- A metering issue at **Hedge End** that caused the winter 2012/2013 gas consumption not to be counted.
- Many of the stores shown in the graph are part of larger malls and therefore do not have the same proportion of external walls to lose heat through as there is in Cheshire Oaks.
- Most of the stores do not have any external lighting loads.

Taking all these factors into consideration, Cheshire Oaks is highly likely to be the most energy efficiency “premier” M&S store, as it was designed to be.

The electricity consumption as read by these sub-meters is shown in Figure 25. The data is divided up by month to allow easier comparison of the data over the changing seasons.

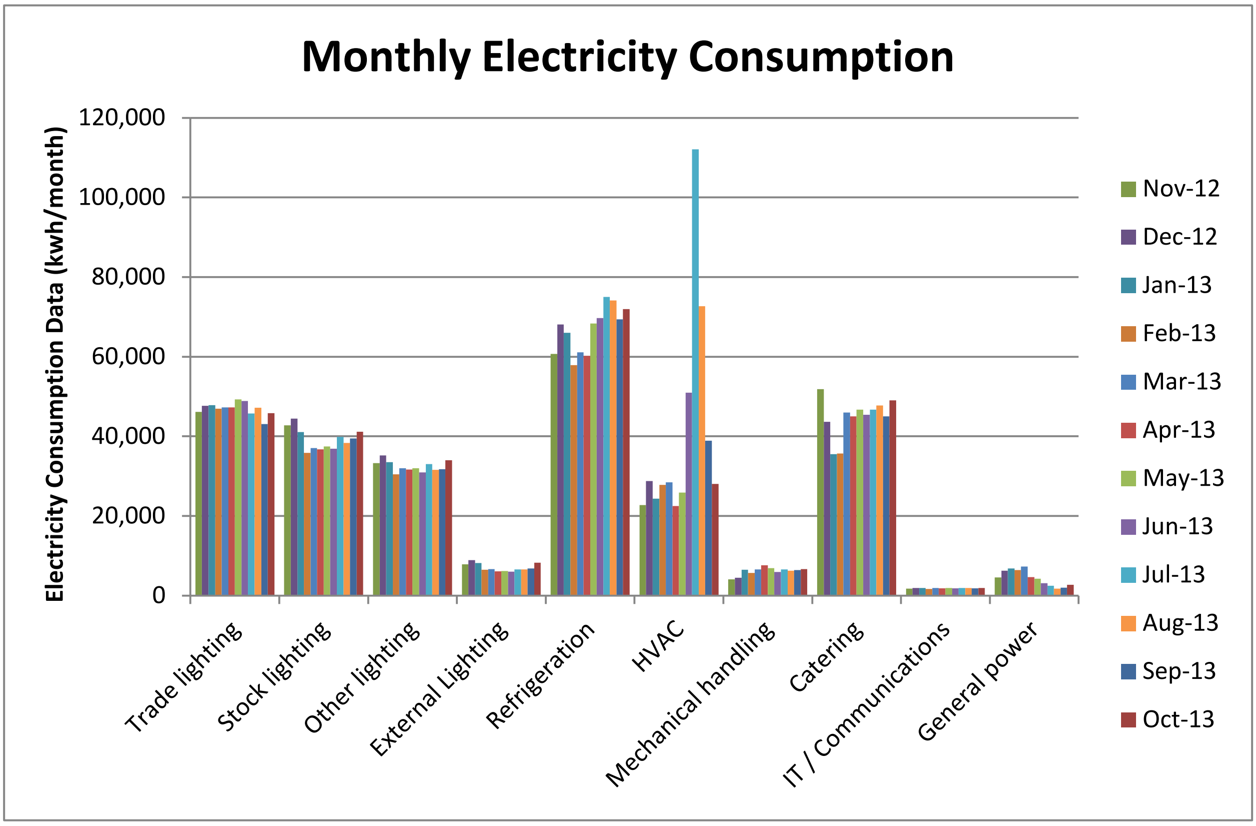


Figure 25 – Monthly electricity consumption per sub meter category

Annual totals compared to the design predictions and user specified benchmarks are shown in the TM22 detailed assessment shown in Figure 26 and Table 2.

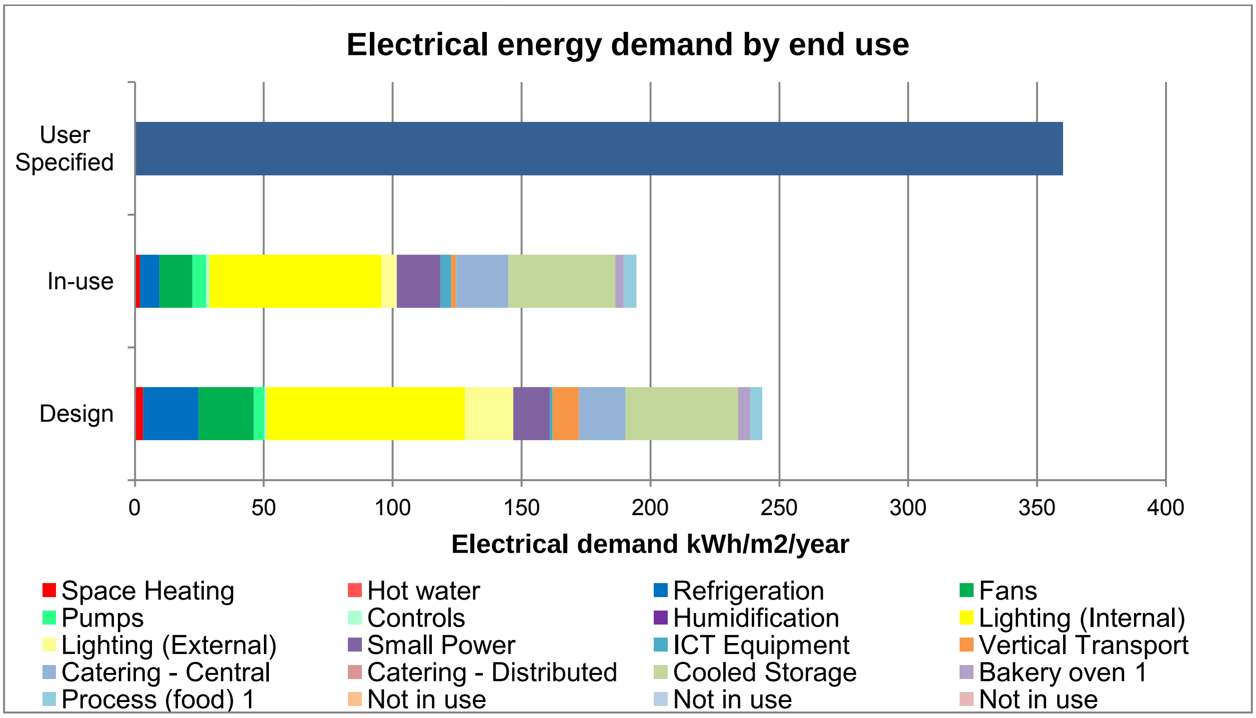


Figure 26 – TM22 detailed assessment of electricity use

Table 2 – TM22 Actual and design electricity consumption

		Electricity demand (kWh/m2/year)	
System	**Description**	**Design electricity (kWh/m2/year)**	**In-use electricity (kWh/m2/year)**
Space Heating		3.2	1.9
Hot water		0.0	0.0
Refrigeration		21.6	7.6
Fans		21.4	12.7
Pumps		4.1	5.4
Controls		0.9	1.2
Lighting (Internal)		77.0	66.8
Lighting (External)		18.8	6.0
Small Power		14.1	17.0
ICT Equipment		1.0	4.1
Vertical Transport		10.3	1.9
Catering - Central		18.1	20.4
Cooled Storage		43.6	41.5
User 1	Bakery oven 1	4.7	3.1
User 2	Process (food) 1	4.7	5.0
Total		**243.4**	**194.5**
Metered building energy use		193.9	193.9
Variance TM22 versus metered total		49.5	0.6
Variance TM22 versus metered total		25%	0%

The lighting load accounts for a significant amount (42%) of all the electricity used by the store. This is as expected due to the extensive shop floor space and the requirement for good quality lighting for displaying the goods. The November to January peak in stocking lighting consumption is due to the longer working hours used during this period.

As the lights play such a significant part in the overall energy consumption, it is important to ensure that their use is well managed. Figure 27 shows how well controlled the lighting is for the store. There is very effective switching on and off of the trading lights to match trading hours. The stocking lights come on a few hours earlier than opening time in the morning and stay on for an hour or so after the store has closed. The back of house lighting electricity consumption is fairly consistent partly because the lights are left on most of the time.

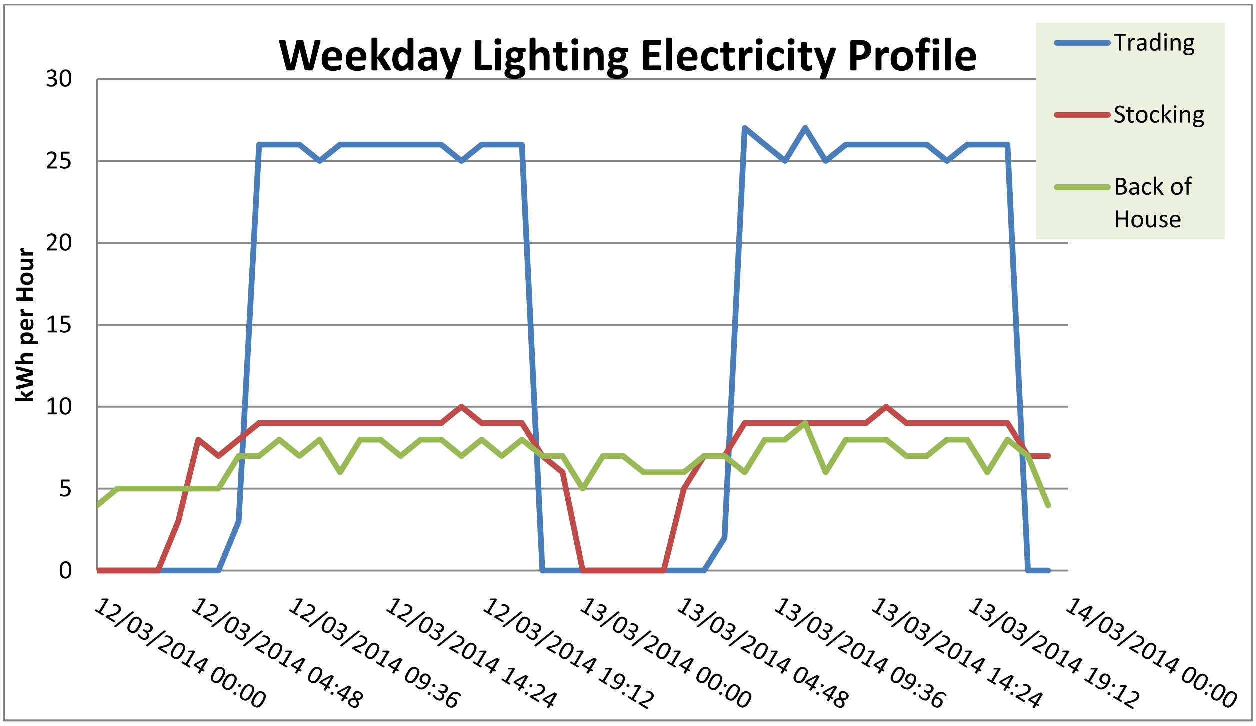


Figure 27 – Weekday profile for selected lighting use (a single trading, stocking and back of house circuit used for each line)

The profiles for the weekend show a similar story except the operating hours are clearly shorter for Sunday.

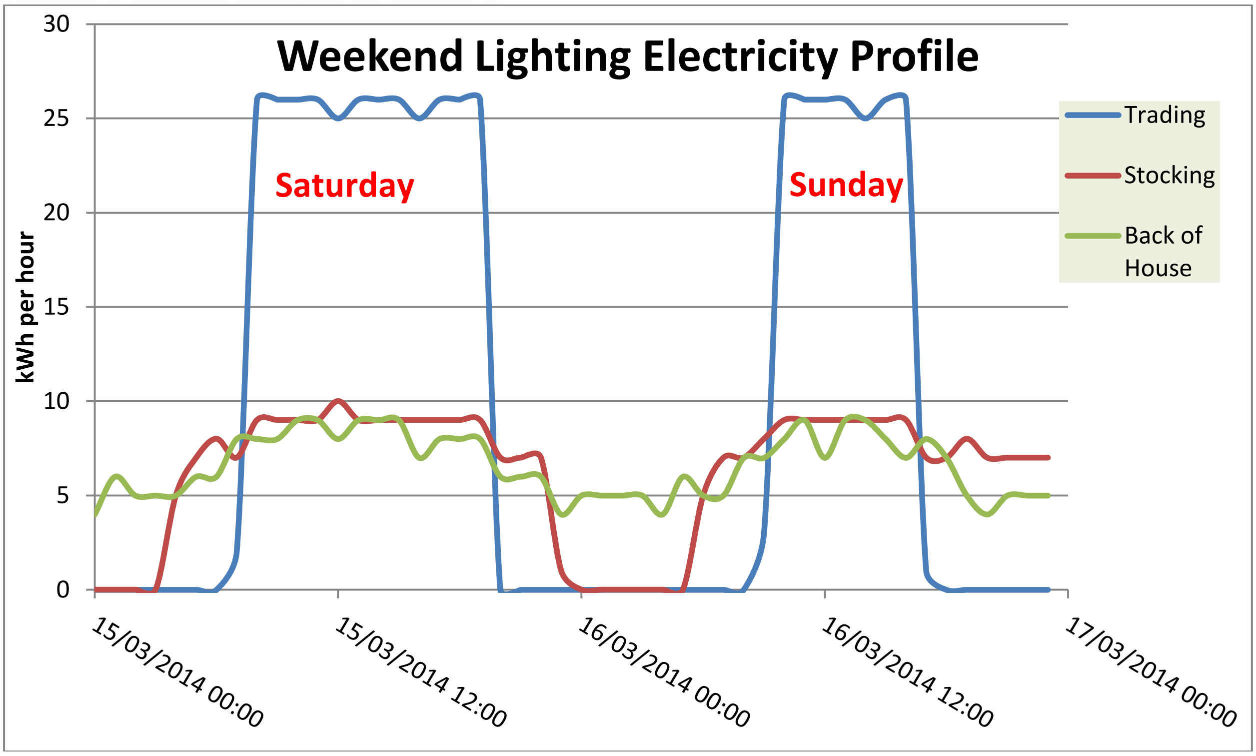


Figure 28 – Weekend profile for selected lighting use (a single trading, stocking and back of house circuit used for each line)

These graphs also demonstrate how the lighting load is distributed, confirming the data show in Figure 25. The majority of the lighting energy used in store is on trading lighting, with stocking lighting second and then back of house lighting

During July 2013 a number of the metal halide spots in the front of house were exchanged for more efficient metal halide spot with the same light output. Figure 29 shows the electricity consumption from a trade lighting sub-meter before and after the installation.

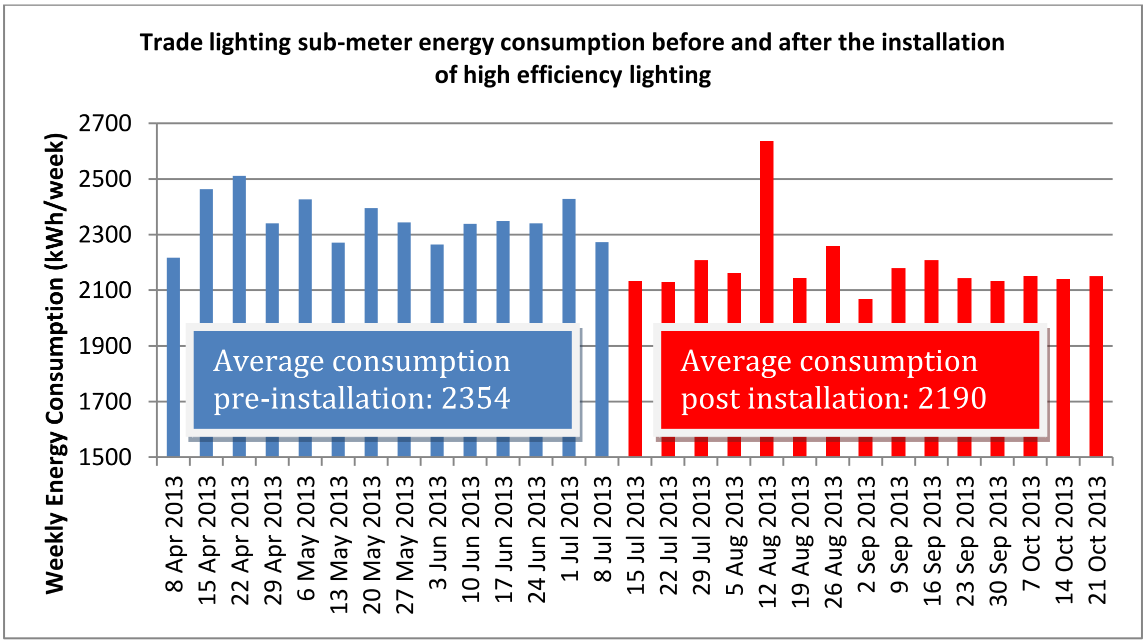


Figure 29 – Weekly total electricity consumption from a trade lighting sub-meter

The lux levels within the store are no different to those used in other similar retail store, typically designed to be around 500 lux in the main front of house areas. Some handheld readings were taken on an ad-hoc basis and the lighting levels were confirmed to be approximately 500 lux at the level of the goods. However accent lighting was used throughout the store to highlight displays. The lighting levels were not felt to be excessive either by the assessor or the customers asked. The use of metal halide spots and T5 tubes over LED predominantly is an issue of cost as the lighting was designed some years ago when LEDs where more expensive than they are today. However it should be noted that the metal halide lamps in question are considered to be reasonably energy efficient and produce over 90 lm/W and the T5's 95 lm/W, which both are higher than many commercially available LED lamps.

Although no complete lighting schedules were available for the store, readings from the submetering indicate that the installed lighting has a total "Circuit Watts / m²" of 11.1 W/m². Converting this to an installed power density gives 2.11 W/m²/100Lux. By way of reference the EU's voluntary Green Public Procurement criteria for interior retail lighting states a maximum of 3.5 W/m²/100Lux, whereas best practise is 1 Wlm²/100lux. Cheshire Oaks falls mid way between these two as is expected due to the amount of local accent lighting used for commercial purposes.

The readings from the sub-meters show that on average there has been a 7% reduction in electricity consumption on the trading lighting circuit examined. This trend was seen across all the other sub-meters where the lighting was changed. It is important to note that the metal halide spots make up only part of the lighting on the trade lighting circuits, and it is estimated that the overall reduction in electricity consumption associated with the spots is 20%.

The refrigeration loads are the second largest and are show two distinct peaks, one during the winter and again in May and June. The main driver for the refrigeration energy use is the rate at which chilled and frozen food is bought. This accounts for the peak seen over the busy Christmas and New Year period. The increase in energy consumption in May and June is suspected to be due to an increase in external temperatures.

The HVAC energy consumption is reasonably consistent throughout the monitoring period with the exception of the summer months of June to August when the monthly consumption more than doubles from the average. This increase in energy consumption was tracked down to the main AHUs. Figure 30 shows how the energy consumption of the main AHUs varies with the external air temperature. It clearly shows that there is significant increase in energy consumption when the external air temperature rises above 14°C. This is due to the compressors being used to provide cooling to the air supplied to the store. The energy consumption is fairly consistent when the external air temperature is between 7 – 12°C, but there is a clear increase in power as the temperature gets cooler, with a peak a 0°C. This has been found to be due to the increase in power arising from the increased use of recirculation air fans and the AHU heaters.

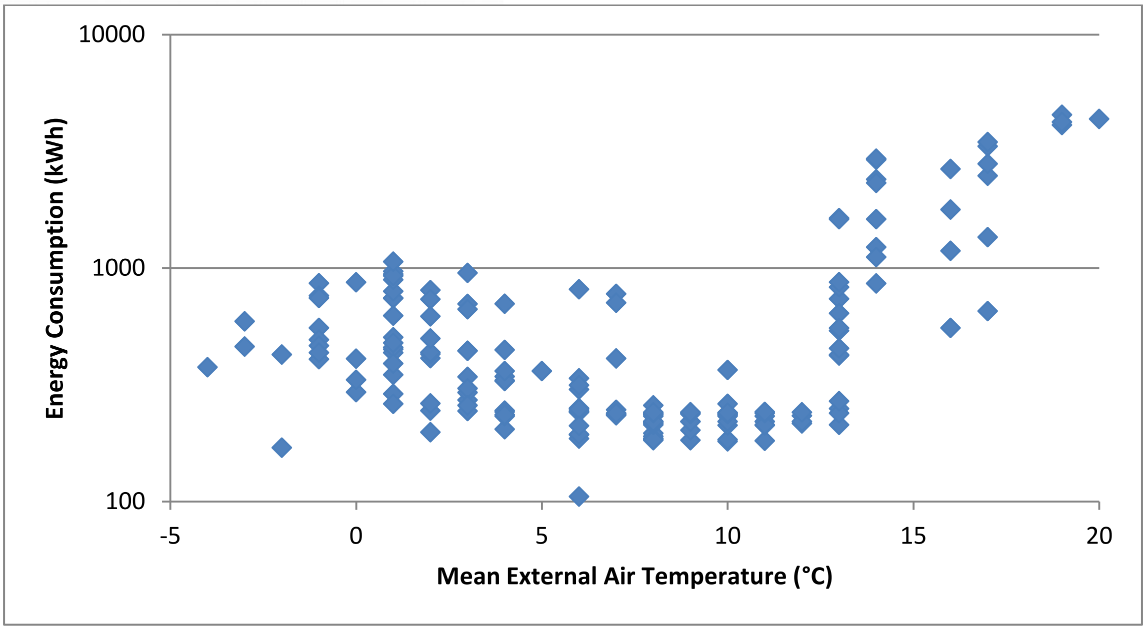


Figure 30 – AHU electricity consumption measured against external air temperatures – weekdays only (Note: a logarithmic scale is used on the vertical axis)

The store's cafes have proven to be very popular, with the total number of customers visiting it making it the most popular 'coffee shop' in the area. Figure 31 shows how the electricity consumption associated with catering compares with the footfall into the store.

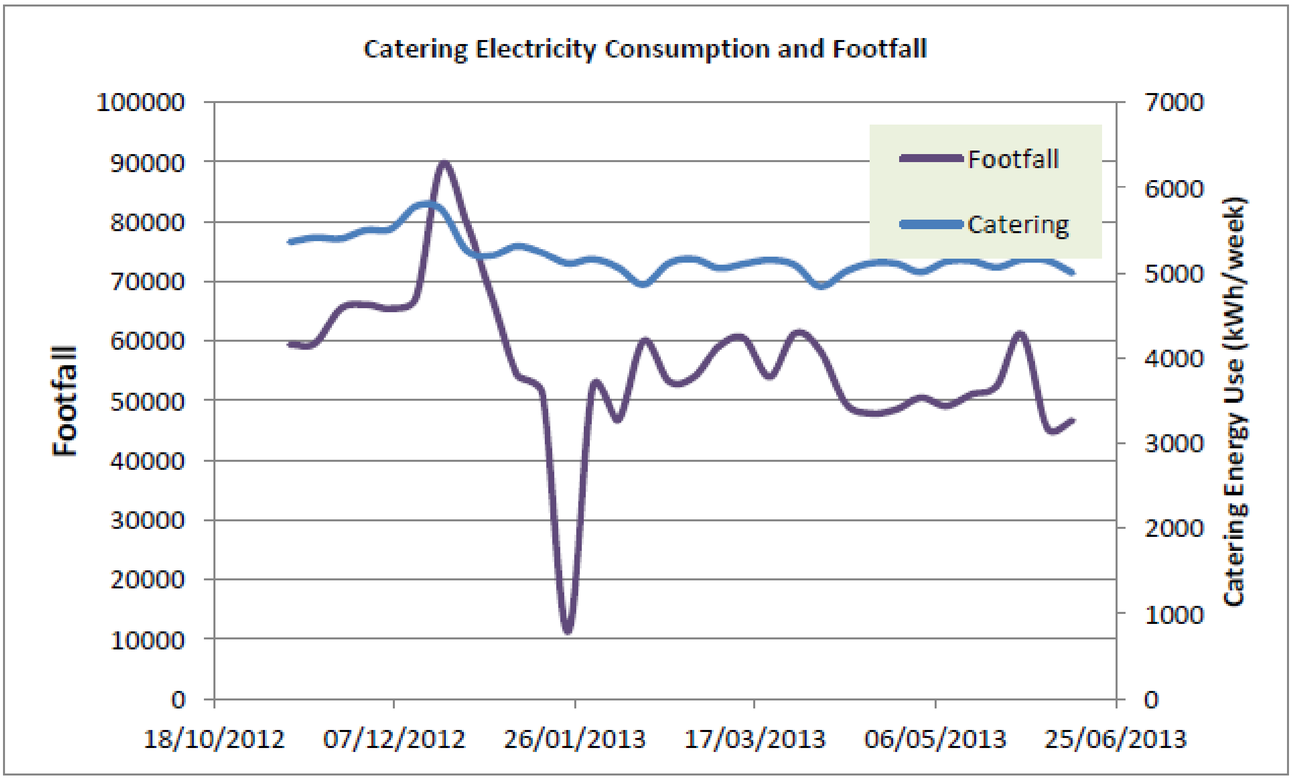


Figure 31 – Catering electricity consumption shown against footfall

There is a clear increase in electricity consumption seen over the busy Christmas and New Year Period, which shows there is some correlation with footfall. Outside this period there is a fairly consistent baseline of approximately 5,000kWh/week energy consumption, regardless of trends in footfall. For example there is no reduction in consumption below this baseline during periods of very low footfall – such as the period experienced at the end of January 2013 when there was heavy snow in the area. This issue was raised during the third POE workshop and an action was raised to investigate whether some of the ovens could be switched off during periods of low footfall in order to save energy.

The TM22 analysis also provides a rough approximation of the utilisation of the various end use systems. This is shown in Table 3.

Table 3 – Additional metrics for electricity demand from TM22

		Additional metrics for electricity demand				
System	Description	In-use electricity (kWh/year)	In-use % of total	In-Use Full load W/m2	System hours/year	Utilisation
Space Heating		36,073	1.0%	1.2	1,600	18.3%
Hot water		0	0.0%	0.0	0	0.0%
Refrigeration		148,309	3.9%	13.8	553	6.3%
Fans		247,359	6.5%	5.6	2,258	25.8%
Pumps		104,784	2.8%	4.7	1,148	13.1%
Controls		23,606	0.6%	0.2	7,175	81.9%
Lighting (Internal)		1,296,807	34.3%	16.1	4,161	47.5%
Lighting (External)		116,620	3.1%	3.4	1,744	19.9%
Small Power		329,779	8.7%	6.9	2,458	28.1%
ICT Equipment		79,240	2.1%	0.5	8,289	94.6%
Vertical Transport		36,359	1.0%	3.4	550	6.3%
Catering - Central		395,472	10.5%	12.3	1,660	18.9%
Cooled Storage		805,361	21.3%	8.1	5,094	58.1%
User 1	Bakery oven 1	60,953	1.6%	2.5	1,239	14.1%
User 2	Process (food) 1	96,203	2.5%	3.3	1,513	17.3%
Total		3,776,926	100.0%	82.0		

As would be expected, controls and ICT show high utilisation figures as they are always on, and infrequently used, or part loaded systems such as pump and lifts show low utilisation. In order to get a fuller picture of utilisation the energy consumption for individual days can be observed such as shown in Figure 32

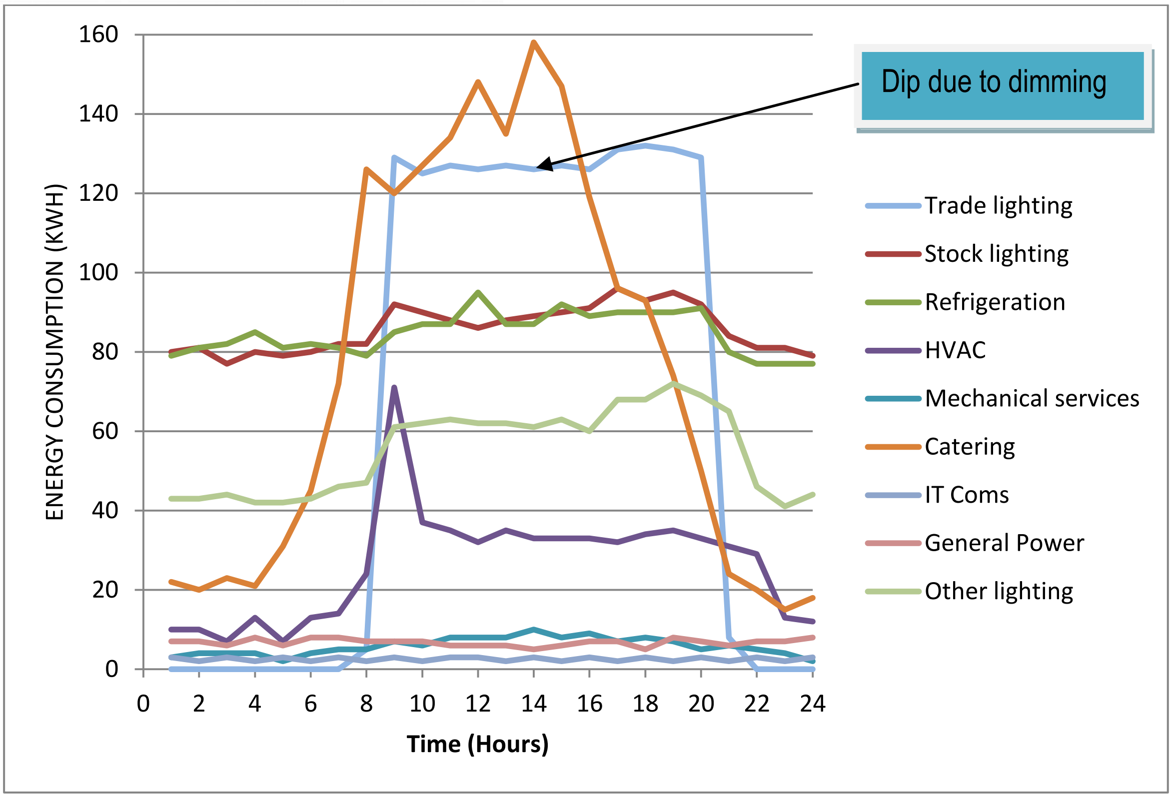


Figure 32 – Electricity consumption for Saturday 3rd November 2012

As expected, the trading lighting, catering and HVAC power consumption show a strong correlation with the store's opening hours of 08:00 to 20:00. The peak in the HVAC power consumption is due to the systems bringing the temperature of the building up to the pre-set value. The high level of air tightness, good insulation values of the building and good use of recirculation air all contribute to the relatively low 'steady-state' power consumption of the HVAC system.

The catering load starts early in the morning to ensure fresh food is available as soon as the store opens, and then starts to decrease as soon as the lunchtime period is over and the ovens are not required as intensively.

The stocking lighting and refrigeration, which operate 24 hours per day, show relatively even energy consumption throughout the day as expected.

The following graphs show how average annual energy consumption compares to the maximum and minimums for weekdays, Saturdays and Sundays.

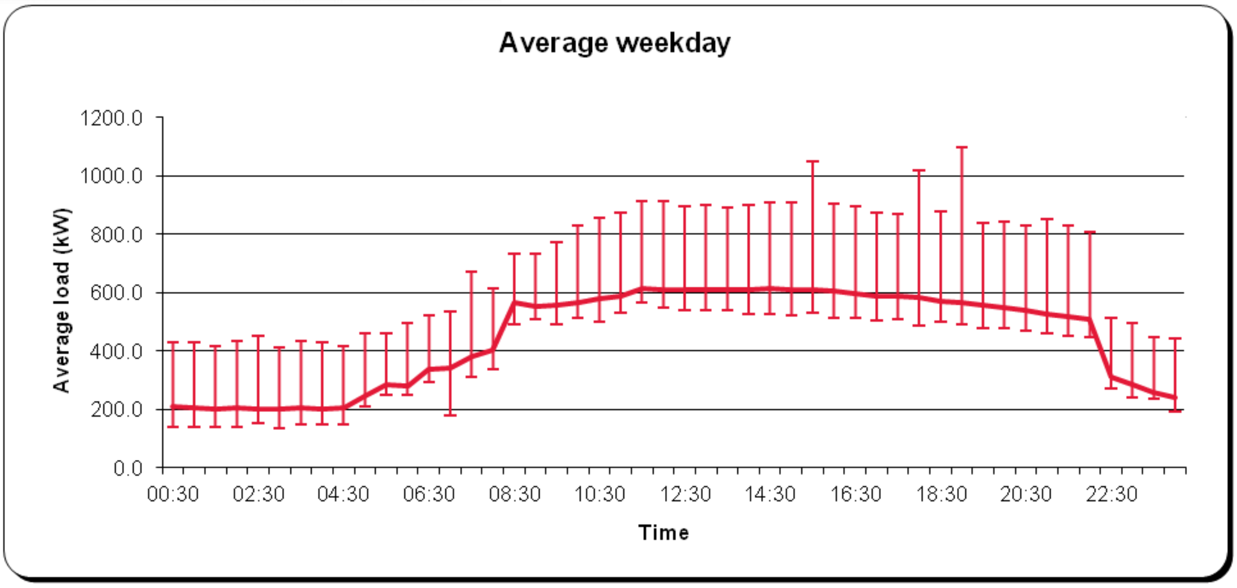


Figure 33 – Average weekday energy consumption for Cheshire Oaks

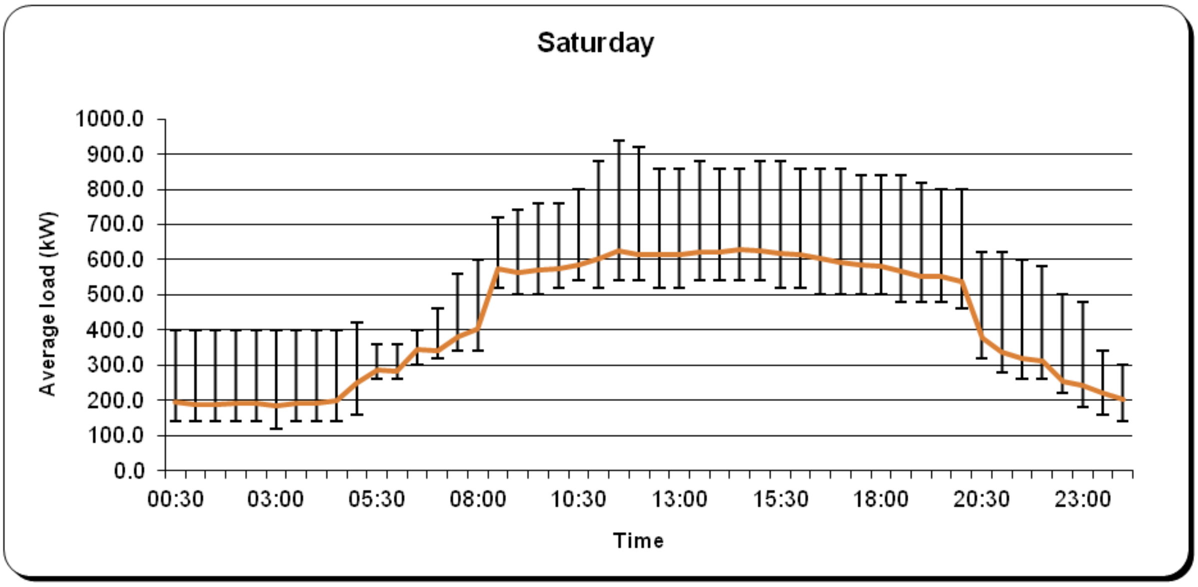


Figure 34 - Average Saturday energy consumption for Cheshire Oaks

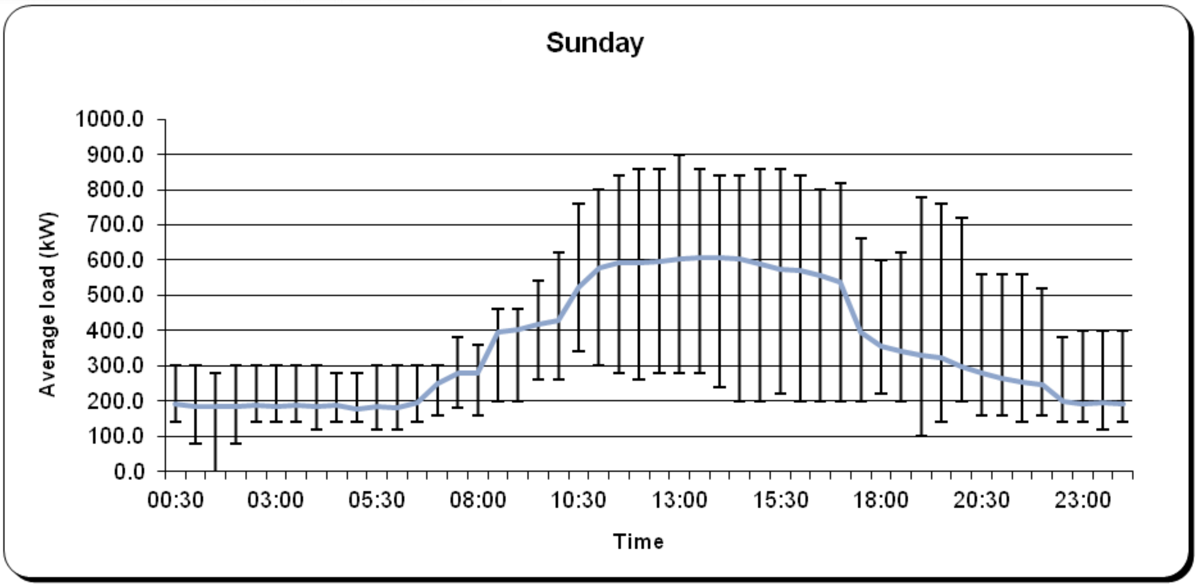


Figure 35 – Average Sunday energy consumption for Cheshire Oaks

The graphs clearly show that the average baseline consumption is around 200kW, (10.3W/m²). By way of comparison 10-15W/m² is considered a typical 'out of hours' energy consumption for an office. The average opening hours energy consumption is shown to be around 600kW (30.9W/m²), regardless of the day of the week. There is a gradual ramping up of energy in the morning as staff prepare for opening – this is when a significant amount of the catering takes place. There is also a gradual ramping down of energy consumption after the store has shut, which is when stocking takes place. The average is near the bottom of the error bars in the graphs which is a good indicator that the store operates fairly consistently in terms of energy consumption, and that it is not often driven very far above the baseline energy consumption for that time of day. If energy consumption was more erratic, the average would be expected to be closer to the middle of the error bars.

What is clear from all of these graphs is that the Cheshire Oaks store has a base load that is approximately 1/3 of the full load. Further investigation from the TM22 analysis reveals the following breakdown of out of hours energy consumption.

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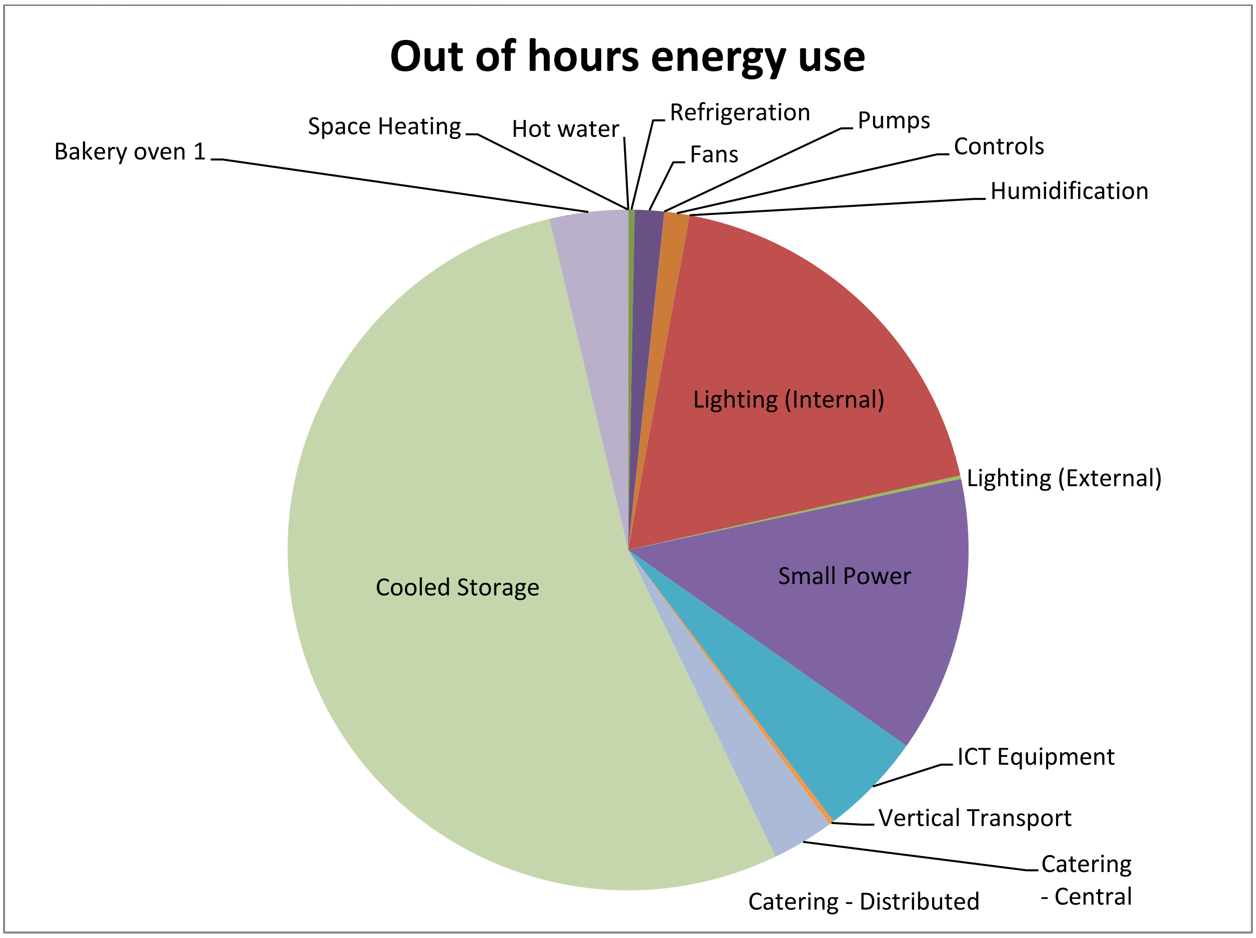


Figure 36 – Out of hours electricity consumption from the TM22 analysis

As expected the cooled storage accounts for over a half of the out of hours energy consumption. This is because the refrigeration system cannot be switched off without compromising food quality. The next biggest use is internal lighting. Part of this can be explained by the fact that the building periodically has longer operating hours which means that lights are on during the hours designated as 'out of hours'. Also there is some lighting needed for any work being undertaken in the back of house areas. Further investigations into the sub-meter readings revealed that the static inverter used for the emergency lighting system is responsible for almost 6% of the out of hours energy consumption.

Small power accounts for the next biggest proportion of the out of hours energy use. This includes cleaner's floor sockets, display items, screens and items plugged in to wall sockets in the back of house. The TM22 analysis captures 314,138kWh of the total 411,000kWh of Monday to Friday out of hours energy consumption, (approximately 76%). The remaining energy consumption is likely to be distributed in a similar proportion to that shown in Figure 36.

The overall electricity performance of the store is ahead of both the comparator store at White City and the designer's estimates as shown in Figure 37.

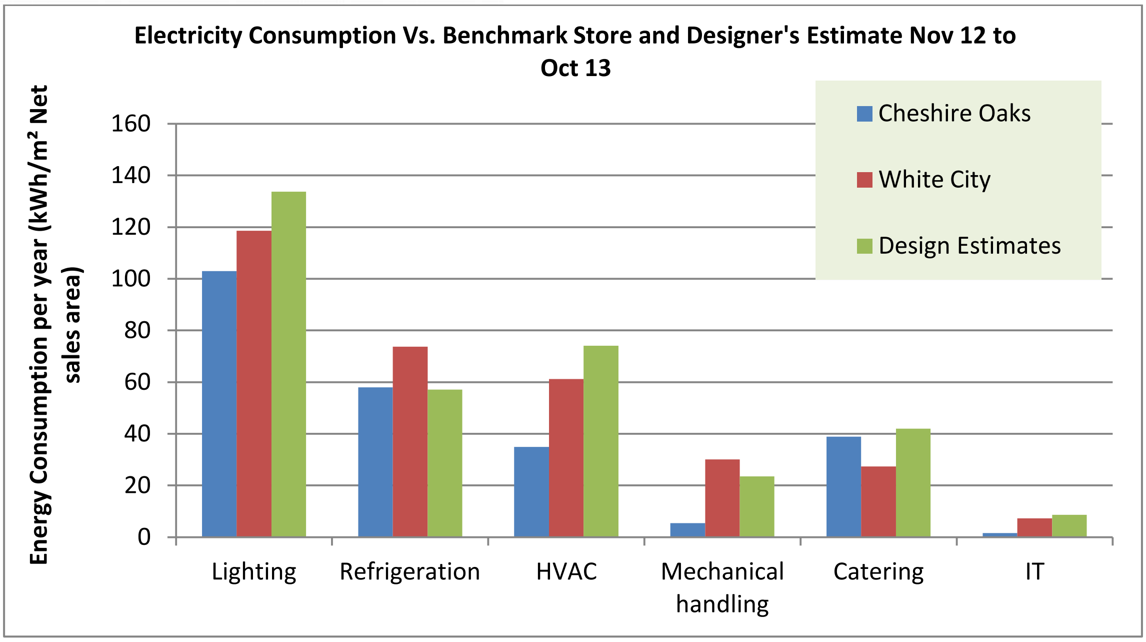


Figure 37 – Cheshire Oaks actual electricity consumption measured against the White City comparator store (also actual data – not corrected for hours of opening) and designer's estimates. Note this is net sales area and not GIA as used in the TM22

In all areas apart from refrigeration, the actual performance is better than the designer's estimate – this is a very rare occurrence as most buildings underperform compared to the designer's estimates. It is important to note the designer's estimates were produced as high level 'rough order of magnitude' figures. For example, the lighting energy consumption was estimated by using a predicted Watts/m² value, rather than by adding the individual ratings of the selected luminaires. The actual refrigeration load is almost exactly the same as the designer's estimate, however it should be noted that the number of refrigerated units in the store increased over the first year, beyond the number used in the designer's estimates. The disparity between the designer's estimates and the actual performance is due to improvements made to the energy efficiency of the refrigeration cabinets between the design stage and actually being installed onsite.

The difference in electricity consumption due to manual handling at Cheshire Oaks and White City can partly be explained because White City is spread over three floors and there are only two floors at Cheshire Oaks and therefore has a greater demand for mechanical handling services.

The electricity consumption shown for White City is taken from the actual energy consumption for the site over the monitoring period. No adjustment has been made to the White City figures to account for the difference in store opening hours (73 hours per week at White City against 88 hours per week at Cheshire Oaks). Even with its longer opening hours, the Cheshire Oaks store is outperforming the White City store in all areas, apart from catering - Cheshire Oaks has significantly larger catering facilities. Also the number of alternative eating options available to visitors to the White City store is greater as it is part of the wider Westfield shopping mall, which has an extensive food hall and attached restaurants and cafes.

A full breakdown of the electricity load is provided in Table 4. It shows that the total electricity consumption for the Cheshire Oak store is currently 36% less that the White City store (before any adjustment is made for the longer opening hours at Cheshire Oaks) and 20% less than the designer's estimates. The stated design aim for the store was that it should be 30% more energy efficient than a peer store.

Table 4 – Cheshire Oaks Energy Consumption against benchmarks Nov 12 to Oct 13 - Note this is net sales area and not GIA as used in the TM22

Sub-meter category	Cheshire Oaks consumption (kWh/m²)	Westfield White City consumption (kWh/m²)	% reduction of actual over White City	Design estimate consumption (kWh/m²)	% reduction of actual of benchmark (kWh/m²)
Trade lighting Other lighting	103	119	13%	134	23%
Refrigeration	58	74	21%	57	-2%
HVAC	35	61	43%	74	53%
Mechanical handling	5	30	82%	23	77%
Catering	39	27	-42%	42	7%
IT / Communications	2	7	78%	9	81%
Total Electricity consumption	276	428	36%	346	20%

These figures are shown in ‘energy consumption per net sales area’ because the GIA for the Westfield White City store was not available.

6.2 Heating Consumption Data

Gas is the primary heat source for the front of house heating systems and therefore represents the majority of the heat input into the building. It is also used for the generation of domestic hot water. Figure 38 shows the TM22 analysis of the building's heat demand.

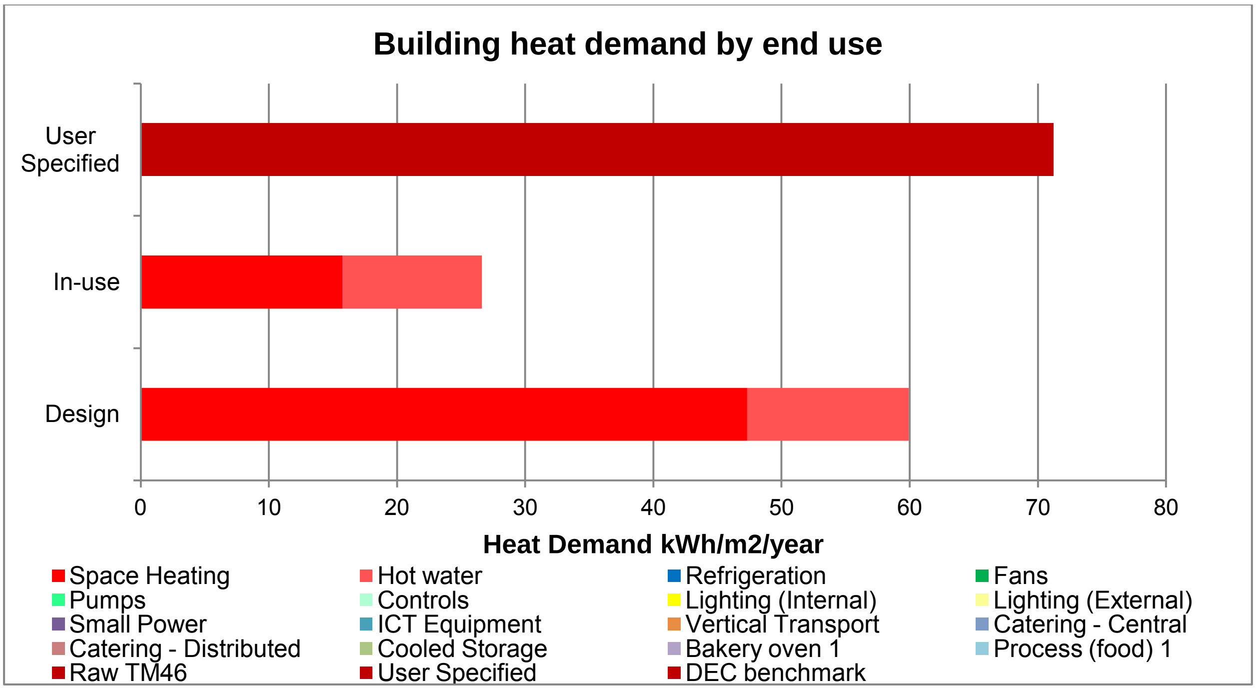


Figure 38 – Building heat demand by end use

The chart clearly shows that the in use heating energy use was considerably lower than anticipated in design and also when compared against the user specified benchmark. It is felt that this is due, in part, to the insulation of the Hempclad wall being better than expected, and also that the revolving doors reduced infiltration. In the discussion had during the final POE workshop it was stated that one of the reasons why the actual HVAC performance was better than predicted was because the hempcrete walls provided better than expected levels of insulation and a high level of thermal mass. This resulted in the building staying warmer in the winter and cooler in the summer when compared to the estimates made at design stage. For example, the BMS showed that the internal air temperature dropped by less than 1 °C when the external air temperature was 0°C over night. Other stores investigated lost on average 7 °C overnight for the same period.

Figure 39 shows the gas consumption against degree days for the local area. It appears that the gas consumption baseline for the store is approximately 5,000kWh per week, (this is roughly equivalent to 80,000l of hot water).

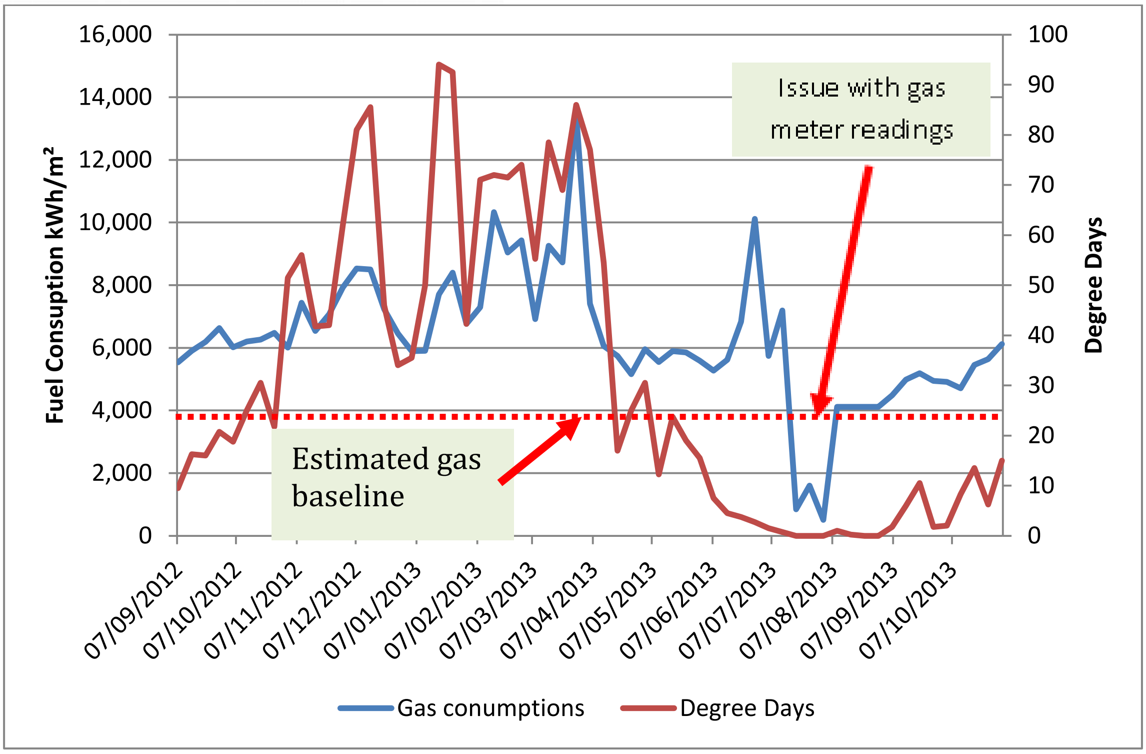


Figure 39 – Cheshire Oaks gas consumption against degree days

The gas consumption typically tracks the degree days fairly well with peaks in consumption coinciding with peaks in degree days. An issue can clearly be seen with the gas consumption in late June 2013 and early July 2013. This was traced to an issue with the burners in the air handling units and has subsequently been fixed. There was an error with the gas meter in August which resulted in the low readings seen on the graph. This too was resolved quickly when spotted. Figure 40 shows how the weekly gas consumption correlates with degree days.

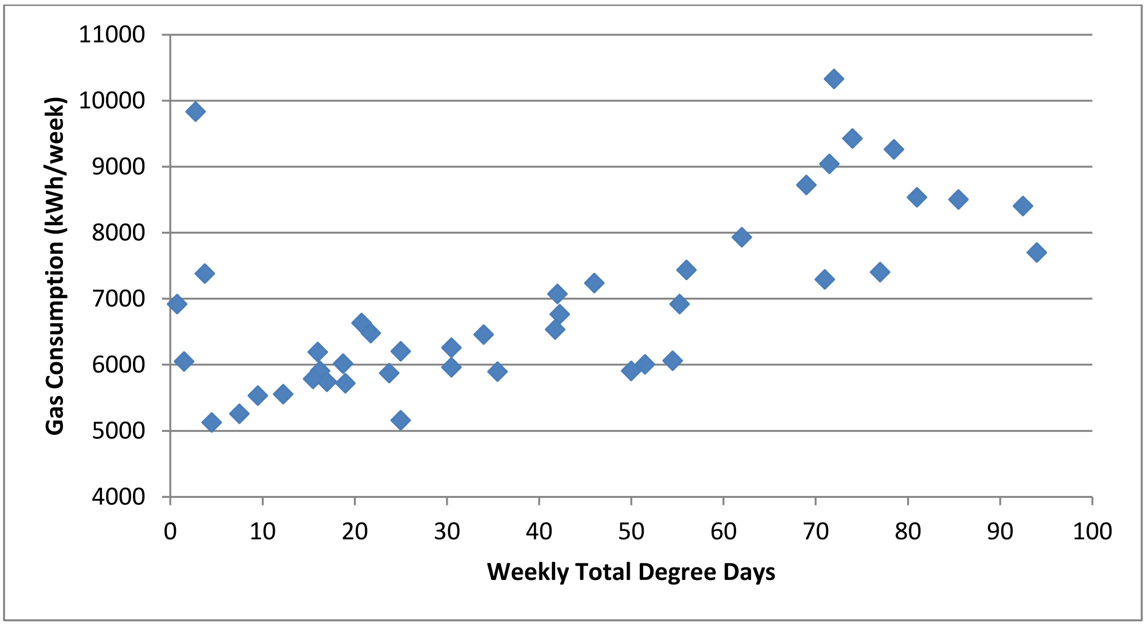


Figure 40 – Scatter plot of gas consumption against degree days

The plot shows that there is a reasonably good correlation between gas consumption and the degree days, without a significant leap in gas consumption on the very coldest weeks. This suggests the building is well insulated and has a good level of air tightness. This fact is made even more apparent when the gas consumption is compared to that of the White City store, (which has been used as a comparator store during the study), where the peaks in consumption during very cold periods are significantly higher than consumption during milder periods – see Figure 41.

This vast discrepancy in the gas consumption has led to further investigations being carried out at the White City store to determine if there is a problem with the heating plant, such as a situation where there is simultaneous heating and cooling taking place.

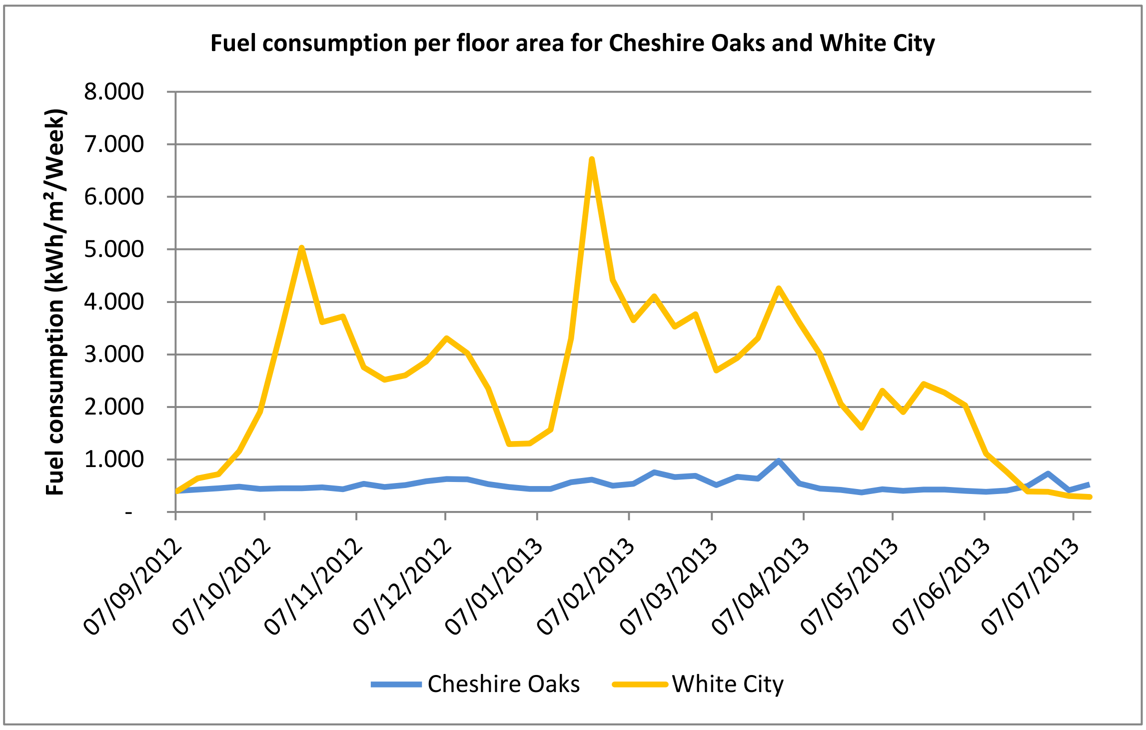


Figure 41 - Comparison of heating and DHW fuel usage for White City and Cheshire Oaks

There is no sub-metering on the gas; all data is taken from the main incoming meter. The result of this is that when issues are spotted, (such as the high gas consumption seen at the end of June), it can be difficult to attribute the issues to a particular system. This increases the work and cost required to identify and rectify problems.

The store's biomass boiler is only used to meet the winter heat demand and ran from 29th November 2012 to 1st April 2013. The heat meter readings from the biomass boiler for the winter period are provided in Figure 42

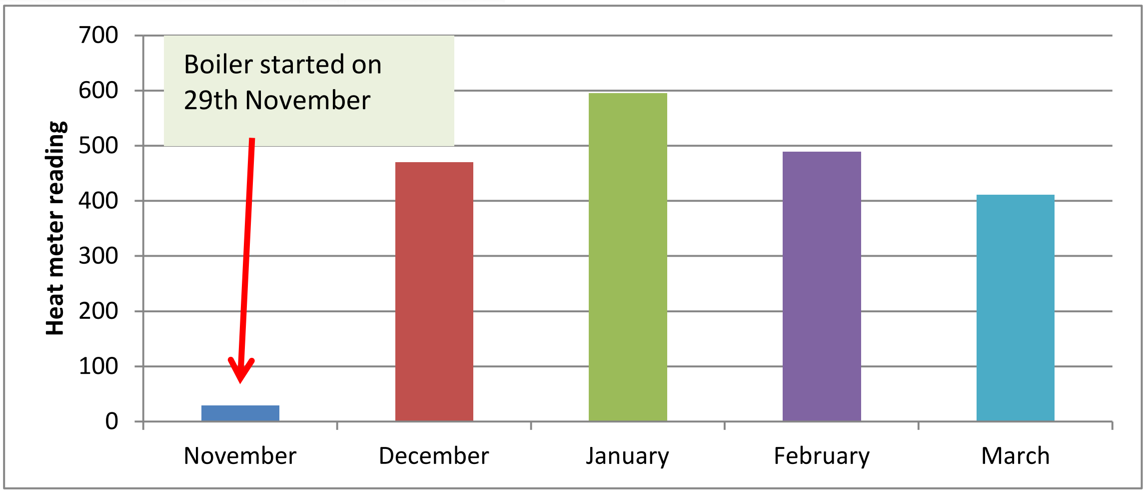


Figure 42 – Monthly biomass boiler heat meter readings

The heat meter readings have been taken off the BMS and are stated as being in kWh/month. Given that the boiler is rated at 300 kW it is felt that there may be an error with the heat meter readings and it may need to be adjusted. For the purpose of this analysis it is assumed that the heat meter is out by a factor of 100, and the boiler is operating at 90% efficiency. This gives a total fuel input of 196,400 kWh. In order to validate this figure it has been cross-checked with the fuel delivery notes. In total it has been reported that 41.78 tonnes of wood pellets have been delivered to the store. Using a net CV conversion factor of 4.72 kWh/kg[1] gives a total energy value of the pellets as 197,202kWh. This indicates that the heat meters do give an accurate indication of the heat produced by the boilers, albeit out by a factor of 100.

The biomass boiler was scheduled to operate from 1st November, however, due to an issue with the pellets being delivered at too high a pressure, it was not started until 29th November. It was found that the store was well heated throughout November without the boiler and therefore the scheduled boiler operation period is being re-assessed to see if there is an opportunity to reduce it in the future.

It is not clear to what extent the heat recovery system contributes to the overall heating load of the store as there is currently no means by which to monitor the system. Work is underway to look at the potential of adding additional monitoring on the heat recovery pumps to give a more precise figure for this system.

As shown in Table 5 the heating demand for Cheshire Oaks is 66% less than the White City benchmark store and there is an 80% reduction in carbon emissions.

[1] Defra conversion 2013 factor: http://www.ukconversionfactorscarbonsmart.co.uk/

Table 5 – Gas and biomass consumption against design estimates and benchmarks - Actual figures - Note this is net sales area and not GIA as used in the TM22

Sub-meter category	Cheshire Oaks consumption (kWh/m²)	Westfield White City Benchmark (kWh/m²)	% reduction of actual over benchmark	Design estimate consumption (kWh/m²)	% reduction of actual of benchmark (kWh/m²)
Total gas consumption	24	114	66%	43	45%
Total biomass consumption	14			54	73%
Carbon emissions from heating	4.4 $kgCO_2/m^2$	21.6 $kgCO_2/m^2$	80%	7.9 $kgCO_2/m^2$	40%

6.3 Water consumption

The mains water into the site is supplemented by water from a rainwater harvesting tank. The rainwater harvesting system was not fully operational until mid way through January 2013. The problem with the system was traced back to a blockage in one of the pipes which appears to have occurred during construction.

There is no sub-metering data available for the rainwater harvesting system and so the amount of water it supplies has had to be inferred from the mains water meter. During periods of extended dry weather the store uses on average 19m³ of water per day. This has been used to calculate an 'estimated total water use' figure for the store over the whole year. This in turn allows an estimation to be made of the rainwater harvesting use. The results of these calculations are shown in Figure 43. (Note additional water consumption has been accounted for during the busier Christmas period.)

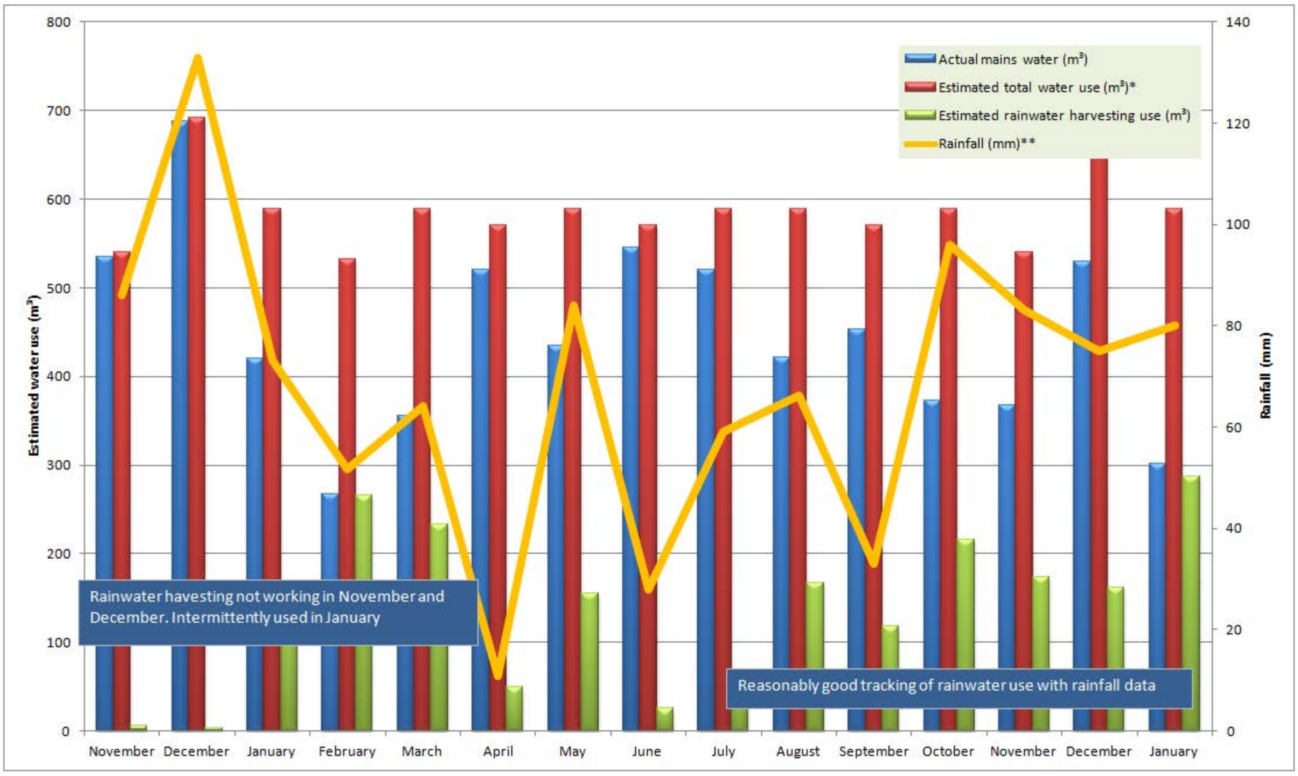


Figure 43 – Estimated water consumption and rainwater harvesting system use.

Using this method to estimate the water supplied through the rainwater harvesting tank, gives the annual total of water supplied by the system as 27% of all the water used in store. It is important to note that rainfall data for the area was only available in monthly totals, and therefore it was not possible to match hourly/daily rainfall to the estimated rainwater harvesting use. The average daily use of 19m³ per day or 261 l/m²/year puts Cheshire Oaks as the most water intensive store Marks & Spencer own, but this is explained because it has more café seats than any other store, and it has extensive green wall watering demands. The actual water use matches the designer's estimates very closely (20m³/day).

The rainwater harvesting system is used for flushing both staff and customer toilets, and for watering the green wall. As such it was only ever designed to provide a certain proportion of the site's overall water supply. The design aspiration was that it would serve 25% of the store's water use and it has exceeded this in reality. Given the lack of submetering on the water system it is not entirely clear what proportion of the water demand from the toilets and green wall was actually met by the rainwater harvesting system. Therefore doing a proper analysis on the effective use of rainwater cannot be achieved. It is also not clear what the design parameters for the rainwater harvesting system was beyond the desire to serve 25% of the total demand.

In addition to this, the level of water in the rainwater harvesting tank was not freely available through interrogation of the BMS. Again this limited any assessment on how the tank's volume was affected by rainfall and customer footfall. Easy to access in-tank level monitoring would have allowed the operators to know if the tank was regularly full, suggesting that a larger tank may have allowed even more rainwater to be utilised. Conversely, if the tank was found to be regularly low on water, this would have suggested that a smaller and cheaper tank could have been installed without significant impact on the overall contribution of rainwater to the total demand.

The water itself was collected from the roof of the building. One third of the roof has its drains connected to the rainwater harvesting tank. The rest of the rainwater from the roof goes to the site drains.

6.4 Conclusions and key findings for this section

Overall the first year's energy consumption has been better than predicted in terms of both electricity and heating fuel use. The reduction achieved against the design targets taken from the TM22 are shown in Table 6.

Table 6 – Cheshire Oaks actual energy consumption against the design targets from the TM22 report

Gross Internal Area m2	19,417						
CO2 intensity factors	0.55	0.194	0.025		**Reduction at Cheshire Oaks**		
Fuel	**Electricity**	**Natural gas**	**Biomass**	**TOTAL**	CO2	Electricity	Energy
Delivered energy (kWh)	3,765,830	330,561	199,343				
Annual energy (kWh/m2)	193.9	17.0	10.3	**221.2**			
Annual CO2 (kg/m2)	106.7	3.3	0.3	**110.2**			
Design energy (kWh)	4,726,057	550,000	749,000				
Design annual energy (kWh/m2)	243.4	28.3	38.6	**310.3**		20%	29%
Design annual CO2 (kg/m2)	133.9	5.5	1.0	**140.3**	21%		

The key reasons that are thought to be behind this are:

- The close cooperation between the designers, contractors, equipment suppliers and facilities staff meant that all systems were correctly commissioned and operated in accordance with the design requirements.

- The actual energy-using systems installed were more efficient than predicted at design stage.
- Close monitoring of the energy use meant that issues were identified and corrected quickly.

The hempcrete wall panels were a new product and therefore the in-use performance could not be fully modelled at design stage. In use it proved to have better than predicted insulation properties and thermal mass. This in turn reduced the gas consumption in the winter and air conditioning load in the summer.

At the project inception stage, a target to achieve 30% energy reduction with 35% lower carbon emissions compared to a similar sized M&S was set. In reality the store achieved a 42% energy reduction and 40% carbon emissions reduction over the comparator store.

Deeper investigations into energy use patterns showed that the automated controls used in store were very effective at ensuring that energy was only used when it was required and that systems were switched off when not in use. This can be attributed in part to the fact that the local facilities management team are not empowered to make adjustments to control set-points which could have resulted in systems wasting energy.

The rainwater harvesting tank contributed approximately 27% to the overall water demand.

7 Technical Issues

7.1 Overview

Overall the building has experienced relatively few technical issues in the operation of its systems. This is reflected through the fact that the annual energy consumption of the building is well below the designer's estimates, (see Section 6). Where technical issues were encountered they were followed up quickly by the facilities management team with support from the appropriate contractor. This led to those with the most knowledge about the individual systems addressing the problems encountered.

The commissioning process was closely supervised by M&S's facilities management team based in the head office, who are responsible for the operation of all the stores. This team have an extensive knowledge of building operation and therefore were able to ensure the building services were set up and operated in line with expectations. This team were also the only people with the authority to make changes to the control systems used at Cheshire Oaks. Given that all the shop floor building services, including the light switches, are fully automated, there was no local control allowed of the internal conditions within the store. This played a key role in ensuring that the energy consumption was fairly consistent day to day.

There have been a few teething problems setting up some of the systems and these are described in the following sections.

7.2 Biomass boiler

There was an initial issue with the biomass boiler, insofar as the pellets were being delivered at too high a pressure. The wood pellet delivery truck blows wood pellets into the boiler wood storage hopper. If this is done at too high a pressure the pellets become compacted in the bottom of the hopper and are not able to be fed into the boiler effectively.

The wood pellet deliver pressure was changed from approximately 10 barG to less than 1 barG and no further issues have occurred. In order to prevent similar issues arising in the future, it was decided that a concise boiler operation note has been produced, which is located by the boiler.

There was also a change in the wood pellet supplier part way through the heating season, however the reason for this was more commercial than technical.

7.3 CO_2 Refrigeration System

The commissioning period for the CO_2 refrigeration system went on for several weeks longer than expected, which was primarily due to the number of leaks which occurred in the system. These leaks have been rectified and the system is now operating correctly. The system itself operated for the full year without any significant issues occurring.

7.4 Rainwater Harvesting System

The rainwater harvesting system experienced a problem where the tank was not filling up beyond 25% despite very heavy rainfall, and also the pump controls had a tendency to lock out. This meant that the store was relying on mains water to a greater extent than was necessary.

The contractor was called out a number of times in the first five months of opening. The root cause of the issue was discovered to by a blockage in the pipework connecting the roof collector to the underground tank. It is not clear how the pipework became blocked in the first place, however it does appear to be construction waste that caused the blockage rather than anything that occurred post completion.

Since the blockage was removed there have been no other issues reported with the rainwater harvesting system and the system appears to be well utilised when sufficient rainwater is available.

7.5 Sub-metering

For the first two months of operation the sub-meters were not communicating properly with the automatic monitoring and targeting system so a detailed breakdown of the energy use by type was not available for this period. The issue was fully resolved by the beginning of November 2012, two months after the store had opened. The data collected by the meters before this period was lost and therefore there are no details about the store's operation during the first months. Unfortunately this means that is has not been possible to do a full analysis of the state of the store on opening compared to the later "steady-state" operation.

The sub-metering has proved to be a valuable resource for being able to track energy consumption of the various sub-systems in the store. They are monitored on a real time basis by a third party monitoring company who are able to spot issues as and when they occur.

7.6 AHU Burner Issues

As part of the POE, the gas consumption was regularly checked against degree days for the area in order to assess how the building's heating system performs with different external temperatures. In both September 2012 and July 2013 it was noted that the gas consumption seen was higher than expected compared to the actual degree days. Further investigation showed that the gas burners on the AHUs were firing more than necessary, wasting gas in the process. This issue was quickly corrected once spotted and the gas consumption quickly returned to normal levels.

7.7 Conclusions and key findings for this section

The building and its systems were generally installed and commissioned well, which has led to relatively few technical issues. Where there have been teething problems, they have mostly been quickly resolved. The POE process itself was key to ensuring that the performance of the various systems was reported back to the relevant party in a timely manner.

8 Key messages for the client, owner and occupier

8.1 Overview

The first year's performance of the store should be viewed as a strong success in terms of the in use performance of the building. This building is not a typical building for M&S as it was designed to be a flagship sustainable learning store where the best practice knowledge and experience could be collected and used to inform future sustainable practices. There are a number of key lessons that have come to light during this post occupancy evaluation which can be useful to both the continued successful operation of the store and to inform new/refurbishment projects.

8.2 Sustainable focus

It is believed that the most important success factor at Cheshire Oaks was the clear focus on sustainability from the outset. By setting out with the specific goal of creating a sustainable learning store, all parties from the client, designers, contractors, and sub-contractors, to facilities management and store staff all understood exactly what was trying to be achieved. The designers were given clear targets on what the expected performance of the building was to be, and this was backed up by support from the client to be innovative in achieving this. A good example of this is the use of the Hemcrete© wall panels, which were a relatively new product that had not been used on this scale before. M&S worked directly with the manufacturer to ensure that they were in a position to produce sufficient panels at the size and specification required.

This focus on sustainability remained strong during the construction phase by ensuring that the environmental manager reported directly to the project director rather than the project manager. This meant that sustainability was part of all the decisions made on site.

In operation the building users themselves are very aware of the sustainable credentials of the building, and there are guided tours which specifically highlight the unique aspects of the store.

It is not clear to what extent the success of the Cheshire Oaks store is due to the increased level of scrutiny it received by being such a 'flagship' project. Discussions with the design team and the contractors highlighted that they considered the Cheshire Oaks store a prestigious project for their respective companies too and as a result they gave it slightly more attention than they would typically give to a retail building. The challenge for M&S is to work with their building supply chain and attempt to replicate the focus on future projects.

8.3 Getting the basics right

The fundamental principles of energy efficient buildings are well understood, and much of Cheshire Oaks' successful operation can be attributed to the attention given to these. This starts at the design stage with a highly efficient building envelope which includes:

- High levels of insulation
- Elements of thermal massing (earth mounds)
- Good air tightness
- Revolving doors to main entrance and car park entrance.
- Excellent 'daylight' provisions integrated into shell design

The building services themselves were relatively simple and were designed to avoid problems seen on more complex systems, such as where the heating and cooling systems are operated at the same time. Where possible, heat was reclaimed rather than wasted, and the cooling systems were designed to make full use of fresh air from outside.

The commissioning team used to set up the building services were fully aware of the energy performance targets expected and were fully committed to achieving this. Once this was achieved the control systems were fully 'locked' to ensure that the operation was maintained in an 'as commissioned' condition.

The facilities staff were fully engaged with operating the building in the best manner to get the most out of the sustainable features. Examples of this are:

- Accepting 'lock down' on controls as a necessary part of achieving the sustainability targets, even if this took decision making power away from them
- Use of revolving doors (i.e. maintaining them in operation). It was noted on other sites that they were often left open and thus negating benefit.
- Willingness to delay start-up of biomass boiler plant i.e. reduce 'heating season' and thus energy / carbon

The key lesson of M&S is that these fundamental principles of energy efficient building design should be always given the full attention deserved in future projects.

8.4 Incorporate the ability to learn from new features into the design process

One of the purposes of a sustainable learning store is to provide quantitative information on the performance of new sustainable features. However, there are a number of situations where the ability to assess the success of a new sustainable feature has been hampered because simple monitoring systems have not been included in the design.

An example of this is the biomass boiler, which is a new feature for a Marks & Spencer store, however unlike most other major energy using systems in the building, no easy way has been provided of measuring and quantifying its performance. The amount of wood pellets burnt, the boiler running hours, and the heat output can all be easily monitored and logged, however the ability to do this was not part of the original design and therefore has not been provided. The same situation is true of the heat recovery system used on the refrigeration plant. Without proper evidence of the performance of these systems, it is difficult to assess whether it is cost effective to use them in future stores.

This issue extends to the way the electrical distribution and sub-metering is designed. If a new lighting system is being trialled for example, then is it important that the electrical distribution circuits and sub-meters are dedicated to the new lighting system alone, and no other plant items are also connected to the circuit.

8.5 Spending extra time with specialist designers on new features can save time and costs during construction

Some of the issues experienced during the construction could have been avoided had specialist designers been used at an early stage for the new features. For example the pre-cast concrete pipes intended for use as earth ducts for the displacement ventilation had to be changed to plastic pipe during construction. This is because it was discovered that the excessive loading placed on them would cause them to crack. Also the pipe trenches themselves have inadequate drainage and therefore are permanently flooded. Using drainage and buried pipe specialists to design the earth ducts would have allowed the concrete pipes to be installed correctly, thereby allowing the free cooling potential of the ducts to be realised.

Another example of where specialist designers could have foreseen an issue is with the deflection in the first floor. The actual deflection of the first floor was twice the calculated deflection, which resulted in the screed cracking and a special flexible grout being used.

8.6 Beware of unintended consequences when setting energy efficiency targets

The energy management bureau used to remotely monitor the BMS is incentivised to keep energy consumption down. In order to help them achieve this they have control over all the building services, including the heating and the lighting, and no local control of these services is permitted. On occasions when the in-store staff have had to work outside the usual hours, their requests to have the heating kept on for longer has been denied by the energy management bureau on the grounds of energy efficiency. This could be avoided by providing an ‘exceptions log’ where legitimate out of hours energy use can be recorded and taken into consideration when energy consumption is analysed.

8.7 Consider the use of a soft landings process post handover

The soft landings process involves the designers and constructors staying involved with the building beyond the practical completion and is considered to be very useful in buildings such as Marks & Spencer sustainable learning stores. Whilst the commitment shown by both the designers and contractors has been strong for the first year POE process, the soft landings approach would have seen these parties staying involved in the ongoing operation of the building in years 2 and 3. This would have allowed year on year performance to be compared and the process would have ensured that the good operational practises were properly bedded into the way the building is operated for the long term.

8.8 Pushing the envelope

The Cheshire Oaks building has rightly been promoted as an example of a sustainable building that others should seek to learn from, however there is certainly the potential to improve its energy efficiency even further. Marks & Spencer’s approach is to always consider demand reduction first and foremost. Engineering designs start from a position of ‘how do we deliver the lowest possible energy and carbon design’ which entails continual review of emerging technologies to further cost effective energy reduction. As a company Marks & Spencer feel that first and foremost there is still work to do in the area of demand reduction through the implementation of more efficient technologies and practices, and then secondly to reduce their reliance on grid solutions. They state that they are committed to making the step changes in energy consumption necessary where and when the technology is available and can be effectively implemented.

Some of the technologies and approaches that are felt could reduce the overall energy consumption are:

LED lighting: The reduced cost and increased availability of LED lighting has in recent years made them a cost effective alternative to other light sources, including the metal halide spots and T5 tubes which make up a significant proportion of the lighting at Cheshire Oaks. They also have the added advantage of longer lamp lives which means lower ongoing maintenance costs. Given the high lm/W output of the existing lighting, the overall savings may only be in the region of 5% or so, but over the lifetime of the building, this could be considerable.

CHP: Given that the store has a high electricity base load, long operational hours and a year round heating and cooling demand, CHP could potentially reduce the overall fuel costs and carbon. There is the potential to include absorption cooling with the CHP as the summer chiller load is high. A well run CHP should produce a minimum of 10% savings over conventional systems and depending on the configuration used the savings could potentially be more.

Lower energy cooling: Given that the summer cooling loads can be significant, there may be some merit in utilising less energy intensive cooling systems such as evaporative coolers, which are increasingly being deployed in data centres. Evaporative cooling required no refrigerants or large compressor loads and therefore could potentially make significant operational savings. The electricity associated with cooling at Cheshire Oaks is approximately 50% of the entire HVAC electricity consumption. Also earth ducts could make a bigger contribution to the cooling requirements. This was part of the original specification for Cheshire Oaks, however issues in the construction process meant that the system was changed from concrete earth tubes with lots of thermal mass for cooling, to plastic with very little thermal mass.

Better heat recovery: The heat recovery system as currently employed only provides heat to the food hall, whereas the possibility exists to use it in the wider store to offset the other building heating systems. It is not clear how much of an extra contribution this would make due to the lack of sub-metering on the Cheshire Oaks heat recovery system.

Catering load controls: Catering accounted for over 14% of all the electricity used in store and was felt to be the area with the least scrutiny when investigating energy efficiency. It was suggested that there could be better matching of oven operation with footfall, as they are currently run at set times regardless of the demand. Also an exercise could be undertaken to determine if more energy efficient catering equipment is available and if the existing equipment could be utilised more efficiently.

Marks & Spencer tend not to build new stores, instead preferring to occupy a developer's shell. This does mean however that they are constrained in their ability to influence the selection of energy efficient building fabrics, or building integrated renewables.

Renewable technologies could make a greater contribution to the energy consumption of the store. For example the Cheshire Oaks store has an approximate roof area for 10,000m². Assuming 75% of this could be covered in photovoltaic cells with an average annual production of 60 kWh/m², then there could be a total of 450,000 kWh produced annually. This is about 12% of the current annual demand of 3,776,926 kWh. Whilst this would reduce net electricity imports it is not currently felt to be as cost effective as investing in other energy reduction activities.

8.9 Conclusions and key findings for this section

A central theme from the key messages identified in this study is to have a clear end to end strategy for adopting new sustainable systems and technologies. This starts at the design stage by ensuring that the appropriate level of specialist expertise is brought in to advise on the issues surrounding the new systems. It should be followed up by defining a clear process by which the performance of the new system is to be measured and quantified. Finally a soft landings process is a very good way of ensuring the lessons learnt from new systems are fed back to the design teams and contractors to be incorporated into future buildings.

9 Wider lessons

9.1 Overview

The design, construction and operation of the Cheshire Oaks store can provide some lessons for the industry, clients, building operators and the supply chain. Many of the key lessons stated in Section 8 are also applicable to the wider industry, especially:

8.2 Sustainable focus

8.3 Getting the basics right

8.5 Spending extra time with specialist designers on new features can save time and costs during construction

8.6 Beware of unintended consequences when setting energy efficiency targets

In addition to these other lessons are:

9.2 Clients should make clear statements regarding sustainability goals for their buildings

The Marks & Spencer Sustainable Construction Manual provides clear, unambiguous guidance on sustainable issues to all parties involved in the provision of new buildings. The manual is broken down into the following sections:

- Carbon
- Water
- Waste
- Materials
- Biodiversity
- Travel & access
- Supporting communities
- Archaeology & heritage

In order to ensure the various sustainability goals are built into every aspect of the building process, each section of the manual has details regarding the following stages:

- Site selection,
- Design & specification,
- Construction,
- Completion & building handover
- In use

The end result of this is that sustainability is made an integral part of the decision making at every stage of the project.

Setting clear sustainability goals at the outset and reinforcing them at every stage of the process, make them much more likely to be achieved.

9.3 The Importance of Good Controls

Well designed, constructed and commissioned buildings can still perform well below expectations if appropriate controls are not used. Sometimes this poor performance is due to excessively complicated controls, with difficult to understand user interfaces. In other situations, very simple controls are provided in an attempt to not over-complicate the system, with the unintended consequence that this limits the ability of the building services to be operated holistically. In addition to this, simple controls tend not to provide good quality feedback on the operation of the services being controlled.

The key lesson to be drawn from the control systems at Cheshire Oaks is that a well set up, integrated control system, can produce repeatable building performance all year round. Part of the reason for the success is that only a limited number of people had access to the controls, and the set points were only changed when a real need was identified with the building's operation. This means that all changes to the building's controls are documented centrally and can be monitored for the impact on energy use.

Another reason for Cheshire Oaks's success is that the control system provides feedback on all the main energy using system at a level of detail that is useful to the operators. For example, the data on the individual air handling units can readily be compared to each other via an easy to use web interface. This allows issues to be quickly identified when one is not operating efficiently.

Locking off the controls to all but a few people can work in situations where there are a large number of short term visitors to a building, such as found in retail. This approach should be used with care when employed in buildings with many full time occupants who place significant value on the ability to influence their working environment.

9.4 Conclusions and key findings for this section

As with the conclusion to the previous section, the wider lessons for industry that can be gained from the experiences at Cheshire Oaks are that the successful operation relies on having a clear end to end strategy for the building's performance which all parties should be signed up to. Taking a building from its original concept to a fully operational building has many steps along the way, and things can go wrong at any of these stages if the requisite focus isn't given to the in-use performance.

Another lesson is that it is important to strike the correct balance in the complexity of a building, its services and controls. There may be a temptation to simplify systems to make the operation easier for the building users, but in doing so there is a missed opportunity to provide, good quality, easy to understand information on the building's performance. Doing so helps to spot where energy is being wasted at an early stage and allows regular benchmarking to take place.

10 Appendices

10.1 Site Plans

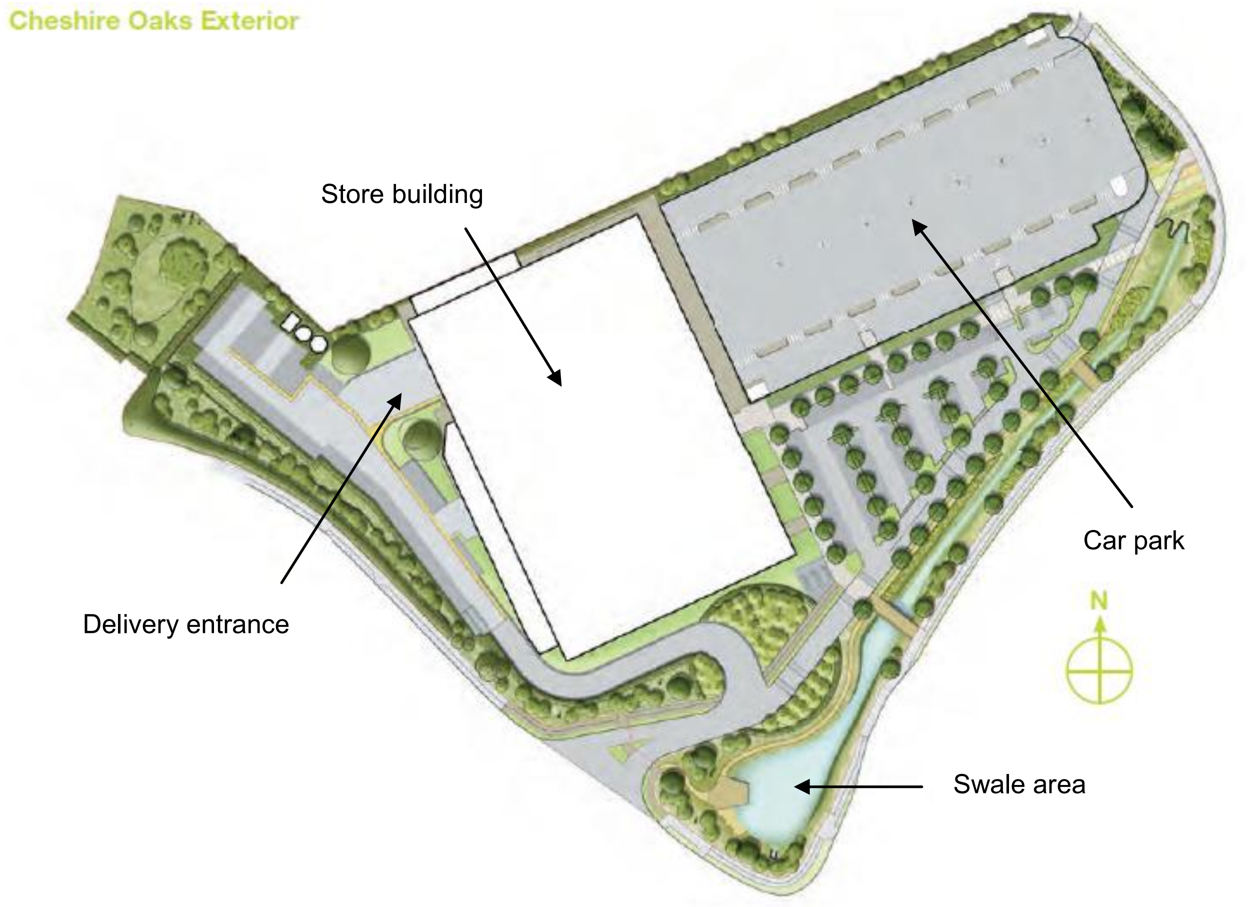


Figure 44 Plan of the store lot

Figure 45 Ground floor plan

First floor

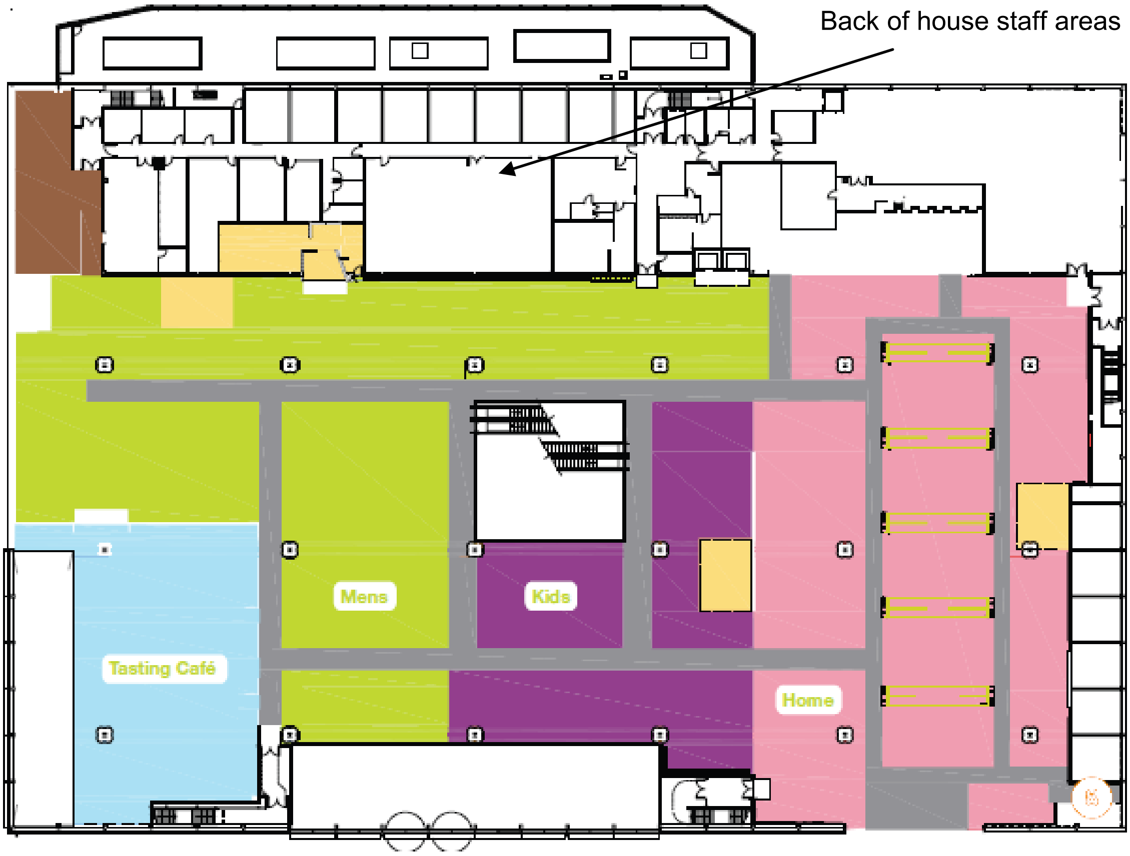


Figure 46 First floor plan

10.2 Energy Consumption Data

Note all areas given in this section are net sales areas and not GIAs.

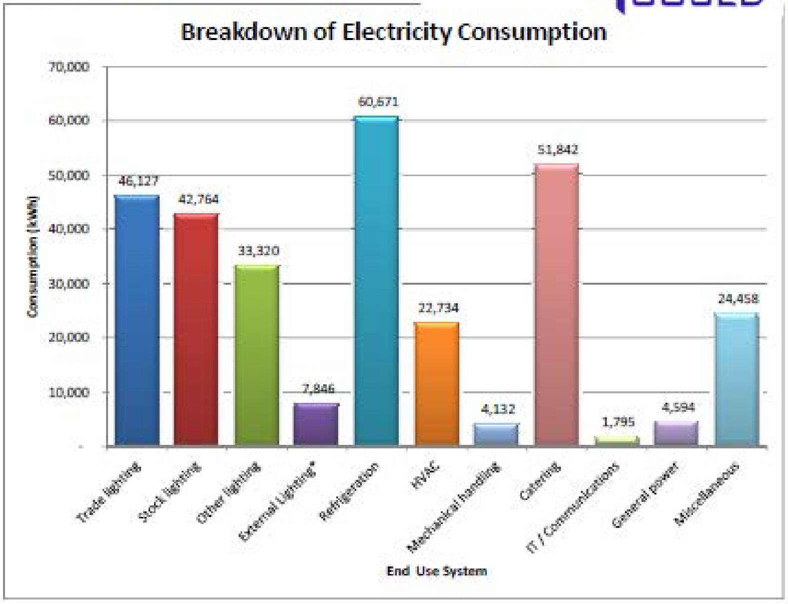
November 2012

M&S

Cheshire Oaks Store Consumption Summary — **Days** 30
Period 01/11/2012 **to** 30/11/2012

FAITHFUL GOULD

Electricity consumption:		
Trade lighting	46,127	kWh
Stock lighting	42,764	kWh
Other lighting	33,320	kWh
External Lighting*	7,846	kWh
Refrigeration	60,671	kWh
HVAC	22,734	kWh
Mechanical handling	4,132	kWh
Catering	51,842	kWh
IT / Communications	1,795	kWh
General power	4,594	kWh
Miscellaneous	24,458	kWh
Total Electricity consumption	300,283	kWh
Gas consumption	30,943	kWh
Biomass boiler output	2900	kWh
Water consumption	534.4	m³



	Actual	Benchmark	% Reduction of Actual over benchmark	Projected	% Reduction of Actual over Projected
Internal Lighting	8.84 kWh/m²	10.85 kWh/m²	19%	10.99 kWh/m²	20%
External Lighting*	0.57 kWh/m²				
Refrigeration	4.39 kWh/m²	5.07 kWh/m²	13%	4.69 kWh/m²	7%
HVAC	1.64 kWh/m²	2.70 kWh/m²	39%	6.09 kWh/m²	73%
Mechanical handling	0.30 kWh/m²	3.21 kWh/m²	91%	1.93 kWh/m²	85%
Catering	3.75 kWh/m²	2.60 kWh/m²	-44%	3.45 kWh/m²	-9%
IT / Communications	0.13 kWh/m²	0.62 kWh/m²	79%	0.56 kWh/m²	77%
General power	0.33 kWh/m²				
Miscellaneous	1.77 kWh/m²				
Total Electricity consumption	21.71 kWh/m²	39.02 kWh/m²	44%	26.30 kWh/m²	17%
Gas consumption	2.24 kWh/m²	10.26 kWh/m²	78%	3.27 kWh/m²	32%
Biomass boiler output					
Water consumption	38.64 l/m²	0.04 l/m²	-90892%	- l/m²	

Notes

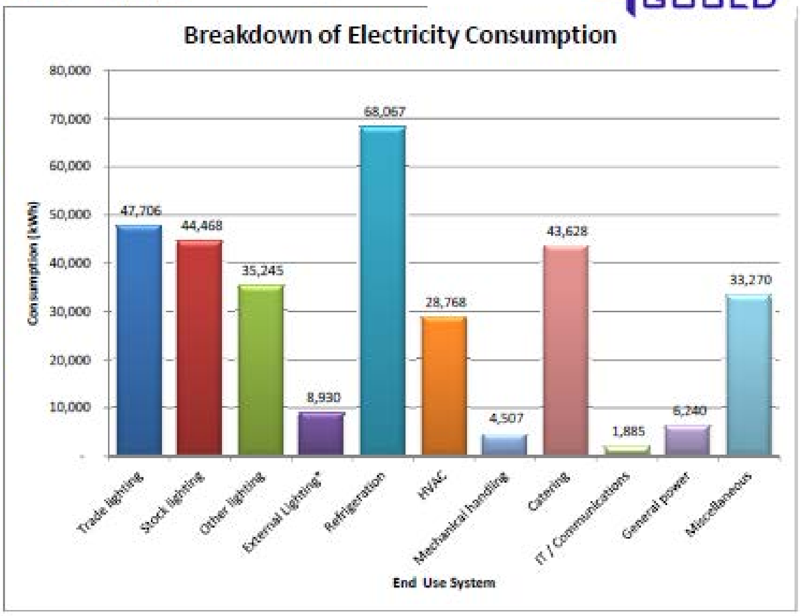
* External Lighting Includes Car Park, Signage lighting and Electric Car Charge points
Where no Benchmarks have been inputted this data is not current available
The total electricity, gas and water benchmarks have been prorated on the number of days in the month only annual data was available.

December 2012

Cheshire Oaks Store Consumption Summary — **Days** 31

Period 01/12/2012 to 31/12/2012

Electricity consumption:		
Trade lighting	47,706	kWh
Stock lighting	44,468	kWh
Other lighting	35,245	kWh
External Lighting*	8,930	kWh
Refrigeration	68,067	kWh
HVAC	28,768	kWh
Mechanical handling	4,507	kWh
Catering	43,628	kWh
IT / Communications	1,885	kWh
General power	6,240	kWh
Miscellaneous	33,270	kWh
Total Electricity consumption	322,713	kWh
Gas consumption	33,682	kWh
Biomass boiler output	4,700,000	kWh
Water consumption	687.93	m³



	Actual		Benchmark		% Reduction of Actual over benchmark	Projected		% Reduction of Actual over Projected
Internal Lighting	9.21	kWh/m²	10.62	kWh/m²	13%	11.36	kWh/m²	19%
External Lighting*	0.65	kWh/m²						
Refrigeration	4.92	kWh/m²	4.90	kWh/m²	0%	4.85	kWh/m²	-1%
HVAC	2.08	kWh/m²	2.22	kWh/m²	6%	6.29	kWh/m²	67%
Mechanical handling	0.33	kWh/m²	2.60	kWh/m²	87%	2.00	kWh/m²	84%
Catering	3.15	kWh/m²	2.67	kWh/m²	-18%	3.56	kWh/m²	11%
IT / Communications	0.14	kWh/m²	0.63	kWh/m²	78%	0.58	kWh/m²	77%
General power	0.45	kWh/m²						
Miscellaneous	2.41	kWh/m²						
Total Electricity consumption	23.33	kWh/m²	36.81	kWh/m²	37%	27.17	kWh/m²	14%
Gas consumption	2.44	kWh/m²	14.21	kWh/m²	-2309%	3.38	kWh/m²	28%
Biomass boiler output	339.84	kWh/m²	-			6.97	kWh/m²	-4778%
Water consumption	49.74	l/m²	0.04	l/m²	-113255%	-	l/m²	

Notes

* External Lighting Includes Car Park, Signage lighting and Electric Car Charge points
Where no Benchmarks have been inputted this data is not current available
The total electricity, gas and water benchmarks have been prorated on the number of days in the month only annual data was available.

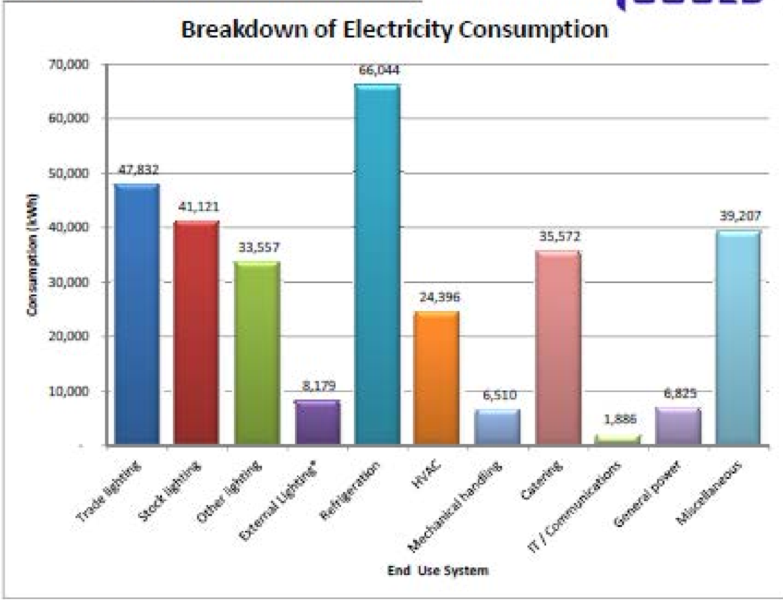
January 2013

M&S

Cheshire Oaks Store Consumption Summary Days
Period 01/01/2013 to 31/01/2013 31

FAITHFUL GOULD

Electricity consumption:		
Trade lighting	47,832	kWh
Stock lighting	41,121	kWh
Other lighting	33,557	kWh
External Lighting*	8,179	kWh
Refrigeration	66,044	kWh
HVAC	24,396	kWh
Mechanical handling	6,510	kWh
Catering	35,572	kWh
IT / Communications	1,886	kWh
General power	6,825	kWh
Miscellaneous	39,207	kWh
Total Electricity consumption	311,129	kWh
Gas consumption	30,778	kWh
Biomass boiler output	5,944,400	kWh
Water consumption	420.42	m³



	Actual	Benchmark	% Reduction of Actual over benchmark	Projected	% Reduction of Actual over Projected
Internal Lighting	8.86 kWh/m²	11.28 kWh/m²	21%	11.36 kWh/m²	22%
External Lighting*	0.59 kWh/m²				
Refrigeration	4.78 kWh/m²	5.10 kWh/m²	6%	4.85 kWh/m²	2%
HVAC	1.76 kWh/m²	1.96 kWh/m²	10%	6.29 kWh/m²	72%
Mechanical handling	0.47 kWh/m²	3.71 kWh/m²	87%	2.00 kWh/m²	76%
Catering	2.57 kWh/m²	2.78 kWh/m²	8%	3.56 kWh/m²	28%
IT / Communications	0.14 kWh/m²	0.65 kWh/m²	79%	0.58 kWh/m²	77%
General power	0.49 kWh/m²				
Miscellaneous	2.83 kWh/m²				
Total Electricity consumption	22.50 kWh/m²	39.19 kWh/m²	43%	27.17 kWh/m²	17%
Gas consumption	2.23 kWh/m²	12.14 kWh/m²	-3458%	3.38 kWh/m²	34%
Biomass boiler output	429.82 kWh/m²			6.97 kWh/m²	-6070%
Water consumption	30.40 l/m²	0.04 l/m²	-69176%	- l/m²	

Notes

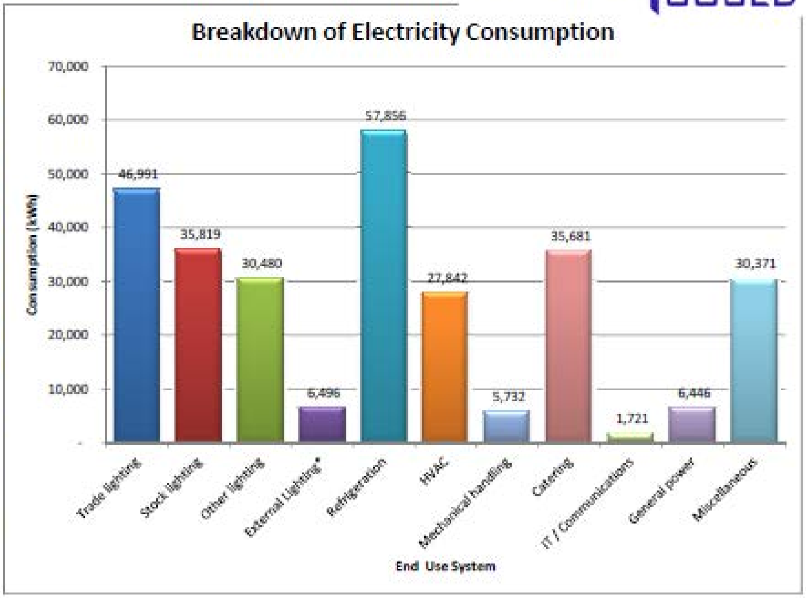
* External Lighting Includes Car Park, Signage lighting and Electric Car Charge points
Where no Benchmarks have been inputted this data is not current available
The total electricity, gas and water benchmarks have been prorated on the number of days in the month only annual data was available.

February 2013

M&S — FAITHFUL GOULD

Cheshire Oaks Store Consumption Summary — **Days** 28
Period 01/02/2013 to 28/02/2013

Electricity consumption:		
Trade lighting	46,991	kWh
Stock lighting	35,819	kWh
Other lighting	30,480	kWh
External Lighting*	6,496	kWh
Refrigeration	57,856	kWh
HVAC	27,842	kWh
Mechanical handling	5,732	kWh
Catering	35,681	kWh
IT / Communications	1,721	kWh
General power	6,446	kWh
Miscellaneous	30,371	kWh
Total Electricity consumption	285,434	kWh
Gas consumption	35,948	kWh
Biomass boiler output	4,888,800	kWh
Water consumption	266.82	m³



	Actual	Benchmark	% Reduction of Actual over benchmark	Projected	% Reduction of Actual over Projected
Internal	8.19 kWh/m²	9.99 kWh/m²	18%	10.26 kWh/m²	20%
External Lighting*	0.47 kWh/m²				
Refrigeration	4.18 kWh/m²	4.61 kWh/m²	9%	4.38 kWh/m²	5%
HVAC	2.01 kWh/m²	2.62 kWh/m²	23%	5.69 kWh/m²	65%
Mechanical handling	0.41 kWh/m²	2.73 kWh/m²	85%	1.80 kWh/m²	77%
Catering	2.58 kWh/m²	2.43 kWh/m²	-6%	3.22 kWh/m²	20%
IT / Communications	0.12 kWh/m²	0.60 kWh/m²	79%	0.53 kWh/m²	76%
General power	0.47 kWh/m²				
Miscellaneous	2.20 kWh/m²				
Total Electricity consumption	20.64 kWh/m²	38.81 kWh/m²	47%	24.54 kWh/m²	16%
Gas consumption	2.60 kWh/m²	9.58 kWh/m²	-3618%	3.05 kWh/m²	15%
Biomass boiler output	353.49 kWh/m²			6.29 kWh/m²	-5518%
Water consumption	19.29 l/m²	0.04 l/m²	-48577%	- l/m²	

Notes

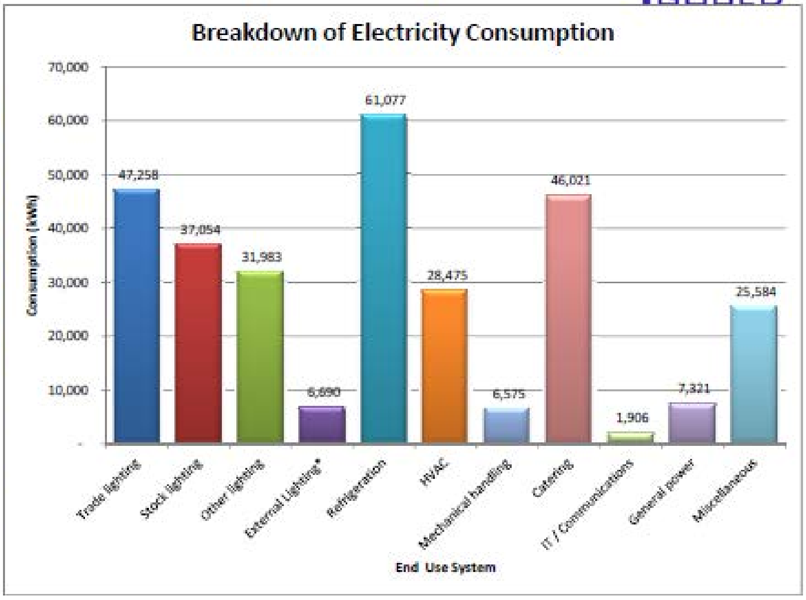
* External Lighting Includes Car Park, Signage lighting and Electric Car Charge points
Where no Benchmarks have been inputted this data is not current available
The total electricity, gas and water benchmarks have been prorated on the number of days in the month only annual data was available.

March 2013

Cheshire Oaks Store Consumption Summary

Period	**01/03/2013 to 31/03/2013**	**Days 31**

Electricity consumption:		
Trade lighting	47,258	kWh
Stock lighting	37,054	kWh
Other lighting	31,983	kWh
External Lighting*	6,690	kWh
Refrigeration	61,077	kWh
HVAC	28,475	kWh
Mechanical handling	6,575	kWh
Catering	46,021	kWh
IT / Communications	1,906	kWh
General power	7,321	kWh
Miscellaneous	25,584	kWh
Total Electricity consumption	299,944	kWh
Gas consumption	41,448	kWh
Biomass boiler output	4,111,100	kWh
Water consumption	355.67	m³



	Actual	Benchmark	% Reduction of Actual over benchmark	Projected	% Reduction of Actual over Projected
Internal Lighting	8.41 kWh/m²	11.06 kWh/m²	24%	11.36 kWh/m²	26%
External Lighting*	0.48 kWh/m²				
Refrigeration	4.42 kWh/m²	5.94 kWh/m²	26%	4.85 kWh/m²	9%
HVAC	2.06 kWh/m²	3.65 kWh/m²	44%	6.29 kWh/m²	67%
Mechanical handling	0.48 kWh/m²	3.20 kWh/m²	85%	2.00 kWh/m²	76%
Catering	3.33 kWh/m²	2.65 kWh/m²	-26%	3.56 kWh/m²	7%
IT / Communications	0.14 kWh/m²	0.64 kWh/m²	78%	0.58 kWh/m²	76%
General power	0.53 kWh/m²				
Miscellaneous	1.85 kWh/m²				
Total Electricity consumption	21.69 kWh/m²	42.97 kWh/m²	50%	27.17 kWh/m²	20%
Gas consumption	3.00 kWh/m²	10.60 kWh/m²	72%	3.38 kWh/m²	11%
Biomass boiler output	297.26 kWh/m²			6.97 kWh/m²	-4167%
Water consumption	25.72 l/m²	0.04 l/m²	-58506%	- l/m²	

Notes

* External Lighting Includes Car Park, Signage lighting and Electric Car Charge points
Where no Benchmarks have been inputted this data is not current available
The total electricity, gas and water benchmarks have been prorated on the number of days in the month only annual data was available.

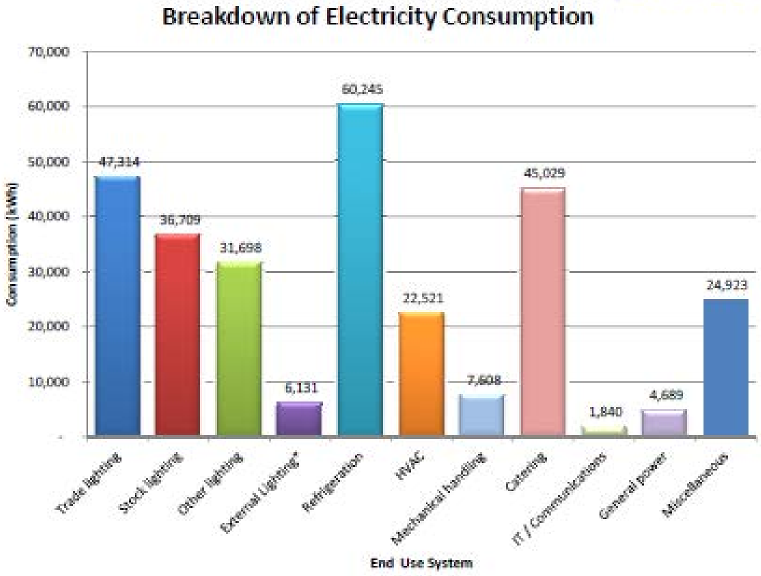
April 2013

M&S

Cheshire Oaks Store Consumption Summary | **Days**
Period 01/04/2013 to 30/04/2013 | **30**

FAITHFUL GOULD

Electricity consumption:		
Trade lighting	47,314	kWh
Stock lighting	36,709	kWh
Other lighting	31,698	kWh
External Lighting*	6,131	kWh
Refrigeration	60,245	kWh
HVAC	22,521	kWh
Mechanical handling	7,608	kWh
Catering	45,029	kWh
IT / Communications	1,840	kWh
General power	4,689	kWh
Miscellaneous	24,923	kWh
	#REF!	
Total Electricity consumption	288,707	kWh
Gas consumption	26,741	kWh
Biomass boiler output	-	kWh
Water consumption	520.29	m³



	Actual		Benchmark		% Reduction of Actual over benchmark	Projected	% Reduction of Actual over Projected
Internal lighting	8.37	kWh/m²	10.70	kWh/m²	22%	10.99 kWh/m²	24%
External lighting	0.44	kWh/m²					
Refrigeration	4.36	kWh/m²	5.75	kWh/m²	24%	4.69 kWh/m²	7%
HVAC	1.63	kWh/m²	3.53	kWh/m²	54%	6.09 kWh/m²	73%
Mechanical handling	0.55	kWh/m²	3.10	kWh/m²	82%	1.93 kWh/m²	72%
Catering	3.26	kWh/m²	2.57	kWh/m²	-27%	3.45 kWh/m²	6%
IT / Communications	0.13	kWh/m²	0.62	kWh/m²	79%	0.56 kWh/m²	76%
General power	0.34	kWh/m²					
Miscellaneous	1.80	kWh/m²					
Total Electricity consumption	20.88	kWh/m²	41.58	kWh/m²	50%	26.30 kWh/m²	21%
Gas consumption	1.93	kWh/m²	10.26	kWh/m²	81%	3.27 kWh/m²	41%
Biomass boiler output	-	kWh/m²				6.74 kWh/m²	100%
Water consumption	37.62	l/m²	0.04	l/m²	-88490%	- l/m²	

Notes

* External Lighting Includes Car Park, Signage lighting and Electric Car Charge points
Where no Benchmarks have been inputted this data is not current available
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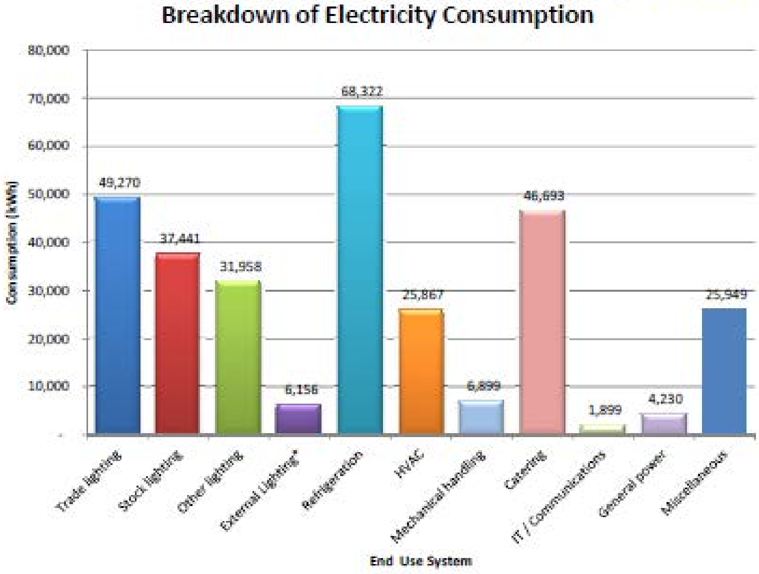
May 2013

M&S

Cheshire Oaks Store Consumption Summary
Period 01/05/2013 to 31/05/2013
Days 31

FAITHFUL GOULD

Electricity consumption:		
Trade lighting	49,270	kWh
Stock lighting	37,441	kWh
Other lighting	31,958	kWh
External Lighting*	6,156	kWh
Refrigeration	68,322	kWh
HVAC	25,867	kWh
Mechanical handling	6,899	kWh
Catering	46,693	kWh
IT / Communications	1,899	kWh
General power	4,230	kWh
Miscellaneous	25,949	kWh
Total Electricity consumption	304,683	kWh
Gas consumption	25,289	kWh
Biomass boiler output	-	kWh
Water consumption	434.43	m^3



	Actual		Benchmark		% Reduction of Actual over benchmark	Projected	% Reduction of Actual over Projected
Internal lighting	8.58	kWh/m²	11.06	kWh/m²	22%	11.36 kWh/m²	24%
External Lighting*	0.45	kWh/m²					
Refrigeration	4.94	kWh/m²	5.94	kWh/m²	17%	4.85 kWh/m²	-2%
HVAC	1.87	kWh/m²	3.65	kWh/m²	49%	6.29 kWh/m²	70%
Mechanical handling	0.50	kWh/m²	3.20	kWh/m²	84%	2.00 kWh/m²	75%
Catering	3.38	kWh/m²	2.65	kWh/m²	-27%	3.56 kWh/m²	5%
IT / Communications	0.14	kWh/m²	0.64	kWh/m²	79%	0.58 kWh/m²	76%
General power	0.31	kWh/m²					
Miscellaneous	1.88	kWh/m²					
Total Electricity consumption	22.03	kWh/m²	42.97	kWh/m²	49%	27.17 kWh/m²	19%
Gas consumption	1.83	kWh/m²	10.60	kWh/m²	83%	3.38 kWh/m²	46%
Biomass boiler output	-	kWh/m²				6.97 kWh/m²	100%
Water consumption	31.41	l/m²	0.04	l/m²	-71484%	- l/m²	

Notes

* External Lighting Includes Car Park, Signage lighting and Electric Car Charge points
Where no Benchmarks have been inputted this data is not current available
The total electricity, gas and water benchmarks have been prorated on the number of days in the month only annual data was available.

June 2013

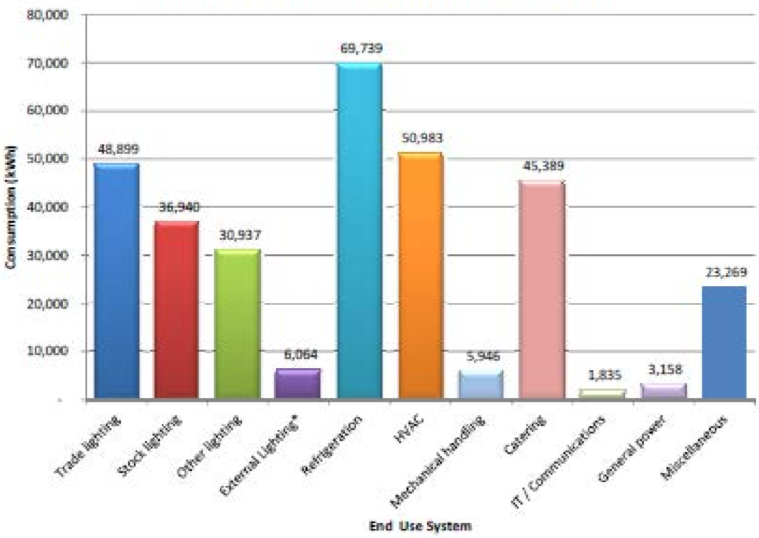
M&S

Cheshire Oaks Store Consumption Summary
Period 01/06/2013 to 30/06/2013
Days 30

FAITHFUL GOULD

Electricity consumption:		
Trade lighting	48,899	kWh
Stock lighting	36,940	kWh
Other lighting	30,937	kWh
External Lighting*	6,064	kWh
Refrigeration	69,739	kWh
HVAC	50,983	kWh
Mechanical handling	5,946	kWh
Catering	45,389	kWh
IT / Communications	1,835	kWh
General power	3,158	kWh
Miscellaneous	23,269	kWh
Total Electricity consumption	323,159	kWh
Gas consumption	29,370	kWh
Biomass boiler output	-	kWh
Water consumption	544.66	m³

Breakdown of Electricity Consumption



	Actual	Benchmark	% Reduction of Actual over benchmark	Projected	% Reduction of Actual over Projected
Trade lighting Other lighting	8.44 kWh/m²	9.90 kWh/m²	15%	10.99 kWh/m²	23%
External Lighting*	0.44 kWh/m²				
Refrigeration	5.04 kWh/m²	6.59 kWh/m²	24%	4.69 kWh/m²	-7%
HVAC	3.69 kWh/m²	5.48 kWh/m²	33%	6.09 kWh/m²	39%
Mechanical handling	0.43 kWh/m²	2.51 kWh/m²	83%	1.93 kWh/m²	78%
Catering	3.28 kWh/m²	2.25 kWh/m²	-46%	3.45 kWh/m²	5%
IT / Communications	0.13 kWh/m²	0.58 kWh/m²	77%	0.56 kWh/m²	76%
General power	0.23 kWh/m²				
Miscellaneous	1.68 kWh/m²				
Total Electricity consumption	23.37 kWh/m²	34.70 kWh/m²	33%	26.30 kWh/m²	11%
Gas consumption	2.12 kWh/m²	10.26 kWh/m²	79%	3.27 kWh/m²	35%
Biomass boiler output	- kWh/m²				
Water consumption	39.38 l/m²	0.04 l/m²	-92639%	- l/m²	

Notes

* External Lighting Includes Car Park, Signage lighting and Electric Car Charge points
Where no Benchmarks have been inputted this data is not current available
The total electricity, gas and water benchmarks have been prorated on the number of days in the month only annual data was available.

July 2013

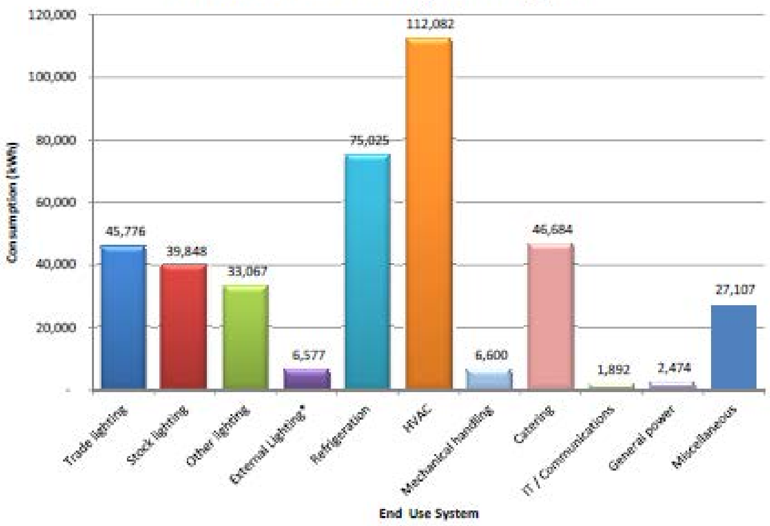
M&S

Cheshire Oaks Store Consumption Summary **Days**
Period **01/07/2013 to 31/07/2013** **31**

FAITHFUL GOULD

Electricity consumption:		
Trade lighting	45,776	kWh
Stock lighting	39,848	kWh
Other lighting	33,067	kWh
External Lighting*	6,577	kWh
Refrigeration	75,025	kWh
HVAC	112,082	kWh
Mechanical handling	6,600	kWh
Catering	46,684	kWh
IT / Communications	1,892	kWh
General power	2,474	kWh
Miscellaneous	27,107	kWh
Total Electricity consumption	**397,132**	**kWh**
Gas consumption	**14,025**	**kWh**
Biomass boiler output	**-**	**kWh**
Water consumption	**519.99**	**m³**

Breakdown of Electricity Consumption



	Actual	Benchmark	% Reduction of Actual over benchmark	Projected	% Reduction of Actual over Projected
Internal Lighting	8.58 kWh/m²	11.06 kWh/m²	22%	11.36 kWh/m²	24%
External Lighting*	0.48 kWh/m²				
Refrigeration	5.42 kWh/m²	5.94 kWh/m²	9%	4.85 kWh/m²	-12%
HVAC	8.10 kWh/m²	3.65 kWh/m²	-122%	6.29 kWh/m²	-29%
Mechanical handling	0.48 kWh/m²	3.20 kWh/m²	85%	2.00 kWh/m²	76%
Catering	3.38 kWh/m²	2.65 kWh/m²	-27%	3.56 kWh/m²	5%
IT / Communications	0.14 kWh/m²	0.64 kWh/m²	79%	0.58 kWh/m²	77%
General power	0.18 kWh/m²				
Miscellaneous	1.96 kWh/m²				
Total Electricity consumption	28.72 kWh/m²	42.97 kWh/m²	33%	27.17 kWh/m²	-6%
Gas consumption	1.01 kWh/m²	10.60 kWh/m²	90%	3.38 kWh/m²	70%
Biomass boiler output	- kWh/m²				
Water consumption	37.60 l/m²	0.04 l/m²	-85583%	- l/m²	

Notes

* External Lighting Includes Car Park, Signage lighting and Electric Car Charge points
Where no Benchmarks have been inputted this data is not current available
The total electricity, gas and water benchmarks have been prorated on the number of days in the month only annual data was available.

August 2013

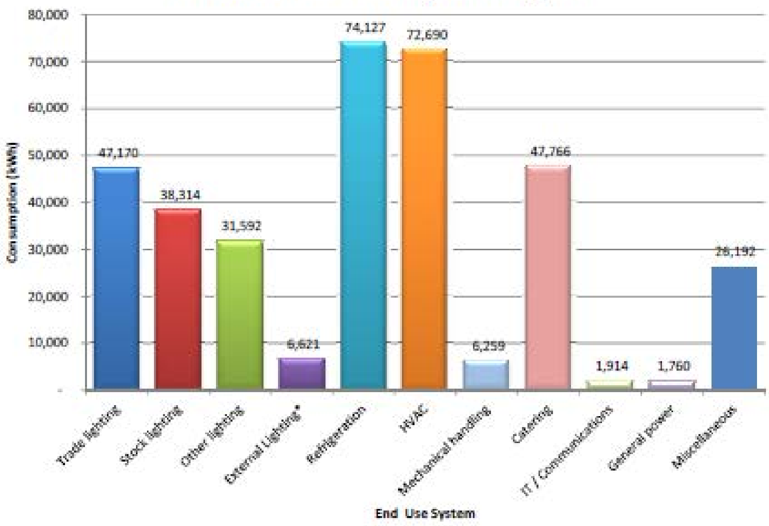
M&S

Cheshire Oaks Store Consumption Summary **Days**
Period **01/08/2013 to 31/08/2013** **31**

FAITHFUL GOULD

Electricity consumption:		
Trade lighting	47,170	kWh
Stock lighting	38,314	kWh
Other lighting	31,592	kWh
External Lighting*	6,621	kWh
Refrigeration	74,127	kWh
HVAC	72,690	kWh
Mechanical handling	6,259	kWh
Catering	47,766	kWh
IT / Communications	1,914	kWh
General power	1,760	kWh
Miscellaneous	26,192	kWh
Total Electricity consumption	**354,405**	**kWh**
Gas consumption	**17,389**	**kWh**
Biomass boiler output	**-**	**kWh**
Water consumption	**421.62**	**m^3**

Breakdown of Electricity Consumption



	Actual		Benchmark		% Reduction of Actual over benchmark	Projected		% Reduction of Actual over Projected
Internal Lighting	8.47	kWh/m^2	11.06	kWh/m^2	23%	11.36	kWh/m^2	25%
External Lighting*	0.48	kWh/m^2						
Refrigeration	5.36	kWh/m^2	5.94	kWh/m^2	10%	4.85	kWh/m^2	-10%
HVAC	5.26	kWh/m^2	3.65	kWh/m^2	-44%	6.29	kWh/m^2	17%
Mechanical handling	0.45	kWh/m^2	3.20	kWh/m^2	86%	2.00	kWh/m^2	77%
Catering	3.45	kWh/m^2	2.65	kWh/m^2	-30%	3.56	kWh/m^2	3%
IT / Communications	0.14	kWh/m^2	0.64	kWh/m^2	78%	0.58	kWh/m^2	76%
General power	0.13	kWh/m^2						
Miscellaneous	1.89	kWh/m^2						
Total Electricity consumption	25.63	kWh/m^2	42.97	kWh/m^2	40%	27.17	kWh/m^2	6%
Gas consumption	1.26	kWh/m^2	10.60	kWh/m^2	88%	3.38	kWh/m^2	63%
Biomass boiler output	-	kWh/m^2						
Water consumption	30.49	l/m^2	0.04	l/m^2	-69373%	-	l/m^2	

Notes

* External Lighting Includes Car Park, Signage lighting and Electric Car Charge points
Where no Benchmarks have been inputted this data is not current available
The total electricity, gas and water benchmarks have been prorated on the number of days in the month only annual data was available.

September 2013

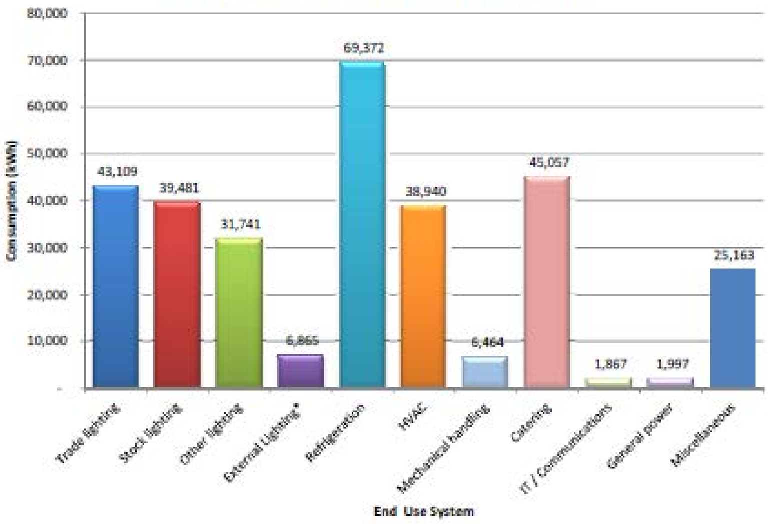
M&S

Cheshire Oaks Store Consumption Summary | **Days**
Period 01/09/2013 to 30/09/2013 | **30**

FAITHFUL GOULD

Electricity consumption:		
Trade lighting	43,109	kWh
Stock lighting	39,481	kWh
Other lighting	31,741	kWh
External Lighting*	6,865	kWh
Refrigeration	69,372	kWh
HVAC	38,940	kWh
Mechanical handling	6,464	kWh
Catering	45,057	kWh
IT / Communications	1,867	kWh
General power	1,997	kWh
Miscellaneous	25,163	kWh
Total Electricity consumption	310,056	kWh
Gas consumption	21,067	kWh
Biomass boiler output	-	kWh
Water consumption	452.39	m^3

Breakdown of Electricity Consumption



	Actual		Benchmark		% Reduction of Actual over benchmark	Projected		% Reduction of Actual over Projected
Internal Lighting	8.27	kWh/m²	10.70	kWh/m²	23%	10.99	kWh/m²	25%
External Lighting*	0.50	kWh/m²						
Refrigeration	5.02	kWh/m²	5.75	kWh/m²	13%	4.69	kWh/m²	-7%
HVAC	2.82	kWh/m²	3.53	kWh/m²	20%	6.09	kWh/m²	54%
Mechanical handling	0.47	kWh/m²	3.10	kWh/m²	85%	1.93	kWh/m²	76%
Catering	3.26	kWh/m²	2.57	kWh/m²	-27%	3.45	kWh/m²	5%
IT / Communications	0.13	kWh/m²	0.62	kWh/m²	78%	0.56	kWh/m²	76%
General power	0.14	kWh/m²						
Miscellaneous	1.82	kWh/m²						
Total Electricity consumption	22.42	kWh/m²	41.58	kWh/m²	46%	26.30	kWh/m²	15%
Gas consumption	1.52	kWh/m²	10.26	kWh/m²	85%	3.27	kWh/m²	53%
Biomass boiler output	-	kWh/m²						
Water consumption	32.71	l/m²	0.04	l/m²	-76928%	-	l/m²	

Notes

* External Lighting Includes Car Park, Signage lighting and Electric Car Charge points
Where no Benchmarks have been inputted this data is not current available
The total electricity, gas and water benchmarks have been prorated on the number of days in the month only annual data was available.

October 2013

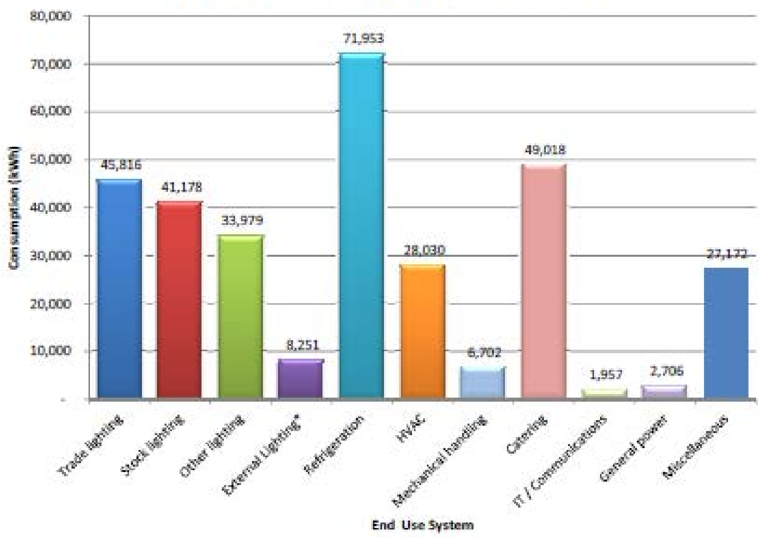
M&S

Cheshire Oaks Store Consumption Summary **Days**
Period 01/10/2013 to 31/10/2013 **31**

FAITHFUL GOULD

Electricity consumption:		
Trade lighting	45,816	kWh
Stock lighting	41,178	kWh
Other lighting	33,979	kWh
External Lighting*	8,251	kWh
Refrigeration	71,953	kWh
HVAC	28,030	kWh
Mechanical handling	6,702	kWh
Catering	49,018	kWh
IT / Communications	1,957	kWh
General power	2,706	kWh
Miscellaneous	27,172	kWh
	#REF!	
Total Electricity consumption	**316,762**	**kWh**
Gas consumption	**23,881**	**kWh**
Biomass boiler output	**4,700,000**	**kWh**
Water consumption	**372.97**	**m³**

Breakdown of Electricity Consumption



	Actual		Benchmark		% Reduction of Actual over benchmark	Projected	% Reduction of Actual over Projected
Internal Lighting	8.75	kWh/m²	11.06	kWh/m²	21%	11.36 kWh/m²	23%
External Lighting*	0.60	kWh/m²					
Refrigeration	5.20	kWh/m²	5.94	kWh/m²	12%	4.85 kWh/m²	-7%
HVAC	2.03	kWh/m²	3.65	kWh/m²	45%	6.29 kWh/m²	68%
Mechanical handling	0.48	kWh/m²	3.20	kWh/m²	85%	2.00 kWh/m²	76%
Catering	3.54	kWh/m²	2.65	kWh/m²	-34%	3.56 kWh/m²	0%
IT / Communications	0.14	kWh/m²	0.64	kWh/m²	78%	0.58 kWh/m²	76%
General power	0.20	kWh/m²					
Miscellaneous	1.96	kWh/m²					
Total Electricity consumption	22.90	kWh/m²	42.97	kWh/m²	47%	27.17 kWh/m²	16%
Gas consumption	1.73	kWh/m²	10.60	kWh/m²	84%	3.38 kWh/m²	49%
Biomass boiler output	339.84	kWh/m²				4.60 kWh/m²	-7288%
Water consumption	26.97	l/m²	0.04	l/m²	-61357%	- l/m²	

Notes

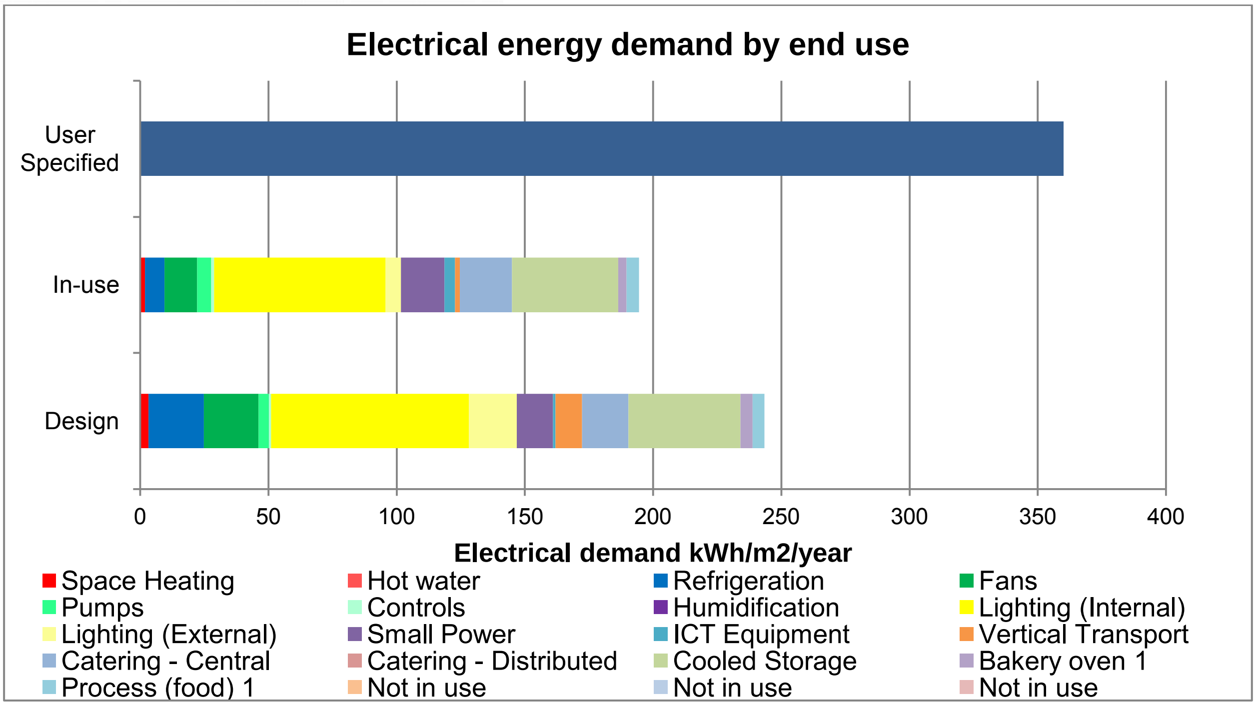
* External Lighting Includes Car Park, Signage lighting and Electric Car Charge points
Where no Benchmarks have been inputted this data is not current available
The total electricity, gas and water benchmarks have been prorated on the number of days in the month only annual data was available.

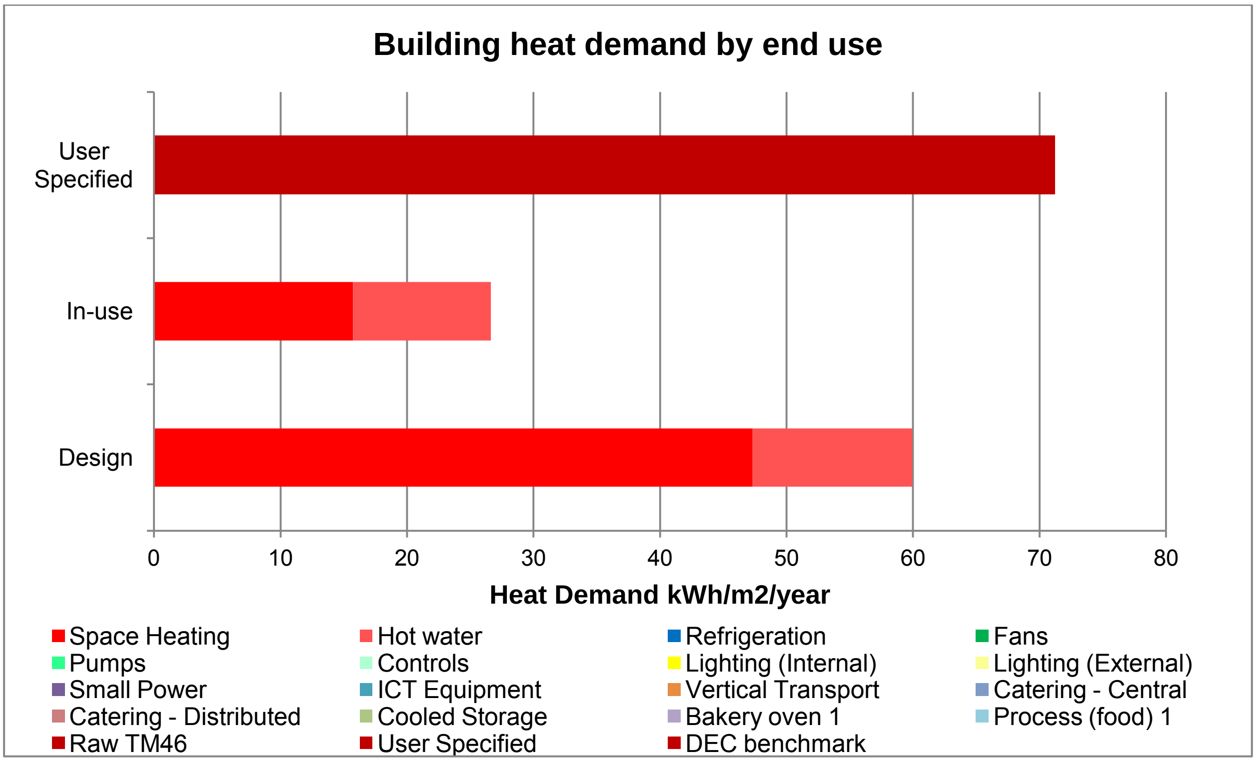
10.3 TM22 Output Summaries

Energy demand

		Heat demand (kWh/m2/year)		Electricity demand (kWh/m2/year)	
System	Description	Design (kWh/m2/year)	In-Use (kWh/m2/year)	Design electricity (kWh/m2/year)	In-use electricity (kWh/m2/year)
Space Heating		47.3	15.7	3.2	1.9
Hot water		12.6	10.9	0.0	0.0
Refrigeration		0.0	0.0	21.6	7.6
Fans		0.0	0.0	21.4	12.7
Pumps		0.0	0.0	4.1	5.4
Controls		0.0	0.0	0.9	1.2
Lighting (Internal)		0.0	0.0	77.0	66.8
Lighting (External)		0.0	0.0	18.8	6.0
Small Power		0.0	0.0	14.1	17.0
ICT Equipment		0.0	0.0	1.0	4.1
Vertical Transport		0.0	0.0	10.3	1.9
Catering - Central		0.0	0.0	18.1	20.4
Cooled Storage		0.0	0.0	43.6	41.5
User 1	Bakery oven 1	0.0	0.0	4.7	3.1
User 2	Process (food) 1	0.0	0.0	4.7	5.0
Total		**59.9**	**26.6**	**243.4**	**194.5**
Metered building energy use		59.9	26.6	193.9	193.9
Variance TM22 versus metered total		0.0	0.0	49.5	0.6
Variance TM22 versus metered total		0%	0%	25%	0%

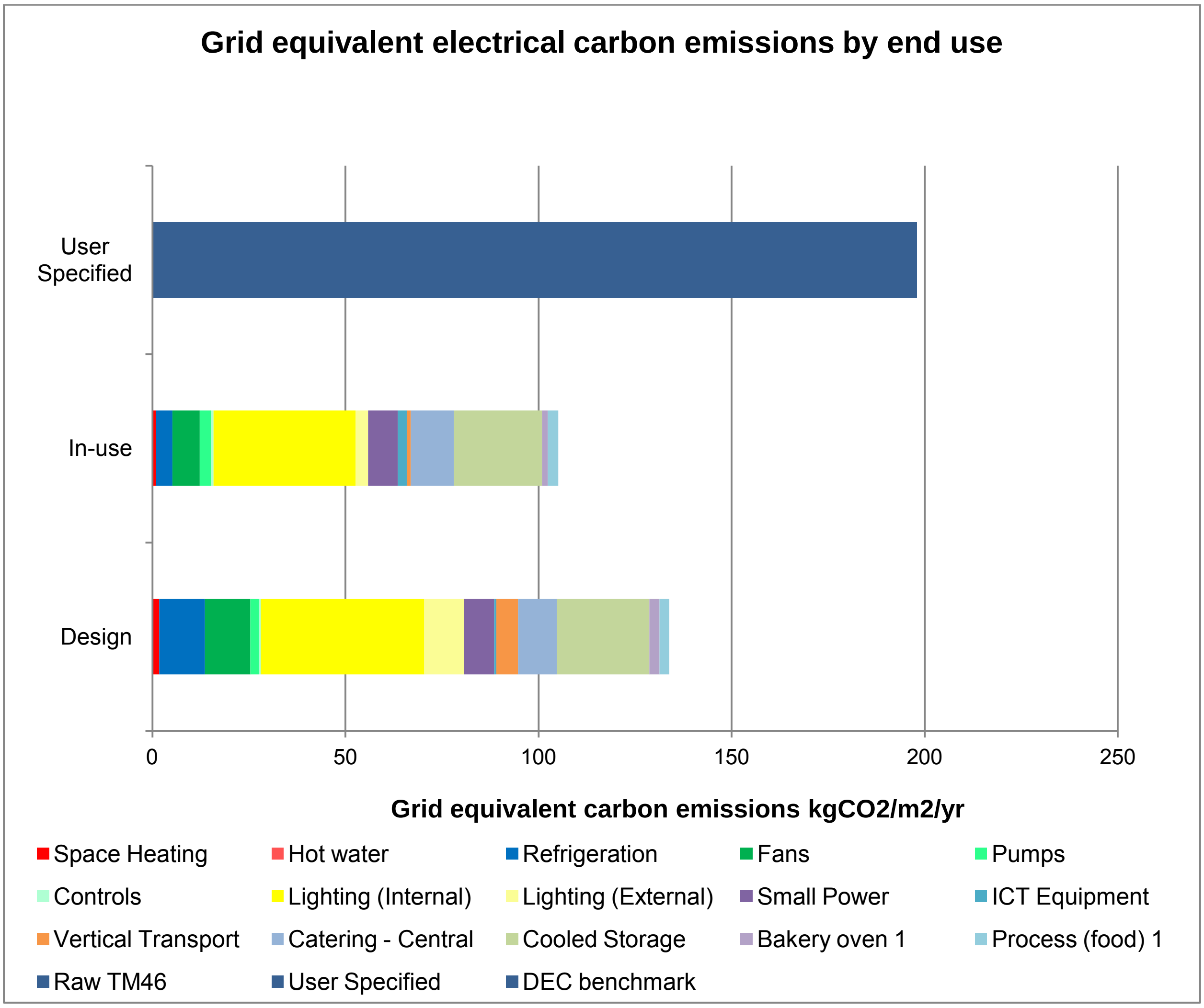
		Additional metrics for electricity demand				
System	Description	In-use electricity (kWh/year)	In-use % of total	In-Use Full load W/m2	System hours/year	Utilisation
Space Heating		36,073	1.0%	1.2	1,600	18.3%
Hot water		0	0.0%	0.0	0	0.0%
Refrigeration		148,309	3.9%	13.8	553	6.3%
Fans		247,359	6.5%	5.6	2,258	25.8%
Pumps		104,784	2.8%	4.7	1,148	13.1%
Controls		23,606	0.6%	0.2	7,175	81.9%
Lighting (Internal)		1,296,807	34.3%	16.1	4,161	47.5%
Lighting (External)		116,620	3.1%	3.4	1,744	19.9%
Small Power		329,779	8.7%	6.9	2,458	28.1%
ICT Equipment		79,240	2.1%	0.5	8,289	94.6%
Vertical Transport		36,359	1.0%	3.4	550	6.3%
Catering - Central		395,472	10.5%	12.3	1,660	18.9%
Cooled Storage		805,361	21.3%	8.1	5,094	58.1%
User 1	Bakery oven 1	60,953	1.6%	2.5	1,239	14.1%
User 2	Process (food) 1	96,203	2.5%	3.3	1,513	17.3%
Total		3,776,926	100.0%	82.0		
Metered building energy use		3,765,830				
Variance TM22 versus metered total		11,095.7		**Building GIA:**	19,417	
Variance TM22 versus metered total		0%				

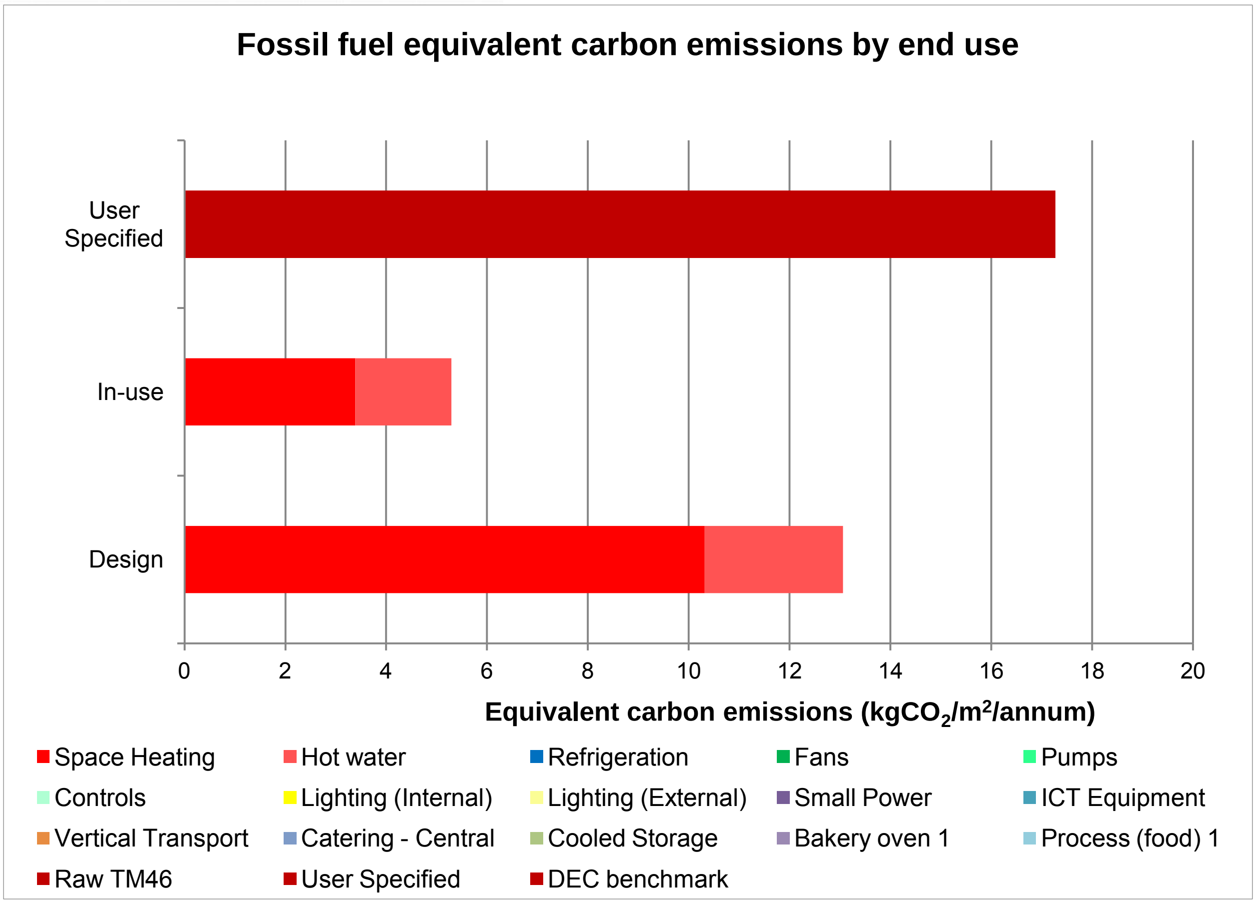

Electrical energy demand by end use
User Specified
In-use
Design
0
50
100
150
200
250
300
350
400
Electrical demand kWh/m2/year
Space Heating
Hot water
Refrigeration
Fans
Pumps
Controls
Humidification
Lighting (Internal)
Lighting (External)
Small Power
ICT Equipment
Vertical Transport
Catering - Central
Catering - Distributed
Cooled Storage
Bakery oven 1
Process (food) 1
Not in use
Not in use
Not in use


Building heat demand by end use
User Specified
In-use
Design
0
10
20
30
40
50
60
70
80
Heat Demand kWh/m2/year
Space Heating
Hot water
Refrigeration
Fans
Pumps
Controls
Lighting (Internal)
Lighting (External)
Small Power
ICT Equipment
Vertical Transport
Catering - Central
Catering - Distributed
Cooled Storage
Bakery oven 1
Process (food) 1
Raw TM46
User Specified
DEC benchmark

Carbon Results

		Fuel /Thermal (kgCO2/m2/year)		Electricity (kgCO2/m2/year)		Total carbon emissions	
System	Description	Design Fuel/Thermal equivalent emissions	In-use Fuel/Thermal equivalent emissions	Design grid equivalent emissions	In-use grid equivalent emissions	Design total equivalent emissions	In-Use total equivalent emissions
Space Heating		10.3	3.4	1.7	1.0	12.1	4.4
Hot water		2.7	2.3	0.0	0.0	2.7	2.3
Refrigeration		0.0	0.0	11.9	4.2	11.9	4.2
Fans		0.0	0.0	11.8	7.0	11.8	7.0
Pumps		0.0	0.0	2.2	3.0	2.2	3.0
Controls		0.0	0.0	0.5	0.7	0.5	0.7
Lighting (Internal)		0.0	0.0	42.3	36.7	42.3	36.7
Lighting (External)		0.0	0.0	10.3	3.3	10.3	3.3
Small Power		0.0	0.0	7.8	9.3	7.8	9.3
ICT Equipment		0.0	0.0	0.6	2.2	0.6	2.2
Vertical Transport		0.0	0.0	5.7	1.0	5.7	1.0
Catering - Central		0.0	0.0	10.0	11.2	10.0	11.2
Cooled Storage		0.0	0.0	24.0	22.8	24.0	22.8
User 1	Bakery oven 1	0.0	0.0	2.6	1.7	2.6	1.7
User 2	Process (food) 1	0.0	0.0	2.6	2.7	2.6	2.7
Total		**13.1**	**5.7**	**133.9**	**107.0**	**146.9**	**112.7**




Fossil fuel equivalent carbon emissions by end use
User Specified
In-use
Design
0
2
4
6
8
10
12
14
16
18
20
Equivalent carbon emissions (kgCO2/m2/annum)
Space Heating
Hot water
Refrigeration
Fans
Pumps
Controls
Lighting (Internal)
Lighting (External)
Small Power
ICT Equipment
Vertical Transport
Catering - Central
Cooled Storage
Bakery oven 1
Process (food) 1
Raw TM46
User Specified
DEC benchmark

10.4 BUS Survey Summary

From a pool of around 200 possible respondents (Staff count 169 on Thursday, 181 on Friday), 81 completed questionnaires were received. The summary results from these are presented below with more detailed analysis in later sub-sections.

Overall

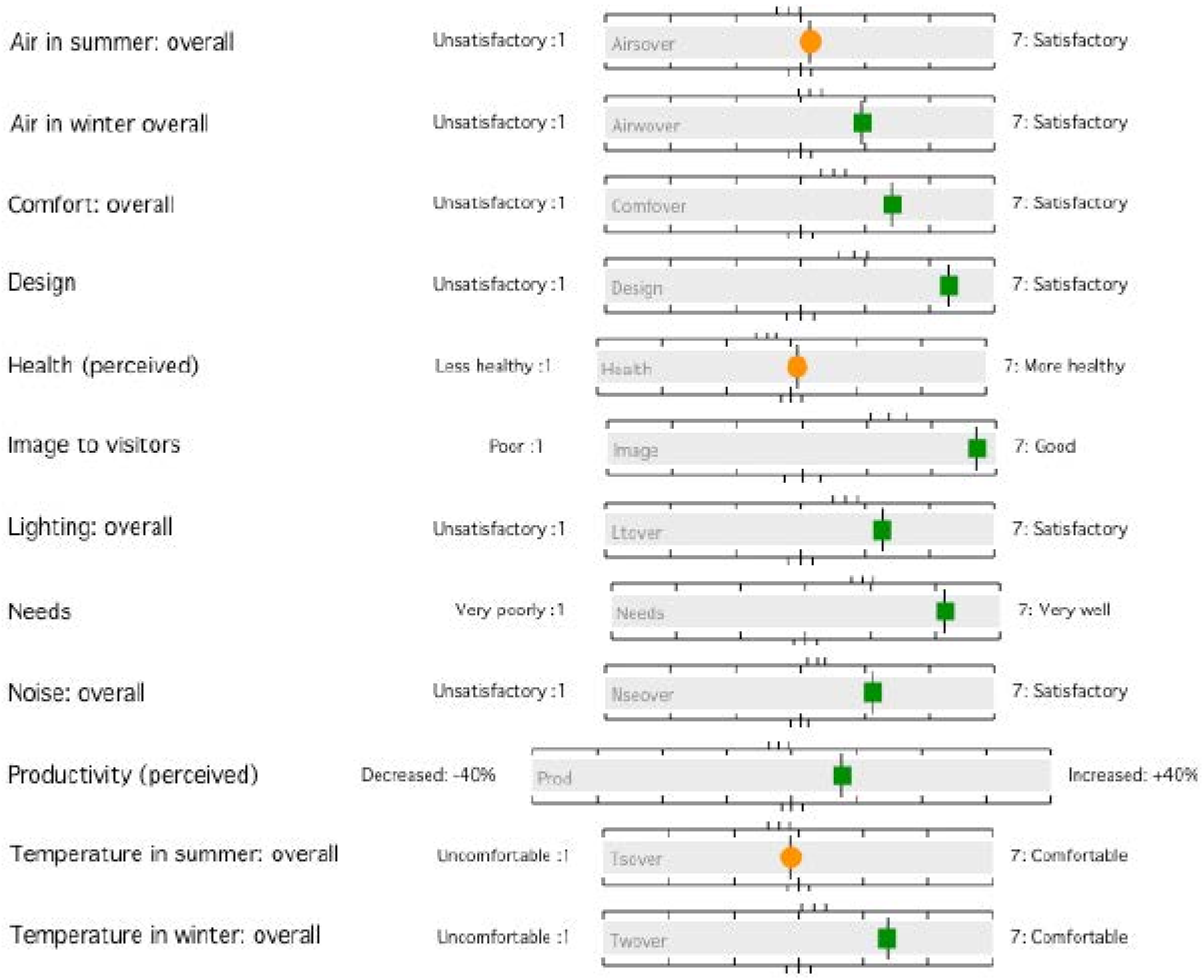


Figure 47 BUS survey overall summary results

Temperature

The staff surveyed included not just those who worked in air conditioned areas (offices and retail areas) but also in the unconditioned back of house areas of the store. The temperatures were found to be stable all year round, with slightly too hot in summer and near benchmark in winter.

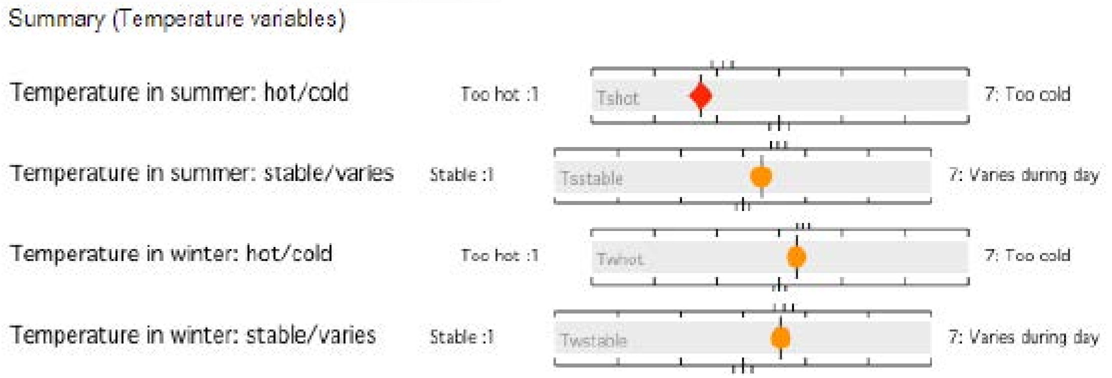


Figure 48 Temperature results from the BUS survey

Air

The air in both summer and winter was perceived to be odourless and dryer than the benchmark. In summer air was perceived as being a little stiller and a little stuffier than the benchmark.

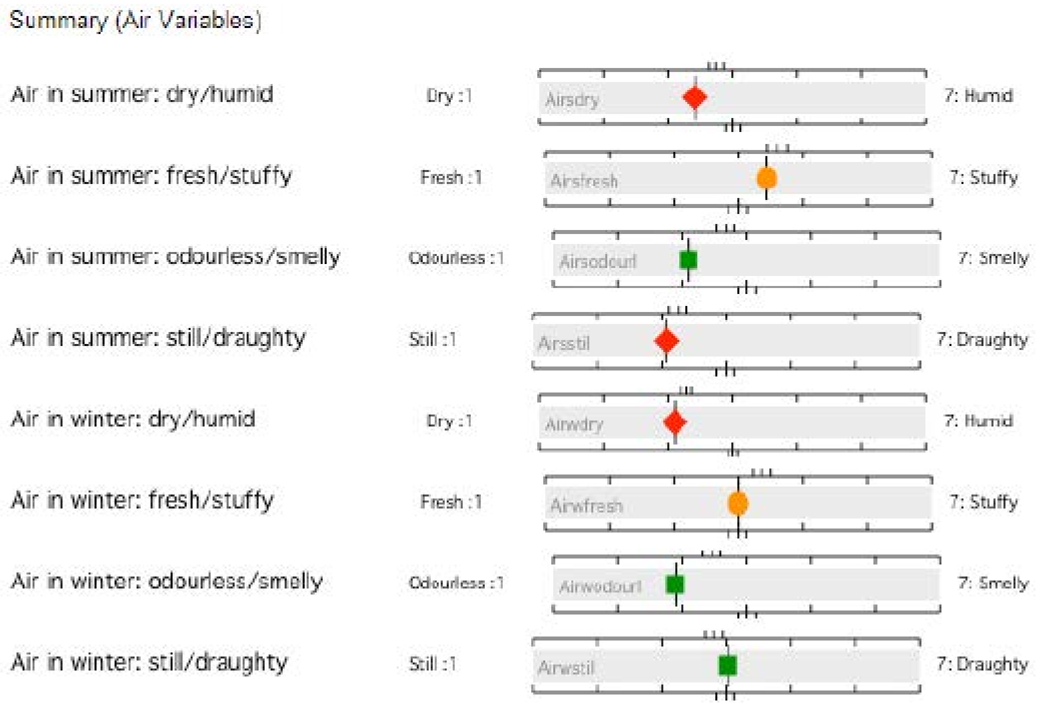


Figure 49 Air results from the BUS survey

Lighting

In the CO store, natural light was rated within benchmarks and little glare from sun and sky was reported. But two of the four lighting variables are in the red zone, see Figure 50. Cheshire Oaks was rated by staff as having slightly too much artificial light, and slightly too much glare from artificial lights. Note that in focus groups, glare was found to be an issue for staff in a small part of the sales area on the ground floor in the mornings; and in the upstairs cafe at certain times when the sun was low.

Figure 50 Lighting variables from the BUS survey

Noise

One of the four noise variables were in the red zone, with Cheshire Oaks perceived as having too little noise from outside, the remaining variables are within benchmark values. This can be a negative factor for offices.

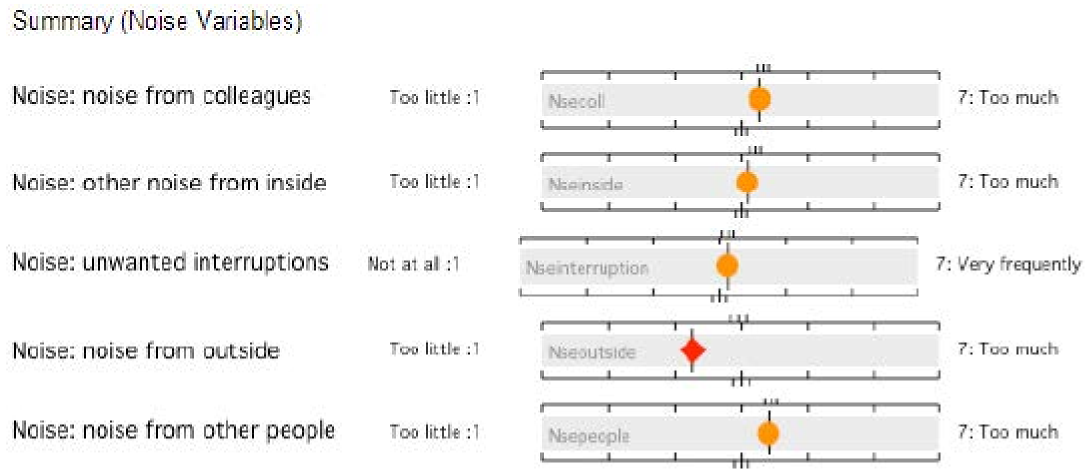


Figure 51 Noise variables for the BUS survey

Control

All control variables were well below benchmark, CO is mechanically ventilated with a remotely managed Building Management System so most staff have no direct control at all over their environment.

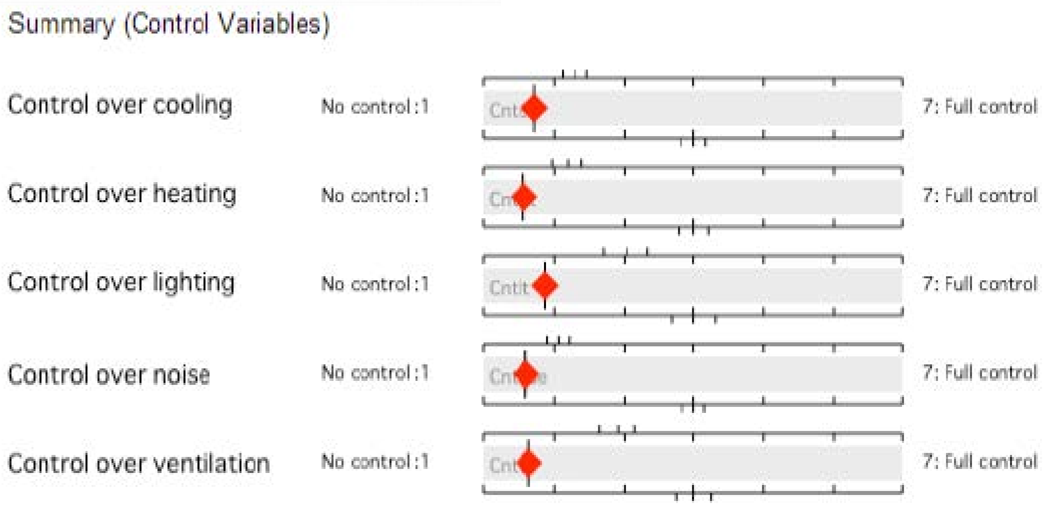


Figure 52 Control results from the BUS survey

Design and needs

All design and needs variables were rated to be well above benchmark values

Figure 53 Design/needs results from the BUS survey

Facilities Management

Most of these variables were rated as being well above the benchmark with “image to visitors” particularly high. The only “red zone” variable in this section was “space at desk” which was actually a little higher than benchmark, towards too much space.

The “perceived health” variable, tended towards the more healthy and is slightly above the benchmark but not significantly higher than the mean of all buildings surveyed using the BUS methodology.

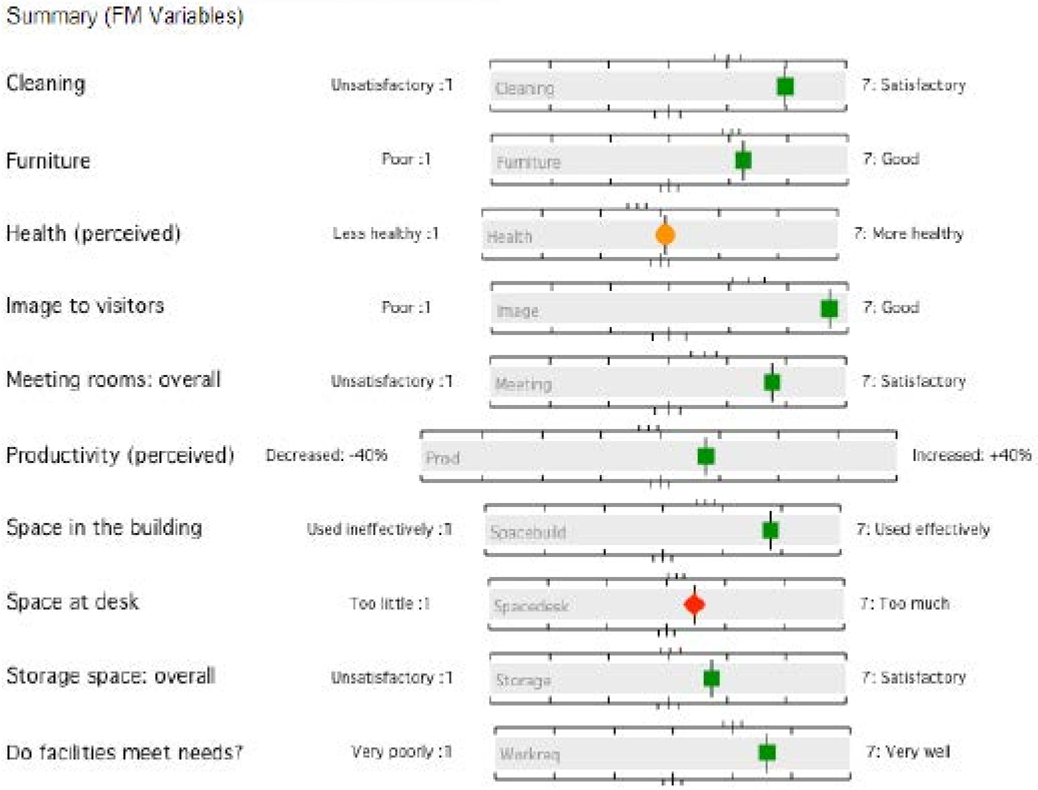


Figure 54 FM results from the BUS survey

10.5 Store Photos

Figure 55 – Front of store with planted embankment

Figure 56 – South side of store with planted embankment

Figure 57 – Green wall on car park

Figure 58 – Upper deck of car park showing LED lamp posts and first floor of store

Figure 59 – Displacement ventilation column

Figure 60 – Internal roof showing steel support tree, glulam roof frame, track lighting and north light

Figure 61 – High level glazing

Figure 62 – Chilled food cabinets with top entry CO_2 connections

Figure 63 – Back of house recycling area

Figure 64 – Biomass boiler wood pellet delivery chute

Figure 65 – Electric car charging point