University Park Campus

Chemistry Building

Energy Survey Report

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Carbon Reduction Manager

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Summary of potential energy savings

Opportunity	Description	Estimated annual savings			Estimated Cost (£)	Payback (years)
		KWh	£	CO2 t		
1	Turn CT heating off when outside temp exceeds 18C	7,990	£684	1.2 t	none	n/a
2	Cooling set points 25°C instead of 23°C	3,250	£471	0.3 t	none	n/a
3	Turn VT heating off when outside temps exceeds 15C	2,360	£342	0.24t	none	n/a
4	Turn DHW pump off overnight	30,828	£2,005	5.8t	None	n/a
5	Fume Cup'd Labs temp set p reduced to 12C overnight	668,600	£30,087	124t	none	n/a
6	Convert remaining 41 fume cupboards to VAV system	166,844	£11,779	38 t	£295,000	25 years
7	Thermal insulation to roof	165,000	£7,425	30 t	£380,000	51 years
8	Replace lamps with LED using same light fittings	113,496	£16,458	11 t	£109,200	7 years
8a	Replace complete fitting with LED	113,496	£16,458	11 t	£378,320	22 years
9	Replace quadrangle glazing	210,000	£9,450	39t	£1,040,000	110 years
10	Install gas fired decentralised boilers	1,321,000	£59,400	244 t	£1,600,000	27 year

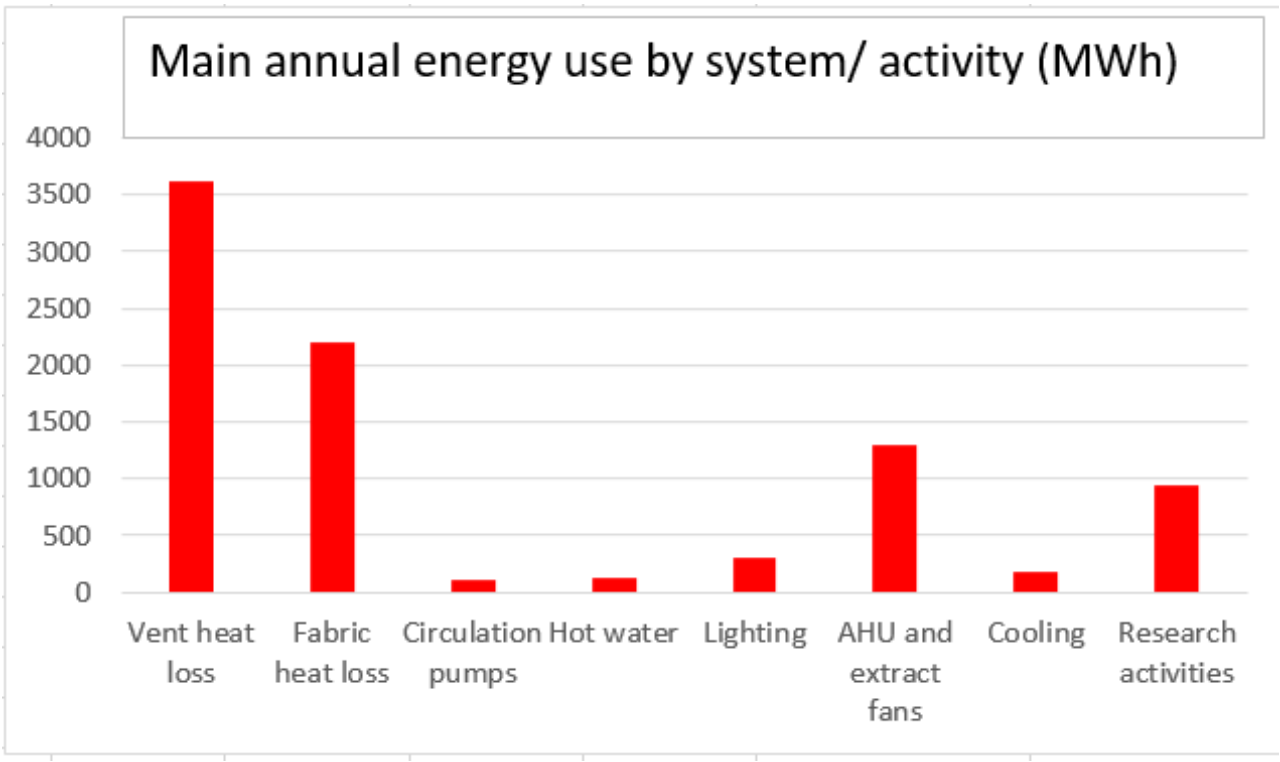
Carbon emissions based on predicated UK average power generation emission factor of 0.11 kgCO2/kWh over the next 12 years and fixed emission factor for combustion of natural gas

Background

Chemistry Building is part of the faculty of Sciences and is a heavily serviced, high energy use teaching and research building. Average annual energy and water consumption, current utility cost and scope 1 and 2 carbon emission are shown below. Energy use is 237kWh/m2 for electricity and 485kW/m2 for natural gas with typical CIBSE benchmark annual energy use for this type of building of 195kWh/m2 for electricity and 220kWh/m2 for natural gas.

Electricity	3,200,000 kWh, £464,000, 611 t CO2
Natural Gas	6,500,000 kWh, £292,500, 1,203 t CO2
Water	8,200,000 Lts, £18,040

The main energy consuming systems and activities are shown below the greatest being the heating energy required for the large number of ventilation systems that serve the building, followed by the fabric and natural vent heat losses, power for the numerous air handling units and extract fans, research activities and power consumed by the remaining building services systems.



Utilities

The electrical supply to the building is from the 11kV substation 1 and consists of 4 x 400amp 3 phase supplies serving the original main distribution panel, 160amp 3ph to the workshop area, 100amp 3ph to laser lab A20, 400amp 3ph to the 'vertical extension' and a dedicated 63amp 3 phase supply to the chiller in rear yard compound.

Original 4 x 400amp incoming electrical supply located in basement area

Heating to the building is via 125 mm diameter HPHW (140°C at a pressure of 10 Bar) from the main boiler house and site heat network. The HPHW also serves 2 x 2,000 litre domestic hot water calorifiers to provide water at 60°C throughout the building via an extensive pumped distribution network.

The building is served by a 125mm diameter natural gas supply from an external meter and supplies gas use within laboratories.

Mains cold water service is via a 54mm diameter to provide mains drinking water and a 125mm diameter serving a roof top stoarge tank for general hot and cold water service throughout the building.

Building Management System

The majority of the building services systems are contolled by local BMS panels located throughout the main and roof top plant rooms. The controls include contstant temperature (CT) and weather compensated varibale temperature (VT) heating circuits, domestic hot water, chilled water plant and circulation pumps and numerous air hanling plant with assoicated 3 port valve heating controls. The control panels are all networked to provide remote access for adjustment and monitoring along with alarms where approriate.

Building Fabric

The building has an internal floor area of 13,453m2 over 3 story plus basement plant room for heating and hot water generation along with roof top level plant room for air handling ventilation plant , approx' 5,200m2 of lab area and 2,100m2 of office type space. Constructed in 1960 with typical U values of 1.3w/m2K for the walls, 0.9 w/m2K for the roof, many of the original windows have been replaced (except the south west quadrangle) and have U value between 2.5 and 3.0 w/m2K and average floor U value of

0.6w/m2K. The ‘vertical extension’ was constructed in 1996 with typical U valves of 0.8w/m2K for the walls, 0.6w/m2K for the roof, 3.0w/m2K for the glazing.

The SW quadrangle still has the original single glazed window and would benefit from replacement with the latest low heat loss high performance double glazing system which would achieve estimated annual energy savings of 210,000 kWh

Large areas of original single glazing in the south west quadrangle

Heating

The heating system consists of 4 shell and tube heat exchangers, fed by HPHW from the main boiler house, to provide LPHW heating with estimated output of 2,000KW. These provide constant temperature heating to 2 roof top circuits for the roof top plant room air handling units, lecture theatre air handling units, vertical extension air handling units and 6 variable temperature weather compensated control radiator circuits. The heating water circulation is provide by 10 end suction pumps with total motor rating 17.5kW. Annual heating energy for the building is estimated to be 6,500,000 kWh together with 105,000 kWh of electrical energy for the circulation pumps.

Main heating calorifiers located in basement plant room

The heating calorifiers are to be replaced by high efficiency gas fired condensing boilers under the capital backlog replacement programme and should save around 1,320,000kWh. There is also an option to provide additional supplementary heat pumps to provide heating through the mild months of the heating season should a suitable life time cost per tonne of carbon saved be achieved.

Main VT and CT heating pumps located in basement plant room

As there are no reheat requirements for humidity control or domestic hot water requirement from this system it is recommended the CT pumps are turned off when outside temperature exceed 18°C. This will save electrical energy of up to 3,240 kWh and also standing heat losses on the distribution pipework of around 4750kWh. There is also the opportunity to save a further 2,360kWh by reducing the temperature at which the VT radiator circuit pumps turn off from 16°C down to 15°C

Cooling

There is no general cooling provided to the building only to targeted areas mainly due to the high equipment gains in individual labs or where a particular process requires certain environmental conditioned to be maintained. Most of this cooling is provide local DX split comfort cooling units with external condensers located on roof top walkways or the A floor balcony area. There is a dedicated chilled water system that serves the 2 main lecture theatre air handling units with circulation provided by run and standby duty inline pumps with motor rating 3kW. Annual electrical consumption energy of the chiller is around 13,000 kWh which could be reduced by increasing the cooling temperature set point from 23°C to 25°C and will save an estimated 3,250 kWh of electrical consumption.

Ventilation and fume cupboards

The building has 270 fume cupboards so requires large amounts of replacement air to maintain air balance throughout. There are approximately 45 air handling units that in total are capable of delivering around 65m3/sec of fresh air into the labs when all the fume cupboards operating. Two air handling units are dedicated to the lecture theatres (2.8m3/sec) and one smaller unit (1.7m3/sec) and operate on occupancy demand PIR detection via the BMS. The majority of the supply air ventilation is required for the fume cupboards, 154 of which operate on a variable air volume principal which matches extract rate to sash position, with a further 75 to either be replace or retrofitted with

VAV in the next 12 to 18 months. There are a remaining 41 fume cupboards that operate on a fixed volume extract and would benefit from installation of VAV system. Energy savings are achieved by reducing the extract rate and subsequent supply air rate by approximately 75% with estimated savings of 166,844 kWh achievable. Any retrofit VAV installations to these fume cupboards needs to align with wider plans to refurbish laboratories in general within the Chemistry building to avoided installing new systems that may be replaced in the next few years. Approximately 65% of the fume cupboards are used for research activity and often operate on a continuous 24/7 basis. There is opportunity to significantly reduce the heat demand on the supply air systems by reducing the lab space overnight temperature set point down to 12°C instead of the usual 20°C. Due to the high air change rate within fume cupboard labs and low ambient temperature through the winter this would achieve an annual energy saving 668,600 kWh. The efficiency and effectiveness of the supply air ventilation system is currently undergoing a comprehensive review under the capital backlog replacement programme.

Typical fume cupboard located throughout many of the laboratories

Hot water service

Domestic hot water service is provided by 2 x 2000L cylinders , with heat source from the HPHW main boiler house plus electric immersion heaters for summer use when the district heating is not available. Based on daily water consumption of 5,000 litres the system annual energy consumption is estimated at 91,150 kWh. Other energy use associated with this system include the standing heat loss on the circulating flow and return system pipework, estimated at 38,345 kWh and the circulation pump at 9,641 kWh. There is an opportunity to reduce these operating standing losses over night and at weekends simply by turning the circulation pump off during these out of hours periods. This would achieve annual savings of 6,178 kWh of energy used by the circulation pump and approximately 24,650 kWh of heat loss on the circulating distribution pipework. This change in operational control would require sign off/ agreement from our compliance team to ensure we are not compromising any water hygiene requirements.

Domestic hot water calorifiers located in basement plant room

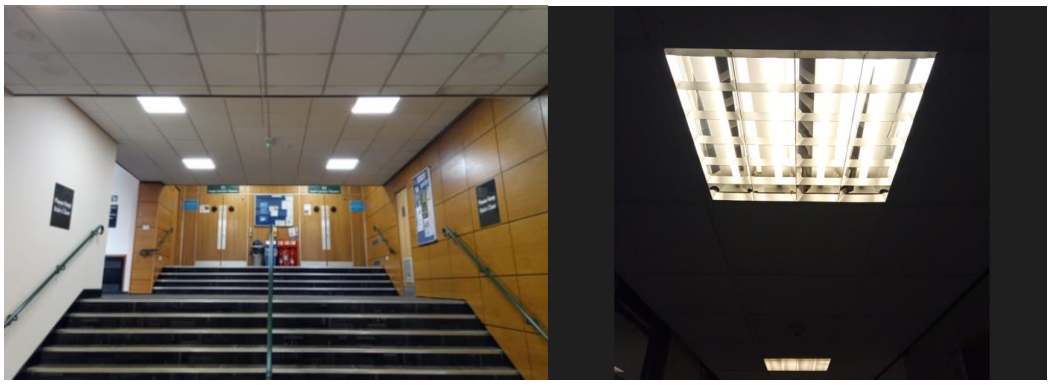
Cold water service

The cold water service is provided by a pressurised system with cascade set of inverter driven variable speed pumps and large 200m3 storage tank adjacent to electrical substation 1. Cold water service to the building is via a 125mm main serving a roof top stoarge tank for general hot and cold water service and a 54mm to provide mains drinking throughout the building. The variable speed pump set consists of 6 x 5.5kW motor pumps and maintains a pressure of 4.5 Bar with annual energy consumption of 15,500kWh.

Pressurised water supply pump set located adjacent to substation 1

Lighting

Lighting throughout the building is mainly florescent light source with a combination of 600mm x 600m recessed fittings with T5 and T8 lamps. There is approx. 20% of LED panel light source in areas that have recently been refurbished and some corridors on A and C floors. Annual energy consumption is significant and estimated to be around 310,000 kWh. It is recommended that the light source is replace with LED and there are 2 options available, either complete light fitting replacement or replacement of lamps with direct LED equivalent. Both achieve similar energy saving, but the option to replace the complete fitting is considerable more expensive and disruptive. Either option would achieve annual savings of around 113,500 kWh.



Typical LED panel lighting in main lobby area and typical 4 lamp fluorescent lighting

Compressed air and Vacuum service

There is no building wide compressed air or vacuum systems throughout the building, just local units to provide service for the specific specialist equipment.

Air compressor serving main workshop area

Laboratory equipment

There is a significant amount of specialist equipment used throughout the main research laboratory areas which in total is estimated to consume around 950,000 kWh annually. Survey and use of laboratory equipment is underway as part of the LEAF initiative for sustainable labs with the aim to reduce unnecessary energy consumption.