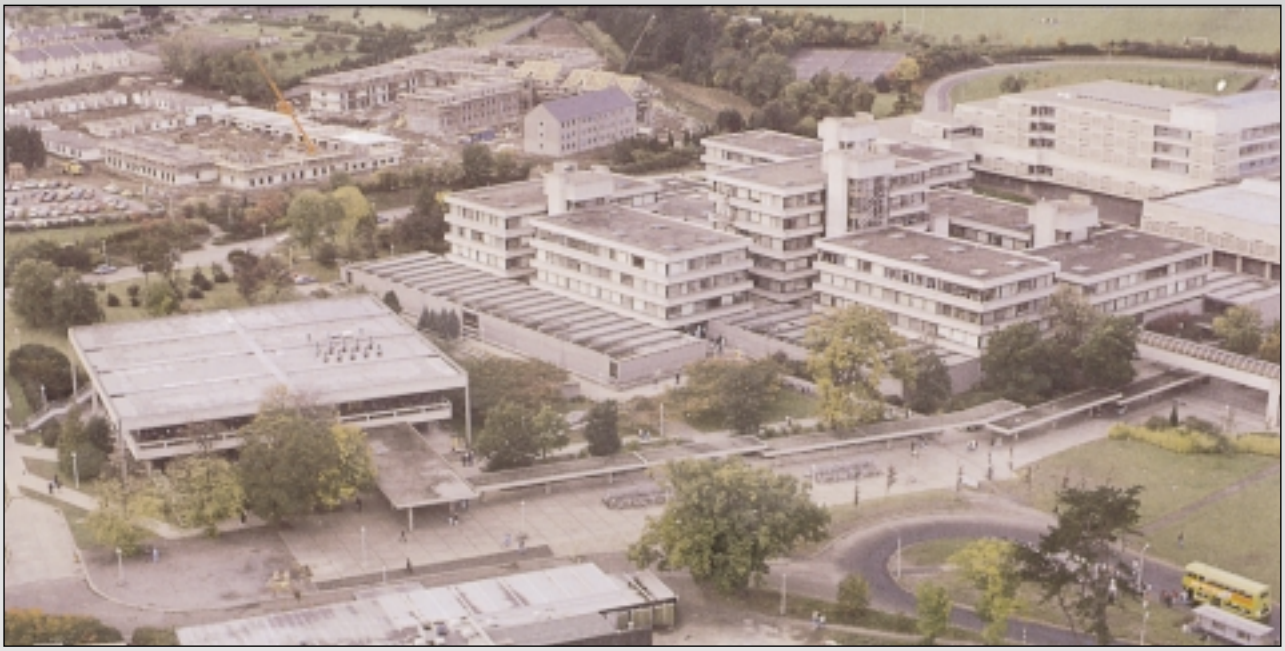
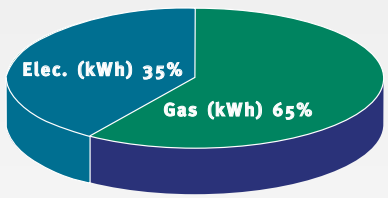
BUILDING ENERGY MANAGEMENT SYSTEMS AT UCD BELFIELD

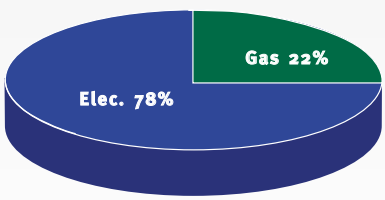


Over the past 12 years University College Dublin has been involved in the development of a Building Energy Management System (BEMS) which has achieved energy cost savings of £350,000 per year at current prices and has reduced the College's overall energy bill from the equivalent of almost 5% of total expenditure in 1983 to just 1.7% in 1995. A break-down of the energy consumption and energy costs is shown in Fig. 1.

FIG 1. UNIVERSITY COLLEGE DUBLIN ENERGY CONSUMPTION BREAKDOWN



ENERGY COST BREAKDOWN



UCD is the largest third level institution in the country with 13,700 full-time students, 2,100 part-time students and a further 6,000 attending a variety of courses at night. The College encompasses not just the Belfield campus but Carysfort College in Blackrock, the Veterinary College in Ballsbridge, the Earlsfort Terrace and Newman House properties and Lyons Estate, a research farm in Celbridge, County Kildare. The total building floor area is 200,000 square metres, excluding student residences which are managed separately from the general College estates. The total annual energy bill is £1.4 million.

All aspects of the planning, installation, programming and commissioning of the College's BEMS have been undertaken within the Mechanical & Electrical (M&E) Services division of the Buildings and Services Department. As a result, an in-house competence has been developed which has proven invaluable as the system has expanded to its present size of more than 5,000 hardware points.

The development of the Belfield campus began 30 years ago now comprises a total building area of 146,000 square metres. Most of the Belfield buildings are supplied with heat from a central boilerhouse which was converted to natural gas in 1986. Buildings constructed after that time were heated from local gas-fired boilers, as are a number of peripheral buildings on the campus. Electricity is supplied from a high tension ring main feeding local transformers and is metered on high tension Max Demand tariff.

Heating is supplied through calorifers, feeding radiators and fan convectors. Large areas of buildings are heated and mechanically ventilated by means of air handling units and specialist areas such as computer rooms and archives are air conditioned. Hot water is supplied from storage calorifiers and, more recently, from directly fired water heaters. Electrical loads consist of lighting and general services, motive power, laboratory and workshop equipment, catering equipment and some waterheating.

All pre-1986 buildings on the campus were fitted with stand alone electrical and pneumatic controls. This meant that over 100,000 square metres of buildings were fitted with time-clocks, thermostats and temperature controllers of different types and ages. Day to day maintenance of these controls was a considerable headache and the only real information on performance was through complaints from occupants.

Against this background it was decided to install a BEMS instead of conventional controls in a major extension to the library building. This was completed in 1986. The system was fairly basic in comparison to what is available today but it gave a valuable insight into the potential of BEMS technology.

Around this time a BEMS was developed as an engineering post-graduate project at UCD. It was decided to install this system to control heating in the existing Agriculture building. This proved successful and made an immediate improvement in environmental conditions in the building. Following this it was decided to install a system in the Arts/Commerce building to control the switching of lighting and plant to monitor electricity consumption through a check meter. This led to a 10% reduction in electricity consumption in the building resulting in a decision to install BEMS on a campus-wide basis. But with 100,000 square metres of buildings it was clearly seen that it was going to be a long road.

An informal specialist group from within the contract and supervisory maintenance staff was set up to undertake the phased installation of BEMS in all existing buildings. Investment in the BEMS is ongoing at a rate of approximately £100,000 per annum. Within this figure, however, is a considerable level of expenditure on the replacement of old time clocks, controllers and actuators which are obsolete and would require replacement in any event.

The BEMS now comprises more than 5,000 hardware points associated with a wide range of applications. These include Max Demand monitoring and control, fixed time and optimum start control of HVAC plant, event based control and occupancy linking.

Event based control is probably the most powerful BEMS feature. It is used in a wide area of applications on the campus. These include outside temperature over-ride of heating where the heating systems are switched off when the outside temperature rises above a set value; frost protection, where the boiler is brought on when outside temperature falls below 2 degrees C or if the return water temperature falls below 5 degrees; and pump sequencing, where a smaller pump is used when flow and return differential is less than 10 degrees C.

Event based control is also used in combination with time scheduling and delay timers to provide occupancy control of lecture theatre lighting and ventilation. Outside lighting is controlled using a combination of time-scheduling and outside light level, and lights are switched on and off at certain times accordingly. For example, two out of every three lights are switched off at 1am when there is little or no pedestrian or vehicular traffic on the campus. Fixed time scheduling is used extensively to control mechanical ventilation, compressors and fans. Optimisers are used to provide variable preheat periods on boilers and pumps in order to minimise energy consumption.

Weather compensation is used on radiator circuits, mostly in combination with inside temperature sensing so that compensation will only take place when inside temperature is within a set band. Direct Digital Control is used on air-handling and air-conditioning plant to control motorised valves and actuators. The main ESB meter provides outputs to the BEMS for kWh consumption, day/night changeover and Max Demand synchronisation. This information forms the basis for shedding pre-determined loads in order of priority to keep within target values for Max Demand.

All the main buildings at Belfield have been fitted with electrical check meters which provide inputs to the BEMS. This allows individual buildings to be monitored on a daily basis. Flow measuring valves have recently been installed on the heating supply pipework from the central boilerhouse to individual buildings. The BEMS can combine the information coming from these valves with temperature differentials measured at the flow and return pipework to produce an overall heat supply calculation for each building. It is intended to use this information to have the BEMS produce a weekly total energy consumption report for each building.

Overall energy performance has been measured in accorcance with Part 4 of the CIBSE Building Energy Code, in terms of total energy consumption per square metre. The initial rating for Belfield was 1.0 GJ per square metre. This was classified as 'fair'. Over the following six years this was progressively improved until a figure of 0.6 GJ per square metre was achieved in the 1989/90 heating season - a 'good' classification. However, since then that has risen to 0.7 GJ per square metre due to a 40% increase in student numbers in that time. In those terms total energy consumption per student has continued to fall.

As a result of the BEMS the overall energy cost saving is estimated at £350,000 per annum. A significant part of this is the improved electrical load factor which has reduced the average unit cost for electricity by 0.5p per unit. With an annual consumption of 13 million units this reduction alone is worth £65,000 per annum.

These cost savings alone have more than justified UCD's commitment to BEMS. However, there are other benefits including improved comfort conditions for staff and students, centralised control which is vitally important on a large site like Belfield, and the facility to access the system by modem for remote diagnosis and solving of problems, reducing call-outs for maintenance staff.

Clearly then, an investment of £100,000 per annum in BEMS at UCD has paid handsome dividends in terms of cost reductions and improved comfort and efficiency.

Source/Text: UCD Building Services Department.

For further information on BEMS and other energy saving technologies and initiatives contact:

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