

Making it pay

The UK government department that oversees the Building Regulations set itself the task of increasing efficiency at its headquarters. **Darren Bryant** describes how air conditioning system changes alone enabled the property to raise its energy certificate rating – a task that won his company the accolade of EPC of the Year in the CIBSE Low Carbon Performance Awards 2010

Efficient Air Ltd was set the challenge of inspecting the air conditioning system at a UK government building to show the value of such inspections in improving efficiency at low cost. The building, Eland House in London, is home to the Department of Communities and Local Government (CLG). We found that the savings identified for the property in effect paid for the costs of the inspection and recommendations in a short period.

In figures, the cost of the air conditioning survey was £3,744, and the low-cost actions taken cost £8,200. The payback period of the actions was less than five months, and overall savings made came to a total of £32,642.

When we carried out the inspection, the property had a Display Energy Certificate (which covers operational energy efficiency) with an F rating, one grade above the lowest grading of G. CLG was keen to test whether an air-con inspection could in effect lower energy bills, and reduce the carbon footprint at Eland House, which opened in 1998.

The building's Energy Performance Certificate rating (based on the design intentions) was a C, which underlines the important differences between design and actual operations when it comes to energy efficiency. As a result of this difference, we were asked to develop detailed recommendations for improving the performance of the air conditioning system.

It was agreed that our objectives for the inspection were to:

- Highlight operating anomalies;
- Compare the size and appropriateness of cooling plant with the cooling demands of the building;



Eland House, the new-build home of the Department for Communities and Local Government, achieved payback on its investment in improvements to its air conditioning system. This case study won the EPC (energy performance certificate) of the Year award in the CIBSE Low Carbon Performance Awards 2010



- Ascertain the effectiveness of current maintenance regimes; and
- Identify no-cost/low-cost initiatives and capital investment opportunities.

One of the barriers we often face is the lack of information about what equipment and systems are being used on a site. Only rarely are we able to find a log book – we found just one in the course of 300 inspections, for example. However, with Eland House we did discover the necessary information on systems, and inspected a range of assets (see Figure 1).

We identified a range of low-cost energy saving initiatives. We found that, if implemented, these quick-wins could yield a 9.9 per cent reduction of

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the building’s energy load – which equates to an annual cost saving of £32,642 and a CO₂ reduction of 238 tonnes (see Figure 2). These modifications are to do with things we find in most buildings, which include:

- Building management system (BMS) set points not correctly set;
- Heating fighting cooling;
- Humidity levels not correctly set up;
- Refrigerant levels within chillers;
- Lagging missing from ductwork and pipework; and
- Dampers control valves not connected properly.

Figure 1: Assets inspected

- Eleven air-handling units
- Two main water chillers
- Sample of terminal units
- Building management system
- Two direct expansion split air conditioning units

Once these quick-wins have been established, capital investment opportunities can be identified for further analysis of energy saving measures and paybacks on these. Such measures include, for example, equipment that can analyse data and performance of large chiller plant; sub-metering; looking at replacing belt-driven fans with direct drive ones with variable speed; and so on.

Around these capital investments, which tend to have a payback period of two to three years, there are also more peripheral issues to consider, such as solar shading and lighting, which of course impact on the cooling load and plant energy costs.

To look at cooling load in relation to plant size, we used the CIBSE guide, TM44, to help with the assessment of cooling load, basing this on occupancy density and solar shading levels compared with the combined cooling capacity of the equipment installed. With Eland House, the cooling load equated to 2,585 kW, while the combined cooling capacity equated to 2,614 kW of installed plant – which was the appropriate level.

As a result of the changes made at Eland House – resulting in the 9.9 per cent reduction in total building energy load – the Display Energy Certificate rating >

Figure 2: Air-con inspection: low-cost energy saving initiatives identified

Description of works – for more detail, see Figure 3	Energy reduction kWh	Carbon dioxide reduction Tonnes	Annual cost saving	Implementation cost	Payback period (Months)
BMS control adjustment, calibration and policy adoption	277,296	105	£12,474.00	£2,000.00	2
Filter replacements	47,500	26	£3,970.00	£1,850.00	6
Chilled Beam BMS Control modifications	15,000	8	£1,254.00	£600.00	6
AHU 1 - Repair / Replace CW valve	12,500	5	£800.00	£400.00	6
AHU 1 - BMS control adjustments	10,000	4	£650.00	£300.00	6
AHU 2 - Repair / replace control valves	45,000	14	£2,034.00	£500.00	3
AHU 2 - Re-fit control actuator	30,000	9	£1,350.00	£350.00	3
AHU 3 - Repair / replace control valves	12,500	5	£800.00	£400.00	6
AHU 3 - Replacing ductwork lagging	6,000	2	£300.00	£300.00	12
AHU 4 - BMS control adjustments to reduce Air Flow	70,000	38	£5,800.00	£300.00	1
AHU 6 - Repair / replace control valves	2,250	1	£145.00	£175.00	15
AHU 6 - Repairing the damper control	5,835	1.4	£196.00	£175.00	12
AHU 101 - Repair / replace control valves	45,000	14	£2,034.00	£500.00	3
AHU 104 - Repair / replace control valves	8,550	4	£550.00	£175.00	4
AHU 104 - Repair the damper control	2,950	2	£285.00	£175.00	8
	549,881	238	32,642	£8,200.00	3

> was raised to E from F. This was solely as a result of focusing on improvements in the air conditioning systems. Further capital investments would improve the energy load further.

So, even in these hard times, we can see there is real value in assessing the air conditioning and making low-cost improvements. The value of an energy performance certificate lies in taking expert advice on developing the recommendations associated with the certificate, and then implementing them to achieve cost, energy and carbon savings in practice. ●

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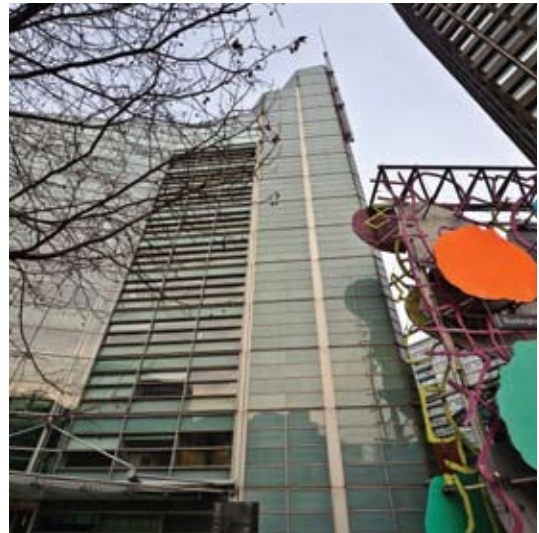


Figure 3: Detailed inspection findings and recommendations

1. Air-handling unit (AHU) supply temperatures are not consistent.

Temperature ranges being supplied at the time of inspection ranged from 15.1C to 28.4C a temperature differential of 13.3C. Excessive supply temperatures provided by office AHU's will not only result in increased heating costs during the winter season but will also result in the chilled beam circuits having to work harder to overcome higher internal temperatures. Specific consideration should therefore be given to:

- Adopting a heating schedule policy to ensure optimum temperatures are maintained. This should take into consideration the various solar elevations of the building;
- Ensuring a dead band of at least 3C (+/- 1.5C) is factored into BMS strategies to prevent simultaneous heating and cooling between the Air Handling Units, perimeter heating circuits and the chilled beam units; and,
- More frequent temperature and pressure sensor calibration, for optimum control efficiency.

2. At present chilled beam circuits are operational from 7am to 5.30pm Monday to Friday all year round. It is considered however, that during winter months when ambient air temperatures are below 15C and solar heat gains are minimal that conditioned air supplied by AHU systems should be adequate to overcome the internal temperature gains of the building without the need to run the chilled beam systems. Consideration should therefore be given to controlling the 'on floor' secondary chilled water pumps on

demand only, either based on an outside air temperature set point (ambient hold-off) or controlled on an internal upper temperature limit which could be set as high as 26C in any given zone. Predicted savings are based on the circulating pump being held off for just two months of the year. These savings have been calculated on the audited running frequency of 27.9Hz.

3. AHU 2 – Both the pre-heat coil and the heating coil control valves appear to be letting by on this unit. The BMS was calling for cooling only, however both heating coils were on. This would indicate that there is a fault with both control valves. Replacing or repairing these valves will prevent losses in the system from over-heating and re-cooling.

4. AHU 2 – The control actuator for the fresh air dampers on this unit has been disconnected. This means that this damper is always fully open. This air during winter months will require significant heating to achieve the desired temperature set point. This will therefore increase heating costs and reduce the control of heat recovery from the unit. Replacing the control actuator and regulating the amount of fresh air will provide the following estimated savings.

5. AHU's 1, 3, 6, & 104 – The cooling coil control valve was letting by on these units. The BMS was calling for heating only, however both coils were on. This would indicate a fault with the cooling valves. Replacing or repairing the valve/actuators will prevent losses in the systems from over cooling and reheating.

6. AHU 4 – This is a fixed speed system controlled by a VSD at 43.5Hz. However the unit was providing almost 10 air changes per hour to a basement plant-room. It is not considered necessary to condition plant areas unless these areas are subjected to temperatures in excess of 30C. Therefore consideration should be given to permanently isolating the heating battery on this unit and controlling the fan speed to provide a minimum amount of fresh air free-cooling (say at 20Hz), when plant-room temperatures exceed 30C. This would reduce both heating loads as well as power consumed by the motor.

7. AHU 6 – It would appear that there is a problem with the actuator on the fresh air dampers on this unit. The BMS was saying that there was no fresh air into this unit and that it was in full recirculation mode. However, on inspection, it was found that the fresh air dampers were fully open. This will be causing problems with the control of the unit, which will then mean that more mechanical conditioning will be required to condition the space.

8. AHUs 1, 101 & 104 – There appears to be a problem with the control strategies of these units. The recirculation dampers were fully closed, suggesting that the units at the time of inspection were in full fresh air mode. This air therefore requires significant heating to achieve the desired condition temperature. By adjusting the control of the dampers, so as to use heat recovery from re-circulated air and free cooling from fresh air, the amount of mechanical conditioning can be reduced.