Victoria University of Wellington

ENERGY AUDIT REPORT

Adam Art Gallery

prepared for:

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3 End Uses

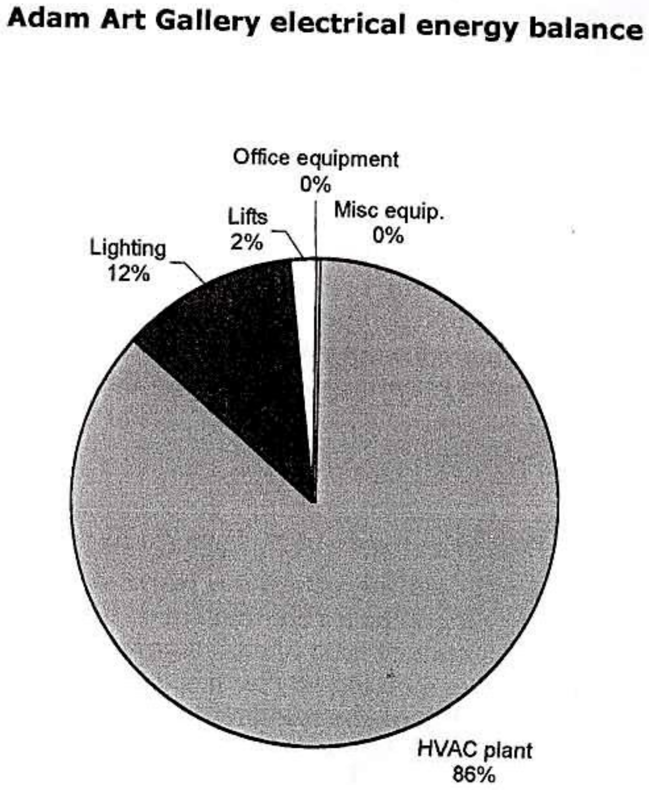

Figure 8: Adam Art Gallery annual electrical energy balance

The Adam Art gallery uses only electricity as a direct energy source. The building houses exhibitions of artworks that change regularly.

3.1 HVAC

Environmental conditions are important to the preservation of many of the artworks on display and both temperature and humidity need to be controlled. The building is provided with an HVAC system that controls temperature and humidity to within agreed tolerances. The original specification for the environmental conditions in the gallery was a setpoint of 20°C ± 1°C and 50% ± 3% RH relative humidity. This was found to result in extremely high electricity use.

The relative humidity parameters were widened to 50%RH ± 5% and subsequently to ± 7% with a 14% deadband. Humidification is achieved by using electric energy to produce steam which is injected into the air supply ducts. Dehumidification is achieved by condensing moisture out of the air by passing it over refrigerated coils. Both activities are very energy hungry. Loosening the tolerances and widening the deadband will have made major reductions in energy used in humidifying and dehumidifying the air.

Heating is achieved by use of a very large (80 kW) electric heating element which distributes hot air throughout the air ducts. This heater is controlled by the need for heating as detected by the sensors.

The HVAC system uses about 90% of the total energy use in the building. This quantity will vary according to the number of light units installed, which varies with each exhibition. The electricity supply to the building is monitored by the BMS. From July 15 a BMS history has been recording the power demand half hourly. Graphs are shown in section 2.1 plotting the kWh/day and a load profile in kW. The average plot falls within a band from 20 kW to 40 kW with three night time peaks over the four month period up to 80 kW. These indicate where there has been heating demand in the early morning. This clearly shows that the HVAC system operates constantly, 24 hours per day.

The building is modern and presumably well constructed, insulated and sealed against infiltration of external air. It has automatic doors at point of entry and is generally fairly quiet so there is not a high heat or humidity load from visitors. Under normal conditions, the major influences that change interior conditions will be ingress of outside air through the entry when people are passing through and changes directly as a result of the visitors present.

There is no logged data of an equivalent type for summer. The graph in Figure 4 for that part of the year is shown by a line showing 34% of the total for the Hunter/Stout Adam Art gallery Stream meter, since this was the only way the data could be represented. However, the Gallery has a large black wall facing north which is bound to result in a large solar gain in summer. This in turn will require increased cooling from the chilling units, so we suspect that the actual summer load profile will be much higher than the winter one.

Summer more cooling

Recommendations

Maintain the BMS history on the electrical use for the gallery. The half hourly electrical data that has been recorded by the BMS should be maintained on an ongoing basis. In order to best manage the energy use it is necessary to have annual data to take account of seasonal changes. This will prove invaluable for energy management as it will be possible to diagnose problems and to identify with accuracy the energy use effects of any changes made to the building or its HVAC or control system. Histories should also be permanently maintained of the inside and outside temperature preferably from a number of different sensors independently and likewise with humidities.

Experiment with introducing periods of no HVAC. Keeping the HVAC plant on permanently is an effective way of ensuring that the air conditions stay within agreed tolerances but it is costly, as evidenced by an energy use index of 408 kWh/sq m.yr. This EUI value is calculated on current use as logged since June 2003. Before the humidity band was widened the EUI would have been higher, probably 500-600 kWh/sq m.yr.

In many circumstances it is quite likely that the air conditioning can be turned off for a certain time without the conditions creeping out of tolerance. At least one major art gallery has experimented with turning off its air conditioning and has found that for most of the year it can have the main air handling plant off for 10+ hours per night. It has also been found that it is possible to have a number of short duration breaks during the day when the mixing boxes that control air quality are off. This process has been done in collaboration with the conservation department and is constantly monitored by them independently and has to date not caused any problems, but has made very substantial energy savings.

We suggest that the a similar trial can be carried out at the Adam Art Gallery. The exact manner in which this can best be achieved will depend on the system layout. For example, if temperature and humidity sensors are in ducts, the system will need to be run for a period before accurate gallery conditions can be measured. The following points, however, must be carried out with the safeguards mentioned already in place and confirmed as working, or similar ones more appropriate to the conditions. Major fans should be examined to ensure that they have a mechanism such as soft start or VSD to ensure that frequent starting from stationery will not damage bearings or mounts.

Safeguard measures:

- Narrow the RH deadband from 12% to 10%.
- Make software changes such that if the plant is programmed to be off and tolerance reaches the extent of the deadband, the plant is called on.

Energy saving measures:

- Install a temperature deadband of 1°C either side of setpoint.
- Alter the setpoint to be 20°C in winter, 21°C in swing seasons and 22°C in summer, after confirming with a major gallery or conservators that this is acceptable. We understand it is regarded as quite acceptable.
- Start by programming a one hour period when all the HVAC plant is off at night and a half hour period during the day. Monitor conditions closely. If no problems are encountered, add to or lengthen the off periods. Depending on the thermal characteristics of the building, this may be built up to the HVAC being off all night and for a number of short periods during the day. On Monday the building is closed to the public. If there is little staff activity, it may prove possible to have significant periods with no air conditioning.
- Monitor the conditions achieved and alter the schedules to suit the change of seasons. For example, it is more likely to be possible to have the HVAC off for extended period at night during the summer than in winter.
- Look back at BMS historical data and see if a reason can be identified for the sudden jumpfrom a steady daily demand of 700-800 kWh to 1,300 kWh for the period around October 2003.
- Calibrate temperature and humidity sensors regularly. If CO_2 sensors are present to adjust the amount of fresh air brought into the building, these should be calibrated annually.

If the HVAC can be reduced so that it is off for two three hour periods overnight and on Mondays, and for three forty minute periods throughout the day, savings will be 69,000 kWh/yr worth $7,400/yr, as shown in Appendix E1.

This measure needs further investigation to establish what can be done using existing facilities with safety and to determine the realistic hours that the system can be kept off without creating unreasonable conditions

Set occasional histories on the three cooling units and the heater to make sure they are not acting simultaneously due to incorrectly sited sensors, for example. This can be a major energy waste in spaces such as this since high power can be used in conflicting ways but the result is neither felt by occupants nor shows up as a problem on sensors in the space.

3.2 Lighting

The lighting in the gallery is of two types. The public exhibition spaces have track lighting with two types of fitting. 'Wall washers' provide a general even spread of light across a large area. The lamps used in these fittings are 150W Osram halolux lamps. Spotlights are then used to illuminate specific works. These lights are fitted with capsule type halogen lamps of 100W output.

This lighting is on an automatic lighting control system and is dimmed to provide a suitable level of light for each show. Excess light is avoided as it is detrimental to artworks, for example, the guide for light level on prints is 70 lux, a level that would be considered dangerously low in an office environment. At the time of our inspections, we estimated that wall washers were dimmed to about 40% of full value and spotlights to about 25%. Appendix C shows the maximum installed load and does not take account of the dimming, so the real lighting density is lower than the 10.88 W/sq m figure shown. The real value will depend upon the dimming and lamp requirements for the exhibition in progress.

For the show on display, there were 95 fittings in the public gallery – about 75% of them were spotlights and the remainder were wall washers. We spoke with Danae Mossmann, one of the staff in charge of the gallery and obtained details of the lighting system and how it is operated. We heard that at night a few lights are kept on in key areas for security reasons. The lighting control panel has eight settings and two are used – one for day and one for night. The setting is changed manually.

On the night tour, there were a surprisingly large number of lights going. We found 24 display lights running, and many of them were in areas that did not seem to pose security issues. In particular, one gallery had 11 lights running.

In non public parts of the building, fluorescent lighting is used. One corridor was noted as being fully illuminated at night seemingly due to a pneumatic timed switch that was not working correctly.

Recommendations

Change the night lighting arrangements to meet the requirements. Inspect the gallery in night light setting and confirm which lights are actually required. We suspect that one track light is intended to remain powered up at light and that a number of fittings have been installed into this track in error. From our discussion with Danae Mossmann we got the impression that at night a minimal level of illumination was in place with slightly more on particular works that pose a security issue. Lights that are running unnecessarily add to energy costs and to the 'light burden' in lux hours received by the works.

As shown in Appendix E2, reducing the number of lights on in night setting by 50% will result in savings of 2,560 kWh/yr worth $275/yr.

Repair the inoperative pneumatic timer switch, or replace it with an electronic one.

As shown in Appendix E3, repairing the timer switch will result in savings of 2,600 kWh/yr worth $278/yr.

3.3 Lifts

There is a lift in the Adam Art Gallery. The plant room was not inspected but we suspect that the motor is about 20kW as are the majority of hydraulic lifts are about this size. This lift gets little use and only a small allowance has been made for it in the energy balance.

3.4 Other

There is virtually no other power used in the art gallery and the loads that do exist are small and get virtually no use. They are shown on the energy balance but are insignificant.

4 Summary of Recommendations

Categories are A 'no cost', B 'technical solution', or C 'needs further investigation'

Index		End use	Measure	Saving kWh/yr	Saving $/yr	Category
3.1	E1	HVAC	Introduce period when HVAC is off	69,012	7,411	C
3.2	E2	Lighting	Reduce lighting down to its intended security function	2,562	275	A
3.2	E3	Lighting	Check and repair pneumatic timer switches	2,596	278	A
			Total no cost	**5,188**	**553**	
			Total for further investigation	**69,012**	**7,411**	

Table 5: Summary of recommendations