ENERGY MANAGEMENT CONTROL SYSTEMS

IN HOTELS

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1. ABSTRACT

The author has implemented a large number of Energy Management Systems (EMS) in hotels. One of the latest EMS projects implemented is at the Mercure hotel in Sydney with a guaranteed energy saving. This paper deals with the technology that has been used in the EMS project, along with the achieved energy saving against the predicted energy saving. This paper also addresses the pitfalls of this technology which may reduce energy savings.

2. INTRODUCTION

This is an emerging but proven technology with the primary objective of saving energy, without compromising the comfort level, by reducing energy waste. There are basically three levels of control used in hotels which are:

- Discrete and analogue control system
- Control system based on Building Management System (BMS) which is now implemented in most medium to large sized business hotels
- Advanced control system or EMS. This is an emerging leading edge technology which provides superior control utilising extensive intelligent optimisation, and energy performance monitoring. This not only reduces energy usage but also improves building performance and maintenance

3. SYSTEM ARCHITECTURE

An energy management control system (EMS) is a three tier system as shown in figure 1 below.

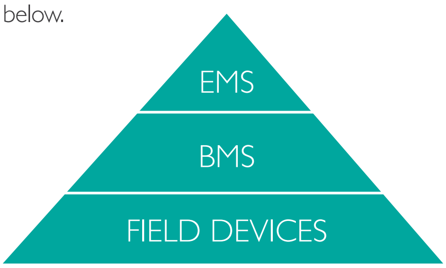

Figure 1: Hierarchy of EMS

Tier 1: Field devices

To make the EMS successful it requires the extensive use of field devices for both monitoring and control, along with variable speed drives (VSD) for fans and pumps. It also monitors energy use from major equipment, and may require modification for air handling units (AHU) to introduce economy cycles or free cooling.

Tier 2: BMS

A BMS is required to provide basic monitoring, control and operator interface. A BMS is a prerequisite to implement an EMS.

Tier 3: EMS

This is the brain or intelligence of the entire control and monitoring system to improve energy efficiency. Here the control system behaves differently than a conventional control system.

4. FUNCTIONALITY OF THE EMS

The functionality of the EMS is primarily supervisory control spearing the intelligent and optimal control with an extensive monitoring and reporting system. The primary functions for the hotel energy management control system are listed below.

4.1 Chiller optimal control

The conventional control of the chiller is stepping logic control with a lead/lag system, constant chilled water and condenser water temperature set point control.
The EMS controls the chiller differently than conventional control providing the following control functions:

- Chiller selection based on cooling load and chiller energy efficiency to provide the cooling demand with the least energy consumption
- Economic loading of chiller when multiple chillers are operating
- Demand limiting of chillers. This function is used to load the chiller to its optimum efficiency when multiple chillers are operating. Demand limiting is also very useful in starting up the chillers to reduce the start-up load peaking and to smooth out the chiller operation
- Chilled water temperature reset or variable chilled water temperature control. Its economic success very much depends upon the intelligence of the control algorithm. Basically the higher the

cooling load the lower the chilled water temperature set point

- Condenser water temperature reset or variable condenser water temperature control. This is a well-established technology - the lower the condenser temperature, the higher the chiller efficiency. Although the cooling tower requires more energy as shown in figure 2.
- Chiller interlocking is based upon the weather and time of night

All the chillers have a recommended condensing water temperature which depends upon the type of chiller. This algorithm is even more complex when there is a mixture of chillers such as modern chillers with VSDs and conventional or older constant speed chillers.

4.2 Variable flow pumping control system

Chilled water and condenser water pumps operate at constant water flow with or without VSD. The EMS provides variable flow control. This changes the CHW flow or differential pressure DP set point based upon

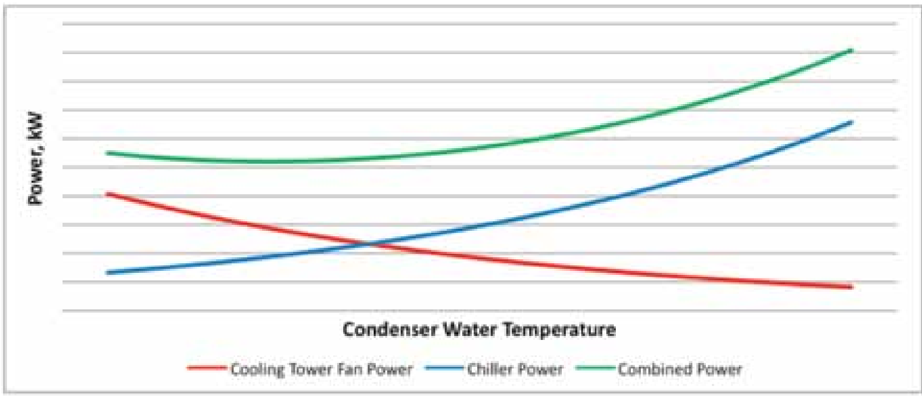

Figure 2: Cooling tower power consumption VS water temperature

the cooling load of the chiller. The limit of flow variation depends upon the chiller type.

4.3 VSD for fans

The methodology of control varies very much with the type of application, some of these methodologies are:

- Fresh air supply fan speed control. This requires a feed forward control based on the guest occupancy and fresh air requirement in the guest rooms.
- Toilet exhaust fan speed control. The toilet exhaust fan should be synchronised with the room supply fan motor speed.
- Kitchen exhaust fan speed control. The required ventilation in the kitchens are based upon kitchen activity. The speed is set upon predefined kitchen activity
- Car park ventilation. The car park ventilation fan speed is set to maintain carbon monoxide levels in the car park space. Again the success of energy efficiency depends on the intelligence of the control.
- Function rooms and general space supply air fan speed control. This requires a feed forward and feedback control based upon room temperature and cooling load or ambient air temperature.

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4.4 Economy cycle control

Economy cycle is normally provided when there is return air and fresh air supply to the room with spill air. The most energy efficient economy cycle is based on enthalpy and room CO_2 level control.

Mercure hotel has very limited return air based economy cycle systems. Most of the common areas such as the restaurant, lobby, reception and hallways only supply air without return air. Therefore it uses a unique algorithm to provide the economy cycle function, through VSD control, CO_2 and ambient weather conditions, which is operating very successfully saving energy in cooling, heating and fan power.

4.5 Demand management system

The EMS is connected with the electricity supply meter for two functions which are:

- Demand monitoring and control
- Monitoring load profile, daily and monthly electricity consumption

4.6 Energy and performance monitoring

This provides chiller performance and energy use by all major electricity users including electric duct heaters.

5. ENERGY SAVING

The project was implemented on the basis of economic return on investment. A technical study was carried out to evaluate the functionality required for the EMS project, project costing and estimated energy cost saving. The project was awarded with a guarantee of the energy saving.

Estimated savings are

- Electricity reduction = 20%
- Demand reduction = 100 kVa

Guaranteed savings are

- Electricity reduction = 18%
- Demand reduction = 100 kVa

Energy saving:

The project has been running for over 6 months and showing very encouraging results.

The achieved energy saving from electricity bills from the retailer without any weather or occupancy correction from the baseline period is shown in Figure 3 and Figure 4.

Demand Saving:

The demand reduction in Jan/Feb billing is reduced by 388 kVA.

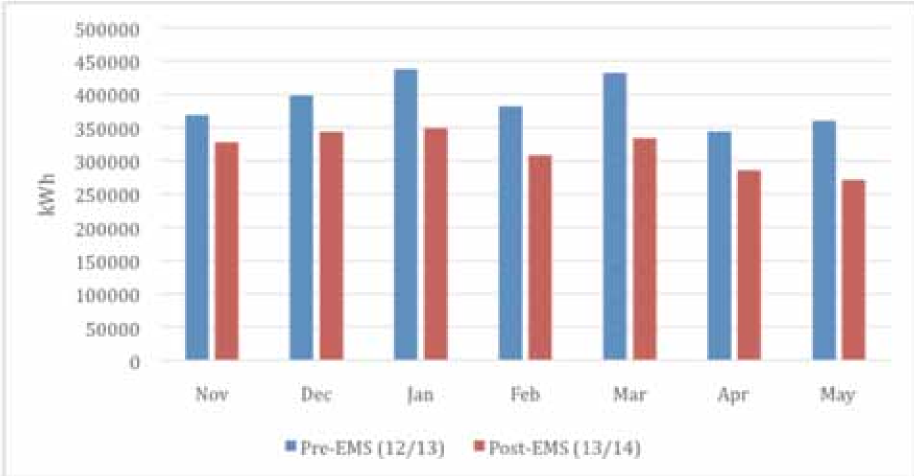

Fig 3: Energy use pre and post EMS

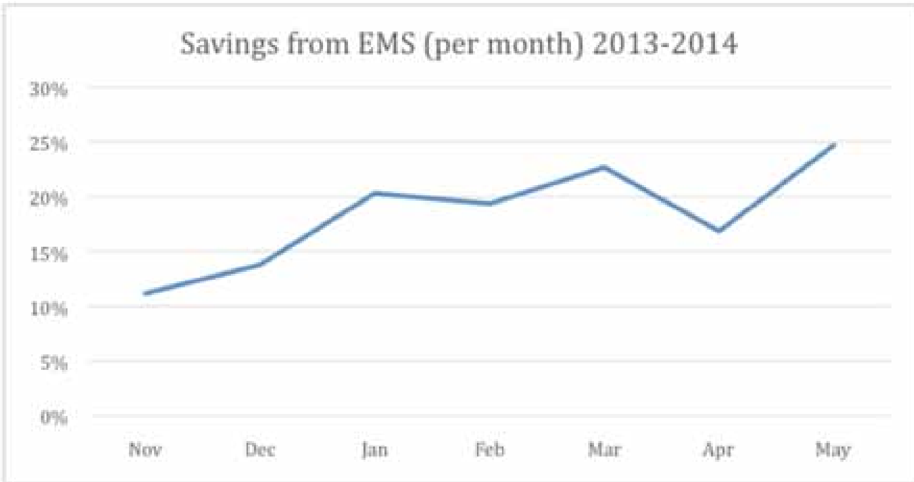

Fig 4: Energy saving from EMS

As the energy saving varies with the season we believe the hotel will achieve around 20% which is in line with the original estimate. However the demand reduction is much more than the expected demand reduction resulting in a greater energy cost reduction than the energy (kWh) saving.

6. PITFALLS OF SUCH A CONTROL SYSTEM

The energy saving can vary from hotel to hotel even with the same control function. Some of the pitfalls of not achieving the savings are:

- Problems with the chiller operation such as - the chiller can't operate at its full load or its minimum load
- Chiller flow lock out – If the chiller flow switch is not calibrated correctly, this will require to run the pumps at a high flow consuming more power
- Unnecessarily setting the room temperature too low
- The system is not tuned correctly to avoid simultaneous heating and cooling
- The chilled or hot water valves malfunction this can cause simultaneous heating and cooling which is very expensive
- The wrong location of temperature and CO_2 sensors
- The hotel maintenance personnel must be properly trained on the control system otherwise the operator will reset the control system resulting in no or less energy saving

7. ACKNOWLEDGEMENT

The author acknowledges the Schwartz Family Company for giving the permission to publish this paper and promoting EMS technology in their hotels.