
# ENERGY MANAGEMENT
## AT SHANGRI-LA HOTEL

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### PROJECT BACKGROUND

The Shangri-La Hotel at The Rocks in Sydney is a prestigious five star hotel and is a benchmark of classic hotels overlooking Sydney harbour. The hotel has 565 guest rooms and suites with superb dining venues, health club with spa, heated pool and a laundry facility. These factors make it a very high energy user, meaning energy management in the hotel has a high priority. The hotel provides a great challenge to improve energy efficiency. This can be achieved by implementing new ideas and features to support green initiatives and sustainability goals, in accordance with Shangri-La environmental commitments.

When AusIndustry introduced the Green Building Fund in 2011, Shangri-La took advantage of this fund to reduce the environmental footprint and energy consumption of the hotel.

Shangri-La management engaged Enman, a team of professional engineers and technologists specialising in energy efficiency improvements, to upgrade the hotel facilities with state of the art cutting edge technology. Enman were engaged to conduct an energy audit to identify economically viable projects which are in line with the future plans of the Shangri-La Hotel.

### CUTTING EDGE TECHNOLOGY

Hotels today have many more opportunities with new and evolving technologies to improve energy efficiency. Some of these technologies are:

- Energy management control system (EMS)
- Variable speed drives (VSD)
- Room management control system
- LED lamps
- New generation environmentally friendly chiller with VSD.

The Shangri-La Hotel selected all these technologies as part of a pilot project to improve their carbon footprint. The greatest challenge is now to successfully apply for the Green Building Fund and execute these projects successfully. Shangri-La management selected Enman to assist

the hotel management in fulfilling their energy efficiency and sustainability goals.

Enman used a holistic approach for their services to Shangri-La as follows:

- Conduct a brief energy audit to identify the key projects requiring state of the art technology and develop business case
- Applied for the Green Building Fund on behalf of Shangri-La. Based on the merit of the projects AusIndustry awarded a half a million dollar grant to encourage Shangri La to implement these projects
- Shangri-La accepted the grant and appointed Enman Pty Ltd as the project manager to implement all the projects as per the Green Building Fund agreement

## MANAGING YOUR SUPPLIER AND TECHNOLOGY

It is always important to select the right contractor and equipment for the job. The competitive tendering process is desirable to keep the project price down. The tendering process is only desirable when multiple contractors can supply the same desired equipment. However the key to the success of the project is to select and appoint the most appropriate and suitably experienced consultant.

### Tendering process

Enman developed a technical specification of works for the various projects in order to benefit most from the competitive tendering process. Based on the merit of various tenderer, Shangri-La management selected the final suppliers. The projects which were awarded are as follows:

- Chiller replacement – Dalkia was appointed to replace the existing Trane chiller with their energy efficient chiller with VSD
- Room management system – INNCOM my Smart CTI Room Control
- LED lamps
- Chiller energy management system (EMS) – Initially the project was awarded to Automated Logic Control who is the incumbent BMS supplier. This EMS was subsequently modified and installed with the Enman Enertrol chiller energy management system to improve the energy saving and meet the requirements of the Green Building Fund.

## PROJECTS

The following are brief descriptions of these carbon reduction projects:

### Chiller Upgrade

Replacement of one of the large chillers with a 1750 kW Trane multi-stage energy efficient chiller with variable speed drive.

The chiller has excellent part load performance and can operate at a very low load with good efficiency.

Main features:

- Full load COP of 6.1 and NPLV of 9.1 VSD Centrifugal Chiller
- Chiller includes 'Rapid Re-start" after failure, 43 seconds after locating power source
- Uses R123 low pressure refrigerant which is not subject to carbon tax

### Control System Upgrade Phase 1

Initially the existing BMS was modified to incorporate advanced control for chiller, pump speed and cooling tower fans and developed as one off system. Therefore it didn't operate successfully and didn't provide the expected savings.

### Guest Room Energy Management System

An INNCOM my Smart CTI Room Control System was selected for this project.

HVAC and lighting represent two of the largest uncontrolled operating expenses in the hotel. The energy management software, hardware and services were designed to minimise energy consumption in spaces with intermittent occupancy.

It was a green approach employed in the HVAC/lighting control system which helps in improving energy efficiency and also minimising the carbon footprint of the hotel.



a. There are four basic modes in which the room control operates on this system -

i. Rented/Occupied
ii. Rented/Unoccupied
iii. Unrented/Occupied
iv. Unrented/Unoccupied

b. The room control software decides which mode to operate under by using information from the PMS interface, the door switch and the motion sensor.

When a guest enters the room and adjusts the thermostat to his/her preferred setting or set point (including fan speed), the temperature in the room is maintained at that set point while the room is occupied.

When the occupancy sensor determines that the room is unoccupied (by reacting to the movement with a static IR sensor and the feedback from a reed switch mounted on the top of the entrance door), the room control adjusts the room temperature to save energy. The Recovery Time technology constantly calculates how far the temperature can drift from the set point and still return to the set point within the pre-programmed recovery time, usually two hours. The set point is twenty one degrees Celsius with the dead band or drift of +2.5 or -2.5 degrees Celsius. The motion sensor works automatically by sensing the presence or absence of people and switching the lighting on or off as required.

The Green Button, an option available on all the room controls, empowers guests to take part in property or brand sustainability programs.

### LED lighting:

The hotel had extensive down lighting in the common areas. This project involved replacement of common area dichroic down lights with innovative low power LED down lights. These replacements were done in phases.

Phase 1: Replacement of halogen down lights with 325 X Evo50 15W and 60 X MR16 6W LED lamps

Phase 2: Replacement of halogen down lights with 1850 Philips 7w, 40,000hrs MR16 lamps.

After completion of most of these major energy related projects Shangri-La, along with Enman, conducted a measurement and verification of the energy savings as a result of implementing these projects. The NABERS star rating of the hotel came to 2 star, which was not satisfactory to Shangri-La management.

### Control System Upgrade Phase 2

### Energy management control system for the chiller plant

After 12 months of successful operation of the above projects, a second phase was implemented.

Although there were good energy savings from the implementation of the above projects, the result was not as high as expected or desired. Therefore Shangri La engineering management in conjunction with Enman conducted a further study to understand the reasons for the shortfall of this saving. Shangri-La then decided to implement a long proven chiller plant energy management

system, the Enman 'Enertrol' proprietary EMS. The control system is a supervisory control which utilises and overlays on top of the existing BMS.

The EMS has been commissioned since the beginning of September 2014 and is already showing substantial energy saving.

The functionality of the EMS is as follows:

## • CHILLER OPTIMAL CONTROL

This is to improve the chiller performance, mainly by improving energy efficiency and reduce operating hours of the chillers.

This control provides the following functions:

- Optimising chilled water temperature. As a chiller is more efficient at a higher chilled water temperature the control system increases the temperature set point whilst still meeting the cooling load of the hotel.
- Optimising condenser water temperature. Modern energy efficient chillers are very susceptible to condenser water temperature. Manufacturers usually recommend condenser water temperature at varying chiller loads. Normally the chiller is more energy efficient at lower condenser water temperature. On the other hand the cooling tower fan energy increases with the decrease of the cooling tower/condenser water temperature. The control system finds the optimum operating point for the condenser water temperature. Modern chillers are especially designed for varying condenser water and chilled water temperature with varying liquid flow.
- Optimising cooling tower fan control – This controls the cooling tower fan sequence and speed of the fans to meet the condenser water temperature required by the chiller to minimise energy consumption. It also uses the concept of free cooling to its maximum.
- Optimising variable chilled water flow – It uses variable speed drives to control the pumps with variable DP set point control. The flow of CHW varies with the chiller loading to minimise pump and chiller energy cost.
- Optimising variable condenser water flow – Like chilled water flow it also controls the flow rate of the condenser water minimising pump and chiller energy.
- Optimising chiller loading and control – The load of this chiller can vary significantly from 100% to under 10% of the capacity. The chiller has an excellent part load performance. The COP of the chiller typically increases with the decrease of the load with the highest COP at around 50% of the maximum chiller loading.
- EMS chiller load cycling – If the load of the chiller is too low the local controller of the chiller goes into cycling mode. This is implemented when the cycling time is too short, as persistent short load cycling can damage the chiller. To overcome this chiller short load cycling the EMS cycles the chiller with a higher cycle time at low load conditions, normally set at up to two starts or cycles per hour. Therefore it allows the system to run the larger,

more energy efficient chiller at a low cooling load with much higher operational efficiency and still not detrimental to the chiller compressor.
There is a much smaller conventional chiller in the plant. It was found that it is much more efficient to operate the large energy efficient chiller with EMS load cycling than operating the smaller chiller.

## • CHILLER PERFORMANCE MONITORING

The EMS provides comprehensive reports to track the chiller systems performance. These are:

- Chiller COP
- Chiller plant KPI which is energy use per unit of cooling
- Chiller plant daily energy report shows actual energy use by the chiller plant and recommended energy use for the weather conditions. The difference shows energy efficiency of the chiller plant operation.

## • DEMAND MANAGEMENT SYSTEM

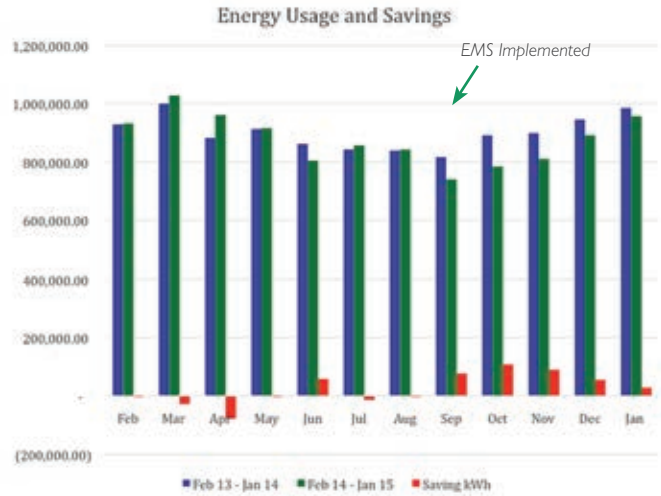
The demand management system provides demand control and energy reporting.

- Monitors electricity supply demand and controls demand if it exceeds its target demand.
  The target demand is set by the operator to minimise demand of the hotel which reduces the overall electricity cost.
- There are also daily and monthly demand and energy consumption reports in order for the engineering management team to take corrective action if there is any abnormality in energy use or demand in the hotel.

Energy saving estimated before the project implementation was 492,600 kWh/year which is 4.5% of the total electricity usage and demand reduction of 90 kVa.

After five months of operation, beginning in September 2014, we investigated the energy saving achieved from the implementation of the EMS control of the chiller plant. Figure 1 below shows the energy usage of the hotel from the electricity bill. It should be noted that the energy usage has not been adjusted to reflect ambient temperatures, or hotel occupancy rates. We expect that this would only vary the results by five percent or less.

*Figure 1 – Energy usage from previous 24 months and savings*




## ENERGY SAVINGS:

The energy savings from the phase 2 implementation of the EMS are as follows:

The electricity saving is expected to be in excess of 4.5% of the total electricity use in the hotel. Months of September, October and November shows quite high energy saving which is due to room renovation program in those months. The current best estimate of energy saving is:

Electricity = 488,000 kWh/year which is 4.5% of hotel electricity usage

Demand = not evaluated yet

The NABERS rating of the hotel is currently 2 star. With the implementation of this EMS control of chiller plant, this is expected to raise the NABERS star rating to 3.

### What is next?

The Hotel just replaced the original timber Cooling Towers with high efficiency stainless steel 3 crossflow (5271kW heat rejection capacity with 225 l/s flowrate) Cooling Towers.

Is there anything else the hotel can undertake to save energy? There are still plenty of things to do to improve the energy efficiency of the hotel.

Considering the future energy savings the following capital projects have been already approved for 2015 and some of them are underway.

- Replacement of old Steam Boiler with 2 X 600kw high efficiency boilers
- Replacement of laundry equipment (eg: Flat Ironer, Towel Folder, Washers ) with energy efficient models
- Installation of VSDs for large exhaust fans
- Re-arrange steam distribution system and replacement of steam traps etc.,

Further implementation of Shangri-La Sydney staff awareness program on Energy Saving best practices is just above to rollout.

The greatest challenge for the Shangri-La Hotel is to improve the NABERS star rating to 4 or 5.

## CONCLUSION

The sustainability of energy savings with any energy management system is only as good as the continued maintenance of the HVAC equipment and the energy management system.

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