

# Dunedin Hospital cures energy waste

CASE STUDY

06/01



Energy Efficiency and  
Conservation Authority  
Te Tari Tiaki Pūngao



## Highlights

- saving \$122,200 a year in energy
- savings guaranteed in an energy performance contract
- borrowed capital \$510,000
- improved building services performance
- more savings ideas still being found

**DUNEDIN HOSPITAL** BUILDING SERVICES TEAM LEADER **RITCHIE FIELDWICK** EXPLAINS THE BENEFITS OUTLINED IN HONEYWELL'S PROPOSAL FOR AN **ENERGY PERFORMANCE CONTRACT**.

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### Dunedin Hospital basics

- 400 beds
- 110,000 bed days a year
- 80,000 m<sup>2</sup> of net floor area
- Includes a medical school
- Energy bill \$1.37 million a year
- Uses a range of Honeywell controls
- Steam is purchased in place of coal or gas
- Some controls date back to 1960s

Otago District Health Board is taking an innovative approach to improving the building services equipment at Dunedin Hospital. It's contracted an external company, Honeywell, to make the improvements.

Honeywell guarantees energy savings of \$122,200 a year that will pay for the capital expenditure within five years.

The project is being financed not from the health board's own funds but by a \$510,000 Crown Energy Efficiency Loan.

#### Refurbishment due

Before Honeywell became involved, Dunedin Hospital's building services team leader Ritchie Fieldwick and his three-person team knew there should be energy saving opportunities.

Plant control systems were getting old and inefficient.

More time was being spent on maintenance and the energy bills were rising.

Service staff members were being paged regularly to deal with alarms from the building services system.

For example, control dampers in the air conditioning and heating ducts were getting 'sticky' and their settings had too much play.

Dunedin Hospital had implemented some energy efficiency measures, such as taking ambient air temperature into account when chilling water for air conditioning.

Honeywell proposed a win-win option by upgrading equipment and guaranteeing energy savings without requiring the health board to outlay capital.

This suited the health board, which was faced with the problem of how to pay for replacing an outdated building management system (BMS).

Honeywell was familiar with the hospital – it had installed HVAC plant and had provided services for the previous 40 years.

#### Energy trends

For the year to June 2003, the hospital spent \$1,367,000 a year on energy. This included \$680,000 for electricity and \$687,000 for 41,000 tonne of steam.

The hospital has a 15-year contract with Meridian Energy-owned business Energy for Industry to purchase a minimum 35,000 tonnes of steam a year.

In 2003 the price of steam was scheduled to increase by 25%. The hospital's electricity contract was also due for updating and was likely to cost more.

Energy for Industry operates an energy centre in Dunedin that pipes steam directly to the hospital and others in the neighbourhood, including the University of Otago, Cadbury's confectionery factory and the New Zealand Towel Supplies laundry.

This arrangement suits the hospital because it does not have to manage the costs and resource consent considerations of operating a boiler.

#### Better systems

The hospital's energy management was ad hoc. Although it had completed energy efficiency improvement projects such as upgrading low pressure hot water heat exchangers and chilled water controls, it had no formal energy policy, plan or

responsibilities. There was no ongoing and active staff awareness programme to save energy.

Honeywell approached the hospital with an offer that would achieve energy cost savings in spite of the hospital's passive approach to energy management.

Honeywell completed an energy audit of the hospital's HVAC system and outlined the potential energy savings.

Honeywell's proposal included improved technology and an increased amount of automation. More of the controls for heating and cooling would become electronic and would respond automatically and more accurately to achieve pre-set temperature targets.

This suited the hospital because energy savings would be automatic instead of relying on the enthusiasm of a constant parade of staff, medical students and others for whom energy management was not a high priority.

The Honeywell programme would also provide the hospital with an energy management evaluation report each quarter so the hospital could see changes in energy use and costs.

These changes would get the hospital on the road to improving energy efficiency and would help the team establish improved energy management procedures.

A Crown Energy Efficiency Loan administered by EECA would be used to finance the energy efficiency improvements. This meant the building services department would not need to compete with others for health board funds.

MAP OF DUNEDIN HOSPITAL COMPLEX. THE **WARD BLOCK** (PINK) AND **CLINICAL SERVICES** (LIGHT BLUE) GOT **EARLY ATTENTION** BECAUSE THE PROPOSED **IMPROVEMENTS** WERE **HIGHLY COST-EFFECTIVE**.



### Performance contract

The arrangement with Honeywell is called an energy performance agreement.

If, at the end of the five year contract, the guaranteed savings are not achieved, Honeywell will pay the shortfall.

If the savings are exceeded, the health board benefits.

Performance contracting is a smart way many large organisations operate in North America and Australia but is not widespread in New Zealand.

The Department for Courts was one of the first to take it up, at the Auckland District Court building. Honeywell is the service provider that has pioneered the concept.

It has a similar arrangement at the five largest hospitals in Tasmania, and in New Zealand operates at the University of Waikato, Otago and Christchurch Polytechnics and Dunedin City Council.

It is commissioning a new performance contract at the Bay of Plenty Polytechnic.

### Agreed savings

One of the key factors to making a performance contract successful is agreement on the savings to be achieved.

Energy savings are affected by factors such as ambient air temperatures and hospital patient bed-days, which can change from year to year.

The building services team works closely with Honeywell to ensure these variations are included in savings calculations.

The calculation of the savings depends on:  
The calculated **cost of a 'baseline'**

1. The **actual cost paid** for energy

The **baseline cost** is the estimated cost that would have been incurred if the energy management program had not been initiated. The important thing to note is that the baseline cost is calculated each month; it is not a fixed amount.

The health board agreed with Honeywell to use the year July 2002–June 2003 as its base year, upon which calculation adjustments are made for each subsequent month to establish the baseline cost.

To establish the energy baseline and to validate the savings produced in its performance contracts, Honeywell uses a software package called Metrix, developed by SRC Systems in Berkeley, California.

The variables for the energy baseline include the energy use for the month and the energy prices for the month.

On-site changes that need to be considered include adding new building plant and equipment, new medical equipment, extra computers and changes in patient numbers or operating times.

The baseline calculation is adjusted for on-site changes. If an on-site factor is shown to be an influential variable it can become a component of the Metrix baseline calculation, improving its accuracy.

Metrix uses regression analysis to identify the impact of relevant variables. These variables always include temperature, and may include another three independent variables such as bed-days or operations performed.

For a hotel it could be occupancy rate or meals served.

Metrix enables Honeywell to track and compare actual utility usage and cost to past performance or expected performance.

For example, if ambient air temperatures in June 2005 were warmer than in June 2003 then less heating would be required. In the example shown in **Table 1**, a 100,000 kWh adjustment is needed because of the difference in air temperatures between the

years and so the correct saving is 20,000 kWh; not 120,000 kWh.

If marginal energy prices increased by 20% during the same period from 10 cents to 12 cents per kWh then energy costs could be greater in June 2005 than in June 2003, even with energy efficiency improvements.

To recognise the cost savings from energy efficiency improvements, an adjustment is needed because of the difference in prices between the years (**Table 2**).

The correct baseline for June is \$108,000 (900,000 kWh/year @ 12 c/kWh). If an adjustment were not made, the result would be a loss of \$5600 in June. With the adjustment, the result is a saving of \$2400.

Honeywell included a maintenance services contract in its proposal to the health board. This gives Honeywell an incentive to ensure plant is kept well-tuned to keep improving energy efficiency and help achieve the guaranteed energy saving targets.

**Table 1 – Energy use adjustment**

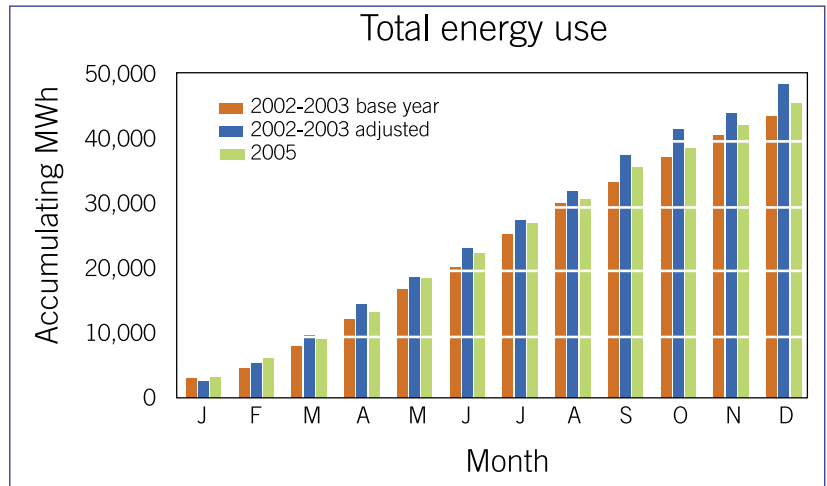
Energy use adjustment	Actual energy use in base-year 2003 (kWh)	Actual energy use, 2005 (kWh)	Baseline use, calculated to 2005 conditions (kWh)	<b>Correct energy saving (kWh)</b>	<i>Energy saving without adjustments (kWh)</i>
June	1,000,000	880,000	900,000	<b>20,000</b>	120,000

**Table 2 – Energy cost adjustment**

Energy price adjustment	Actual energy cost in base-year 2003	Actual energy cost, 2005	Baseline calculated to June 2005 conditions and prices	<b>Correct energy cost savings</b>	<i>Incorrect cost increase calculated</i>
June	\$100,000	\$105,600	\$108,000	<b>\$2400</b>	\$5600

**FIGURE 1:** THE GRAPH SHOWS THE RELATIONSHIP BETWEEN MEASURED ENERGY CONSUMPTION AND THE BASE-YEAR FIGURES ADJUSTED TO TAKE ACCOUNT OF FACTORS SUCH AS DIFFERENCES IN THE NEED FOR HEATING FROM YEAR TO YEAR.

COMPARING THE GREEN BAR (“AFTER IMPROVEMENTS”) TO THE BLUE BAR (“BUSINESS AS USUAL”) GIVES A FAIR INDICATION OF PROGRESS IN ENERGY EFFICIENCY.



RITCHIE FIELDWICK SHOWS THE EXCEL BUILDING INTEGRATOR (EBI) SCREEN, WHICH MAKES IT EASY TO SEE WHAT IS GOING ON AROUND THE HOSPITAL.

ALSO SHOWN: SAMPLE SCREEN DISPLAYS. RIGHT: A SCHEMATIC OF AIR CONDITIONING DUCTING, SHOWING RELATIVE HUMIDITY AND AIR TEMPERATURE.



**Savings achieved**

Although more energy was used in 2005 than in the base year, energy efficiency had improved. 2005 was cooler than the base year, so more heating was needed.

Energy use in 2005 was 45,845 MWh while in the base year (July 2002 to June 2003) it was 43,864 MWh.

After adjusting for differences in ambient air temperature the baseline energy use was 49,205 MWh, which is the amount of energy that would have been used in 2005 without energy efficiency improvements.

In the first year, the health board reduced energy costs by \$110,000, after adjusting for ambient air temperature differences and energy price changes.

It reduced consumption by 510 MWh a year of electricity, 2,850 tonnes of steam and 10,250 GJ of coal. This is equivalent to reducing carbon dioxide emissions by 1,250 tonnes a year.

These savings are based on energy use in the first nine months after all practical completions were achieved (Table 4).

It is likely the 770 MWh/yr projected electricity savings will be achieved after 12 months. Proposed heat recovery options will help achieve the projected coal savings.

Figure 1 shows the differences accumulating for each month during the year.

**Practical issues**

Initially, the new EBI front-end building management system ran too slowly at times for its hospital staff operators. The graphics package was then modified and reloaded, which fixed the problem.

**Financing the investment**

Honeywell helped the health board secure a \$510,000 Crown Energy Efficiency Loan.

The loan from EECA is paid to Honeywell as progress payments for upgrading to the latest and most reliable equipment and controls. The health board owns the new equipment, for which it has a maintenance contract with Honeywell.

The guaranteed \$122,200 annual energy savings will repay the loan and associated fee of \$34,600. After the loan is repaid, the health board will continue to benefit from the energy savings.



**LEFT: A DIRECT DIGITAL CONTROL (DDC) TEMPERATURE SENSOR IS ATTACHED ABOVE A TEMPERATURE GAUGE READING 60°C ON A HOT WATER STORAGE TANK. THE DDC SENSOR GIVES AN ACCURATE READING, WHICH HELPS AVOID OVER-HEATING THE WATER.**

**RIGHT: A CONTROL CABINET WITH NEW DDC CONTROLLERS THAT PROVIDE ANALOG OUTPUT SIGNALS. THESE ALLOW EACH VALVE TO BE CONTROLLED INDIVIDUALLY AND MORE ACCURATELY COMPARED WITH THE PREVIOUSLY INSTALLED PNEUMATIC CONTROLS.**

## THE TECHNICAL SOLUTIONS

When Honeywell upgraded equipment it gave highest priority to the areas where the improvements were most cost-effective, such as the Ward Block and Clinical Services Block.

In January 2005 the existing BMS front-end controller, a Honeywell Excel Building Supervisor Delta 1000 (XBS-I) was replaced with Honeywell's Excel Building Integrator (EBI).

This PC-based building management system can show on a computer screen diagrams of what is going on in the hospital's energy systems.

EBI's enhanced features make it easier for building services staff to manage, read and control HVAC set-points.

The 1980s-vintage Delta 1000, which was central to HVAC controls, did not have energy-saving features and was becoming less reliable.

The EBI is the front-end that communicates with the hospital's various plant rooms, each of which has its own stand-alone controller. If anything puts the centralised EBI out of action, the stand-alone controllers can still be programmed independently.

### Heating and cooling control

The EBI's Direct Digital Control (DDC) enables the operators to program sophisticated schedules, temperature conditions and alarm management.

It allows areas that don't need to operate 24 hours a day on public holidays to be programmed for energy savings, 12 months in advance. On days when those areas are occupied, scheduled times are pre-programmed to maintain the required temperatures without starting cooling or heating earlier than needed, or stopping it later than needed.

DDC transducers with analog signals allow each valve to be controlled individually and more accurately compared with the previously installed pneumatic controls.

The air conditioning controllers have been upgraded with energy management strategies programmed into them.

For example, some chillers are now switched off in winter when previously they were running when not needed.

At least some cooling is required in some parts of the hospital all year and is not shut down completely in winter.

However, when cooling is required in cooler months, the increased use of 'free cooling' means chillers are used less often than previously.

Free cooling uses fresh air instead of using chillers to cool recycled air.

When heating is required in cooler months, some heat is recovered from air that is being expelled from the buildings, and then used to pre-heat incoming air.

Controls for radiator heaters were also upgraded so they respond to changes in the ambient air temperature.

### Variable speed drives

Variable-speed drives (VSDs) were installed on water pumps for the air conditioning system and for the chiller condenser loops.

These included VSDs on three 22 kW condenser loop pumps and motors. Each chiller is a Carrier model with thermal cooling capacity of 1 MW.

VSDs were also installed on four water pumps and motors: 12 kW, two 15 kW and an 18.5 kW for the air conditioning system. Instead of being either fully on or off, the pumps operate accurately using the VSDs and according to how much water is needed for air conditioning.

Humidity controls in the wards have been improved so they are more accurate.

Relative humidity targets are between 40% and 50% in the rooms. Relative humidity is measured in the air supply ducting and is continuously regulated.

All energy efficiency improvements have been managed to ensure conditions remain comfortable within the hospital.

### Domestic hot water

Other improvements included installing DDC temperature sensors on domestic hot water storage tanks (*photo, above*). The sensors that detect the water temperature are more accurate. This saves energy because water temperatures in the storage tanks are not kept unnecessarily high.

The hospital's building and property services staff members have also been trained in operating the new BMS, bringing their skills up to date.



THE BLACK PANEL ON THE WALL IS A **VARIABLE-SPEED DRIVE (VSD)**, WHICH CONTROLS THE SPEED OF A **GREEN CONDENSER PUMP** AND **BLUE MOTOR**.

► Because of the complexity of the system, a number of software parameters needed adjusting even more than six months after installation, to improve efficiency.

This was carried out as part of the maintenance services contract with Honeywell.

The free cooling system will now be controlled by sensing the ambient air temperature.

The free cooling will occur when the outside temperature is between 7°C and 12°C.

Staff still complain it is “too hot” or “too cold”, although this happens no more frequently than before. Fieldwick says it is an ongoing challenge to meet the temperature needs of all staff.

**Other benefits**

The energy savings activities have inspired the building services team to keep looking for other savings ideas.

Staff members now plan more often for when plant may not be needed. For example, main air handlers can be

switched off at night in unoccupied areas such as the hospital’s academic wing.

This has reduced electricity load by 200 kVA electricity at night, and adds to the savings already being achieved in the performance contract programme.

An automated ripple control system is planned, to shed non-essential loads at times of peak power charges.

This includes limiting the operation of chillers and reducing the speed on water pumps.

**Table 3: Energy cost for Dunedin Hospital for base-year July 2002–June 2003**

July 2002–June 2003	Annual energy consumption, kWh	Annual energy cost	Average price, c/kWh
Electricity	13,114,089	\$679,443	5.2
Steam	30,750,000	\$687,634	2.2
TOTAL	43,864,090	\$1,367,077	3.1

**Table 4: Savings in the first year of the energy performance contract**

	Projected	After first nine months
Electricity, MWh	3,845 (770 per year)	510
Steam, tonnes	29,800 (5960 per year)	2850
Coal, GJ	87,000 (17,400 per year)	10,250
CO2 emissions, tonnes	10,300 (2060 per year)	1250
Electricity peak demand, MW	1.48	0

**CREDITS**

**Client** Otago District Health Board

**Main contractor** Honeywell NZ Ltd

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**Mechanical sub-contractors**

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