PENRITH CITY COUNCIL

# POLICY DOCUMENT

## POLICY NAME
Energy Savings Action Plan

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## RELATED DOCUMENTS
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**Purpose**

This ESAP expands upon Council's previous energy management activities, ensuring that Council continues to reduce energy use and associated costs across its range of facilities.

Developed in accordance with the *Local Council Guide for Energy Management Plans (2010),* the ESAP identifies opportunities to improve energy management practices at each of the facilities contained within the plan, as well as across Council more broadly.

**Policy Statement**

This ESAP has a four year timeframe in which identified actions will be considered for implementation. It would be expected that funding potentially cost effective opportunities (those with a payback period of between 5 and 7 years) would be sought over the life of this plan from external sources such as grants.

Monitoring and reporting are important components of the ESAP. Integral to this process will be the annual reporting of Council's progress towards implementing the actions outlined in the plan.

**Scope**

This ESAP contains specific actions for implementation at:

- Penrith Civic Centre
- Ripples Hydrotherapy Pool
- Joan Sutherland Performing Arts Centre
- Lewers Gallery
- Carita Child Care Centre

It also covers general energy management actions that will be relevant to all Council facilities.

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# ENERGY SAVINGS ACTION PLAN 2012

# Contents

# 1. Introduction

Penrith City Council has long recognised the principles of sustainability and articulates a vision for the city focused on the long term. This vision takes into consideration the links between economic, environmental and social aspects of the community, and recognises that well-designed and well-maintained infrastructure and services are an essential foundation in building sustainable communities.

The effective management of resources is an integral part of Council operations, with Council's Strategic Plan 2031 seeking leadership in terms of responsible resource management. Since developing its first energy and greenhouse plan in 2000, Council has developed and implemented a number of energy management strategies, achieving significant improvements in energy efficiency and delivering quality services and facilities to our local community.

Council's last energy plan, the 2007 Energy Saving Action Plan (ESAP), was developed to meet regulatory requirements introduced under the *Energy Administration Amendment (Water and Energy Savings) Act 2005.* This plan identified opportunities to improve efficiency at Council's most energy intensive facilities, and provided a program of works to be implemented over the four year period 2007-11. This plan concluded successfully in 2011, with the facilities included in the plan collectively reducing their energy consumption by 9.8% from the baseline year (2005-2006) over the life of the plan.

In addition to satisfying standards for the Waste and Sustainability Improvement Payment Program, the development of the 2012 ESAP aims to expand upon Council's previous efforts, ensuring that Council continues to improve energy management practices at each of the facilities contained within the plan, and across Council more broadly.

Developed in accordance with the *Local Council Guide for Energy Management Plans (2010),* this ESAP examines Council's current energy management practices, and provides a detailed assessment of five of Council's highest energy using sites. Most importantly, this plan details a program of recommendations to improve on current performance.

This ESAP has a four year timeframe in which identified actions will be considered for implementation. Progress on the implementation of this plan will be reported annually, along with the ongoing performance of each of the 10 sites covered by the plan. This reporting will be undertaken by Council's Sustainability Team, in consultation with the various departments responsible for implementing actions.

## *1.1 Development of this ESAP*

This ESAP expands upon Council's previous energy management activities, ensuring that Council continues to reduce energy use and associated costs across its range of facilities.

Developed in accordance with the *Local Council Guide for Energy Management Plans (2010),* the ESAP identifies opportunities to improve energy management practices at each of the facilities contained within the plan, as well as across Council more broadly.

The development of this plan has been a three stage process:

**Stage 1 -** Management Review: This stage involved a structured self-assessment undertaken with Council's Facilities Managers Group to assess the systems in place within Council for managing energy use across all of its facilities, and identify opportunities for improvement.

**Stage 2 -** Energy Audits of selected sites: Expert consultants, Net Balance, were engaged to undertake in-depth investigations into five selected sites, in accordance with the Australian Standard (AS3598:2000) for Level 3 energy audits.

**Stage 3 -** Compilation of the Plan: The ESAP 2012 is a compilation of all tasks identified in Stages 1 and 2. It provides Council with a prioritised list of management and operational actions to be implemented over the four year life of the plan.

Importantly, this plan has been developed in partnership with the relevant facility managers, with the actions identified by the consultants provided to managers to assess their applicability, and whether the cost effective actions recommended are realistic against upcoming budgetary and other commitments.

## *1.2 Implementation, monitoring and reporting*

This ESAP has a four year timeframe in which identified actions will be considered for implementation. It would be expected that funding potentially cost effective opportunities (those with a payback period of between 5 and 7 years) would be sought over the life of this plan from external sources such as grants.

Monitoring and reporting are important components of the ESAP. Integral to this process will be the annual reporting of Council's progress towards implementing the actions outlined in the plan. In addition, Council will report on the ongoing performance of five sites that were included in Council's previous ESAP (2007-11), including: Councils' Street Lighting network, Ripples Leisure Centre, Penrith Whitewater Stadium, Penrith Memorial Swimming Pool, and the Queen Street Centre.

Reporting will be undertaken by Council's Sustainability Team, in consultation with the various departments responsible for implementing actions.

# 2. Energy Management Review

A key component in the development of this ESAP was the assessment of the systems and processes in place for managing energy use, and the identification of actions to improve energy management across the organisation.

The Energy Management Review was undertaken at Council's Facility Managers Meeting on 28 November 2011 using a tailored rating system based on the example provided in the *Local Council Guide for Energy Savings Action Plans*.

At this meeting, senior staff members from across Council involved in the management and operation of Council facilities examined the systems and processes in place surrounding:

- Senior Management Commitment
- Accountability for Energy Management
- Energy Monitoring and Reporting
- Energy Assessment of Council Facilities
- Operating and Maintenance Procedures

The ranking system used to assess Council's current and desired status against each management area was as follows:

| | |
|---|---|
| **PAPER** | Informal management practices only |
| **BRONZE** | Moderate level of achievement |
| **SILVER** | Leader in Local Government |
| **GOLD** | Best practice in Local Government |

The outcomes of this process are provided in Table 1 below.

**Table 1: Outcomes of Energy Management Review**

| Management Area | Current Ranking 2011-12 | Justification for Current Ranking | Aspirational Ranking |
|---|---|---|---|
| Senior Management Commitment | **BRONZE** | - Council has an adopted target to reduce its greenhouse emissions, but does not have a defined target for energy consumption. | **GOLD** |
| Accountability for Energy Management | **PAPER** | - Accountability for energy management has not been formalised across the organisation. | **SILVER** |
| Energy Monitoring and Reporting | **BRONZE** | - The Data Management System provides basic reporting functions but is not well utilised by facility managers for monitoring purposes.<br>- Consumption is not routinely monitored at the facility level and exceptions are not reported to management. | **SILVER** |
| Energy Assessment of Council Facilities | **SILVER** | - Council has undertaken detailed energy assessments of high energy use sites and evaluates potential actions against operational costs and future renewal of the asset.<br>- Services responsible for implementing actions in the ESAP have not been captured in the Operational Plan. | **GOLD** |
| Operating and Maintenance Procedures | **SILVER** | - Preventative maintenance programs are in place.<br>- Working towards an asset management system and work order system functioning at all facilities.<br>- Contractor timeframes can inhibit change in the short term.<br>- Maintenance is often performing well, but the operating procedures and training of staff to reduce energy consumption may require attention. | **GOLD** |

The actions arising out of the Energy Management Review process and subsequent discussions with managers are provided in Table 2.

**Table 2: Actions resulting from the Energy Management Review**

| Energy Management Action | Management Area this action relates to | Priority | Responsibility |
|---|---|---|---|
| 1. Develop targets to manage energy use and reduce Council's overall energy consumption. | Senior Management Commitment | **HIGH** | Sustainability & Planning |
| 2. Conduct a review of the systems and processes surrounding the management of Council's resource use with the intent of improving the capacity for facility managers to proactively monitor and report against resource use. | Energy Management and Reporting | **HIGH** | Sustainability & Planning |
| 3. Investigate the possibility of developing and including energy related KPI's where appropriate in Council's Operational Plan, Service Specifications and Position Descriptions. | Accountabilities for Energy Management | **HIGH** | Sustainability & Planning |
| 4. Incorporate directives relating to the implementation of cost effective actions identified in Council's Energy Savings Action Plan, where appropriate, in Council's Operational Plan, Service Specifications, and/or Position Descriptions. | Accountability for Energy Management | **HIGH** | Sustainability & Planning |
| 5. Assess the benefits of developing an internal marketing plan around energy management | Accountability for Energy Management | **LOW** | Sustainability & Planning |
| 6. Identify training needs and opportunities to improve energy management across the organisation. | Operating and Maintenance Procedures | **MED** | Sustainability & Planning |
| 7. Investigate opportunities to improve demand management at key sites | Energy Assessment of Council facilities | **MED** | Asset Management |

# 3. Facility based energy audits

In February 2012, Penrith City Council engaged consultancy firm Net Balance to undertake Level 3 technical reviews of the five nominated sites, as detailed below, in accordance with the Australian Standard for Energy Audits (AS 3598:2000).

The five sites which were the focus of the energy audits included:

1. **Penrith Civic Centre:** This site is currently ranked as Council's 3$^{rd}$ highest energy using site and is a key facility with significant presence within the local community. While this site has been audited previously and had all cost effective actions identified in the 2007 ESAP implemented, Council is keen to explore further energy saving opportunities for this site, as well as the potential for the application of solar PV.

2. **Ripples Hydrotherapy Pool:** This site is currently ranked as Council's 5$^{th}$ highest energy using facility and has not been audited previously.

3. **Joan Sutherland Performing Arts Centre:** This site is currently ranked as Council's 6$^{th}$ highest energy using site, and is a key facility with significant presence within the local community. While this site has been audited previously and had all cost effective actions from the 2007 ESAP implemented, energy consumption at this site has increased over the past two years as a result of changes to the operation of the site and increased patronage. The technical audit conducted at this site also included specialist lighting investigations, which were not conducted as part of the previous ESAP.

4. **Lewers Gallery:** This site is currently ranked as Council's 7$^{th}$ highest energy using facility and has not been audited previously. A specialist site, the technical audit conducted at this site included specialist lighting and HVAC investigations to consider the lighting and temperature controls required to exhibit artworks.

5. **Carita Child Care Centre:** While not a high energy using facility, this site has the potential to act as a representative model for the identification and roll out of replicable actions across other similar sites.

The detailed findings of each audit are included in Sections 4 to 8 of this plan. It should be noted that the analysis of energy saving opportunities provided in this plan is based on information provided by facility staff and suppliers, along with sub-metering conducted by Net Balance. Any estimates are based on Net Balance's expertise and experience, supplemented with specific information from suppliers. While they have made every effort to provide accurate, up-to-date information, some of these measures may need to be investigated further to obtain more precise cost estimates and savings potentials.

Recommendations have been classified according to their cost effectiveness and have been allocated into one of the following three categories:

- **Cost Effective** – those recommendations with a payback period of less than 5 years
- **Potentially Cost Effective** – those recommendations with a payback period of between 5 and 7 years
- **Other** – those recommendations with extended payback periods or that require further investigation

These categories are consistent with those identified in Council's Water Efficiency Plan 2011, which identifies projects to improve water efficiency at water intensive facilities.

## *3.1 Summary of cost effective opportunities*

A summary of the cost effective opportunities identified in the energy audits is provided in Table 3.

**Table 3: Summary of cost effective actions identified through the energy audits**

| Site | Action | Cost | Annual Savings | | | Payback |
|---|---|---|---|---|---|---|
| | | | Cost Savings | Energy (kWh) | Emissions ($CO_2^e$) | |
| Civic Centre | Replace 35W halogen down lights with 16 LED equivalent | $9,000 | $2,970 | 6,880 | 7.3 | 3.0 |
| | Replace fluorescent tubes in the basement with more efficient lighting | $7,320 | $2,035 | 10,848 | 11.6 | 3.6 |
| | Change office and library lights to single electronic ballast fluorescent with reflector | $145,500 | $36,172 | 190,664 | 204.0 | 4.0 |
| | **Sub-Total** | **$161,820** | **$41,177** | **208,392** | **222.9** | **3.9** |
| Ripples Hydrotherapy Centre | Review air conditioner temperature set points | None | $480 | 2,668 | 2.8 | Immediate |
| | Install timers on pool water pumps | $300 | $1,225 | 6,808 | 7.2 | 0.2 |
| | Add sensors to pool deck lights | $800 | $355 | 1,972 | 2.1 | 2.3 |
| | Reduce the domestic hot water set point | $100 | $38 | 756 | 0.2 | 2.6 |
| | Change pool deck lights to compact fluorescent models | $1,500 | $526 | 1,878 | 2.0 | 2.9 |
| | Replace fluorescent tubes with more energy efficient lighting | $4,227 | $885 | 4,631 | 4.9 | 4.8 |
| | **Sub-Total** | **$6,927** | **$3,509** | **18,713** | **19.2** | **2.0** |
| The Joan Sutherland | BMS and control systems tuning | None | $700 | 3,900 | 4.1 | Immediate |
| | Lighting (non-stage) | $98,440 | $28,490 | 108,587 | 114.7 | 3.5 |

| | | | | | | |
|---|---|---|---|---|---|---|
| Performing Arts Centre | Voltage Optimisation - non-stage lighting retrofitted | $39,741 | $6,814 | 43,500 | 46.0 | 4.8 |
| | **Sub-Total** | **$138,181** | **$36,004** | **155,987** | **164.8** | **3.8** |
| Penrith Regional Gallery & The Lewers Bequest | Review reception door policy | None | $96 | 660 | 1.0 | Immediate |
| | Café refrigeration of non-perishables | $30 | $53 | 366 | 0.4 | 0.6 |
| | Lighting | $28,435 | $16,715 | 81,100 | 86.0 | 1.7 |
| | Replace the Ancher House HVAC unit | $9,200 | $2,008 | 13,846 | 15.0 | 4.6 |
| | **Sub-Total** | **$37,665** | **$18,872** | **95,972** | **102.4** | **1.6** |
| Carita Child Care Centre | Review air conditioner temperature set point | None | $158 | 750 | 0.8 | Immediate |
| | Reduce the domestic hot water set point | $100 | $65 | 310 | 0.3 | 1.5 |
| | Install passive air extraction fan (Whirlybird) | $500 | $182 | 866 | 0.9 | 2.7 |
| | Install separate laundry exhaust fan switch | $100 | $33 | 156 | 0.2 | 3.0 |
| | Replace fluorescent tubes with more energy efficient lighting | $1,600 | $459 | 1,872 | 2.0 | 3.5 |
| | **Sub-Total** | **$2,300** | **$896** | **3,954** | **4.2** | **2.6** |
| **Total** | | **$346,893** | **$100,458** | **483,018** | **513.5** | **2.8** |

# 4. Civic Centre

## *4.1 Site description*

The Civic Centre is Council's main administrative building and incorporates a customer service area, offices, the Council Chambers, and a public library. Constructed in the early 1990s, the Civic Centre has an approximate floor area of 11,115m$^{2,}$ which includes the 2,742m$^2$ library attached to the eastside of the building.

More specifically, the Civic Centre consists of the following:

**Basement Level:** Car park, Archives, Print Room, PABX, Health and Building Laboratory, Grease Arrestor Room, Lift Motor Rooms, Electrical Switch Room.

**Ground Floor:** Entrance foyer, Reception, General Offices, Meeting Rooms, Seminar Rooms, Library and Theatrette.

**First Floor:** Council Chambers, Meeting Rooms, Mayor's Office, Boardroom, General Office Area, Computer Room and Plant Rooms.

**Second Floor:** Council Chamber Gallery, Function Room, Kitchen, Staff Lunch Room, Plant room No.5.

The Civic Centre is open all year round apart from key public holidays.

| | **Mon-Fri** | **Saturday** | **Sunday** |
|---|---|---|---|
| Civic Centre | 8.30am – 4.00pm | Closed | Closed |
| Library | 9.00am – 8.00pm | 9.00am – 5.00pm | 10.00am – 5.00pm |
| Council Staff | 7.00am – 6.00pm | | |
| Council Meetings | 7.00pm – late (Monday only)<br>Other times as required | | |

The building is concrete in construction and has a semi-gabled metal roof structure. Due to the large thermal mass and unusual design, purging and maintaining consistent temperatures throughout the facility is difficult. Reflective paint has been trialled on the roof and deemed to be successful in reducing heat gain. There are many skylights providing natural light and utilising these to minimise lighting loads should be implemented.

## *4.2 Tariff analysis*

The Civic Centre has an electricity supply contract, with Energy Australia. Table 4 shows the tariffs paid by the Civic Centre in relation to electricity consumption during 2010-11. Unless otherwise stated, an aggregated electricity cost of $0.15 per kWh has been used for the Civic Centre throughout plan. This takes account of all energy-related charges, and includes an increase of 18% based on energy price increases modelled by the NSW Independent Pricing and Regulatory Tribunal (IPART).

**Table 4: Electricity tariff details for the Civic Centre, 2010-11**

| Charge | Amount | Units |
|---|---|---|
| **Energy charges** | | |
| Peak energy charge | 0.070588 | $/kWh |
| Shoulder energy charge | 0.071764 | $/kWh |
| Off peak energy charge | 0.029098 | $/kWh |
| **Network and market charges** | | |
| Peak network charge | 0.039151 | $/kWh |
| Shoulder network charge | 0.025028 | $/kWh |
| Off peak network charge | 0.009106 | $/kWh |
| Demand charges | 12.3193 | $/kVA |
| Network access charge | 11.6400 | $/day |
| NEM administration fee | 0.000401 | $/kWh |
| NEM ancillary fee | 0.000424 | $/kWh |
| Meter charge | 2.3288 | $/day |
| REC surcharge (LRET) | 0.002615 | $/kWh |
| REC surcharge (SRES) | 0.005920 | $/kWh |
| NSW GGAS surcharge | 0.001439 | $/kWh |
| NSW ESS surcharge | 0.000499 | $/kWh |

The main characteristic of this tariff is the significant difference between peak and off-peak rates. Unfortunately, due to the nature of its activities and the times during which the facility is used, it is difficult to take advantage of this differential by load shedding or scheduling.

The Civic Centre incurs peak demand charges based on the maximum electricity demand over the billing cycle. This peak demand figure is then multiplied by the demand charge, and the number of days in the month. Demand charges make up a reasonable component of the cost of the Civic Centre's electricity bills, at around $7,000 per month (30% of the total energy cost). Given the size of these charges, any reduction in peak demand would have an impact in reducing the Civic Centre's energy costs.

Reducing maximum demand can be done best by undertaking energy efficiency measures recommended in this plan.

## *4.3 Energy load profiles and energy consumption patterns*

### 4.3.1 Summary of site performance

The Civic Centre is powered by grid electricity and reticulated natural gas. There are two main electricity meters and a main gas meter. Main meter 1 supplies the lifts, ventilation, server room, lighting and general power while meter 2 supplies the chillers, pumps, supply fans and duct heaters. Gas is primarily used for the kitchen.

In 2010-11, site electricity use totalled 2,169,142 kWh at a cost of $325,371. Over the same period, natural gas consumption totalled 45,428 kWh at a cost of $2,453. Total energy consumption at the site totalled 2,214,570 kWh at a cost of $327,824. This energy consumption resulted in greenhouse gas emissions of 2,328 tonnes of carbon dioxide equivalent ($CO_2$-e).

Total site energy consumption, cost, and greenhouse gas emissions are shown in Table 5.

**Table 5: Split of energy consumption, 2010-11**

| Area | Energy type | Energy consumption (kWh) | % total consumption | Energy cost | GHG emissions[1] (t $CO_2$-e) |
|---|---|---|---|---|---|
| Chillers | Electricity | 140,000 | 6.3% | $21,000 | 150 |
| Fans, Pumps and Duct Heaters | Electricity | 411,557 | 18.6% | $61,734 | 440 |
| Ventilation and Lifts | Electricity | 293,775 | 13.3% | $44,066 | 314 |
| Server Room | Electricity | 306,675 | 13.8% | $46,001 | 328 |
| Lighting | Electricity | 611,308 | 27.6% | $91,696 | 654 |
| General Power | Electricity | 405,827 | 18.3% | $60,874 | 434 |
| Kitchen Gas Appliances | Gas | 45,428 | 2.1% | $2,453 | 8 |
| **TOTAL** | | **2,214,570** | **100.0%** | **$327,824** | **2,328** |

[1] National Greenhouse Accounts (NGA) emission factors for electricity and natural gas were used to determine these values.

This information is also presented graphically in Figure 1.

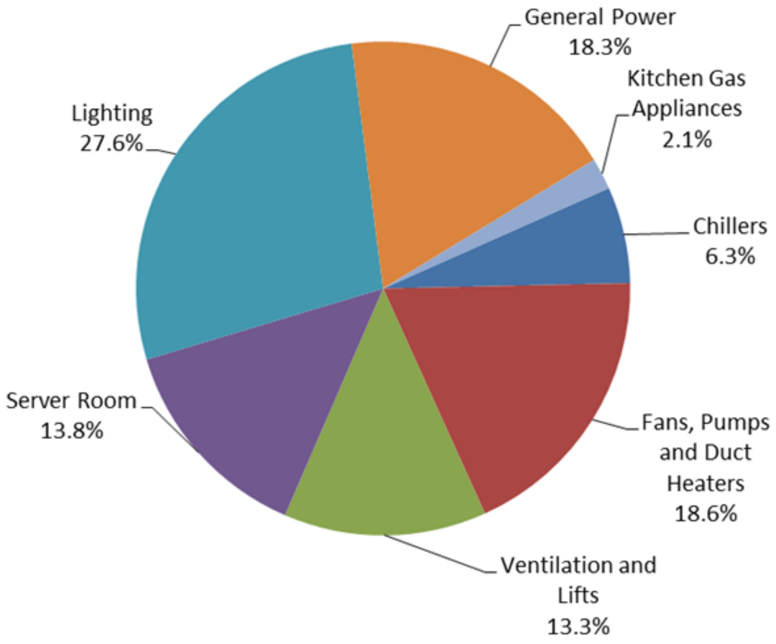


**Figure 1: Breakdown of energy consumption, 2010-11**

Combined, the HVAC (chillers, fans, pumps and ventilation) consumes the largest portion of the site's energy (38.2%), which is a relatively low split as typically 50% of a building's energy use is attributable to HVAC. There is a large server room onsite and the air conditioning component for this brings the total HVAC closer to the 50% mark. However, all things considered the HVAC is still running efficiently (with the exception of the server room). Lighting is the next-largest user at 27.6% and represents the most likely area where energy savings can be achieved.

Benchmarking of office buildings incorporates the NABERS rating scheme to model energy efficiency performance. An indicative NABERS assessment was carried out in the 2011 calendar year as part of Net Balance's analysis, and a value of 2.5 stars was determined. Please note that a more rigorous process will need to be used to determine an official rating. This is about average for a building this size and shows that there is still room for improvement.

### 4.3.2 Annual profile

The Civic Centre had a fairly constant electrical load pattern throughout 2011, dictated largely by the use of HVAC systems to provide a comfortable year-round internal temperature and the fact that cooling and heating are both electric.

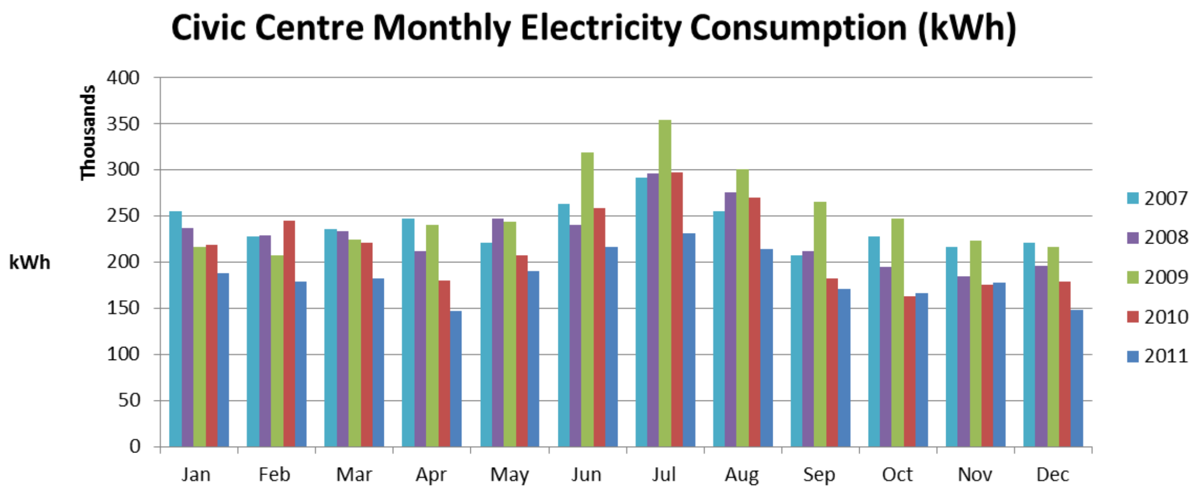


**Figure 2: Average monthly electricity consumption, 2007-11**

Figure 2 shows that electricity use has been trending downwards over the past two years in particular. A major change in energy use occurred in September 2010 with the current electricity usage running ~30% less than 2009 levels and ~15% less than 2010 levels.

### 4.3.3 Weekly profile

As shown in Figure 3 below, electricity consumption patterns at the Civic Centre also vary according to weekday. On Saturdays and Sundays, the site operates only to service the library.

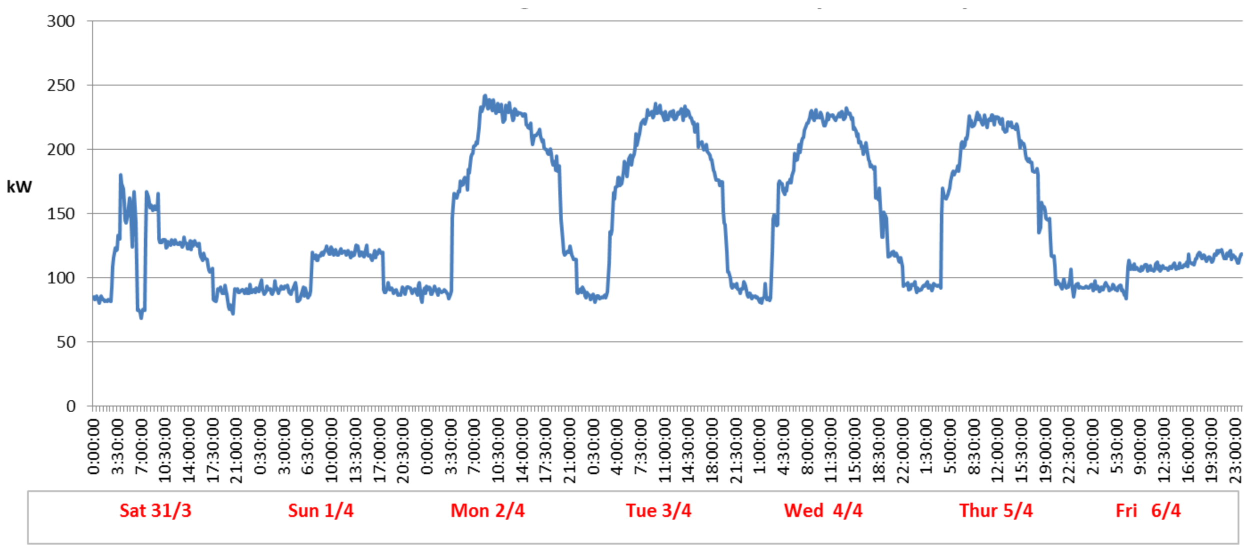


**Figure 3: Sub-metered interval general light and power electrical consumption by weekday, April 2012**

There are a few noticeable anomalies in the profile, one being a large lighting load coming on early Saturday morning (2.00 am) which was repeated over the three weekends that the site was monitored.

The BMS stated a 8.00am to 6.00pm schedule while this profile shows a large lighting load anywhere from 4.00am in the morning, this may be for other purposes such as external lights, foyer lights, car park lights or for cleaners, however this should be reviewed. Savings from trimming the Saturday lighting schedules equates to approximately 39,150kWh or $5,872.50 of energy consumption per annum.

Another area of concern is the apparent baseload from lights running during the day and night on Friday the 6th of April, which was a public holiday. Reviewing public holiday schedules for all equipment to ensure that they switch off on these days is a simple, nil cost energy saving opportunity.

The 80kW baseload that is consistent after hours is also a concern. It is therefore recommended that Council investigate options to reduce the operating times of non-essential equipment.

Using the existing logged data from the BMS, analysis was performed on the non-essential mechanical equipment to determine the energy performance in this area. This circuit feeds the chillers, pumps, supply air, return air fans and auxiliary mechanical equipment. As can be seen in Figure 4 the heating and cooling equipment peak load varies with daily temperatures. Some of the fans/pumps operating on weekdays can be seen to operate on weekends as well, reviewing the need for weekend operation should be carried out as only the library is open. A baseload that varies between 5-10 kW was also observed and since there is no need for any non-essential equipment to operate all of the time this is potentially wasted energy. Auxiliary fans or pumps running in manual can consume large amounts of energy over a year and are the most likely cause. This equates to approximately 23,400kWh or $3,510 of energy consumption per annum.

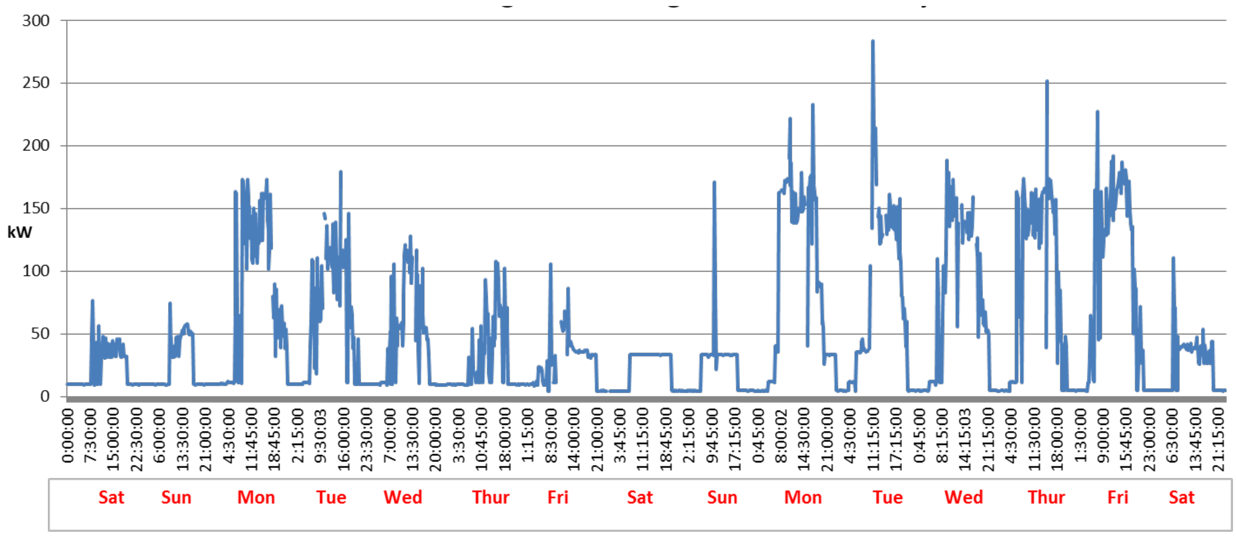


**Figure 4: Sub-metered general light and power electrical consumption by weekday, April 2012**

Based on the analysis performed using the sub metering data it has been determined that greater than 3% of the buildings energy use may be being lost to unnecessary operation of equipment. Fine tuning of buildings can achieve even more savings. The provision of sub metering data to maintenance staff should be implemented so that they can troubleshoot equipment control problems.

## *4.4 Findings of the site audit*

**Building Management System (BMS)**

The Siemens (DDC) style BMS was installed in 2003. This system controls the HVAC and lighting within the building and has enough functionality to provide the potential for energy saving controls for these. These include time scheduling, chiller optimisation (staging, chilled water reset, optimum start, room temperature set point control) as well as economy cycle and purging capability on the fans.

### 4.4.1 Upgrading the existing energy monitoring system

The current metering system onsite consists of several meters that log the building's mechanical energy use in the BMS. This is currently monitored monthly through Energy Usage Reports. If this was monitored more regularly it is likely that a lot of energy could be saved by identifying and fixing out-of-schedule operation.

Adding five more electricity meters to include lighting circuits would allow site management to perform analysis of the entire buildings energy use. Feeding these to a central interface with software that allows for high level energy analysis could save large amounts of energy. Problems identified in the sub-metering analysis are wasting around 3% of the buildings energy which could be saved if identified early. The current software and interface is limited and introducing a back end system and a monitoring regime by an energy champion within the organisation is recommended. This is the most effective means of monitoring a building. These meters could also be used to perform NABERS energy exclusions for the library. Using the existing meters is recommended and there should be no reason why these would not connect to a back end system.

**Table 6: Financial analysis of upgrading existing monitoring system**

| Annual energy savings | Capital expenditure | Annual cost savings | Payback |
|---|---|---|---|
| **66,300 kWh** | $53,975[1] | $9,945 | 5.4 years |
| **Works brief:** | | | |
| ▪ Obtain quotes for further meters and install them (wire to back end system)<br>▪ Identify an energy champion who can monitor the profiles monthly/fortnightly<br>▪ Report to site management any anomalies with the view to rectifying them | | | |

[1] Installed

Wiring the additional meters back to the existing BMS would be a cheaper option costing $38,957 (installed) but would not achieve the same savings. This option would only save 22,100 kWh or $3,315 with a payback of 11.8 years.

**Heating, Ventilation and Air Conditioning (HVAC)**
There are typically significant HVAC energy savings opportunities to be found within office buildings, however many upgrades to the equipment have been made in recent years and much of the major equipment and control is within best practice guidelines.

The Civic Centre is serviced by 2 Powerpax chillers, one main and one low load (1200 and 500 kWr cooling capacity respectively). These units are the most efficient on the market and provide an average coefficient of performance (COP)[1] of around 7 but can operate >12 at part loads. The chilled water loop has a primary pumping arrangement with two chilled water pumps (37 and 18.5 kW). These have associated variable speed drives (VSDs) varying the pump motor speeds with the change in pressure drop across the loop. The two condenser water pumps (37 and 18.5 kW) also have associated VSDs along with the cooling tower fans (ratings unknown).

This system supplies chilled water to the variable refrigerant volume (VRV) air handling units (AHUs) scattered throughout the facility. These AHUs mix chilled water elements with outside air, return and exhaust air which allows for economy cycles, purging and other efficient operational strategies to be incorporated into the air conditioning regime. All fans have associated VSDs and these control the fan speeds with the required air flow.

The heating regime is much simpler with each AHU having an associated electric resistance heater installed within the ductwork. These operate at 100% efficiency but are more costly to run than gas fired hot water heating due to the disparity in energy prices. Even though these are more efficient, upgrading to a system like this would be too costly even with the large reduction in operational costs.

Miscellaneous energy using HVAC equipment includes toilet, kitchen and other exhaust fans running on timers.

### 4.4.2 Replace CRAC units with efficient model and incorporate the site's chilled water loop

Currently, the data centre onsite is supplied cool air by two Atlas 48kWr (cooling capacity) CRAC units that are around 20 years old and are due for replacement. When installed, these units would have been operating in the range of 2.3-2.5 COP and would have decreased further in efficiency since installation.

Replacing these with a new digital scroll CRAC unit and incorporating the highly energy efficient chilled water when the main plant onsite is operational will achieve large energy savings. The average COP of the main chilled water loop would be greater than 7 while the replacement CRAC unit would be more efficient as stated earlier. This design is cheaper and more energy efficient than replacing both the units.

[1] Coefficient of performance (COP) is the energy efficiency measurement of air conditioners. It is calculated from the ratio of cooling or heating capacity (kWr) to the power rating of the equipment (kW). A higher COP indicates a more energy efficient unit.

**Table 7: Financial analysis of CRAC unit replacement with chilled water loop**

| Annual energy savings | Capital expenditure | Annual cost savings | Payback |
|---|---|---|---|
| **95,125 kWh** | $103,000 | $14,269 | 7.2 years |
| **Works brief:** | | | |
| ▪ Review the existing requirement for cooling for sizing purposes<br>▪ Obtain multiple quotes for installation<br>▪ Install new unit and join to the main chilled water loop<br>▪ Ensure CRAC units only run on chilled water when main plant is operating | | | |

The installation of two new digital scroll CRAC units at a greater cost of $128,000 was also investigated but was found to be not as effective, only achieving energy savings of 86,724 kWh and $13,009 with a payback of 9.8 years.

**Lighting**

Light fixtures throughout the Civic Centre vary greatly with many different task specific and aesthetic lighting designs. The office and library spaces are predominately 36W T8 magnetic ballast lights with troffer and air handler. Metal halide, halogen, compact fluorescent, T5 fluorescent, LEDs and par38 lights make up the remaining lights in the Civic Centre. There are also large spotlights installed outside designed to illuminate the Civic Centre during the evening.

Lighting controls are a mix of BMS time schedules, lux sensors and motion sensors. These are all acceptable energy efficient methods of controlling lighting. During site visits however, it was noted that altered schedules in the BMS had allowed the Council hall lights to operate all days and hours while the library and foyer high bay lights were operating concurrently with a large amount of natural light suggesting a faulty or missing lux sensor. Motion sensors in the office meeting rooms were disruptive and switched off at inopportune times during meetings. Reviewing much of the existing lighting regimes to ensure occupant satisfaction as well as operating in an energy efficient manner is important. Monitoring systems are generally good at picking up this non-compliant operation.

Lighting levels observed throughout the entire facility were deemed to be acceptable.

Voltage reduction units (VRU) are installed on the lighting circuits to reduce power consumption. These are 9 years old with a useful life of around 8-10 years. This is an ideal time to upgrade to electronic ballast fluorescent lighting as savings from these VRUs will soon be lost due to failure. Savings estimates in lighting recommendations include losses that would generally have been saved by these units.

### 4.4.3 Replace fluorescent tubes with more energy efficient types in the basement

Lighting technologies currently used throughout the basement are predominantly 36W T8 magnetic ballast fluorescent tubes. The basement has approximately 183 of these single T8 light fittings operating for around 14 hours each day. Net Balance has conducted analysis on the upgrade of T8 (36W) fluorescent tubing to T5 (28W) electronic ballast converter kit tubes. Efforts have been made to match lumens, temperature and CRI between current globes and recommended upgrade globes.

The newer T5 fluorescent light ballast uses approximately 30% less energy than its T8 predecessor for the same light output. T5 tubes have different fittings and will require either the use of T8 to T5 conversion kits, or replacement of the T8 fittings. This plan has assumed continued use of the existing fitting and the fitting of a T8 to T5 conversion kit.

Lighting levels are very similar between 28W T5 tubes and 36W T8 tubes. As such, an upgrade to T5 lighting should not significantly alter the lighting levels experienced at the facility.

Additional benefits in converting from T8 ballast to T5s include:

- longer usable lifespan resulting in reduced maintenance costs associated with replacement
- removal of perceivable light flicker, and audible noise
- reduced environmental impact due to lower mercury content in T5 tubes.

The longer lifespan of T5 lighting will reduce maintenance requirements for lamp replacement by up to 20% compared with T8 lighting. The longer usable life of T5 ballasts will also reduce ongoing ballast replacement costs.

**Table 8: Financial analysis of replacing T8 fluorescent tubes with T5 equivalents in the basement**

| Annual energy savings | Capital expenditure | Annual cost savings | Payback |
|---|---|---|---|
| **10,848 kWh** | $7,320[1] | $2,035[2] | 3.6 years |
| **Works brief:** | | | |
| - Instruct electrician to install T5 tubes with conversion kits | | | |

[1] Installed
[2] Includes $408 in reduced maintenance costs.

### 4.4.4 Change office and library lights to single electronic ballast fluorescent with reflector

Lighting technologies currently used throughout the office and library are predominantly 36W T8 magnetic ballast fluorescent tubes. The office and library has approximately 970 of these dual T8 light fittings operating for around 10 hours (may be longer due to cleaning, after hours work) each week day and weekends for the library. Net Balance conducted analysis on the upgrade of dual T8 (36W) fluorescent tubing to a single T8 (36W) electronic ballast fluorescent with reflector which reduces the electricity consumption by 60%.

**Table 9: Financial analysis of changing office and library lights**

| Annual energy savings | Capital expenditure | Annual cost savings | Payback |
|---|---|---|---|
| **190,664 kWh** | $145,500[1] | $36,172[2] | 4.0 years |
| **Works brief:** | | | |
| ▪ Instruct electrician to remove current fitting and install T8 with electronic ballast and reflector | | | |
| ▪ Note provision for renting scissor lift has not been included in the price and may be required | | | |

[1] Installed
[2] Includes $7,572 in reduced maintenance costs.

Changing the office and library lights from T8 (36W) fluorescent tubing to T5 (28W) electronic ballast converter kit tubes would be a cheaper option costing $77,600 (installed) but would not achieve the same savings. This action would only save 105,924 kWh or $19,783 ($3,894) in reduced maintenance costs) although it has a slightly less payback of 3.9 years.

### 4.4.5 Replace 35W halogen downlights with 16W LED equivalent

During the site visit, Net Balance observed that the halogen downlights in the staff breakout area outside the Nepean room were being upgraded with LED equivalents as a trial.

**Table 10: Replacing halogen downlights with LED**

| Annual energy savings | Capital expenditure | Annual cost savings | Payback |
|---|---|---|---|
| **6,880 kWh** | $9,000[1] | $2,970[2] | 3.0 years |
| **Works brief:** | | | |
| ▪ Continue with planned replacement | | | |

[1] Installed
[2] Includes reduced maintenance costs of $1,938.

**<u>Domestic hot water</u>**

There are 13 small domestic hot water heaters supplying meeting rooms and kitchenettes as well as several instantaneous zip boilers. There is one larger 275L heat pump hot water heater in the plant room and 125L hot water heater in the basement car park for the showers. These operate continuously with exception of the zip boilers which are timed off overnight and on weekends.

**<u>Kitchen</u>**

The kitchen serves the staff cafeteria upstairs with gas ovens, stovetops as well as refrigeration and freezer equipment. It was untenanted at the time of the audit and much of the refrigeration equipment was operating without any contents, wasting energy.

### 4.4.6 Install 20kW solar photo voltaic (PV) unit

The current roof space at the Civic Centre is large enough to comfortably install a 20kW solar PV unit on the north facing side of the building. This area is at a tilt and azimuth angle that is optimal for the capture of energy from the sun's rays and converting it to electricity. There may be a small amount of shading in the morning from the adjacent shopping centre reducing the availability of the system by around 5%.

Given the size and aspect of the roof, it is recommended to install a mono crystalline fixed tilt 20kW system. Other systems such as poly-crystalline and 1 and 2 axis tracking were investigated but were not considered to be as cost effective. A survey of the load bearing capacity of the roof needs to be undertaken before this opportunity is considered. If the sloped roofing area is unsuitable placing the unit on the concrete areas with a tilt beam will add $10,000 to the cost.

A detailed financial analysis has been used to determine the pay-back of this installation. It has taken into account projected electricity prices, renewable energy certificates, feed in tariffs and maintenance costs. A larger PV system could feasibly be installed on the roof, but this would involve a more detailed design and additional costs associated with erecting structural brackets to achieve the desired aspect.

**Table 11: Financial analysis of solar PV installation**

| Annual energy savings | Capital expenditure | Annual cost savings | Payback |
|---|---|---|---|
| **25,158 kWh** | $58,418[1] | $4,526[2] | 12.9 years |
| **Works brief:** | | | |
| ▪ Survey roof for load bearing capacity<br>▪ Obtain multiple quotes for 20kW unit<br>▪ Install system and monitor for operational efficiency | | | |

[1] Installed
[2] Includes $753 for Renewable Energy Certificates (RECs) which are equivalent to one megawatt hour of electricity generation. A renewable energy certificate can be traded for cash and the value of these certificates fluctuates according to market conditions ($30 was chosen for this report).

**Other investigated technologies**

Power factor[2] correction, voltage optimisation and thermal metering were all investigated as part of this plan at the request of the Council. Due to the switch room setup, current demand prices and power factor levels at peak demand, PFC was deemed not financially viable and not recommended. Voltage optimisation was also reviewed but due to the large amounts of energy efficient equipment such as VSDs on pumps and fans, chillers, high frequency lighting, voltage reduction units it will not save much energy.

Thermal metering was also investigated which will not provide any energy savings but can be used to exclude the chilled water energy component supplied to the library for NABERS purposes. The cost per thermal meter uninstalled is around $4,200 to attach to the 5 inch chilled water pipe. A more sophisticated design beyond the scope of this plan is required to determine the final cost of such a system. Number of meters, wiring to the BMS and installation are all considerations required before a detailed design can be implemented.

[2] Power factor is the ratio of the real power flowing to the load, to the apparent power in the circuit. Essentially, it shows the level of synchronisation between the power actually being used by an appliance, compared to the power in the circuit. The power factor ranges between 0 and 1. A power factor of 1 is optimal, and indicates a complete synchronicity between real and apparent power.

## 4.5 Recommendations

The energy audit revealed opportunities with a less than five year payback period resulting in savings totalling $41,177 (208,392 kWh) per year. These options result in reductions of approximately 222.9 tonnes $CO_2$-e per year. In addition, opportunities worth up to $28,740 (186,583 kWh) per year were identified that were outside a five-year payback period. The greenhouse savings associated with these measures is 199.6 tonnes $CO_2$-e per year.

**Table 12: Civic Centre summary of actions**

| Energy saving measure | Costs | Savings | | | Payback | Plan ref |
|---|---|---|---|---|---|---|
| | Implementation cost ($) | Cost savings ($ pa) | Energy (kWh pa) | GHGs (t $CO_2$-e pa) | years | section |
| **Cost effective actions** | | | | | | |
| Replace 35W halogen downlights with 16W LED equivalent | $9,000[1] | $2,970[2] | 6,880 | 7.3 | 3.0 | 4.4.5 |
| Replace basement level T8 fluorescents | $7,320[1] | $2,035[3] | 10,848 | 11.6 | 3.6 | 4.4.3 |
| Replace office and library T8 fluorescents | $145,500[1] | $36,172[4] | 190,664 | 204.0 | 4.0 | 4.4.4 |
| **Total** | **$161,820** | **$41,177** | **208,392** | **222.9** | **3.9** | |
| **Potentially cost effective actions** | | | | | | |
| Monitoring system upgrade | $53,975[1] | $9,945 | 66,300 | 70.9 | 5.4 | 4.4.1 |
| **Other actions** | | | | | | |
| CRAC unit upgrade | $103,000 | $14,269 | 95,125 | 101.8 | 7.2 | 4.4.2 |
| Solar PV installation | $58,418[1] | $4,526[5] | 25,158 | 26.9 | 12.9 | 4.4.6 |
| **Total** | **$161,418** | **$18,795** | **120,283** | **128.7** | **8.6** | |

Note: an aggregated electricity cost of $0.15 per kWh has been used to calculate savings. See Section 4.2 for more detail.
[1] Installed
[2] Includes $1,938 in reduced maintenance costs.
[3] Includes $408 in reduced maintenance costs.
[4] Includes $7,573 in reduced maintenance costs.
[5] Includes $753 for Renewable Energy Certificates (RECs) which are equivalent to one megawatt hour of electricity generation. A REC can be traded for cash and the value of these certificates fluctuates according to market conditions ($30 was chosen for this Report).

# 5. Ripples Hydrotherapy Pool

## *5.1 Site description*

The Ripples Hydrotherapy Centre is situated in St Marys in Western Sydney. The facility was constructed in 1990. The approximate floor area of the Hydrotherapy building is $760m^2$.

The Hydrotherapy Centre consists of the following:

- A Hydrotherapy pool that is 21m x 12m x 1.2m, heated to 32 – 34 degrees Celsius
- Men’s and women’s changing rooms (showers, toilets, sinks)
- A reception/administration area, comprising an office, lobby and retail shop
- A plant room containing water filtration and conditioning equipment along with water heaters and an air conditioning unit
- Six small treatment and baby change rooms down the southern side of the building.

The Centre operates from 8.00am to 7.00pm Monday to Friday, and from 8.00am until 1.30pm on Saturdays. The facility is closed on Sundays and Public Holidays.

The site is of brick construction with a metal roof structure slanting slightly south. The interior utilises wooden cross beams and has large amounts of natural light entering from windows on the north side as well as the roof.

## *5.2 Business activity*

Business activity data for Ripples Hydrotherapy in recent years is shown in Figure 5. The chart shows that the overall trend of throughput levels at the pool has been slightly declining, notwithstanding a regular increase in the number of customers during the autumn months. This overall declining trend should result in slight decreases in energy use at the facility, as there is less need for services such as lighting, heating and cooling.

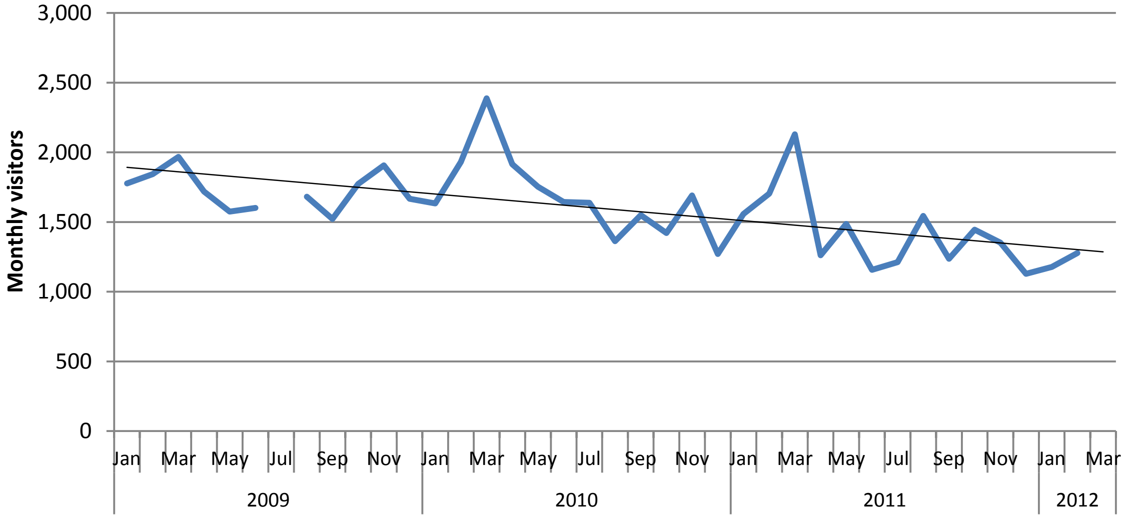


**Figure 5: Monthly customer data for Ripples Hydrotherapy, 2009-12**

The main energy using processes at the Centre (ie. pool heating and pumping) are unlikely to be significantly affected by changing customer numbers, as they are ‘sunk’ energy costs based on the unchanging volume of pool water as opposed to the changing number of patrons.

## *5.3 Tariff analysis*

Ripples Hydrotherapy has an electricity supply contract, through Council, with Energy Australia. Unless otherwise stated, an aggregated electricity cost of $0.18 per kWh has been used for the Hydrotherapy Centre, throughout this plan. This takes account of all energy-related charges, and includes an increase of 18% based on energy price increases modelled by the NSW Independent Pricing and Regulatory Tribunal (IPART).

The tariffs paid by Ripples Hydrotherapy in relation to electricity consumption during 2010-11 are shown in Table 13.

**Table 13: Electricity tariffs details for Ripples Hydrotherapy 2010-11**

| Charge | Amount | Units |
|---|---|---|
| **Energy charges** | | |
| Peak energy charge | 0.070588 | $/kWh |
| Shoulder energy charge | 0.071764 | $/kWh |
| Off peak energy charge | 0.029098 | $/kWh |
| **Network and market charges** | | |
| Peak network charge | 0.039151 | $/kWh |
| Shoulder network charge | 0.025028 | $/kWh |
| Off peak network charge | 0.009106 | $/kWh |
| Demand charges | 12.3193 | $/kVA |
| Network access charge | 11.6400 | $/day |
| NEM administration fee | 0.000401 | $/kWh |
| NEM ancillary fee | 0.000424 | $/kWh |
| Meter charge | 2.3288 | $/day |
| REC surcharge (LRET) | 0.002615 | $/kWh |
| REC surcharge (SRES) | 0.005920 | $/kWh |
| NSW GGAS surcharge | 0.001439 | $/kWh |
| NSW ESS surcharge | 0.000499 | $/kWh |

The main characteristic of this tariff is the significant difference between peak and off peak rates. Unfortunately, due to the nature of its activities and the times during which the facility is used, it is difficult to take advantage of this differential by load shedding or scheduling.

Ripples Hydrotherapy incurs peak demand charges based on the maximum electricity demand over the billing cycle. This peak demand figure is then multiplied by the demand charge, and the number of days in the month. Demand charges make up a reasonable component of the cost of Ripples Hydrotherapy's electricity bills, at around $430 per month (25% of the total energy cost). Given the size of these charges, any reduction in peak demand will have an impact in reducing Ripples Hydrotherapy's energy costs.

Reducing maximum demand can be done best by undertaking energy efficiency measures relating to the pool pumps, the PAC units, and site lighting. Demand management can also be achieved through load scheduling, to spread the electrical load more evenly across the day. However, due to the operating timeframes of the Ripples Hydrotherapy site, and the need to achieve set water temperature and water cycling rates during opening hours, opportunities for load scheduling are diminished.

## *5.4 Energy load profiles and energy consumption patterns*

### 5.4.1 Summary of site performance

Site energy consumption is comprised of electricity from the grid and natural gas from the pipeline network. In 2010-11, site electricity use totalled 176,464 kWh at a cost of $31,764 and natural gas consumption totalled 481,555 kWh at a cost of $24,270. Total annual energy consumption at the site was 658,019 kWh at a cost of $56,034. This energy consumption results in approximately 246 tonnes of carbon dioxide equivalent ($CO_2$-e) of greenhouse gas emissions.

Total site energy consumption, cost and greenhouse gas emissions for the 2010-11 financial year are shown in Table 14. The breakdown of energy use across the site is shown in Figure 6. This chart shows that the major source of energy consumption at Ripples Hydrotherapy is the gas-fired pool water heaters, contributing a massive 72% of total site energy consumption. Water pumps and split HVAC units were also major energy users, at 23% of total usage.

**Table 14: Split of energy consumption, 2010-11**

| Area | Energy type | Energy consumption (kWh) | % total consumption | Energy cost | GHG emissions (t $CO_2$-e)[3] |
|---|---|---|---|---|---|
| General power | Electricity | 4,708 | 0.7% | $848 | 4.2 |
| Lighting | Electricity | 20,160 | 3.1% | $3,629 | 17.9 |
| Split HVAC units | Electricity | 53,354 | 8.1% | $9,604 | 47.5 |
| Pool pumps and fans | Electricity | 98,242 | 15.0% | $17,683 | 87.4 |
| Domestic hot water | Gas | 7,564 | 1.1% | $381 | 1.4 |
| Pool water heating | Gas | 473,991 | 72.0% | $23,889 | 87.6 |
| **TOTAL** | | **658,019** | **100.0%** | **$56,034** | **246.0** |

[3] 2011 National Greenhouse Accounts (NGA) emissions factors for electricity and natural gas were used to determine these values.

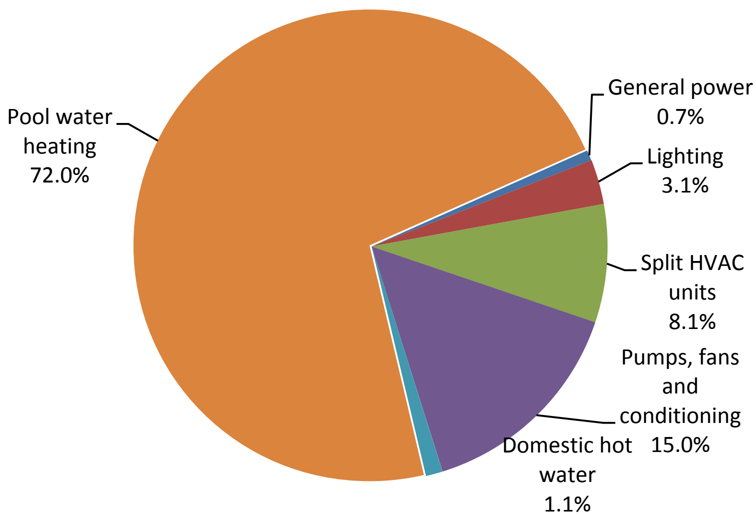


**Figure 6: Breakdown of energy consumption, 2010-11**

### 5.4.2 Annual profile

The site has fairly constant electrical load patterns throughout the year, mainly dictated by the use of HVAC systems to provide a comfortable year-round internal temperature as shown in Figure 7. This chart also shows that electricity use has been trending downwards over the past three years.

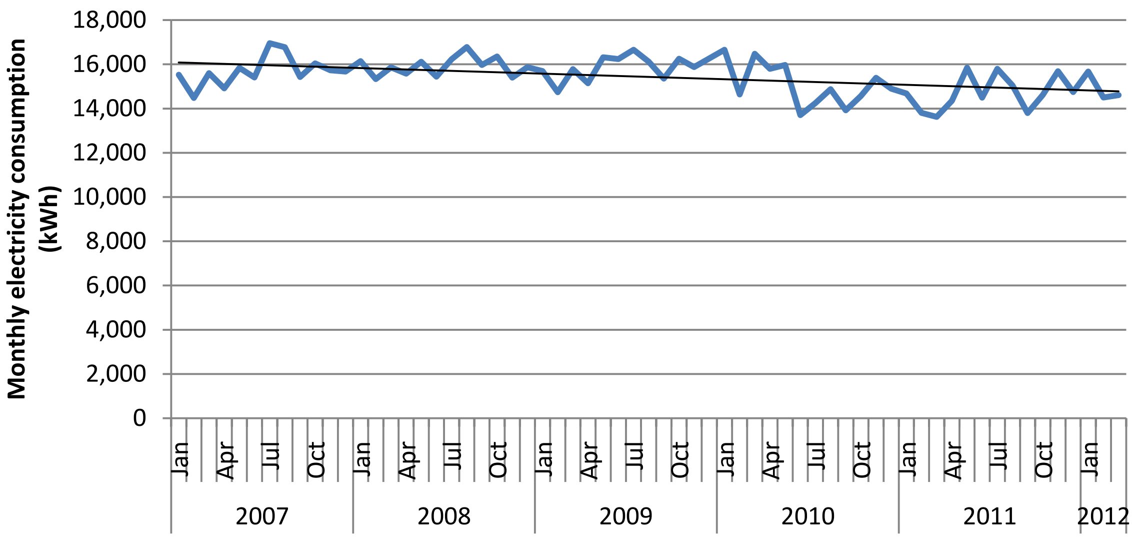


**Figure 7: Average monthly electricity consumption, 2007-12**

Figure 8 shows the comparison of electricity consumption against customer numbers at Ripples Hydrotherapy. This chart indicates that the declining site energy consumption can be at least partly explained by the declining number of customers using the facility.

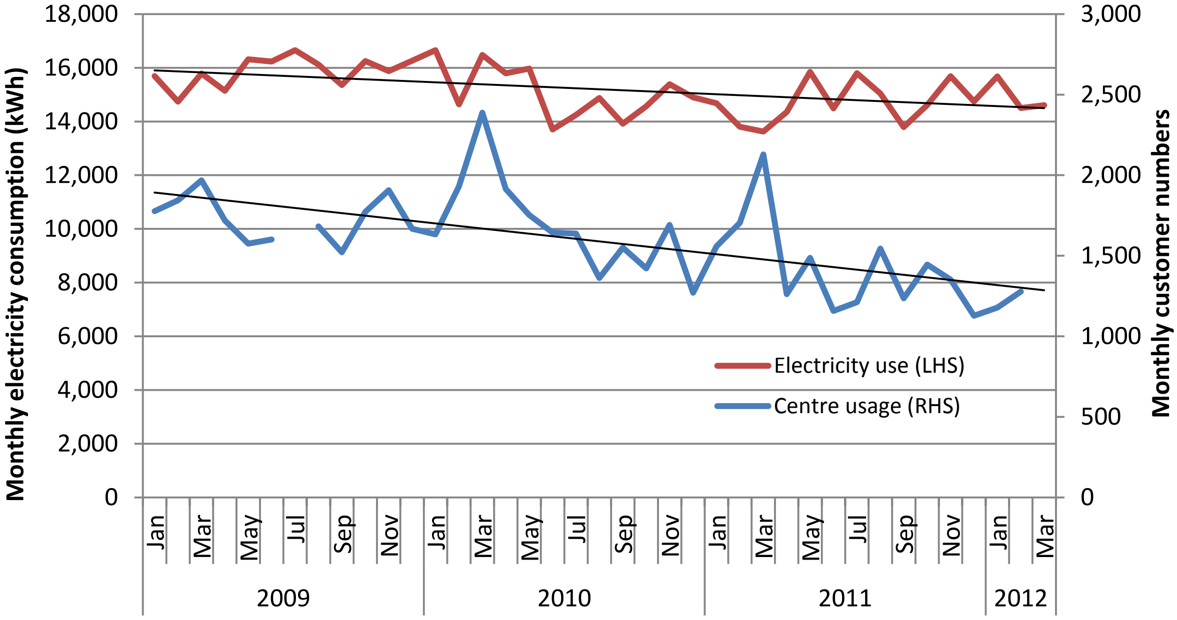

**Figure 8: Electricity consumption vs customer numbers, 2009-12**

### 5.4.3 Weekly profile

Electricity consumption patterns at Ripples Hydrotherapy also vary according to weekday. On Saturdays, the site operates for reduced hours and on Sundays, it does not operate at all. This is shown in Figure 39.

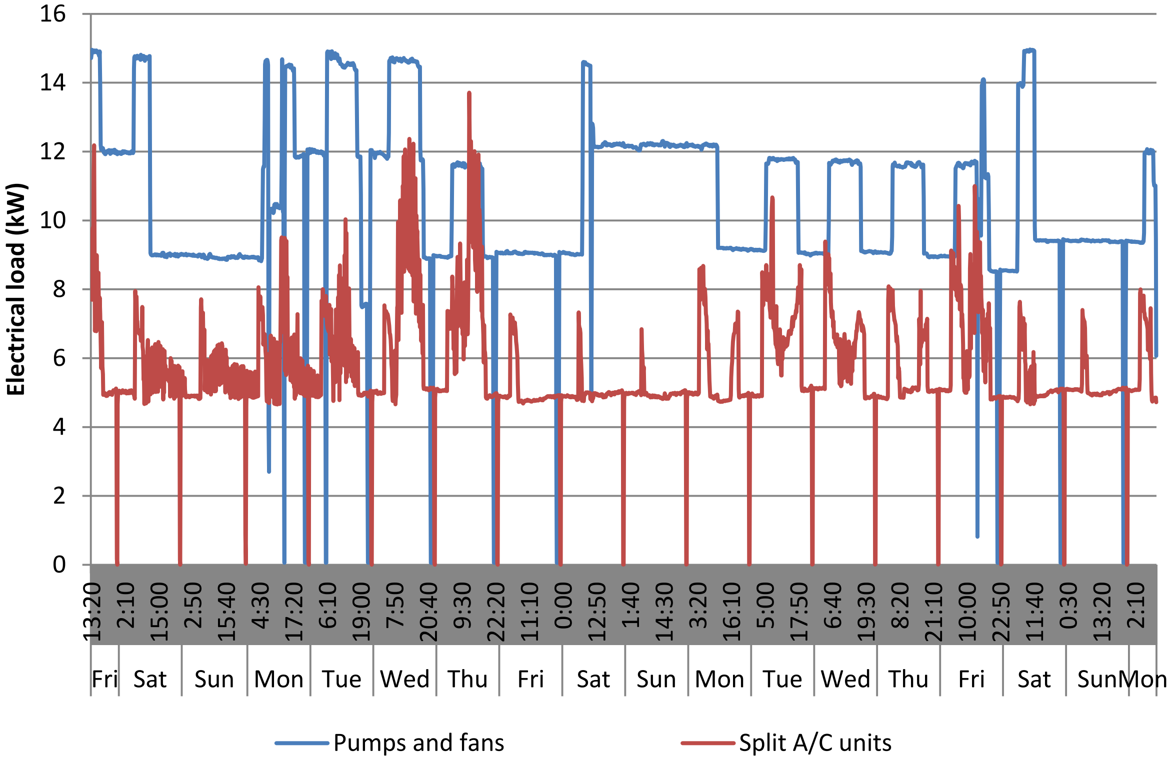


**Figure 9: Sub-metered interval electrical consumption, April 2012**

Figure 9 shows a steady baseload of 5kW of power for air conditioning units, representing the continuous work of condensers, heat rejecters and exhaust fans. The peak work of these units is during the daytime, and varies depending on the outside air temperature. Similarly, the pumps and fans have a baseload of around 9kW of power, representing the continuous work of water cycling pumps. Energy consumption from these sources peaks when the air handling unit fans and standby pumps also come into action.

During the first week of metering, the site was experiencing high outside air temperatures (consistently around 28 degrees), as can be seen by the increased electricity load during this period. In the second week, temperatures rarely exceeded 22 degrees. This meant there was a significantly reduced electricity load as the air conditioning was not used.

## *5.5 Findings of the site audit*

**Heating, Ventilation and Air Conditioning (HVAC)**
HVAC equipment is important at Ripples for maintaining the required temperature of 34°C on the pool deck. It is also important for providing staff and customer comfort in the treatment rooms and reception areas. There are typically significant HVAC energy savings opportunities, however there are some restrictions to these at Ripples due to the special requirements of HVAC.

**HVAC equipment summary**
The pool deck is heated by the same units that heat the pool water, ie. gas-fired Raypac heaters, with heated air distributed through an AirChange air handling unit. The reception area and treatment rooms are each conditioned by separate packaged air conditioning (PAC) units that are manually controlled. Bathrooms are ventilated by a total of four rooftop exhaust fans. The different HVAC equipment for Ripples Hydrotherapy is shown in Table 15.

**Table 15: Heating and associated plant at Ripples Hydrotherapy**

| Serviced location | No. of units | Make/model | Approx. rating (kW) | Year installed |
|---|---|---|---|---|
| Pool deck | 2 | Raypac P0430-N/277BMM | 62-94 | 2001 |
| Pool deck | 1 | AirChange SMAHU1 | Unknown | Unknown |
| Treatment rooms | 6 | Daikin FTY60GAV1A | 2.5 - 7 | 2001 |
| Reception area | 1 | Daikin FAY100FAVE | 12 | 2001 |
| Bathrooms | 4 | Fantech ALP1-TC | 0.2 | 2001 |

### 5.5.1 Review air conditioner temperature set points

Currently, most air conditioning units are set at 22°C and below for cooling days (i.e. during summer months). Increasing these set points to 24°C will reduce the amount of time that the units will operate. Reducing set points to 20°C for heating days will also realise similar savings. Further investigation will need to be carried out to determine whether the revised temperatures are appropriate for staff comfort.

**Table 16: Financial analysis of AC set point review**

| Annual energy savings | Capital expenditure | Annual cost savings | Payback |
|---|---|---|---|
| **2,668 kWh** | $0 | $480 | Immediate |
| **Works brief:** | | | |
| ▪ Adjust thermostat on indoor controls to required temperature | | | |

**Lighting**

Lighting systems at Ripples Hydrotherapy are predominantly made up of 200W mercury vapour low bay lights (on the pool deck) and twin 36W fluorescent tubes in recessed and surface-mounted fittings (in all other areas). The outside of the facility is lit by 100W halogen security lights.

Lighting levels observed at key locations throughout the facility were deemed to be acceptable. Notably, the pool deck lights were left on, even when there was sufficient daylight coming in through glazing around the pool deck.

Lighting throughout the facility is controlled via a local switch for each area. The consultant did not observe the use of energy efficient lighting systems such as zoned lighting, daylight harvesting, sensor lighting or timed lighting during the site walkthrough.

### 5.5.2 Replace fluorescent tubes to more energy efficient types

Lighting technologies currently used throughout the site are predominantly 36W T8 magnetic ballast fluorescent tubes, with limited use of halogen and compact fluorescent globes. The site has approximately 80 of these T8 light fittings operating for around 10 hours each week day. Net Balance has conducted analysis on the upgrade of T8 (36W) fluorescent tubing to T5 (28W) electronic ballast converter kit tubes. Efforts have been made to match lumens, temperature and colour rendering index (CRI) between current globes and recommended upgrade globes to ensure maintenance of lighting quality.

The newer T5 fluorescent light ballast uses approximately 30% less energy than its T8 predecessor for the same light output. T5 tubes have different fittings and will require either the use of T8 to T5 conversion kits, or replacement of the T8 fittings. This plan has assumed continued use of the existing fitting and the fitting of a T8 to T5 conversion kit. Lighting levels are very similar between 28W T5 tubes and 36W T8 tubes.

Additional benefits in converting from T8 ballast to T5s include:

- longer usable lifespan resulting in reduced maintenance costs associated with replacement
- removal of perceivable light flicker, and audible noise
- reduced environmental impact due to lower mercury content in T5 tubes.

The longer lifespan of T5 lighting will reduce maintenance requirements for lamp replacement by up to 20% compared with T8 lighting.

**Table 17: Financial analysis of replacing T8 fluorescent tubes with T5 equivalents**

| Annual energy savings | Capital expenditure | Annual cost savings | Payback |
|---|---|---|---|
| **4,631 kWh** | $4,227[1] | $885[2] | 4.8 years |
| **Works brief:** | | | |
| ▪ Instruct electrician to install T5 tubes with conversion kits | | | |

[1] Installed
[2] Includes $51 in reduced maintenance costs

## 5.5.3 Change pool deck lights to compact fluorescent models

There are 12 metal halide low bay lights servicing the pool deck area. There is an opportunity to replace these lights with more energy efficient compact fluorescent (CFL) models that consume 100W (conservative) versus 150W[4] for the existing fittings. CFL technology is rapidly improving, and these lights now have vastly improved colour profiles that render them suitable for the purpose in question. In addition, CFL lamps will typically take a shorter time to reach full luminance when compared to metal halides.

Installing CFLs will involve replacing the actual light fitting, as well as the bulb. The costing below includes both of these elements, but does not account for the fact that the pool may need to be emptied to enable the works to take place. CFL lamps are compatible with daylight sensors.

**Table 18: Financial analysis of changing pool deck lights to CFLs**

| Annual energy savings | Capital expenditure | Annual cost savings | Payback |
|---|---|---|---|
| **1,878 kWh** | $1,500[1] | $526[2] | 2.9 years |
| **Works brief:** | | | |
| ▪ Instruct electrician to install CFL fittings and luminaires on pool deck roof (note that the pool water may need to be emptied to allow this to take place) | | | |

[1] Installed
[2] Includes $188 in reduced maintenance savings.

## 5.5.4 Add sensors to pool deck lights

During the site visit, Net Balance observed that these lights remain on throughout the day, even when ample natural sunlight lights this space. To address this, daylight sensors could be installed to automatically switch off the pool deck lights when ambient natural light conditions are adequate.

[4] Precise data was not available for these fittings. The figure of 150W is based on the external appearance of the luminaires.

**Table 19: Financial analysis of adding daylight sensors to pool deck lights**

| Annual energy savings | Capital expenditure | Annual cost savings | Payback |
|---|---|---|---|
| **1,972 kWh** | $800[1] | $355 | 2.3 years |
| **Works brief:** | | | |
| ▪ Instruct electrician to fit daylight photosensors to pool deck circuit<br>▪ Adjust lux sensitivities on sensors to ensure adequate light conditions throughout the day on the pool deck | | | |

[1] Installed

## Pool water heating, filtration and conditioning

The Ripples Hydrotherapy Pool requires almost constant heating, filtration and conditioning. The pool temperature is maintained at 32-34°C for therapeutic reasons. A pool cover is applied every night, and all day on Sundays. The pool has UV and diatomaceous earth filtration and treatment systems.

There are a number of pieces of energy-consuming equipment involved in water heating, filtration and conditioning at Ripples Hydrotherapy Centre. These are listed in Table 20.

**Table 20: Main water heating, filtration and conditioning plant at Ripples Hydrotherapy**

| Location | Description | No. of units | Make/model | Approx. rating (kW) | Year installed |
|---|---|---|---|---|---|
| Plant room | Pool water heater | 2 | Raypac P0430-N/277BMM | 62-94 | 2001 |
| Plant room | Pool water circ. pumps | 2 | Unknown | 2 | 2001 |
| Plant room | Pool water UV treater | 1 | Unknown | 0.5 | 2001 |

## Solar thermal heating of pool water

A thermal solar/photovoltaic system was installed at Ripples Hydrotherapy in July 2012. The solar thermal system installed consists of Heliocol Suntex panels, pump and controller unit along with associated plumbing. A 6kW photovoltaic system was installed to offset the expected energy consumption of the additional pump used to run the solar thermal system making it an energy neutral system. Twenty eight 215W Kyocera solar panels were installed and connected to the grid. The total cost for the system was $66,088.

## Pool water pumps

There are two pumps in the plant room responsible for circulating pool water through the filters. Water circulation rates are dictated by mandatory government standards.

The pumps do not have variable speed drives (VSDs), largely because they are tuned quite finely to the prevailing water turnover rates which mean that there is limited scope to reduce their output. However, the pumping system is in constant operation, even when the facility is not used and the water circulation guidelines do not apply.

### 5.5.5 Install timers on pool water pumps

The pumping system responsible for circulating pool water through the filtration and conditioning systems runs constantly to meet relevant government standards. There is an opportunity to slow down this system when the Ripples facility is not in use. This will minimise the run time of these motors, thus reducing their energy consumption and prolonging their working life. The following opportunity is based on bringing one pump offline from 9.00pm to 3.00am on weekdays, and from 4.00pm on Saturdays to 3.00am on Mondays.

Further investigation may be required regarding timers on pumps as generally pumps are controlled by some sort of system on site. It is important that Ripples management ensure that all government standards and requirements are met when implementing this initiative. Net Balance understands that the regulations for pool water turnover rates are somewhat vague on particular requirements.

**Table 21: Financial analysis of installing timers on pool water pumps**

| Annual energy savings | Capital expenditure | Annual cost savings | Payback |
|---|---|---|---|
| **6,808 kWh** | $300[1] | $1,225 | 0.2 years |
| **Works brief:** | | | |
| ▪ Purchase an electronic, multi-setting electricity timer<br>▪ Either configure and install this in-house, or if there are any hazards or issues in doing so, instruct an electrician to carry out the work. | | | |

[1] Uninstalled

**Domestic hot water**

The Ripples Hydrotherapy site is served by two 420L unvented upright hot water storage cylinders. These cylinders run off reticulated natural gas and operate 24 hours a day, seven days a week.

### 5.5.6 Reduce the domestic hot water set point

The domestic water heaters at the Ripples Centre account for approximately 1% of onsite energy use. Net Balance proposes that the domestic hot water set point be reviewed and reduced to 60°C. Typically, when installed, these units are set at 65°C and above.

Reducing the set point just five degrees can save significant amounts of energy, especially as the site uses hot water in customer bathroom areas. The financial analysis is based on an estimated hot water use of four cylinders per weekday and a current set point of 65°C. As the current water usage and set point are estimated, this is included only as a best practice guide.

**Table 22: Financial analysis of DHW set point reduction**

| Annual energy savings | Capital expenditure | Annual cost savings | Payback |
|---|---|---|---|
| **756 kWh** | $100 | $38[1] | 2.6 years |
| **Works brief:** | | | |
| ▪ Instruct plumber to come onsite and review DHW set points<br>▪ If found to be above 60°C reduce as required<br>▪ Review taps and equipment on site for any unacceptable temperature drops | | | |

[1] Energy and cost savings for domestic hot water are calculated based on the reduced energy requirements of heating water to 65°C, apportioned to the volume of water equivalent to four cylinders of water (1,400L) per day.

## 5.6 Recommendations

The energy audit of Ripples Hydrotherapy revealed gas and electricity opportunities savings totalling $3,509 (18,713 kWh) per year, all with payback periods of less than five years. These options also result in reductions to Ripples Hydrotherapy's annual carbon footprint worth 19.2 tonnes $CO_2$-e.

**Table 23: Ripples Hydrotherapy summary of actions**

| Energy saving measure | Costs | Savings | | | Payback | Plan ref |
|---|---|---|---|---|---|---|
| | Implementation cost ($) | Cost savings ($ pa) | Energy (kWh pa) | GHGs (t $CO_2$-e pa) | years | section |
| **Cost effective actions** | | | | | | |
| Adjust cooling set points on split systems | None | $480 | 2,668 | 2.8 | Immediate | 5.5.1 |
| Install timers on pool pumps | $300[1] | $1,225 | 6,808 | 7.2 | 0.2 | 5.5.5 |
| Install sensors on pool deck lights | $800[2] | $355 | 1,972 | 2.1 | 2.3 | 5.5.4 |
| Set DHW temperature to 60°C (gas) | $100 | $38[3] | 756[3] | 0.2 | 2.6 | 5.5.6 |
| Change pool deck lights to CFLs | $1,500[2] | $526[4] | 1,878 | 2.0 | 2.9 | 5.5.3 |
| Change T8s light fittings to T5s | $4,227[2] | $885[5] | 4,631 | 4.9 | 4.8 | 5.5.2 |
| **Total** | **$6,927** | **$3,509** | **18,713** | **19.2** | **2.0** | |

Note: an aggregated electricity cost of $0.18 per kWh has been used to calculate savings. See Section 5.3 for more detail.

[1] Uninstalled

[2] Installed

[3] Energy and cost savings for domestic hot water are calculated based on the reduced energy requirements of heating water to 65°C versus 60°C, apportioned to the volume of water equivalent to four cylinders of water (1,400L) per day.

[4] Includes $188 in reduced maintenance costs.

[5] Includes $51 in reduced maintenance costs.

# 6. Joan Sutherland Performing Arts Centre

## *6.1 Site description*

The facility was initially constructed in 1990, and then significantly extended in 2005. The approximate floor area of the building is 5,744m$^2$.

The JSPAC consists of the following:

- Richard Bonynge Orchestral Hall (660 seats)
- Q Theatre (380 seats)
- Allan Mullins Hall (90 seats)
- Foyer Level 2
- Main foyer, box office and bar
- West foyer and bar
- Offices and meeting rooms
- 27 Studios, teaching and practice rooms
- Dressing, changing rooms and toilets
- Main catering kitchen and two casual kitchens

Operating hours for the site and venues vary according to performance and teaching schedules. On average, energy use starts to pick up between 7.00am and 8.00am and starts to drop down to night levels between 8.00pm and 11.00pm, depending on scheduled activities and performances.

## *6.2 Business activity*

Activity onsite can largely be split into performances (and their rehearsals) and teaching/studio activity. Studio and teaching activity occurs on a regular basis and has relatively predictable operating hours. Performance activity however is less regular although does to some extent follow that of the school terms.

Site office and teaching/studio operating hours are as follows:

| Day | Operating Hours |
|---|---|
| Mon, Tues, Thu, Fri | 9.00am – 9.00pm |
| Wednesday | 9.00am – 10.00pm |
| Saturday | 9.00am – 5.00pm |
| Sunday | As required |

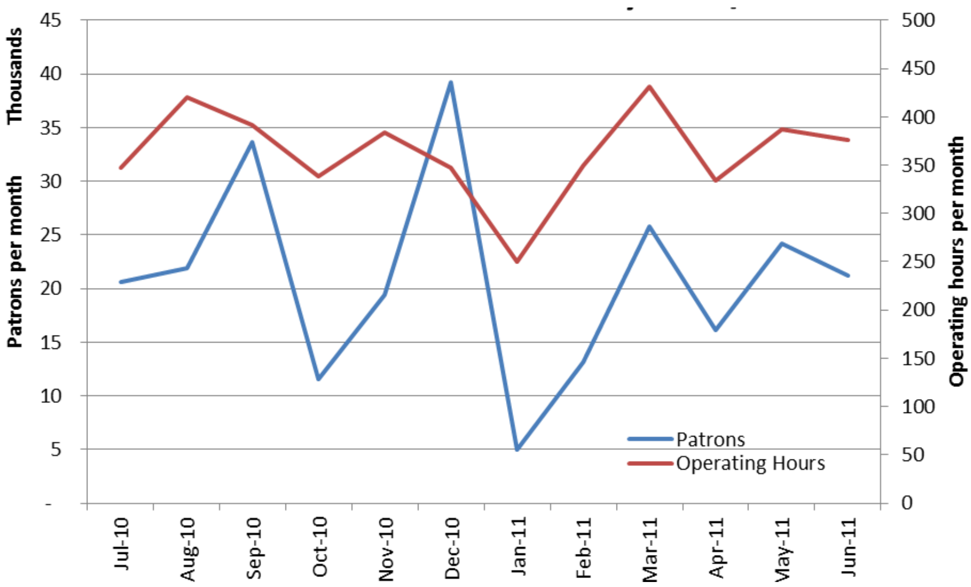


**Figure 10: Monthly business activity data for the JSPAC, 2010-11**

Figure 10 shows the large variability in patronage by month. This variability is governed by performance schedules in the concert hall and Q Theatre. Operating hours also show considerable variability across months, although less so than patronage figures. Both data sets show an annual low during January and February, and a peak at the end of the calendar year and in school terms.

## *6.3 Tariff analysis*

JSPAC is on an electricity supply contract, through Council, with Energy Australia. Unless otherwise stated, an aggregated electricity cost of $0.18 per kWh has been used for the JSPAC throughout this plan. This takes account of all energy-related charges, and includes an increase of 18% based on energy price increases modelled by the NSW Independent Pricing and Regulatory Tribunal (IPART).

Table 24 shows the tariffs paid by JSPAC in relation to electricity consumption during the Financial Year 2010-11.

**Table 24: Electricity tariffs details for JSPAC 2010-11**

| Charge | Amount | Units |
|---|---|---|
| **Energy charges** | | |
| Peak energy charge | 0.070588 | $/kWh |
| Shoulder energy charge | 0.071764 | $/kWh |
| Off peak energy charge | 0.029098 | $/kWh |
| **Network and market charges** | | |
| Peak network charge | 0.136346 | $/kWh |
| Shoulder network charge | 0.078178 | $/kWh |
| Off peak network charge | 0.012131 | $/kWh |
| Network access charge | 11.6400 | $/meter/day |
| NEM administration fee | 0.000349 | $/kWh |
| NEM ancillary fee | 0.000424 | $/kWh |
| Meter charge | 2.3288 | $/meter/day |
| Rec Surcharge (LRET) | 0.003300 | $/kWh |
| NSW GGAS surcharge | 0.001439 | $/kWh |
| NSW ESS surcharge | 0.000544 | $/kWh |

Combined energy and network charges are 20.7c/kWh for peak, 15.0c/kWh for shoulder and 4.1c/kWh for off peak. Given the price differential, there is some economic incentive to move loads from peak times towards shoulder and off peak times. Due to the nature of operations at the JSPAC, there is little scope to shift consumption, except perhaps for some of the domestic hot water heating load. This would require relatively sophisticated control mechanisms and is unlikely to provide an acceptable return on investment.

## *6.4 Energy load profiles and energy consumption patterns*

### 6.4.1 Summary of site performance

Electricity from the grid is the major source of energy used at JSPAC. In 2010-11, electrical energy use totalled 598,373 kWh at a cost of $83,772. This electricity consumption resulted in approximately 634 tonnes of carbon dioxide equivalent ($CO_2$-e) of greenhouse gas emissions. JSPAC also uses some incidental bottled gas onsite used primarily for welding in set construction.

Total energy consumption, cost and greenhouse gas emissions for JSPAC are shown in Table 25. This table shows that the major sources of energy consumption at JSPAC are the lighting and the heating, ventilation and air conditioning (HVAC) units.

**Table 25: Split of energy consumption, 2010-11**

| Area | Energy consumption (kWh) | % total energy consumption | Energy cost ($) | Greenhouse gas emissions (t CO2-e)[1] |
|---|---|---|---|---|
| Lighting – stage | 6,650 | 1.1% | $931 | 7.0 |
| Lighting – other | 220,000 | 36.8% | $30,800 | 233.2 |
| Domestic Hot Water | 22,464 | 3.8% | $3,145 | 23.8 |
| HVAC | 269,800 | 45.1% | $37,772 | 286.0 |
| General Power | 79,459 | 13.3% | $11,124 | 84.2 |
| **TOTAL** | **598,373** | **100%** | **$83,772** | **634.3** |

[1] 2011 National Greenhouse Accounts (NGA) emissions factors for electricity were used to determine these values.

This information is presented in Figure 11.

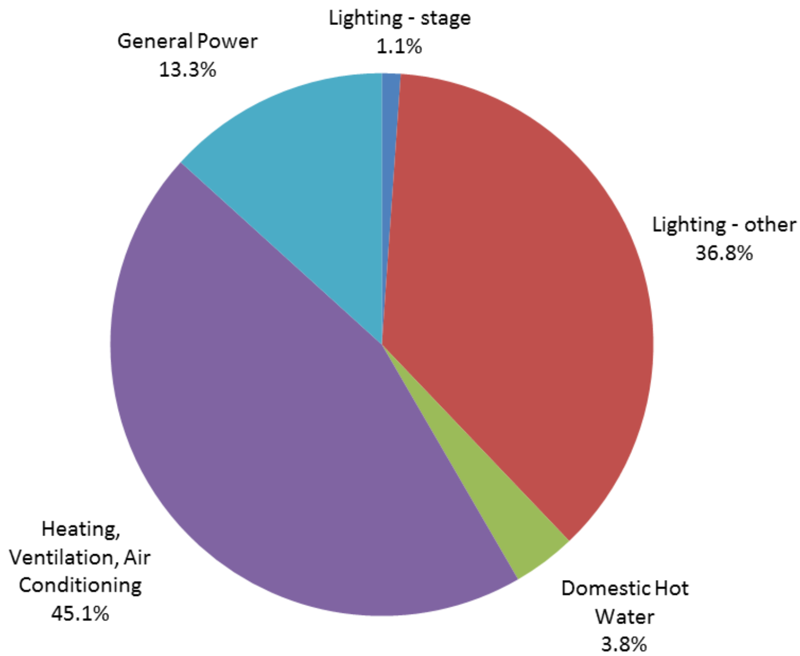


**Figure 11: Breakdown of energy consumption, 2010-11**

### 6.4.2 Annual profile

Electricity use is broadly stable throughout the year but shows some consistent patterns as it is closely related to performance activity. Performance activity has increased gradually over the period 2009-11, and a corresponding increase in energy use can be seen in Figure 12. The profile shows consistently low energy use during school holidays in April and September and to a lesser extent during July. Peak energy consumption months are March, August and December corresponding with term and year-end performances. January and February are typically quiet months and consequently show relatively low energy consumption despite being the hottest months of the year and HVAC demands forming the largest component of energy consumption for the JSPAC. This indicates that measures in place to control energy use whilst rehearsal and production activity is low are working.

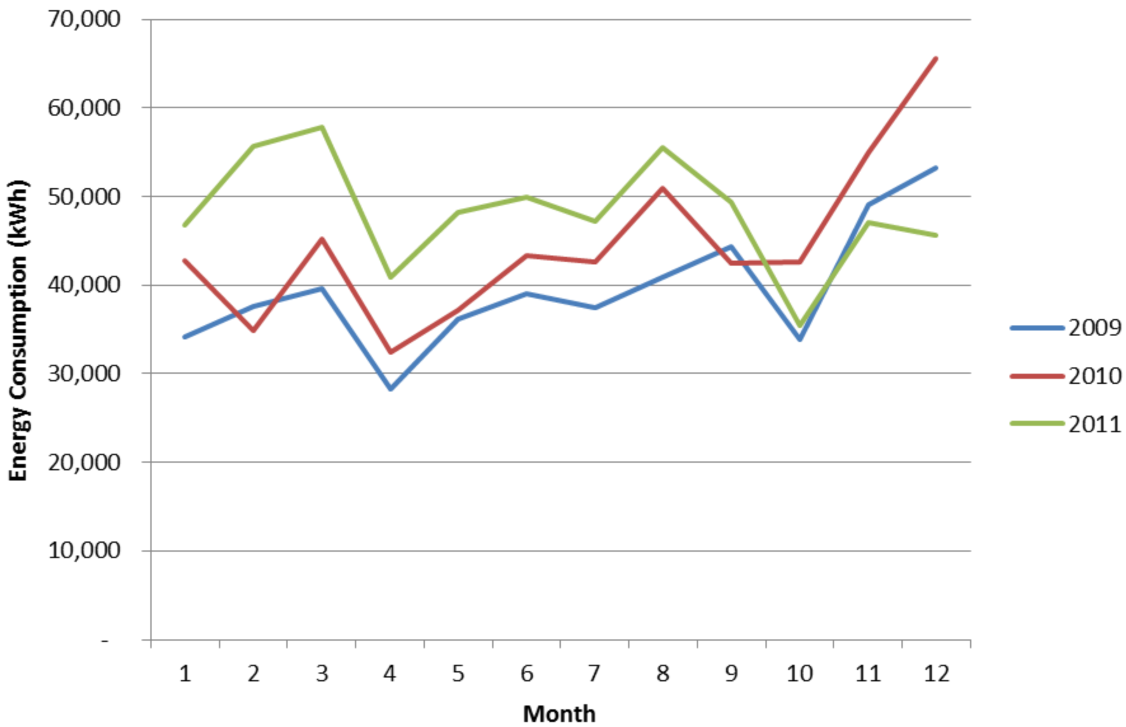


**Figure 12: Monthly energy use profile, 2009-11**

### 6.4.3 Weekly profile

Figure 13 shows the weekly energy consumption profiles for March, October and December 2011. These months were chosen to represent the highest (March), lowest (October) and an intermediate (December) energy consumption months.

All three profiles show a lower consumption on Sundays. The March and October profiles show a gradual increase in consumption during the week and then tailing off again on Saturdays. The December profile is unusual in that it shows a peak in consumption on the Monday. This is likely due to the unusual performance timetables during the Christmas period.

This pattern is also reflected in the site teaching and operating hours shown in Section 6.2.

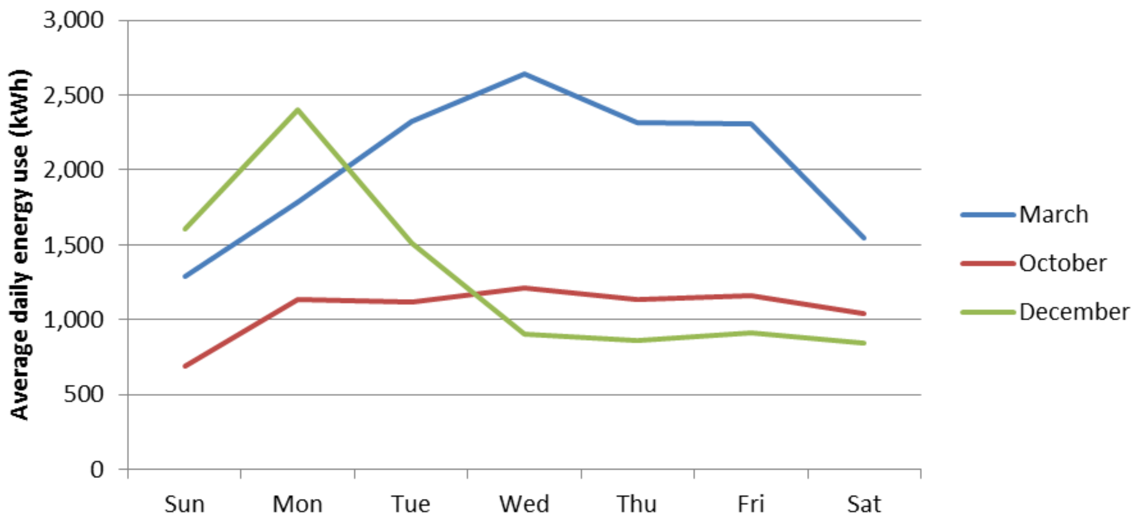


**Figure 13: Weekly average energy use profiles, March, October and December 2011**

### 6.4.4 Daily profile

Figure shows the average half hourly interval energy consumption by month. February, April and July were chosen to show variations in profile through heating, cooling and temperate seasons. December was chosen to show the profile during the busiest performance season.

The April profile shows the lowest energy use. This is due to the relative absence of heating and cooling loads. This profile shows a rise, peak and fall in line with normal office operating hours to a minimum at about 5.00pm, and then increases again from about 6.00pm as evening activities in the studios and teaching rooms increase. This activity and energy use falls gradually from a peak at 7:30pm until it reaches the overnight low at about 11:30pm.

The month of July shows a similar profile, with some additional heating loads, particularly in the morning, in order to bring the building interior up to a comfortable operating temperature. The July profile shows a minimum during the day in the early afternoon before increasing again to a peak at 5:30pm. This is likely due to the reduced heating demand during the day due to internal gains from occupants and solar gain, and then additional heating demand as these gains reduce and outside temperatures drop into the early evening. The July profile drops off from 8.00pm to the overnight low at about 11:30pm.

The February profile shows energy consumption during the cooling season (ie. when air conditioning is required) and when performance activity is relatively low. It shows an earlier rise in energy use than the other profiles. This rise starting at 5.00am is possibly due to cleaning activity and/or early activation of the cooling system. This would appear to be too early, and might represent an opportunity for energy saving by delaying this increase in energy use.

The February profile is considerably higher than the other months, reflecting the high energy use of the cooling system. The cooling demand appears to peak at about 3.00pm before dropping to a shoulder during evening activities and then dropping from 8.00pm to the overnight low from 11:30pm as per the other profiles. The profile shows an early drop off from the peak consumption than expected, which may be due to the trees and roof to the western end of the JSPAC providing afternoon shading. By contrast, the large northern aspect has relatively little protection from the sun during the middle of the day as shown in Figure 15. This northern aspect glazing was also noted by site staff during the audit as contributing to overheating issues through solar gain (Figure 16).

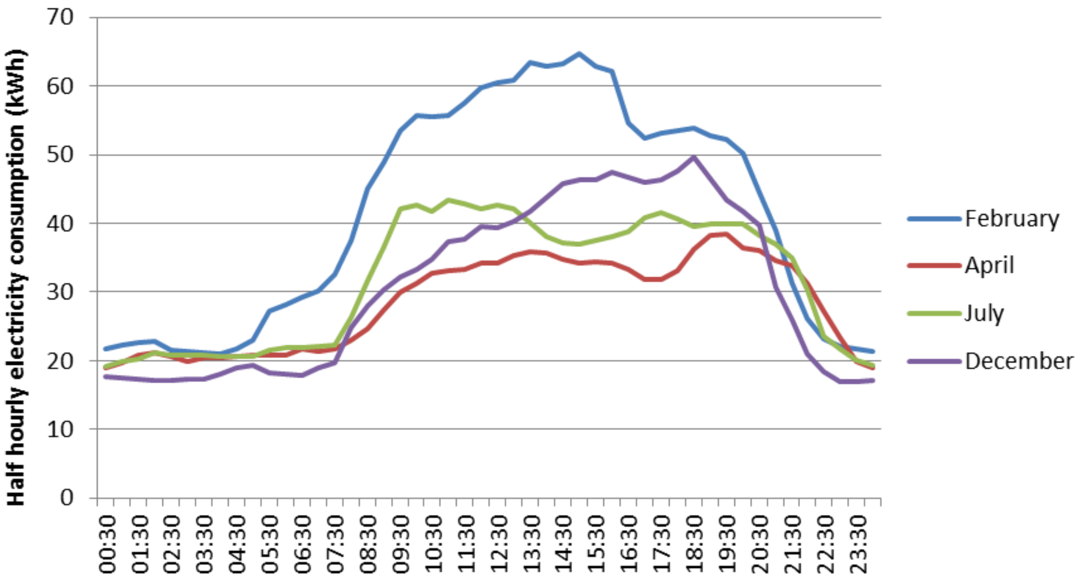


**Figure 14: Average 30 minute interval energy consumption by month, 2011**


**Figure 15: Aerial view of JSPAC showing large northern aspect**

**Figure 16: Solar gain through northern aspect glazing (taken at 12:44pm on 7th March)**

## *6.5 Findings of the site audit*

**Demand analysis and power factor**

JSPAC has a relatively low (poor) power factor[5], at an average of 85% during 2010-11. This is shown below in Figure 17. The power factor was lowest during the first part of 2011, but then improved from November. The JSPAC is not currently on a demand tariff and so despite the relatively poor performance, power factor correction is not considered financially viable at this time.

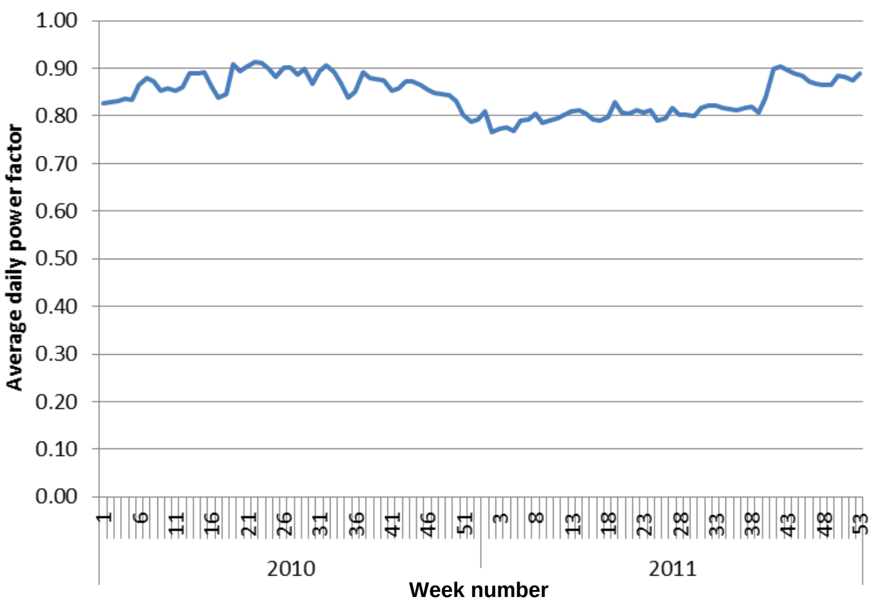


**Figure 17: Average daily power factor, JSPAC, 2010-11**

[5] Power factor is the ratio of the real power flowing to the load, to the apparent power in the circuit. Essentially, it shows the level of synchronisation between the power actually being used by an appliance, compared to the power in the circuit. The power factor ranges between 0 and 1. A power factor of 1 is optimal, and indicates a complete synchronicity between real and apparent power.

### 6.5.1 Voltage optimisation

Within Australia the agreed statutory range for voltage is 230V -6% to +10%. To ensure that the sites located at the extremities of the grid receive voltage above the minimum allowable level, the majority of premises receive voltage at the high end of this range. At the JSPAC the average voltage measured during sub-metering was 247. Equipment onsite is therefore being used at a higher voltage than it was designed and optimised for. This over-voltage results in unnecessary energy consumption.

Due to the relationship between voltage, power and energy, correcting a relatively small over-voltage can lead to significant energy consumption savings. In addition, equipment operating at higher voltage levels will degrade more quickly due to the additional energy being lost through heat and vibration. Correcting this will lead to both reduced energy and maintenance costs.

Net Balance engaged Energywise to provide a quote for their Ark system based on metered electricity data and the site visit. Energywise also provided calculations showing the effects of voltage optimisation without the non-stage lighting retrofit. The capital expenditure would remain the same with the energy savings increasing to 69,600 kWh or $10,903 decreasing the payback to 3.3 years. This is because voltage reduction would provide fewer savings when used in conjunction with more energy efficient lighting retrofits.

**Table 26: Financial analysis of voltage optimisation – non-stage lighting retrofitted**

| Annual energy savings | Capital expenditure | Annual cost savings | Payback |
|---|---|---|---|
| **43,500 kWh**[1] | $39,741 | $6,814 | 4.8 years |
| **Works brief:** | | | |
| ▪ Engage Energywise, or a similar provider, to conduct a detailed site audit to confirm installation requirements | | | |

[1] Saving figures were calculated by Energywise using a slightly different unit energy cost to the one used by Net Balance through the rest of this report.

**Building management systems (BMS)**

Two building management systems (BMS) are in place at JSPAC. The main BMS is used through a computer interface in the basement office and is supplied by Doust Automation and Control and was installed as part of the building extension in 2005. This BMS controls the HVAC units servicing the Q Theatre, concert hall, Allan Mullins Hall, lobbies and public areas. The BMS is managed by the onsite Technical Manager and has schedules per zone that match the performance calendar.

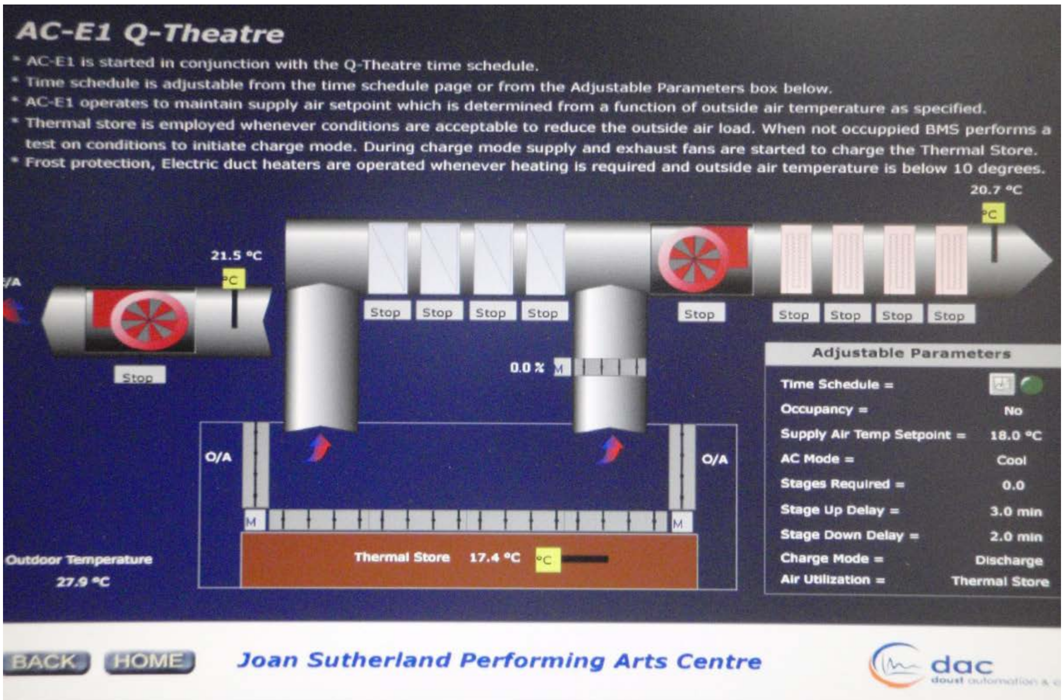


**Figure 18: BMS screenshot**

A number of issues were reported by site technical staff in operation of this BMS including:

- poor cooling performance in the lobby and public areas;
- temperature overshoot issues in the concert hall and Allan Mullins Hall (due to inadequate sensing equipment and/or poor positioning in these areas);
- temperature stratification issues in the concert hall;
- Q Theatre control issues when the outside temperature goes below 10$^{o}$C; and
- lobby and public areas control issues.

JSPAC has previously received quotes from the BMS contractors to investigate and potentially resolve these issues but these have not been followed through due to the high costs involved. The studio and teaching room air conditioning units are controlled by a separate BMS which defines operating schedules and temperature set points for these rooms.


**Figure 19: Studio and teaching**

### 6.5.2 BMS and control systems tuning

Several issues were reported by onsite technical and maintenance staff regarding the operation of the BMS and HVAC systems. These included:

- intake of outside air to the Q Theatre when outside temperatures drop below 10$^{o}$C
- temperature overshooting within the Concert Hall and Alan Mullins Room
- loss of control in the foyer requiring resetting to manual mode.

These issues compromise the HVAC system performance and efficiency. Net Balance understands that Council have previously engaged Doust Automation & Control (dac), the BMS providers, to investigate foyer control issues, and that this work was not undertaken on the basis of costs. Using data obtained during sub-metering, Net Balance estimates the energy and cost implications of the current inefficiency to be 5-10% of the current performance as shown in Table 27. Using this estimate, Council will be able to more effectively evaluate existing and future quotes from BMS contractors.

**Table 27: Financial analysis of BMS and control systems tuning**

| Annual energy savings | Capital expenditure | Annual cost savings | Payback |
|---|---|---|---|
| **3,900 kWh** | None | $700 | Immediate |
| **Works brief:** | | | |
| ▪ Review costs and payback of previous quote from dac using above efficiency loss estimates | | | |
| ▪ Re-engage dac to understand options for confirming and correcting current faults | | | |

## Heating, Ventilation and Air Conditioning (HVAC)

HVAC equipment at the JSPAC is split into two main types: larger centralised ducted systems for the large areas and smaller split systems for the offices and teaching rooms. The larger systems are controlled by the central building management system (BMS) and are set to run in line with performance schedules. The smaller split systems are controlled centrally by a separate management system. The current teaching room installation configuration means that the rooms are all simultaneously conditioned to the same temperature. The JSPAC also has specialised ventilation equipment serving the main kitchen and the toilets.

The HVAC equipment energy consumption forms a large part of overall site demand and was hence the focus of sub-metering efforts within this audit.

### HVAC equipment summary

Approximate details of the HVAC equipment used at the JSPAC are shown in Table 28.

**Table 28: Heating and associated plant at JSPAC**

| Serviced location | No. of units | Make | Approx. rating (Heat/Cool kW) | Year installed |
|---|---|---|---|---|
| Concert hall | 3 | Frigopol | ?/48 | 1990 |
| Q Theatre | 1 | Unknown | Unknown | 2005 |
| Allan Mullins hall | 1 | Frigopol | Unknown | 1990 |
| East lobby first floor foyer | 2 | APAC | ?/226 | 2004 |
| Concert hall lobby | 1 | APAC | ?/98 | 2004 |
| Studio and teaching rooms | 6 | Daikin | 38/36 | 2005 |
| Kitchen | 1 | Diakin | 8/7 | 2005 |
| Offices, meeting rooms, fans, etc. | 10 est. | Various | - | 2000-2005 |

### 6.5.3 Electronic expansion valve fitting to East and West Lobby HVAC plant

The JSPAC has previously received details of an Electronic Expansion Valve (EEV) energy saving opportunity from HVAC maintenance contractors. Fitting EEVs to the older HVAC plant that serves the original part of the building will result in this plant running more efficiently. Costs and savings are taken from the quote provided by James & Scott Air to the JSPAC in October 2011.

Key assumptions used within calculations are a 20% efficiency improvement which is taken as a conservative figure (James & Scott Air report savings of up to 30% can reasonably be expected) and 2,000 operating hours per year (or approximately 5.5hrs/day).

**Table 29: Financial analysis of EEV fitting to East and West Lobby HVAC plant**

| Annual energy savings | Capital expenditure | Annual cost savings | Payback |
|---|---|---|---|
| **22,400 kWh** | $39,680 | $4,032 | 9.8 years |
| **Works brief:** | | | |
| ▪ Confirm options for EEV upgrade with new HVAC maintenance contractor | | | |

### 6.5.4 Temperature sensors in the Concert Hall and Allan Mullins room

The HVAC systems in the Allan Mullins room and Concert Hall appear to overshoot temperature settings leading to reduced occupant thermal comfort and unnecessary energy use through plant cycling. In theory this can be rectified by a combination of sensor equipment and BMS damping. Capital expenditure costs and energy savings in this area are estimations only, and are based on anecdotal accounts of onsite technical and maintenance staff during the site visit, sub-metering of the HVAC loads and assuming a 10% efficiency gain is achieved. Due to this difficulty in providing accurate figures in Table 30, Net Balance recommends engaging HVAC maintenance contractors to investigate the issue and present recommendations. These can then be evaluated in context of the estimated annual savings presented.

**Table 30: Financial analysis of improved temperature sensors in the Allan Mullins room and Concert Hall**

| Annual energy savings | Capital expenditure | Annual cost savings | Payback |
|---|---|---|---|
| **5,000 kWh** | $4,500[1] | $900 | 5 years |
| **Works brief:** | | | |
| ▪ Engage HVAC maintenance contractors and/or dac to confirm and resolve sensor issues | | | |

[1] Recommended budget to achieve 5 year payback.

**Concert hall diffusers**
As noted in Section 6.5.2, site technical and maintenance staff reported issues experienced by concert hall audience members with temperature stratification. This was thought to be more of an issue towards the back of the hall where the HVAC diffusers are closer to the seating.

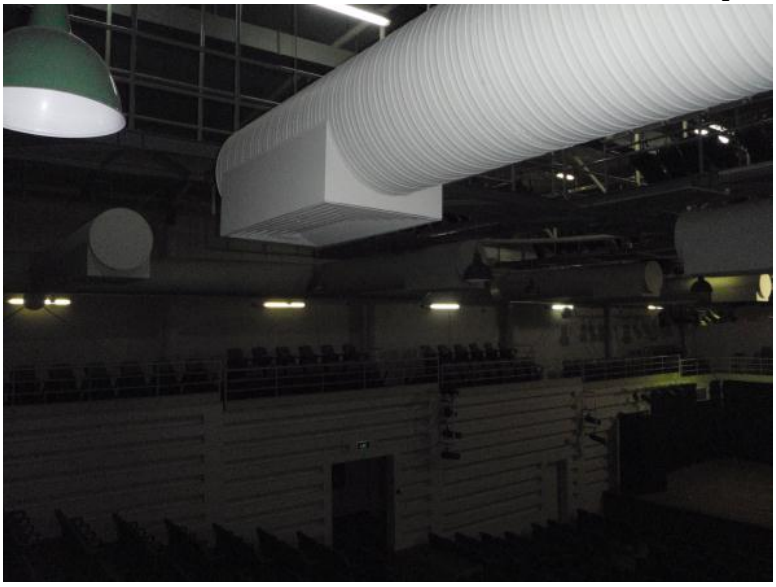

**Figure 20: Concert Hall HVAC diffusers**

The desired outcome is to change the discharge pattern to reduce the 'throw' and/or 'drop' of the conditioned air in this area. This could be achieved by a number of approaches including adjusting terminal velocity at the diffuser and changing the current louver faced diffusers to a diffuser that more effectively mixes the incoming cold air with concert hall air prior to reaching the audience. This could be done at an estimated cost of $500.

**Lighting**
As part of the audit, Net Balance engaged the expert lighting services of Julien Freed Consulting due to the specialist nature of some of the lighting used onsite. Lighting at the JSPAC can be split into specialist lighting used onstage, and the residual general lighting for common areas, foyers, offices, teaching rooms, bathrooms and outdoor areas.

**Specialist stage lighting**
Specialist stage lighting consists of a wide variety of light sources that are typically incandescent, rated in the 0.5-1.2kW range and are only used for short periods of time during performances and rehearsals. The lighting outcomes provided by these units are highly specific, and any energy efficiency-focussed replacements will need to be carefully chosen in order to maintain these important outcomes. Energy efficient lighting that maintains these outcomes does typically exist but is highly specialised and expensive. Despite offering significant power reductions and extended lifetimes, due to the short run times of these units, their expense can rarely be justified on the basis of energy and maintenance cost savings alone.

### 6.5.5 Lighting (non-stage)

Other lighting throughout the JSPAC is more traditional and provides area and task lighting. Non-stage lighting throughout the JSPAC is controlled manually via a local switch for each area.

Two of the components critical to efficient lighting energy use are the lamp/luminaire, and the lighting control system. Onsite lighting control systems, although simple in nature, appeared to be well used by staff during the site visit. The energy efficiency opportunities included in this plan are targeted at lamp and luminaire upgrades.

Lighting technologies currently used throughout the site vary significantly and predominantly include incandescent, halogen, metal halide, linear and compact fluorescent technologies. 'Total cost of ownership' models were used to analyse current lamps/luminaires and potential upgrades. An aggregate of recommendations with a payback of less than 5 years is shown belowin Figure 31.

**Figure 31: Financial analysis of recommended lighting upgrades (aggregate)**

| Annual energy savings | Capital expenditure | Annual cost savings | Payback |
|---|---|---|---|
| **108,587 kWh** | $98,440 | $28,490[1] | 3.5 years |
| **Works brief:** | | | |
| ▪ Review detailed list of recommendations and prioritise replacements by payback<br>▪ Full suggested product descriptions have been provided as an accompanying spreadsheet to this Plan<br>▪ Julien Freed has agreed to provide support as required for exact product selection advice, additional guidance and implementation | | | |

[1] Includes $8,944 in maintenance cost savings.

**Domestic hot water**

The JSPAC site is served by a main bank of three 315L electric powered boilers located close to the changing rooms. The site also has a single 275L electric powered air sourced heat pump boiler located behind the concert hall bar. It was not clear whether this served more than just the bar, but the unit looks to be significantly oversized. The east bar has a smaller 50L electric boiler.

In addition, there are five instant hot water boilers located throughout the site. Each of these units is turned on permanently.

### 6.5.6 Load management (sequence control)

The required hot water loads onsite at JSPAC vary over time. A sequence control load management strategy for bringing the right-sized boilers online and offline to match the required loads can increase energy efficiency. Fewer boilers operating at higher loads is generally a more energy efficient configuration than all boilers operating at lower loads.

More detailed analysis and conversations with the boiler manufacturers and commercial plumbing contractors have resulted in this opportunity becoming less attractive than indicated by the interim assessment, as indicated in Table 32.

**Table 32: Financial analysis of installing sequencing load management**

| Annual energy savings | Capital expenditure | Annual cost savings | Payback |
|---|---|---|---|
| **1,240 kWh** | $7,000[1] | $223 | 31 years |
| **Works brief:** | | | |
| ▪ Consider incorporating hot water load sequencing into major renovations/works if these are undertaken in the future | | | |

[1] Estimated

### 6.5.7 Load management (timer control)

Linking the DHW boilers into the BMS will allow the units energy use to be linked into the demand schedules. This will help to minimise energy used to provide hot water whilst there is little or no demand. Net Balance has estimated a saving of 1.5kWh per boiler per night.

**Figure 33: Financial analysis of installing timer DHW control**

| Annual energy savings | Capital expenditure | Annual cost savings | Payback |
|---|---|---|---|
| **1,697 kWh** | $2,000 | $305 | 6.5 years |
| **Works brief:** | | | |
| ▪ Consider inclusion when the current boiler plant is replaced | | | |

**Bars and kitchens**

The JSPAC has two bars (one in each lobby), a main catering kitchen and a number of smaller kitchens onsite. Across these there are a number of fridges, microwaves and other equipment.

The fridges are the largest energy user in these facilities due to their constant operation. Remaining equipment is only used for short periods of time and is therefore unlikely to contribute materially to site energy use.

**Offices**

The JSPAC has two main and a number of smaller office areas. In total, these areas contain an estimated 40 workstations with desktop computers, screens and supporting office equipment. These areas operate during normal office hours plus some additional use to support teaching and performances after hours and over the weekends.

**Mechanical equipment**

Other electricity consuming items onsite include some mechanical equipment comprised of a vertical lift (primarily serving the studios), assorted workshop equipment, and some lifting equipment (including a forklift which receives very little use).

## 6.6 Recommendations

The energy audit revealed opportunities with a less than five-year payback period resulting in savings totalling up to $36,004 (155,987 kWh) per year. These options also result in reductions in carbon output of 164.8 tonnes $CO_2$-e. Other opportunities worth approximately $1,428 (7,937 kWh) per year were identified that were outside a five-year payback period. The annual greenhouse savings associated with these measures is 8.4 tonnes $CO_2$-e.

**Table 34: JSPAC summary of actions**

| Energy saving measure | Costs | Savings | | | Payback | Plan ref |
|---|---|---|---|---|---|---|
| | Implementation cost | Cost savings ($ pa) | Energy (kWh pa) | GHGs (t $CO_2$-e pa) | years | section |
| **Cost effective actions** | | | | | | |
| 6.5.2 BMS and control systems tuning | None | $700 | 3,900 | 4.1 | Immediate | 6.5.2 |
| Lighting (non-stage) | $98,440 | $28,490[1] | 108,587 | 114.7 | 3.5 | 6.5.5 |
| Voltage optimisation (with lighting retrofitted) | $39,741 | $6,814[2] | 43,500 | 46.0 | 4.8 | 6.5.1 |
| **Total** | **$138,181** | **$36,004** | **155,987** | **164.8** | **3.8** | |
| **Potentially cost effective** | | | | | | |
| Temperature sensors in the Concert Hall and Allan Mullins Room | $4,500[3] | $900 | 5,000 | 5.3 | 5 | 6.5.4 |
| Load management (timer control) | $2,000 | $305 | 1,697 | 1.8 | 6.5 | 6.5.7 |
| **Total** | **$6,500** | **$1,205** | **6,697** | **7.1** | **5.4** | |
| **Other actions** | | | | | | |
| 6.5.6 Load management (sequence control) | $7,000[4] | $223 | 1,240 | 1.3 | 31 | 6.5.6 |

Note: An aggregated electricity cost of $0.18 per kWh has been used to calculate savings. See Section 6.3 for more detail.
[1] Includes $8,944 in reduced maintenance costs.
[2] Costings were performed by Energywise using a slightly different unit energy cost to the one used by Net Balance throughout the rest of the Plan.
[3] Recommended budget to achieve 5 year payback.
[4] Estimated

# 7. Penrith Regional Gallery and The Lewers Bequest

## *7.1 Site description*

The Penrith Regional Gallery and The Lewers Bequest (Gallery) is situated in Emu Plains west of Penrith in Western Sydney, and was established in 1981. The Gallery presents exhibitions, education and workshop programs and special events. The site is made up of various buildings with the approximate floor area being 1,900m$^2$.

The Gallery consists of the following areas:

- Main Gallery
- Lewers House
- Ancher House
- Sonia Farley Studios
- Lounge room and reception
- Offices
- Café
- Outdoor seating
- Storage
- Staff kitchen
- Toilets
- Gardens.

The site is made up of a variety of buildings and constructions. The Lewers House Gallery is the oldest building and dates back to 1905. The gallery was launched in 1981 and had significant extensions and upgrades undertaken in 2005.

The Gallery and café opening hours are listed below. They are also closed Christmas Day, Boxing Day, New Year's Day and Good Friday.

| | | |
|---|---|---|
| Gallery | Monday to Sunday | 9.00am – 5.00pm |
| Café | Wednesday to Friday | 9.00am – 3.00pm |
| | Saturday and Sunday | 8.00am – 4.00pm |

## *7.2 Tariff analysis*

The Gallery is on an electricity supply contract, through Council, with Energy Australia. Table 35 shows the tariffs paid by the Gallery in relation to electricity consumption in 2010-11. Calculations for the Gallery are based on an electricity price of $0.145 per kWh. All prices are inclusive of GST.

**Table 35: Electricity tariffs details for the Gallery 2010-11**

| Charge | Amount | Units |
|---|---|---|
| **Energy charges** | | |
| Peak energy charge | 0.070588 | $/kWh |
| Shoulder energy charge | 0.071764 | $/kWh |
| Off peak energy charge | 0.029098 | $/kWh |
| **Network and market charges** | | |
| Peak network charge | 0.039151 | $/kWh |
| Shoulder network charge | 0.025028 | $/kWh |
| Off peak network charge | 0.009106 | $/kWh |
| Demand charges | 12.3193 | $/kVA |
| Network access charge | 11.6400 | $/day |
| NEM administration fee | 0.000401 | $/kWh |
| NEM ancillary fee | 0.000424 | $/kWh |
| Meter charge | 2.3288 | $/day |
| REC surcharge (LRET) | 0.002615 | $/kWh |
| REC surcharge (SRES) | 0.005920 | $/kWh |
| NSW GGAS surcharge | 0.001439 | $/kWh |
| NSW ESS surcharge | 0.000499 | $/kWh |

Combined energy and network charges are 11.0 c/kWh, 9.7 c/kWh and 3.8 c/kWh for peak, shoulder and off peak times respectively. Peak demand charges typically make up about one quarter of the Gallery's electricity bills. Given the price differential, there is some economic incentive to move loads from peak towards shoulder and off peak. However, due to the nature of operations at the Gallery and HVAC comprising the bulk of the electricity load, there is little scope to shift consumption. This could be achieved using equipment with a storage capacity, however, the added capital expense is unlikely to be paid back within attractive timeframes.

## *7.3 Energy load profiles and energy consumption patterns*

### 7.3.1 Summary of site performance

Electricity from the grid is the only source of energy used at the Gallery. During financial year 2010-11, energy use at the Gallery totalled 355,000 kWh at a cost of approximately $43,723. This electricity consumption resulted in approximately 376 tonnes carbon dioxide equivalent ($CO_2$-e) of greenhouse gas emissions.

Total energy consumption, cost and greenhouse gas emissions for the Gallery are shown in Table 36.

The approximate breakdown of energy use across the site is shown in Figure 21. This Figure shows that the major sources of energy consumption at the Gallery are heating, ventilation and air conditioning (HVAC) and lighting.

**Table 36: Split of energy consumption, 2010-11**

| Area | Energy type | Energy consumption (kWh) | % total energy consumption | Energy cost | GHG emissions (t $CO_2$-e)[6] |
|---|---|---|---|---|---|
| HVAC | Electricity | 240,000 | 67.6 | $29,559 | 254 |
| Lighting | Electricity | 95,000 | 26.8 | $11,701 | 101 |
| General Power | Electricity | 20,000 | 5.6 | $2,463 | 21 |
| **TOTAL** | | **355,000** | **100** | **$43,723** | **376** |

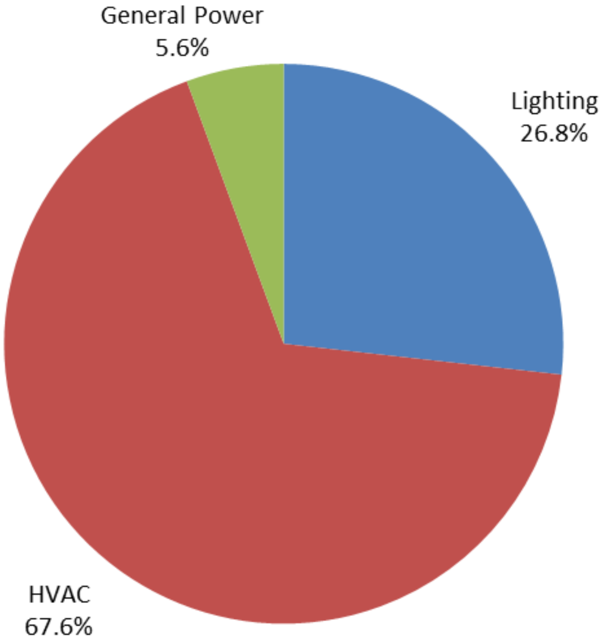


**Figure 21: Breakdown of energy consumption, 2010-11**

## 7.3.2 Annual profile

Figure 22 shows the monthly electricity consumption profile for calendar years 2009, 2010 and 2011. Early 2009 shows a different power consumption profile to 2010 and 2011 (lower in January and February and higher in April). Power use is also slightly lower in December than January and February. This is likely due to the increased cooling requirements during January and February as demonstrated by

[6] 2011 National Greenhouse Accounts (NGA) scope 2 and 3 emissions factors for electricity were used to determine these values.

the higher number of cooling degree days in these months. The reduced December consumption figures may also be due to the Gallery being closed over the Christmas period.

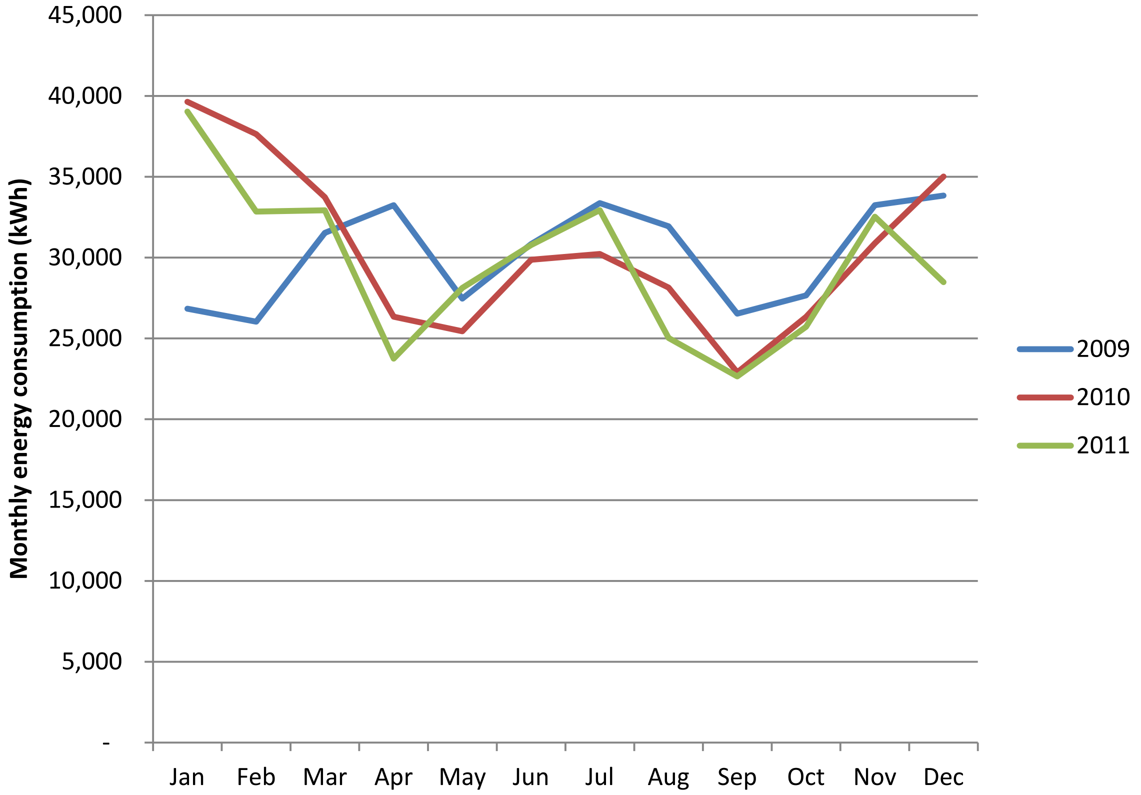


**Figure 22: Monthly electricity use profile, 2009-11**

### 7.3.3 Weekly profile

Figure 23 shows the weekly power use profile varies little during the week. This is due to the Gallery being open seven days a week and the main loads (HVAC and lighting) operating regardless of visitor numbers. The slightly lower consumption for Monday and Tuesdays is likely due to the café being closed.

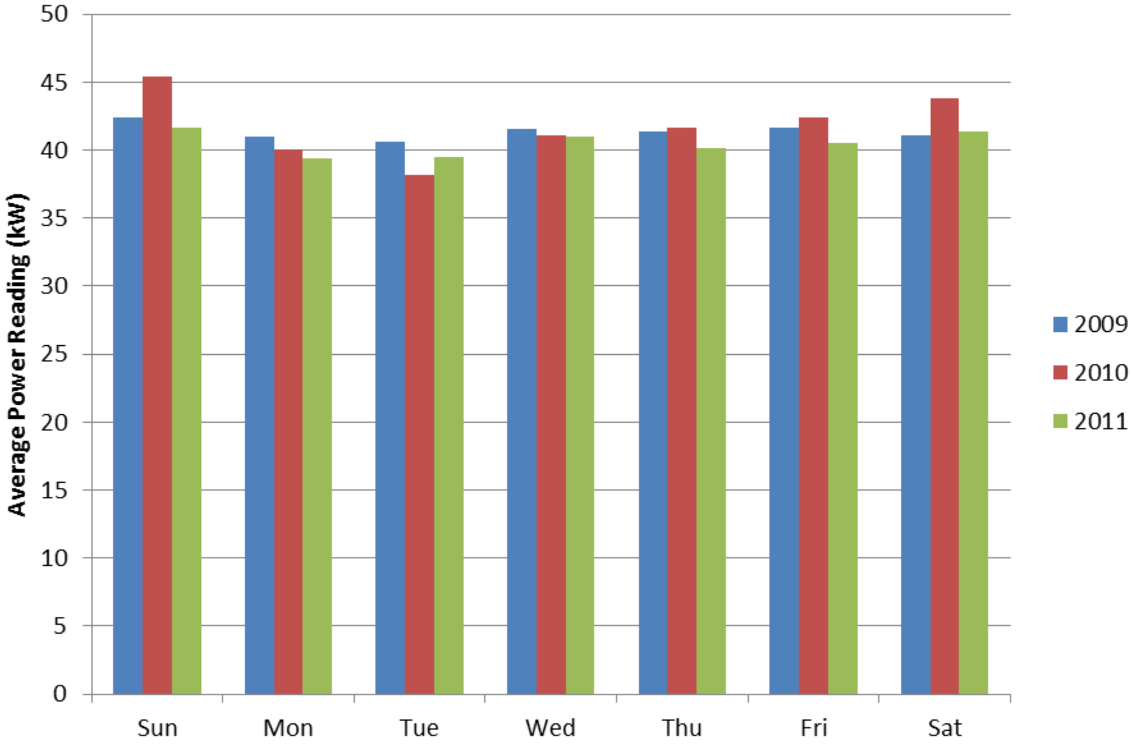


**Figure 23: Weekly power use profiles, 2009-11**

### 7.3.4 Daily profile

Profiles for January, May, July and September have been selected to show seasonal conditions.

The spring and autumn profiles are generally lower than the summer and winter profiles due to reduced heating and cooling requirements. There will still be significant heating and cooling requirements during the night and day due to the narrow temperature and humidity requirements associated with the protection of artworks. The May profile shows an earlier peak and an earlier rise in power consumption after closing which indicates a dominance of heating requirements when compared to the September profile which has a peak in the afternoon coincident with maximum cooling requirements. Both the September and May profiles show a local peak in power consumption at 7.00am and 9:30am respectively. This is likely to be due to equipment being turned on during the morning (e.g. electric fan heaters). These peaks are also more subtly reflected in the other profiles.

Figure 24 shows the daily power use profiles for January, May, July and September. These months were chosen to illustrate the different profiles during spring, summer, autumn and winter.

The summer profile shows the highest power consumption due to the cooling requirements. The power consumption increases during opening hours from the overnight base due to the added load on the HVAC systems compensating for the increased internal heat gains from solar radiation, increased outside temperatures, lighting and people. The summer profile shows a peak during the afternoon which starts to reduce at about 4.00pm to a minimum at about 7.30pm when the building has cooled down. The overnight base consumption is relatively high compared to the other months. This may be due to continued cooling requirements overnight and/or additional dehumidification loads during the summer. Curiously the overnight profile shows a very slight rise to midnight and then a fall again to opening hours, this may be temperature related and indicate that one or more areas are calling for heating overnight.

The winter profile shows an earlier and higher peak at 9.30am. The power consumption rises gradually from midnight to this peak except for a slight jump at 7.30am. This is likely due to the increasing heating demands as the outside temperature drops until the sun rises, and then the additional lighting loads as the lights are returned to full use during operating hours. Power consumption then falls fairly rapidly during opening hours to a minimum at 6.00pm. This is likely due to the reduced heating requirements whilst the buildings are receiving the heating effects of the sun, increased outside air temperature and internal gains from lighting and people. Power consumption then rises throughout the night due to the increasing heating loads as the building and surrounding air cools.

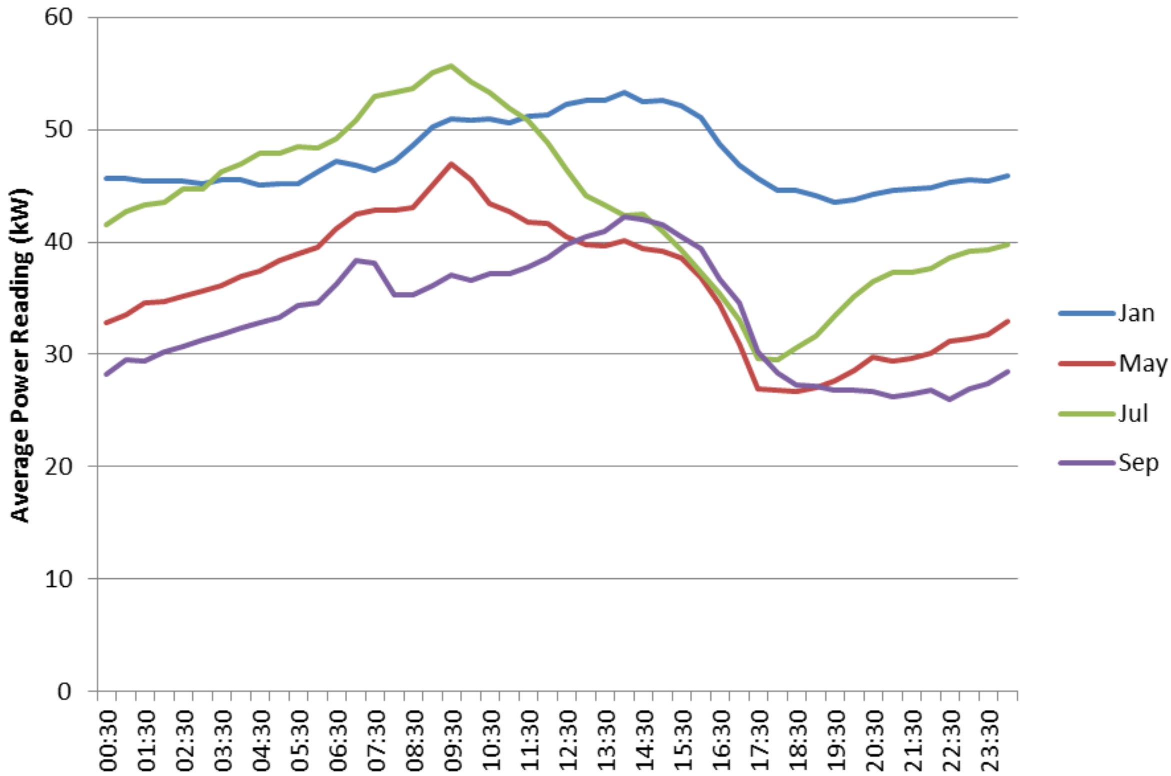


**Figure 24: Daily power use profile**

## *7.4 Findings of site audit*

**Building fabric**

At the time of the audit, consultants noted several areas of water and damp damage, poorly maintained seals and window and door fittings. These will tend to increase the infiltration rate (uncontrolled ventilation) and result in conditioned air being lost to the environment, which places greater loads on the HVAC equipment and increases energy use. The newer buildings generally have low levels of exposed thermal mass resulting in (potential) relatively large diurnal internal temperature swings. These are countered by the constant use of the HVAC plant, again consuming more energy as the Gallery spaces will often be cooled during the day and then heated overnight. This is shown on the daily energy use profiles and is further confirmed by the onsite thermography performed by Thermal Imaging Cameras Australia.

### 7.4.1 Infiltration reduction and building fabric

The buildings suffer from high rates of infiltration. Infiltration is uncontrolled ventilation and results in conditioned air being lost from the building which is replaced by air from outside. As a result the HVAC equipment needs to use more power to maintain the internal conditions required by occupants and artwork. Infiltration is measured in air change rate, which is the number of times the internal air volume is exchanged with the outside per hour. Best practice and recommended air change rates for public buildings such as libraries and galleries are between 4 and 6 air changes per hour. We estimate that the current infiltration rate is likely to be significantly above this (in the region of 8 to 10) due to missing seals or poor maintenance of existing seals around doors and windows, poorly fitting doors and windows and missing or damaged insulation.

In order to further investigate this issue and pinpoint areas for improvement, Net Balance commissioned a thermography study by Thermal Imaging Cameras Australia. Net Balance has estimated the energy and cost savings available from making improvements in building air tightness for the Gallery spaces. Improved air tightness will reduce infiltration and associated energy inefficiencies. Net Balance have modelled a reduction in infiltration rates of two air changes per hour, i.e. an improvement from 8-10 air changes per hour to 6-8 air changes per hour (which is still outside recommendations of 4-6 air changes per hour for public buildings such as galleries).

**Table 37: Financial analysis of infiltration reduction and building fabric**

| Annual energy savings (kWh) | Capital expenditure | Annual cost savings | Payback (years) |
|---|---|---|---|
| 30,593 | TBD | $4,446 | TBD |
| **Works brief:** | | | |
| ▪ Obtain quotes from contractors to implement recommendations included in the thermography report. Compare these quotes with the calculated savings available. | | | |

## Heating, Ventilation and Air Conditioning (HVAC)

HVAC equipment is used for both heating and cooling at the Gallery and is manually operated by the staff. HVAC is used onsite to provide comfortable conditions for Gallery visitors and staff during operating hours, but is also used to maintain conditions in order to best protect artwork being stored and displayed. This latter requirement means that most of the HVAC systems need to be run 24 hours a day, 7 days a week. This requirement to maintain appropriate conditions (both temperature and humidity) to avoid damaging artwork is clearly critical to business operations at the Gallery and is often a requirement made by art lending bodies.

HVAC equipment onsite is split to each main building. The buildings are sufficiently far apart that a centralised system is highly unlikely to be cost effective to install or operate. The current configuration is also a result of the way that the site has been expanded over time. This means that the plant onsite varies significantly in both age and size. There are a number of smaller split systems onsite that serve the staff kitchen, office, reception and Sonia Farley studios. HVAC in the main gallery is supplied by a large central unit and the remaining areas are typically served by their own medium-sized units. Some of the older units are reaching the end of their operational life and could be replaced by units that have significantly higher performance (greater cooling/heating output for the same electrical input) due to advances in HVAC technology. Since many of these units have long run times (24 hours a day, seven days a week), these upgrades represent significant opportunities for energy and cost savings.

The different HVAC equipment for the Gallery is shown in Table 38.

Table 38: HVAC and associated plant at the gallery

| Serviced location | No. of units | Make / model | Approx. rating (Heat/Cool kW) | Year installed |
|---|---|---|---|---|
| Staff kitchen | 1 | Carrier split | 6.5/6.3 | Unknown |
| Reception | 1 | Carrier packaged | 0/2.6 | Unknown |
| Office | 1 | Fujitsu/AFT12RAS-W split package | Unknown | Unknown |
| Lewers Gallery | 1 | Apac split ducted | 23.9/23 | Unknown |
| Ancher House Gallery | 1 | Apac packaged ducted | 16.6/16 | Unknown |
| Sonia Farley 1 | 1 | Apac split ducted | 11.4/11 | 2002 |
| | 1 | Apac split ducted | 19.7/19 | 2002 |
| Sonia Farley 2 | 2 | Daikin split | 5.7/4.9 | Unknown |
| Collection/storage area | 1 | Hirotec/Air Blue | 6/8 | 2000 |
| | 3 | Condair/CP3 | 6-11 | Unknown |
| Main Gallery | 1 | Apac | 45/64 | 2006 |

Some heating is also provided in the office by a 2kW electric fan heater. There are also two extraction fans installed in each of the public toilets provided onsite. These are operated by the light switch in each of the toilets. The toilets are however provided with abundant natural light through two skylights fitted to each bathroom. This results in the extraction fans seldom being used during the day.

### 7.4.2 Replace the reception air conditioning unit

The reception air conditioning unit is at or approaching the end of its effective operational life (typically 10 to 15 years). The current efficiency of this unit will be well below that when first installed. There is an opportunity to install a newer and more efficient unit with a superior coefficient of performance[7] (COP). Taking the capacity of the existing systems into consideration, it is recommended to install like-for-like replacements. For these calculations, Net Balance has assumed a current COP of approximately 1.75 and costed a modern equivalent rated Daikin split unit with a COP of 3.54. This opportunity is only financially attractive if considered an end-of-life replacement option.

[7] The COP determines cooling/heating output per unit of electrical energy consumed. Higher COP indicates greater energy efficiency.

**Table 39: Financial analysis of replacing the reception air conditioning unit**

| Annual energy savings (kWh) | Capital expenditure | Annual cost savings | Payback (years) |
|---|---|---|---|
| 928 | $1,690[1] | $135 | 12.5 |
| **Works brief:** | | | |
| ▪ Obtain a detailed quote through HVAC maintenance contractors | | | |

[1] Uninstalled

### 7.4.3 Replace the Ancher House HVAC unit

The Ancher House HVAC equipment is also at or approaching the end of its effective operational life. As with the HVAC unit in reception, there is an opportunity to install a newer and more efficient unit with a superior COP.

It has been assumed that a current COP of 2 and costed equivalent rated Daikin equipment with a COP of 3.2.

**Table 40: Financial analysis of replacing the Ancher House HVAC unit**

| Annual energy savings (kWh) | Capital expenditure | Annual cost savings | Payback (years) |
|---|---|---|---|
| 13,846 | $9,200[1] | $2,008 | 4.6 |
| **Works brief:** | | | |
| ▪ Obtain a detailed quote through HVAC service contractors | | | |

[1] Uninstalled

### 7.4.4 Implement closed door policy at reception

During the site visit, the reception door was kept open. This significantly increases infiltration into the reception and lounge room areas and increases heating and cooling requirements. Net Balance appreciate that having an open door during operating hours may be part of site policy to encourage visitors to enter via reception and engage with reception staff. However, there is an energy and cost penalty associated with this that should be considered in reviewing ongoing practices.

**Table 41: Financial analysis of implementing a closed door policy for reception**

| Annual energy savings (kWh) | Capital expenditure | Annual cost savings | Payback (years) |
|---|---|---|---|
| 660 | Free | $96 | Immediate |
| **Works brief:** | | | |
| ▪ Review current policy in the light of potential energy and cost savings available. | | | |

Another possible approach would be to relocate the reception air conditioning unit (which would likely occur in combination with implementing opportunity 7.4.3) and install an air curtain over the reception door which is used to minimise infiltration losses.

### 7.4.5 Toilet extraction fan controls

Currently the toilet lights and extraction fans are controlled by the same manually activated switch. Net Balance have analysed an opportunity to separate the lighting and extraction fan controls and to install a basic occupancy and timer switch for the fans whilst keeping the manual lighting switch. These control updates will promote more appropriate use of energy to run the ventilation fans.

**Table 42: Financial analysis of toilet extraction fan controls**

| Annual energy savings (kWh) | Capital expenditure | Annual cost savings | Payback (years) |
|---|---|---|---|
| 84 | $120 | $12 | 10 |
| **Works brief:** | | | |
| ▪ Monitor facilities for instances of the lights and fans being left on overnight | | | |

**Lighting**

There is a large variety of lighting equipment installed onsite reflecting the diverse requirements of gallery, office, outdoor, kitchen and storage areas. Lighting equipment is varied and not always fit for purpose.

Lighting throughout the facility is generally controlled via a local switch for each area. Some areas make use of natural day lighting (e.g. skylights in the toilets). Lighting in the gallery and some outdoor areas are typically dimmed overnight for security reasons. During the site visit, the consultant observed some outdoor lighting which had been left on during the day.

### 7.4.6 Lighting upgrade

Due to the specialist nature of most of the lighting used at the gallery, Net Balance engaged the specialist support of Julien Freed Consulting who attended the site visit on the 6 March 2012. Lighting related recommendations were made by Julien to Net Balance and include lamp and luminaire upgrades based on total cost of ownership (energy, replacement and maintenance costs) reductions. In addition, some of the lighting was considered not fit-for-purpose (e.g. UV intense lighting in the galleries and non-sealed units in food preparation areas) and should be replaced regardless of energy efficiency considerations. These are also included in the calculation of this opportunity. It should be noted that any lighting upgrade to Ancher House would require a heritage consultant's approval.

A significant portion of the current lighting technology used results in considerable internal heat gains (and is the main reason for inefficiencies when compared to the latest technologies). This heat has an impact on the HVAC systems, increasing power requirements during cooling, and reducing heating requirements. Implementing these lighting recommendations will reduce this internal gain and will consequently impact HVAC requirements. Based on the HVAC sub-metering performed and using degree day based extrapolations, the heating and cooling energy requirements are currently broadly equivalent, which indicates the net effect of lighting upgrades on HVAC energy use is likely to be small.

**Table 43: Financial analysis of aggregate lighting upgrade recommendations**

| Annual energy savings (kWh) | Capital expenditure | Annual cost savings | Payback (years) |
|---|---|---|---|
| 81,100 | $28,435 | $16,715[1] | 1.7 |
| **Works brief:** | | | |
| ▪ Consult information provided and develop implementation schedule prioritised by payback | | | |

[1] Includes maintenance cost savings of $4,928.

**Domestic hot water**

The Gallery site is served by two electric 50 litre storage heaters. One is situated in the café and the other in the staff kitchen. These cylinders have a maximum electrical load of 14kW and are understood to operate 24 hours a day, seven days a week.

**Kitchen and cafe facilities**

The Gallery has a café that is open 9.00am to 3.00pm Wednesday to Friday and 8.00am to 4.00pm Saturday and Sunday providing food and drinks. The café has a range of electricity consuming equipment including:

- four fridges
- coffee machine
- dishwasher
- hob range cooker
- hot water tanks

The site has a staff kitchen which contains typical domestic kitchen scale appliances and is used on an ad hoc basis during operating hours.

### 7.4.7 Café refrigeration of non-perishables

Café fridges are used to store both perishables and non-perishables such as soft drinks. There is an opportunity to save energy by turning fridges with non-perishables off whilst the café is closed (i.e. overnight and during the day on Monday and Tuesday). This would most effectively and reliably be done using a seven day programmable timer. Calculations assume one fridge can be stocked with non-perishables and be turned off for eight hours overnight and during Monday and Tuesday.

**Table 44: Financial analysis of Café non-perishables refrigeration opportunity**

| Annual energy savings (kWh) | Capital expenditure | Annual cost savings | Payback (years) |
|---|---|---|---|
| 366 | $30 | $53 | 0.6 |
| **Works brief:** | | | |
| ▪ Confirm which fridges can be run with non-perishables only. Purchase digital seven day timer switches for each of these fridges. | | | |

## *7.5 Recommendations*

The energy audit of the Gallery revealed opportunities with a less than five year payback period resulting in annual savings totalling $23,322 (126,565 kWh) per year. These options also result in reductions to the Gallery's annual carbon footprint worth 134 tonnes CO2-e per year. In addition, opportunities worth approximately $147 (1,012 kWh) per year were identified that were outside a five-year payback period. The greenhouse savings associated with these measures is 1 tonne CO2-e per year. Table 46 lists a schedule of recommended lighting replacements.

**Table 45: Lewers cost effective actions**

| Energy saving measure | Costs | Savings | | | Payback | Plan ref |
|---|---|---|---|---|---|---|
| | Implementation cost ($) | Cost savings ($ pa) | Energy (kWh pa) | GHGs (t $CO_2$-e pa) | years | section |
| **Cost effective actions** | | | | | | |
| Implement closed door policy | Free | $96 | 660 | 1 | Immediate | 7.4.4 |
| Café refrigeration of non-perishables | $30 | $53 | 366 | 0.4 | 0.6 | 7.4.7 |
| Lighting | $28,435 | $16,715[1] | 81,100 | 86 | 1.7 | 7.4.6 |
| Replace the Ancher House HVAC unit | $9,200[2] | $2,008 | 13,846 | 15 | 4.6 | 7.4.3 |
| **TOTALS** | **$37,665** | **$23,322** | **126,565** | **134** | **1.6** | |
| **Other actions** | | | | | | |
| Toilet extraction fan controls | $120 | $12 | 84 | 0 | 10 | 7.4.5 |
| Replace the reception air conditioning unit | $1,690[2] | $135 | 928 | 1 | 12.5 | 7.4.2 |
| Infiltration reduction and building fabric | TBD | $4,436 | 30,593 | 32 | TBD | 7.4.1 |
| **TOTALS** | **$1,810** | **$147** | **1,012** | **1** | **12.3[3]** | |

Note: an aggregated electricity cost of $0.145 per kWh has been used to calculate savings. See Section 7.2 for more detail.

[1] Includes $4,928 in reduced maintenance costs.

[2] Uninstalled

[3] Payback does not include Infiltration reduction and building fabric action as implementation cost and payback are yet to be determined.

**Table 46: Schedule of recommended lighting replacements**

| Sheet Ref # | Locn # | Area | Current lamp/luminaire description | Qty | Energy | Energy Costs | Maint-enance Costs | Total Costs | Recommended Replacement Description | Energy Cost Saving | Maint-enance Cost Saving | Energy Saving | Total Savings | Capex | Pay back |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 8 | Main gallery | I: INCANDESCANT | 32 | 13,578 | $1,973 | $1,160 | $3,133 | PHILLIPS PAR 38 LED DIMMABLE | $1,529 | $836 | 10,523 | $2,365 | $2,880 | 1.22 |
| 1 | 9 | Main gallery | I: INCANDESCANT | 21 | 11,138 | $1,619 | $761 | $2,380 | PHILIPS PAR 30 LED DIMMABLE | $1,425 | $598 | 9,802 | $2,023 | $1,470 | 0.73 |
| 1 | 10 | Main gallery | I: INCANDESCANT | 18 | 19,656 | $2,857 | $453 | $3,310 | PHILIPS PAR38 LED DIMMABLE | $2,685 | $328 | 18,477 | $3,013 | $2,880 | 0.96 |
| 2 | 3 | Ancher Gallery | I: INCANDESCANT | 8 | 3,395 | $493 | $290 | $783 | PHILLIPS PAR 38 LED DIMMABLE | $382 | $209 | 2,631 | $591 | $720 | 1.22 |
| 2 | 4 | Ancher Gallery | I: INCANDESCANT | 8 | 4,243 | $617 | $290 | $907 | PHILIPS PAR 30 LED DIMMABLE | $543 | $228 | 3,734 | $771 | $560 | 0.73 |
| 2 | 6 | Ancher Gallery | I: INCANDESCANT | 1 | 796 | $116 | $42 | $158 | TARGETTI MAGMA 25WATT LED TRACK SPOT | $96 | $42 | 663 | $138 | $460 | 3.32 |
| 3 | 1 | External Café seating area | OTHER | 16 | 4,543 | $660 | $821 | $1,481 | PHILIPS 10 WATT REPLACEMENT LAMP | $559 | $654 | 3,844 | $1,213 | $1,120 | 0.92 |
| 3 | 2 | External Café seating area | 100W HALOGEN | 16 | 8,736 | $1,270 | $582 | $1,852 | LED 34 WATT EVO6 | $945 | $566 | 6,500 | $1,511 | $3,200 | 2.12 |
| 3 | 3 | Covered Way | I: INCANDESCANT | 8 | 10,483 | $1,524 | $239 | $1,762 | TARGETTI MAGMA 25WATT LED RECESSED | $1,397 | $239 | 9,610 | $1,635 | $3,600 | 2.20 |
| 3 | 5 | Covered Way | I: INCANDESCANT | 1 | 655 | $95 | $30 | $125 | METAL HALIDE FLOOD | $70 | $4 | 480 | $74 | $360 | 4.89 |
| 4 | 2 | Entry Walkway | I: INCANDESCANT | 1 | 291 | $42 | $25 | $67 | PHILIPS PAR38 EXTERIOR | $33 | $18 | 226 | $51 | $90 | 1.77 |
| 4 | 7 | Reception | H: 50 WATT MR16 HALOGEN | 3 | 710 | $103 | $65 | $168 | EVO 50 WIDE GLARE CONTROL | $75 | $65 | 513 | $139 | $300 | 2.16 |
| 5 | 1 | Loungeroom | I: INCANDESCANT | 4 | 1,165 | $169 | $99 | $269 | PHILLIPS PAR 38 LED DIMMABLE | $131 | $72 | 903 | $203 | $360 | 1.77 |
| 5 | 5 | Lewers Verandah | OTHER | 5 | 4,004 | $582 | $322 | $903 | PHILIPS 10 WATT REPLACEMENT LAMP | $529 | $242 | 3,640 | $771 | $775 | 1.01 |
| 5 | 6 | Lewers Gallery | OTHER | 21 | 11,466 | $1,666 | $828 | $2,494 | TARGETTI MAGMA 25WATT LED TRACK SPOT | $1,389 | $828 | 9,555 | $2,217 | $9,660 | 4.36 |
| | | | | **TOTALS** | **94,859** | **$13,786** | **$6,007** | **$19,793** | | **$11,787** | **$4,928** | **81,100** | **$16,715** | **$28,435** | **1.70** |

# 8. Carita Children's Centre

## *8.1 Site description*

The Carita Children's Centre is situated in South Penrith in Western Sydney. The approximate floor area of the building is 360m$^2$.

The Centre consists of the following:

- Staff office and reception
- Kitchen, toilets, cleaning and laundry facilities
- Small miscellaneous office
- Baby room
- Young children's room
- Older children's room
- Store rooms
- Outside play area.

The Centre operates from 7.00am to 6.00pm Monday to Friday. The facility is closed on the weekends. Cleaners operate in the building after hours.

## *8.2 Tariff analysis*

Carita Children's Centre has a domestic electricity supply contract, through Council, with AGL. Unless otherwise stated, an aggregated electricity cost of $0.21 per kWh has been used for the Centre throughout this plan. This takes account of all energy-related charges, and includes an increase of 18% based on energy price increases modelled by the NSW Independent Pricing and Regulatory Tribunal (IPART).

Table 47 shows the tariffs paid by Carita Children's Centre in relation to electricity consumption during 2010-11.

**Table 47: Electricity tariff details for Carita Children's Centre 2010-11**

| Charge | Amount | Units |
|---|---|---|
| **Energy charges** | | |
| Peak energy charge | 0.1893 | $/kWh |
| Peak energy charge >1,500 kWh | 0.2096 | $/kWh |
| Off peak energy charge | 0.1003 | $/kWh |
| **Network and market charges** | | |
| Supply charge | 41.08 | $/Quarter |
| Off peak service charge | 3.16 | $/Quarter |

The main characteristic of this tariff is the significant difference between peak and off peak rates. Unfortunately, due to the nature of its activities and the times during which the facility is used, it is difficult to take advantage of this differential by load shedding or scheduling.

## *8.3 Energy load profiles and energy consumption patterns*

### 8.3.1 Summary of site performance

Electricity from the grid is the only source of energy used at Carita Children's Centre. In 2010-11, energy use totalled 36,710 kWh at a cost of $6,608. This electricity consumption resulted in 34 tonnes of carbon dioxide equivalent ($CO_2$-e) of greenhouse gas emissions.

Total energy consumption, cost and greenhouse gas emissions for Carita Children's Centre during 2010-11 is shown in Table 48. The breakdown of energy use across the site is shown in Figure 25. This chart shows that the major source of energy consumption at Carita Children's Centre is the HVAC. The lighting was another main power user along with the kitchen and laundry facilities (general power).

**Table 48: Split of energy consumption, 2010-11**

| Area | Energy type | Energy consumption (kWh) | % total energy consumption | Energy cost | GHG emissions (t $CO_2$-e)[1] |
|---|---|---|---|---|---|
| HVAC | Electricity | 12,114 | 33.0% | $2,181 | 13.0 |
| Car Park Lights | Electricity | 6,570 | 17.9% | $1,183 | 7.0 |
| House Lighting | Electricity | 7,164 | 19.5% | $1,290 | 7.7 |
| Domestic Hot Water | Electricity | 2,489 | 6.8% | $448 | 2.7 |
| General Power | Electricity | 8,373 | 22.8% | $1,507 | 9.0 |
| | **TOTAL** | **36,710** | **100.0%** | **$6,609** | **39.4** |

[1] 2011 National Greenhouse Accounts (NGA) scope 2 and 3 emissions factors for electricity were used to determine these values.

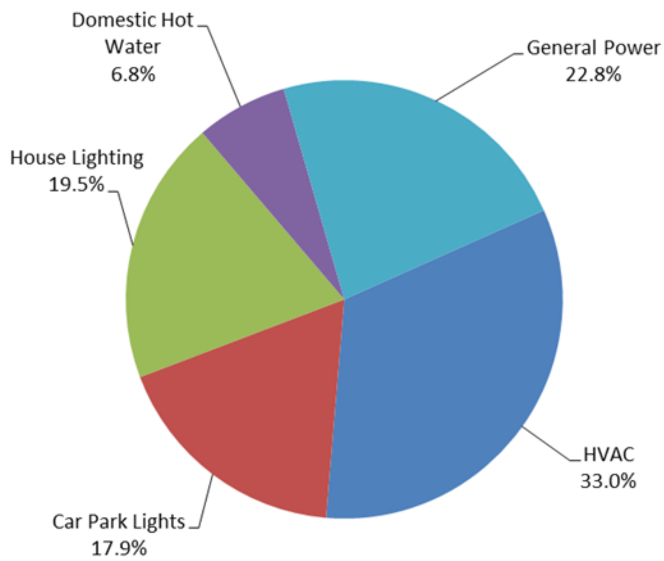


**Figure 25: Breakdown of energy consumption, 2010-11**

### 8.3.2 Annual profile

Figure 26 shows that there has been variable electricity consumption patterns over the last three years, due to the alternating billing periods and what appears to be missing consumption in the billing data. Analysis of electricity invoice data over a longer period reveals that the site has experienced very little change in energy use.

This chart also shows that quarterly energy use is not variable throughout each single year suggesting HVAC equipment is used relatively consistently throughout the year.

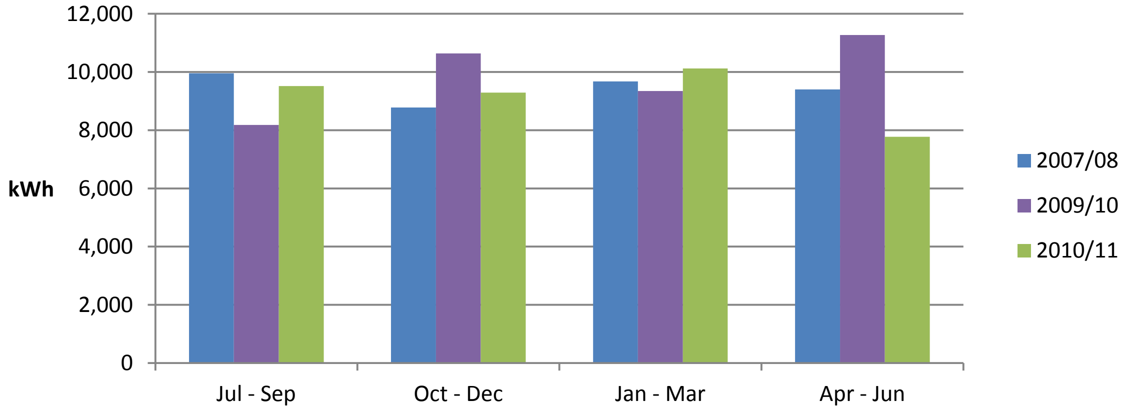


**Figure 26: Quarterly electricity consumption, 2010-11**

### 8.3.3 Weekly profile

Electricity consumption patterns at Carita Children's Centre also vary according to weekday. On weekends the Centre is not operational. On weekdays, energy consumption is relatively static except for changes in air conditioning requirements as shown in Figure 27.

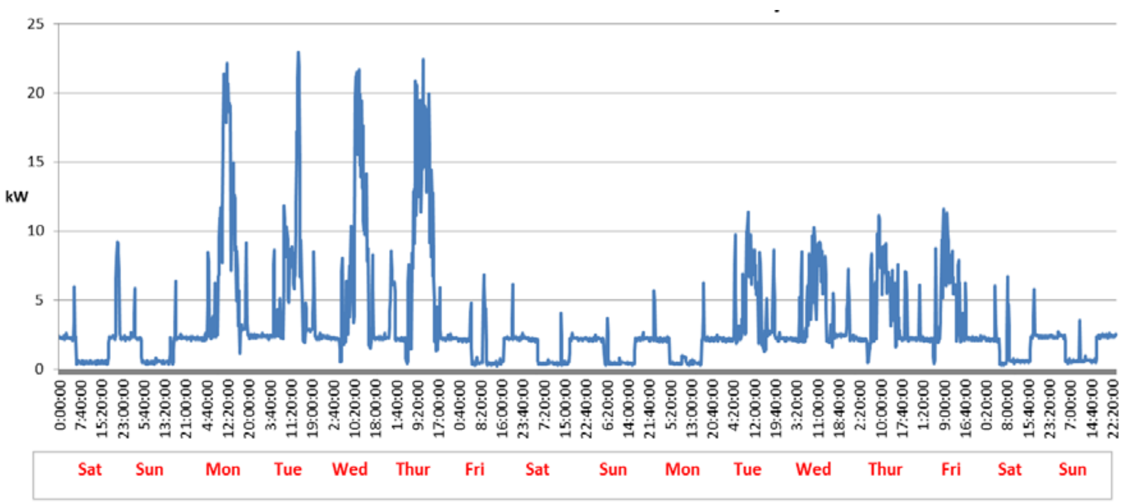


**Figure 27: Five minute interval energy consumption, March/April 2012**

During the first week of metering, the site was experiencing high outside air temperatures (consistently around 28 degrees) which required the use of air conditioning, as can be seen by the increased electricity load during this period. In the second week, temperatures rarely exceeded 22 degrees. This meant there was a significantly reduced electricity load as the air conditioning was not used. This highlights the site's sensitivity to varying HVAC requirements as other loads remain consistent. The 2kW baseload overnight is explained by the high-wattage car park security lights operating as part of this site's electricity load. Spikes in consumption after hours are explained by cleaning activity and the domestic hot water system maintaining temperature.

## *8.4 Findings of the site audit*

**Building fabric**

The building is made from a mixture of single brick veneer and double brick, with double brick forming the majority of the north-facing side of the building. This reduces heat gain throughout the day and is considered a good insulator due to the air cavity between the two walls of bricks. The roof space has very little insulation and would provide minimal protection against heat gain through the ceiling from the roof cavity. This coupled with the galvanised steel roofing providing minimal solar reflection mean that the roof cavity would experience extreme temperatures of as much as 65 degrees in summer. As the air conditioning is ducted through the roof space, this would also reduce its efficiency operating in these temperatures.

### 8.4.1 Insulation upgrade

To overcome the problem of heat loss and heat gain through the roof space, it is recommended that effective insulation be installed, which will in turn reduce consumption associated with HVAC operation. Loose-fill cellulose fibre for the roof cavity is an appropriate retrofit insulation option for this site as batts would need alteration to install, and because of the small area of the site.

As only a small amount of the roof space was surveyed during the site visit, another survey should be conducted to determine the current insulation levels in the entire roof space before this opportunity is implemented. This is a long-life option and paybacks should be viewed in that light.

**Table 49: Financial analysis of installing insulation in roof space**

| Annual energy savings | Capital expenditure | Annual cost savings | Payback |
|---|---|---|---|
| **1,211 kWh** | $4,320[1] | $254 | 17 years |
| **Works brief:** | | | |
| ▪ Review entire roof space for existing insulation<br>▪ Ensure electrical wiring is not exposed<br>▪ Pump in loose fill insulation (this is particularly good for small roof spaces) | | | |

[1] Installed

### 8.4.2 Install passive air extraction fan (Whirlybird)

The roof cavity at the Carita Children's Centre would experience high temperatures during the hot Western Sydney summer due to the galvanized steel roofing. The building would also experience significant heat gain through the ceiling as a result of minimal insulation installed. To remove the heat from the roof cavity while also removing moist air in winter (to reduce mould build up) it is recommended to install three 'Whirlybird' or passive air extraction fans on the roof.

**Table 50: Financial analysis of installing passive air extraction fan**

| Annual energy savings | Capital expenditure | Annual cost savings | Payback |
|---|---|---|---|
| **866 kWh** | $500[1] | $182 | 2.7 years |
| **Works brief:** | | | |
| ▪ Review roof cavity to ensure it is all connected and isn't sectioned off<br>▪ Install fans and eave vents to maximise air removal<br>▪ Ensure installation does not cause water to leak into roof cavity | | | |

[1] Installed

A solar powered roof cavity extraction fan, at a cost of $980 (installed), was also investigated as an alternative to the passive air extraction fan. The solar fan removes the heat from the roof cavity and replaces it with the ambient outside air temperature by drawing air from under the eaves. This would create greater operational efficiencies from the ducted air conditioning as it would benefit from the lower operating temperature inside the roof cavity, where the ducts are located. A thermostat was recommended to be installed on this unit to minimise operation when outside air temperature is at a comfortable level. Annual savings are calculated as 1,444 kWh or $303 with a payback of 3.2 years. This would not be suitable if the roof cavity is found to be sectioned off.

The passive air extraction fans provide a comparable level of performance to the solar powered extraction fan but reduced flow rates mean they will not be quite as effective. It is more robust technology however, and is cheaper, and is the preferred option in this case.

## Heating, Ventilation and Air Conditioning (HVAC)

HVAC equipment is used for both heating and cooling at the Children's Centre and is operated manually by staff. There are typically significant HVAC energy savings opportunities to be made around the control of such systems for example fine-tuning system set points, minimising operating temperatures inside roof spaces and using other methods to maintain relative comfort levels in the building such as insulation and fans.

### HVAC Equipment Summary

The building has two ducted Carrier air conditioning units with localised controls serving the two main children's play areas. These units are around 15 years old and would be operating typically with a coefficient of performance (COP[8]) of below 2.0, which is relatively inefficient compared to many newer systems. Other HVAC equipment includes extraction fans for the kitchen, toilet and laundry. The different HVAC equipment for Carita Children's Centre is shown in Table 51.

[8] Coefficient of performance (COP) is the energy efficiency measurement of air conditioners. It is calculated from the ratio of cooling or heating capacity (kWr) to the power rating of the equipment (kW). A higher COP indicates a more energy efficient unit.

Table 51: HVAC and associated plant at Carita Children's Centre

| Serviced location | No. of units | Make / model | Approx. rating (kW) | Year installed |
|---|---|---|---|---|
| Air Conditioners | 2 | Carrier – 38QCA065 | 10 | 1997 |
| Toilet exhaust | 1 | Unknown | 0.2 | Unknown |
| Laundry exhaust | 1 | Unknown | 0.4 | Unknown |
| Kitchen exhaust | 1 | Westinghouse | 0.2 | Unknown |

### 8.4.3 Replace air conditioning units

There are two air cooled Carrier air conditioners (~10 kW each) supplying heating and cooling to the building. These units would be running at reduced efficiency since installation. There is an opportunity to install newer and more efficient units at end of life (typically after 15 to 20 years). These units operate throughout the year but work hardest in the warmer months. They are ducted inside the roof space with remote condensing units on the east face of the building.

Taking the capacity of the existing systems into consideration, it is recommended to install like-for-like replacements.

Table 52: Financial analysis of AC replacement

| Annual energy savings | Capital expenditure | Annual cost savings | Payback |
|---|---|---|---|
| **4,644 kWh** | $8,704[1] | $975 | 8.9 years |
| **Works brief:** | | | |
| ▪ Survey cooling/heating requirements of staff<br>▪ Obtain quotes for replacement and installation<br>▪ Ensure replaced technology COP is in the vicinity of 3 and above | | | |

[1] Uninstalled

### 8.4.4 Review air conditioner temperature set point

Currently the two air conditioning units are set at 22°C for cooling days (i.e. during summer months). Increasing these set points to 24°C will reduce the amount of time that the units will operate. Adjusting set points to 20°C for heating days will also realise similar savings. Further investigation will need to be carried out to determine whether the revised temperatures are appropriate for staff comfort.

Table 53: Financial analysis of AC set point review

| Annual energy savings | Capital expenditure | Annual cost savings | Payback |
|---|---|---|---|
| **750 kWh** | $0 | $158 | Immediate |
| **Works brief:** | | | |
| ▪ Adjust thermostat on indoor controls to required temperature | | | |

**Lighting**

Lighting at Carita Children's Centre is predominantly made up of twin 36W fluorescent tubes with surface-mounted fittings, with some recently installed T5 28W fluorescent tubes and 13W CFL lights. The outside of the facility is lit by 100W halogen security lights. Lighting throughout the facility is controlled via a local switch for each area.

Lighting levels observed at key locations throughout the facility were deemed to be acceptable.

### 8.4.5 Replace fluorescent tubes to more energy efficient types

Lighting technologies currently used throughout the site are predominantly 36W T8 magnetic ballast fluorescent tubes, with limited use of halogen and compact fluorescent globes. The site has approximately 40 of these T8 light fittings operating for around 12 hours each week day. Net Balance has conducted an analysis on the upgrade of T8 (36W) fluorescent tubing to T5 (28W) electronic ballast converter kit tubes. Efforts have been made to match lumens, temperature and colour rendering index (CRI) between current globes and recommended upgrade globes to ensure maintenance of lighting quality.

The newer T5 fluorescent light ballast uses approximately 30% less energy than its T8 predecessor for the same light output. T5 tubes have different fittings and will require either the use of T8 to T5 conversion kits, or replacement of the T8 fittings. This plan has assumed continued use of the existing fitting and the fitting of a T8 to T5 conversion kit.

Lighting levels are very similar between 28W T5 tubes and 36W T8 tubes. As such, an upgrade to T5 lighting should not significantly alter the lighting levels experienced at the facility. Additional benefits in converting from T8 ballast to T5s include:

- longer usable lifespan resulting in reduced maintenance costs associated with replacement
- removal of perceivable light flicker, and audible noise
- reduced environmental impact due to lower mercury content in T5 tubes.

The longer lifespan of T5 lighting will reduce maintenance requirements for lamp replacement by up to 20% compared with T8 lighting. The longer usable life of T5 ballasts will also reduce ongoing ballast replacement costs.

Table 54: Financial analysis of replacing T8 fluorescent tubes with T5 equivalents

| Annual energy savings | Capital expenditure | Annual cost savings | Payback |
|---|---|---|---|
| **1,872 kWh** | $1,600 | $459[1] | 3.5 years |
| **Works brief:** | | | |
| ▪ Instruct electrician to install T5 tubes with conversion kits | | | |

[1] Includes $66.24 in reduced maintenance cost savings.

### 8.4.6 Install separate laundry exhaust fan switch

Currently, the switch in the laundry operates both the exhaust fan and the light in the laundry simultaneously, which means these devices cannot be operated independently. This in turn can mean that one or both devices sometimes work unnecessarily. It is recommended to rewire these circuits so that they each have individual switches.

Table 55: Financial analysis of installing separate laundry exhaust fan switches

| Annual energy savings | Capital expenditure | Annual cost savings | Payback |
|---|---|---|---|
| **156 kWh** | $100 | $33 | 3.0 years |
| **Works brief:** | | | |
| ▪ Instruct electrician to rewire and install two switches | | | |

**Domestic hot water**

The Centre is served by an unvented Dux hot water storage cylinder. This cylinder is rated at 3.6kW and runs off electricity. It operates 24 hours a day, seven days a week and provides hot water for the laundry, kitchen, bathroom and various cleaning tasks throughout the week.

### 8.4.7 Reduce the domestic hot water set point

The water heater at the facility accounts for approximately 7% of onsite energy use. Net Balance proposes that the domestic hot water set point be reviewed and reduced to 60°C. Typically when installed these units are set at 65°C and above.

Reducing the set point even 5 degrees can save significant amounts of energy, especially as the site uses hot water for cleaning, kitchen, bathroom and laundry purposes. The financial analysis is based on an estimated hot water use of 1 cylinder per weekday and a current set point of 65°C. As the current water usage and set point is estimated this is included only as a best practice guide and for potential to be repeated across all Children's Centres.

**Table 56: Financial analysis of DHW set point reduction**

| Annual energy savings | Capital expenditure | Annual cost savings | Payback |
|---|---|---|---|
| **310 kWh** | $100 | $65 | 1.5 years |
| **Works brief:** | | | |
| ▪ Instruct plumber to come onsite and review DHW set points<br>▪ If found to be above 60°C reduce as required<br>▪ Review taps and equipment on site for any unacceptable temperature drops | | | |

## Kitchen and laundry facilities

The Carita Children's Centre has a kitchen that operates between 8.30am and 1.00pm providing food for children and staff in the morning and for lunch. There is an internal laundry with a small commercial sized washing machine and dryer, the laundry facilities are used throughout the day on an ad hoc basis.

**Table 57: Auxiliary energy using equipment in Kitchen and Laundry**

| Location | Description | No. of units | Make/model | Approx. rating (kW) |
|---|---|---|---|---|
| Kitchen | Refrigerator | 2 | Various | 0.15 |
| Kitchen | Oven | 1 | Westinghouse | 5 |
| Kitchen | Dishwasher | 1 | Ecomax500 | 3.2 |
| Kitchen | Microwave | 2 | Various | 1 |
| Laundry | Washing machine | 1 | Maytag | 2 |
| Laundry | Dryer | 1 | Whirlpool | 4 |

## Miscellaneous equipment

Other pieces of equipment in the building include computers, a printer, upright and ceiling fans and audio-visual equipment.

## *8.5 Recommendations*

The energy audit of Carita Children's Centre revealed opportunities with a less than five year payback period resulting in annual savings totalling $1,133 (5,398 kWh) per year. These options also result in reductions to Carita Children's Centre's annual carbon footprint worth 5.8 tonnes $CO_2$-e per year. In addition, opportunities worth approximately $1,229 (5,855 kWh) per year were identified that were outside a five year payback period. The greenhouse savings associated with these measures is 6.3 tonnes $CO_2$-e per year.

**Table 58: Carita Children's Centre summary of actions**

| Energy saving measure | Costs | Savings | | | Payback | Plan ref |
|---|---|---|---|---|---|---|
| | Implementation cost ($) | Cost savings ($ pa) | Energy (kWh pa) | GHGs (t $CO_2$-e pa) | years | section |
| **Cost effective actions** | | | | | | |
| HVAC set point review | None | $158 | 750 | 0.8 | Immediate | 8.4.4 |
| Domestic hot water set point reduction | $100 | $65 | 310 | 0.3 | 1.5 | 8.4.7 |
| Passive air extraction fans (whirlybird) | $500[1] | $182 | 866 | 0.9 | 2.7 | 8.4.2 |
| Laundry exhaust fan and light rewiring | $100 | $33 | 156 | 0.2 | 3.0 | 8.4.6 |
| T8 to T5 light conversion | $1,600 | $459[2] | 1,872 | 2.0 | 3.5 | 8.4.5 |
| **Total** | **$2,300** | **$897** | **3,954** | **4.2** | **2.6** | - |
| **Other actions** | | | | | | |
| HVAC end of life replacement | $8,704[3] | $975 | 4,644 | 5.0 | 8.9 | 8.4.3 |
| Loose-fill cellulose roof insulation | $4,320[1] | $254 | 1,211 | 1.3 | 17.0 | 8.4.1 |
| **Total** | **$13,024** | **$1,229** | **5,855** | **6.3** | **10.6** | - |

Note: an aggregated electricity cost of $0.21 per kWh has been used to calculate savings. See Section 8.2 for more detail.

[1] Installed

[2] Includes $66.24 in reduced maintenance costs.

[3] Uninstalled

## *9. Abbreviations*

| | |
|---|---|
| AHU | Air Handling Units |
| BMS | Building Management System |
| COP | Coefficient of Performance |
| CRAC | Computer Room Air Conditioning |
| CRI | Colour Rendering Index |
| ESAP | Energy Savings Action Plan |
| HVAC | Heating, Ventilation and Air Conditioning |
| IPART | Independent Pricing and Regulatory Tribunal |
| kWh | Kilowatt Hour |
| kWr | Kilowatt Rated |
| PAC | Packaged Air Conditioning |
| PFC | Power Factor Correction |
| VRU | Voltage Reduction Unit |
| VRV | Variable Refrigerant Volume |
| VSD | Variable Speed Drive |