XXXXX XXXXXX (CTS XXXX)

Type 2 Energy Audit

Client: Owners Corporation for CTS XXXX

Date: 18th January 2017

Project No. CTSXXXX-XXX

Tariff Lighting Solar HVAC Batteries Microgrid Recharge Water Mechanical Leisure

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Executive Summary

This report is the result of an energy audit at the XXXXX XXXXXX, XXX XXXXXX XX, XXXXXXXXXXX. It was undertaken on behalf of the Executive Committee of Strata Plan CTS XXXX and commissioned by the Owners Corporation. As a result of the audit the site can now identify exactly how much it is paying for its energy, where the energy it consumes on site is going, and what proportions are being used by different assets. The report has also identified a number of solutions that if implemented will have a material impact on the energy consumption of the site and the amount it pays for the energy it uses.

The audit period in this study is from 29/11/16 to 10/1/17, with the site work taken from 29/11/16 to 2/12/16. This audit is limited to the base building services for the site, comprising common area facilities such as lifts, escalators, pool, common hot water system, central air-conditioning, central heating and common area lighting. The common area electricity consumption for XXXXX XXXXXX was approximately 1,723,674 kWh p.a. at a cost of $152,960 and the gas consumption was 1,383,297MJ p.a. at a cost of $32,709 excluding GST.

The following key opportunities for the improvement of the building's energy performance have been identified through our site visit and subsequent investigation:

- Energy tariff review
- Power factor correction
- Lighting upgrade
- Central air-conditioning control
- Hot water heating
- Solar energy
- Energy management improvement

Successful implementation of the identified opportunities has the ability to achieve annual savings of approximately 204,741 kWh of electricity and 1,244,967 MJ of gas. Annual energy cost savings are expected to be approximately $84,741, with total project costs of approximately $285,951 giving a 3.4 year payback. This excludes energy supply tariff review which could deliver over $40,000 in additional annual savings without any major project costs.

Savings have been assessed to a medium level of accuracy, meeting the requirements for a Type 2 audit. A summary of measures is provided in **Table 13** in the Conclusions. All dollar figures in this report are exclusive of GST.

1. Introduction

Wattblock has been commissioned by the Owners Corporation of Strata Plan CTS XXXX, to undertake a Type 2 energy audit of the facilities at XXX XXXXXX XX, XXXXXXXXXXX. The Type2 energy audit was undertaken in accordance with the guidelines set forth in AS/NZS3598:2014.

A physical site audit was conducted at the site on 29th November 2016 to inspect and account for the energy consuming assets at the site. A shorter follow-up visit was conducted on the 12th December. To assist Wattblock in the audit process, the property manager, XXXXXX, provided electricity and gas bills for the past 24 months. The on-site maintenance manager, XXXXXX, also provided assistance during the site audit with his understanding of the systems being used for lighting and HVAC, and the general day-to-day workings of the building.

During the site visit, a physical inspection of the available energy consuming assets was made. Based on this observation and the estimates of energy consumption according each asset, an energy end use balance has been prepared. Please note that AS/NZS3598 Energy Audit Standard stipulates that the accuracy of the audit should be to a medium level of accuracy and that all individual energy consuming components contributing more than 10% of total consumption should be accounted for.

XXXXX XXXXXX is a luxury hotel apartment complex located in the historic XXXXXX precinct at XXXXXXXXXXX. The complex is approximately 30 years old. It has 144 self-contained one and two bedroom apartments across levels 2 to 13. A single corridor on each floor provides access to each apartment and 3 elevators allow for quick and easy access to the floors.

A central main lobby provides entry to the building, with an escalator immediately inside leading to the reception area on level 1. On this floor are the main facilities of the building, including a large outdoor BBQ and entertaining area complete with fresh herbs, and a solar heated outdoor pool.

The property has a restaurant on level 1 called “XXXXX XXXXXX”, and a function center on the ground floor overlooking the river called “XXXXXX”. These areas are billed and managed separately and as such their energy usage has not been included in this audit. The reception and back-of-house for the hotel services are similarly excluded. These areas share electricity through an embedded electrical network and are separately billed by XXXXXX XXXXX for their share of the energy use.

The embedded network was set up to supply electricity to the XXXXX XXXXXX prior to the review period. This technology involves bulk buying of electricity in order to obtain cheaper energy rates. XXXXXX’s embedded electrical network covers apartment lots, common areas, and the commercial premises. All areas may benefit from further tariff review.

This energy audit report focuses on energy saving opportunities for the common area. It also covers hot water supply and air-conditioning used inside residential apartments, as the energy costs are paid by the Owners Corporation. A central hot water system is used to supply hot water and a central heating and cooling system for air-conditioning to individual apartments. As a result, it is the responsibility of the Owners Corporation to approve and implement any projects to drive down energy costs in these areas.

2. Understanding Energy Billing

XXXXX XXXXXX's total annual expenditure on energy is estimated at $409,470. Gas accounts for the 8% of the total at $32,709 p.a. The gas billing is related to common hot water supply for apartments, commercial premises and common areas. However, this is fully paid by the Owners Corporation.

Electricity accounts for majority 92% of the energy cost at $376,761p.a. This is the total electricity supply to the embedded electrical network for the apartments, common areas, and commercial premises combined. For further explanation of the embedded electrical network setup refer to Appendix 1.

Wattblock has analysed the energy usage data for the XXXXX XXXXXX strata complex and identified that common area electricity use accounts for approximately 1,723,674 kWh or 69% of the annual energy use for the whole complex.

Figure 1 Electricity use breakdown of the embedded network

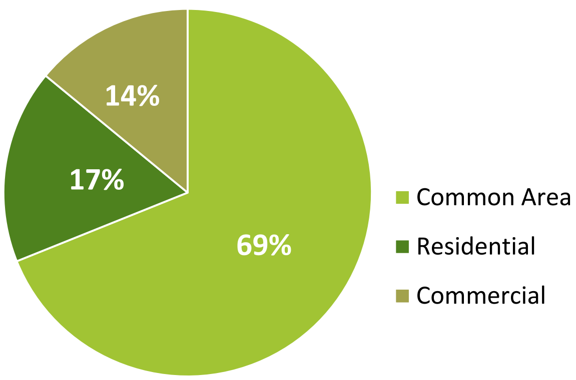


Table 1 Electricity use breakdown of the embedded network

Energy Consuming Asset	Consumption (kWh)	Percentage
Common Area	1,723,674	69%
Residential	426,987	17%
Commercial	350,720	14%
Total	2,501,382	100%

The following sections provide an overview of energy billing and opportunities for XXXXX XXXXXX. For further details on energy billing analysis and supporting calculations refer to Appendix 1.

Electricity Bills

Due to the presence of an embedded electrical network, the electricity retail contract must be negotiated for the entire building including apartments, common areas, and commercial premises. In order to reduce the overall electricity bill, the first step is to understand the components of the billing. The billing can be broken into three main types of charges.

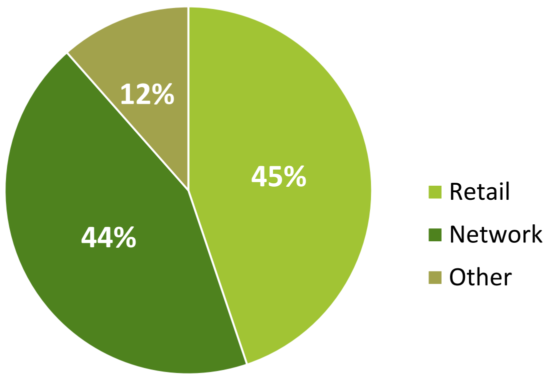
1. **Retail charges:** Retailers purchase energy from large power plants and re-sell it to their customers. XXXXXXX is the existing energy retailer contracted to provide electricity to the site. Retail charges account for 45% of the bill. This is split between Peak and Off Peak charges at $109,051 and $60,470 respectively. A tariff review can often reduce these costs.
2. **Network charges:** These charges cover the costs of the electricity poles and wires that are built to transport electricity to the block. The network provider in the region is XXXXXXXX and network tariffs are fixed by regulators. Network charges account for 44% of the bill at $164,582. Of this total, peak demand charges account for $107,576. Demand cost savings are discussed further below.
3. **Other charges:** Market charges are paid by all energy users to ensure the reliability of the electricity network and to prevent blackout. Environment charges include government incentive programs such as a rebate for installing solar panels. These environmental charges and benefits are passed on to customers.

Figure 2 shows the split of electricity charges between Retail, Network and Other for XXXXX XXXXXX. **Table 2** provides a breakdown of all annual electricity charges.

Table 2 Breakdown of annual electricity charges

Component	Annual charges
Peak	$109,051
Off-peak	$60,470
Retail charges subtotal	**$169,521**
Volume charge	$43,402
Peak demand charge	$107,576
Service charge	$13,605
Network charges subtotal	**$164,582**
Other charges subtotal	**$42,658**
Total charges	**$376,761**

Figure 2 Percentage split of electricity charges



As discussed, the total electricity bill is then split between common areas, commercial premises, and all the individual apartments via a sub-metering and billing system. It is understood that the commercial arrangement with the embedded network operator charges a fixed usage rate to all lots and that the common area is billed for the outstanding difference. The billing terms are detailed further in Appendix 1. Therefore any benefits from reducing the overall electricity supply rates may flow directly to the common area billing which is paid by the Owners Corporation. However, this is subject to agreement with the embedded electrical network operator and further investigation is recommended to achieve the most equitable distribution of benefits.

Gas Supply Bills

XXXXX XXXXXX has a common gas hot water system which supplies hot water to apartments, commercial premises, and common areas. The bill is paid by the Owners Corporation.

The current energy retailer for gas supply is XXXXXX. According to Wattblock's analysis the annual gas usage is estimated at 1,383,297 MJ with higher usage in winter. The average cost of gas is approximately $0.0236/MJ giving total annual billing of $32,709. For further information on the gas account and analysis see Appendix 1.

Reducing Electricity and Gas Bills

This report covers three methods that can be used to reduce the energy billing for XXXXX XXXXXX.

1. **Tariff savings:** A tariff review involves finding the electricity and gas retailers in the market that offer the best available energy rates. The review can potentially reduce the retail component of your billing, but not network and other charges as tariffs are fixed by regulators, the government and the market. Tariff review may benefit not just common areas but also commercial and apartment energy costs.
2. **Energy cost savings:** Reduce the energy consumption through energy efficiency upgrades such as LED lighting and the use of solar energy.

3. **Demand cost savings:** One component of the electricity network charges, known as the network demand charge, applies an additional fee based on the peak energy consumption. Throughout the day the demand of electricity fluctuates and peak demand generally occurs at night when everyone is at home and using the facilities in the building. Reducing energy consumption during peak demand periods or improving the efficiency of power usage with a power factor correction unit can lower peak demand charges.

3. Tariff Review

The following section focuses the analysis on the retail tariff savings opportunities for electricity and gas. As noted in the prior section, electricity supply is for the whole embedded electrical network including common areas, commercial, and individual apartments.

Electricity Tariff Review

The current electricity contract with XXXXXXX is a Time Of Use (TOU) tariff where different rates are charged according to the time of day the electricity is being used. This is shown on the electricity bill as peak and off-peak consumption. The times allocated for peak and off-peak times are:

- **Peak usage** – between 7am & 11pm Monday to Friday (excluding public holidays)
- **Off-peak usage** – between 11pm & 7am Monday to Friday, all day during weekends

Within the last year there have been two electricity pricing increases. The first occurred on 1st January 2016 when XXXXX XXXXXX switched from XXXXXXX to XXXXXXX. The second occurred in July 2016 when XXXXXXX increased their rates. **Table 3** shows a total 47% increase in the peak retail rate and 3% increase in off-peak retail rate in 2016 in comparison to 2015.

Table 3 Retail energy rates for 2015 and 2016 (ex GST)

	2015	Current	Impact
Peak Usage	6.0411 c/kWh	8.8737c/kWh	**Up 47%**
Off Peak Usage	4.5976 c/kWh	4.7522c/kWh	**Up 3%**

In 2016, the annual peak energy usage for XXXXX XXXXXX was 1,228,918kWh and off-peak usage was 1,272,464kWh. The impact of the rise in retail energy rates is significant to the overall energy cost as XXXXX XXXXXX is a large energy user. The pricing increase resulted in an additional annual cost of $36,778 to the building as shown in **Table 4** representing a 28% increase on retail usage charges.

Table 4 Retail energy costs for 2015 and 2016 (ex GST)

	2015	Current	Impact
Peak Usage	$74,240	$109,051	**Up $34,811**
Off Peak Usage	$58,503	$60,470	**Up $1,967**
Total	$132,743	$169,521	**Up $36,778**

The impact of this increase in electricity costs is likely to have been passed on to commercial and residential lots in whole or in part with the common areas paying the difference. As noted in Appendix 1 the lot rates were increased during the year. This should be confirmed with the embedded electrical network operator. However, priority should be given to first reducing the overall electricity supply cost regardless of the commercial arrangement.

Gas Tariff Review

Gas billing is currently based on a daily supply charge of $1.20 and tiered usage rates. For the first 51,000 MJ per month the rate is 2.437c and drops to 2.248c thereafter. XXXXXX is using an average 125,754 MJ per month which takes it well into the second pricing tier. For the review period there has been a 9% increase in the gas supply rate.

Gas is a smaller component of the overall energy costs. However, energy retailers provide discounts where they are awarded both electricity and gas supply contracts. Currently XXXXX XXXXXX uses XXXXXXX for electricity supply and XXXXX for gas supply.

Solution – Competitive Electricity and Gas Tariff Review

The building can secure the best prices on the retail market by engaging in a tariff review. For a large customer like XXXXX XXXXXX there are a number of options to consider, such as competitive auctions, to help get the best results. An auction process drives a high degree of price tension, is fully transparent and often attracts participation from all major retailers in your area. The average cost reduction that can be expected is in the range of 10% to 20%.

Because XXXXX XXXXXX has both electricity and gas accounts, it makes sense to conduct a tariff review for both at the same time. As noted, some energy retailers offer additional discounts if they are awarded both electricity and gas accounts.

The Owners Corporation may also need to review the commercial terms with the embedded electrical network operator. The commercial terms may dictate the processes and responsibilities around engaging with energy retailers. It is also important to understand how supply cost changes flow through to the billing of sub-metered lots and the common area billing. Engagement is needed to ensure benefits are distributed in the most equitable manner in accordance with the Owners Corporation preferences. Furthermore, the embedded electrical network operator is itself an intermediary in the energy supply chain and may also be subjected to competitive review for their services.

4. Common Area Energy Consumption

Understanding how energy is consumed in a building is the first place to start when considering energy efficiency initiatives. It is important to see which facilities are consuming the most energy, but also how systems interrelate. Wattblock provides the following breakdown of the current energy footprint at XXXXX XXXXXX. For further detail on these facilities refer to Appendix 2.

4.1. Gas Usage Breakdown

XXXXX XXXXXX uses 1,383,297 MJ of gas at a cost of $32,709 p.a. The gas usage is for common hot water heating supplied to apartments, commercial premises, and common areas. There is no sub-metering in place that would enable a breakdown of end usage. However, it is expected that the majority of the usage will be driven by apartment hot water demands from showers, washing machines, dishwashers, and hot water taps in kitchens, laundries and bathrooms. A smaller proportion of the usage will be associated with the restaurant kitchen facilities. There would be a minor contribution to usage from the common areas and back office.

4.2. Electricity Usage Breakdown

The electricity use breakdown for common areas has been developed based on analysis of the site's seasonal daily electricity profiles, off-peak and peak consumption, and the observed equipment load and operational patterns. The estimated energy use breakdown is shown in **Table 5** and **Figure 3** below.

Figure 3 Electricity use breakdown

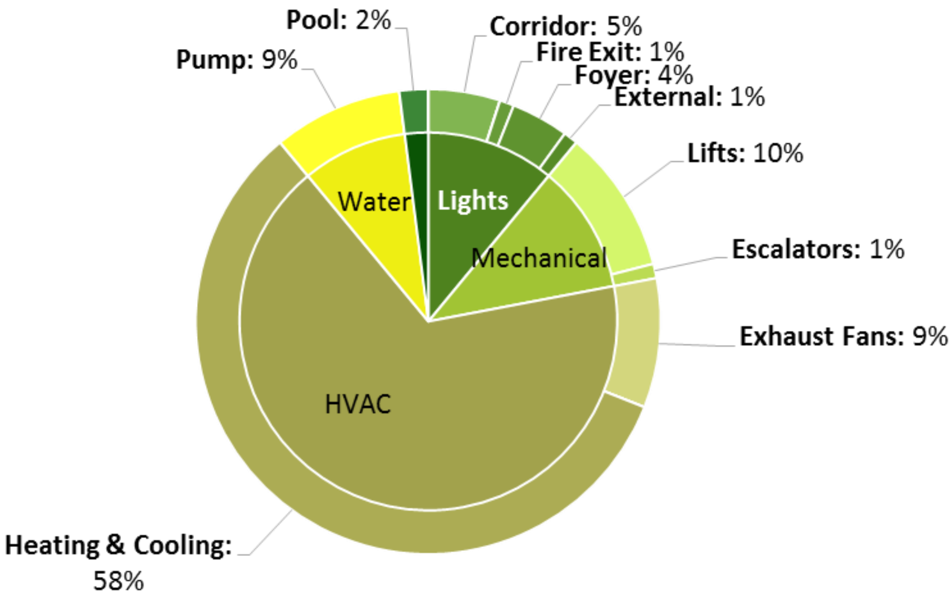


Table 5 Electricity use breakdown of common area

Energy Consuming Asset	Consumption (kWh)	Percentage
Corridor Lights	80,198	5%
Fire Exit Lights	20,323	1%
Foyer Lights	74,907	4%
External Lights	15,750	1%
Lifts	179,015	10%
Escalator	15,000	1%
Exhaust Fans	153,290	9%
Heating and Cooling	1,024,003	58%
Water Supply Pumps	153,888	9%
Pool Pumps	33,770	2%
Total	**1,750,144**	**100%**

5. Shorter Payback Recommendations (Up to 4 Years)

The sections below focus on energy and demand cost saving opportunities with a payback of under 4 years.

5.1. Power Factor Correction

5.1.1. Background

Power factor is a measure of how efficiently power is being used, which impacts on the estimated $107,576 in annual peak demand charges. A power factor of 1 would mean 100% of the power supply is being used efficiently. A power factor less than 1 represents power being used less efficiently. Using the interval data provided by XXXXXXX, the average power factor for XXXXX XXXXXX is calculated to be 0.82. As this strata complex is a large energy user, improving the power factor to 0.96 can represent significant savings. Strata buildings of similar size to XXXXX XXXXXX generally have a power factor greater than 0.9 and there are several reasons which contribute to a low average power factor for XXXXXX common areas.

1. There are three lifts that service XXXXX XXXXXX from levels G – 13. They have an asset life of over 30 years. Although the lift shell has been renovated, the lift motors remain the original motors. Old lift motors operate on poor power factors between 0.47 – 0.77.
2. There is a large number of water pumps at XXXXX XXXXXX for hot water and cold water supply, as well as the circulation of water for the central cooling system. These water pumps have a power factor in the range of 0.7 – 0.8.
3. The presence of an embedded electrical network which includes the power demands of commercial premises and apartments in addition to common area energy usage. This means there is installed electrical equipment that is outside of the remit of the Owners Corporation to manage.

The efficiency of power usage impacts on the peak demand charges in the overall energy billing. Peak demand charges are priced based on the peak energy demand as measured in Kilovolt Ampere (kVA) over the billing period. A better power factor does not reduce energy usage, but it does lower peak demand. In the month of October 2016, the peak demand for XXXXX XXXXXX was 520 kVA with a charge of $9,569.60. The annualized peak demand charges for 2016 are estimated to be $107,576.

5.1.2. Recommendations

Replacing motors and pumps with more modern energy efficient upgrades is a possibility, but would be a very expensive and complex exercise. Furthermore the Owners Corporation cannot upgrade equipment on commercial premises or in apartments. Alternatively, it is possible to improve the overall power factor performance with installation of a Power Factor Correction unit for the whole of the embedded electrical network power supply. Power factor correction capacitors reduce the total current supplied by the energy retailer to the load and as a result the distribution system capacity is increased. Power factor correction capacitors are rated in electrical units called “VAR”. One VAR is equivalent to one volt-ampere of reactive power.

Based on the energy demand of the building, Wattblock recommends installing a 150 kVAR power factor correction unit to improve the efficiency of power usage. The equipment can be located near the electricity distribution board. **Figure 4** shows a typical 250 kVAR power factor correction unit, with a power factor of 0.96 on the display in the middle. The power factor of your buildings power usage will be shown on the device in real time.

Figure 4 A 250 kVAR power factor correction unit

5.1.3. Savings Calculations

The installation of a 150 kVAR power factor correction unit is estimated to improve the average power factor from 0.82 to 0.96. This is estimated to translate to a 14.6% reduction to average monthly peak demand from 487.1 kVA to 416.1 kVA. In the most recent billing the network monthly peak demand tariff for XXXXX XXXXXX is $18.403/kVA. This translates to an annual cost savings of $15,688 as illustrated in **Table 6**.

The capital cost of the project is estimated at $13,330, which includes the purchase of the 150 kVAR unit and an estimated allowance for installation by a qualified electrician. Therefore this project is estimated to deliver a payback on investment of 0.8 years.

Table 6 Financial analysis of a 150 kVAR power factor correction unit

Measure	Power factor correction
Reduction to average monthly peak demand	71.04 kVA
Annual energy usage cost saving	N/A
Annual peak demand cost saving	$15,688
Capital cost	$13,330
Pay back	0.8 Years

The estimated savings and payback are further dependent on the commercial relationship around the operation of the embedded electrical network. The savings calculated above are for the total energy billing costs for common areas, commercial premises, and apartments. In particular, the savings are not related to a reduction in energy usage which is measured by the sub metering system. Therefore it may need to be negotiated with the embedded electrical network operator to pass on the benefits of these savings including the amount of the benefit and who the beneficiary will be. It is expected that under the current arrangement the full benefit of reduced demand charges will be passed through to the common area billing.

5.2. Common Area Lighting Upgrade

5.2.1. Background

The building has common area lighting running 24 hours in the entrance portico, foyer, corridors and fire stairs. The external lighting is run on a timer that is switched between seasons, so that lighting is only on while it is dark. Accounting for this seasonal variance in daily running hours, it is expected that the external lighting attached to the timer would run on average 10 hours per day. The annual lighting energy consumption for XXXXX XXXXXX is estimated to be 191,178 kWh representing 11% of common area energy use. For detailed documentation and analysis of the existing lighting systems refer to Appendix 2.

Recently the building upgraded 15 external 250 Watt mercury vapour light fittings with an LED replacement. Mercury vapour lights have a high wattage and low efficiency, so this project is expected to provide large savings.

<u>Fire Escapes</u>

XXXXXX has 2 fire stairs, one at either end of the building, that run from levels G - 13. The fire stairs are illuminated by a total of 58 high-powered single tube ‘T8’ 36 Watt fluorescent lights. Historically the lights in the fire stairs have been on a pneumatic switch, which automatically turns off after a short period to save energy. However, these lights have been changed to run 24 hours to meet fire safety regulations and enhance the safety for residents. This has resulted in a significant increase in energy consumption in the fire stairs of up to 40 times the previous level, which is equivalent to an annual energy cost of $2,955.

Upgrading the 36 Watt fluorescent tubes to high quality LED battens with sensors is a cost effective way to reduce energy while meeting safety guidelines. LED lights are more energy efficient while providing the same level of illumination. Furthermore, LEDs with integrated occupancy sensors can run at 20% brightness in standby mode when residents are not using the fire stairs. This produces further energy savings while remaining compliant with fire safety regulations. These LEDs brighten to full capacity when the motion sensors are triggered, therefore providing the same level of amenity when people need to use the fire stairs. Emergency exit lighting also includes battery backup power so that the stairwells remain illuminated in the event of a power failure.

An LED upgrade in fire stairs is estimated to reduce energy consumption by 72%, saving 14,531 kWh of energy per year. This does not include the green running man exit lights which are included below under Corridor Lights.

Foyers

The reception foyer area is well illuminated with a combination of decorative wall fittings with Compact Fluorescent Lights (CFLs), recessed down lights with mercury vapour bulbs, and 36 Watt fluorescent tubes to illuminate the ceiling as shown in **Figure 5** below. There are also a number of fluorescent tube lights by the pool.

Figure 5 Foyer with fluorescent tube ceiling lights, downlights and wall light fittings

It was noted on the site assessment that a number of the fluorescent tubes appear to have blown. Furthermore some of the tubes were cool white and some were warm white. In order to retain the aesthetic with sufficient lighting levels, and considering the location of these lights, it is recommended to replace all old tubes with LED tubes without occupancy sensors. This option can halve the energy consumption in comparison to the existing levels, reinstate consistency in lighting temperature aesthetic, and reduce maintenance costs associated with replacing fluorescent tubes.

Wall fitting with CFLs and mercury vapour down lights can also be upgraded to LED. Mercury vapour is a type of high intensity discharge lamp. They use a lot of energy and are extremely inefficient. On the ground level and level 1, there are a number of 80 Watt mercury vapour bulbs running 24 hours. As this is an older technology, these fittings can be replaced with an LED down light to reduce running costs significantly.

The LED upgrade in foyers, replacing fluorescent tubes, CFLs and mercury vapour down lights, is estimated to reduce energy consumption by 74%, saving 49,485 kWh of energy per year.

External Flood Lights

Another major lighting upgrade opportunity is the replacement of the larger 250 Watt mercury vapour bulbs that are in the main entrance portico and in the ceiling just inside the front doors. It was noted on the visit dated 12th December that the 15 external fittings had already been replaced with 30 Watt LED down lights. It is recommended that the 4 remaining 250 Watt fittings located in the foyers are also replaced.

Corridor Lights

The corridors between apartments are illuminated by decorative wall mounted lights containing Compact Fluorescent Lights (CFLs). These lights are on 24 hours a day as the corridors are enclosed spaces without natural lighting. These lights can also be replaced with energy efficient LED alternatives without the need to change the decorative glass fittings. It is important to select the LED bulb with the same colour temperature as existing lights in order to ensure the same interior lighting design.

The corridors also have the green 'running man' exit signs located outside the doorways to the fire stairs. These lights typically contain mini fluorescent tubes which can be upgraded to more energy efficient LED lights. This has already been done with some of the exit signs in the building.

The LED upgrade of the wall mounted light fittings and the remaining 'running man' exit lights in the corridors is estimated to reduce energy consumption by 67%, saving 60,063 kWh of energy per year.

Apartments

While access to the apartments was not a part of the site assessment, the maintenance manager mentioned an essential service light just inside the door of each apartment that runs 24 hours. He stated that a number of these were still the old halogen dichroic downlights which run at 35 Watt. It is understood that the replacement of these lights with a more efficient LED light has already begun, and it is recommended that all remaining halogen down lights be replaced with an LED down light.

5.2.2. Recommendations

1. Replace the existing 58 x single T8 1200mm 36W emergency battens in the fire stairs with new LED 18W batten type with a sensor that runs at 20% brightness when unoccupied.

2. Replace 42 x single T8 1200mm 36W fluorescent tubes in foyers and 6 x single T8 1200mm 36W fluorescent tubes in pool area with 18W LED tubes.
3. Replace 25 x emergency exit signs with LED exit signs.
4. Replace remaining 4 mercury vapour bulbs in foyers with LED down lights.
5. Replace remaining halogen dichroic 'essential service' down lights in apartments with an LED down light.
6. Replace compact fluorescents lights in foyer and corridor wall fittings with LED retrofits.

5.2.3. Savings Calculations

Table 7 below shows estimated energy savings and costs for the replacement and/or refurbishment of all lighting equipment identified in the above recommendations. Upgrading all 675 lights is estimated to cost $55,965 including supply of the lighting products and installation by an electrician. The project is expected to achieve a payback of 2.1 years on the initial investment due to dramatically reduced energy consumption of these common area lights.

Table 7 Financial analysis of LED lighting upgrade

Measure	LED lighting upgrade
Annual energy consumption saving	124,234 kWh
Annual energy usage cost saving	$12,719
Annual peak demand cost saving	$5,343
Annual maintenance savings	$8,025
Annual savings	$26,087
Capital cost	$55,965
Pay back	2.1 Years

Overall energy consumption of these lights is estimated to be reduced by 70% or 124,234 kWh per year. Because lighting contributes to peak energy demands there is also an estimated 8% reduction to peak energy demand. Given consideration of current peak and off peak energy usage rates and peak demand charges this translates to annual cost savings of approximately $18,062. This includes both energy usage savings and peak demand savings.

In addition, LED lamps have a significantly longer lifespan to that of traditional incandescent, halogen and fluorescent lamps. The calculation of true cost of ownership should therefore take into account not only the energy costs of running the current inefficient lamp types but also the cost of replacing them regularly. Wattblock estimates an additional annual maintenance savings of $8,025 giving a total $26,087 in annual cost savings for all lighting upgrades in the recommendations.

Both the savings from reduction in energy usage and peak demand charges should pass directly to the common area bills paid by the Owners Corporation. As discussed previously this depends on the commercial agreement with the embedded electrical network operator.

For the purposes of this audit these savings and costs are estimated based on similar projects that have been completed in other residential apartment buildings. These figures are not formal quotations but could be considered to be representative of the market and are suitable for budgeting purposes. This is a medium accuracy estimate as per the Standard.

5.3. Permafrost Injection in Chillers

5.3.1. Background

A central air-conditioning system is used for the residents and common areas at XXXXX XXXXXX. The operation of the system is complex and the details are discussed in Appendix 2. While the benefit from the central air conditioning is split between the residents and common areas, it runs on the common area power supply and the energy consumed is paid for by the Owners Corporation. Any cost savings identified will therefore accrue to the Owners Corporation to realise payback on investment. The recommended projects in this section focus on improving the efficiency of the air conditioning chillers.

There are four chillers located in the ground floor plant room which are used to produce chilled water. The chilled water is circulated around the building through a chilled water loop to cool down the room temperature inside each residential unit. As a result of this process the chilled water slowly warms up. In order to maintain the temperature of the chilled water loop a refrigerant is used inside the chillers to facilitate the process of heat transfer that removes heat. The problem arises when the oil used in the chiller machinery leaks into the refrigerant circuit. The oil molecules form a barrier that decelerates the heat transfer inside the refrigerant circuit. This results in the chiller working longer to produce the same amount of cooling capacity, in turn increasing the energy consumption of the system. This issue becomes increasingly apparent on systems that are 3 years and older.

Figure 6 Chillers located in the plant room on the ground floor

5.3.2. Recommendations

Wattblock recommends PermaFrost for improving energy efficiency of the air conditioning chillers. The project involves injecting PermaFrost manually into the existing lubrication oil for the chiller compressors. Through applying the highly thermos-conductive compound into the refrigerant circuit, the stagnant oil layer on the inner lining of the refrigerant coils is permanently removed (**Figure 7**), thereby significantly improving heat transfer. In comparison to a normal operating system without oil barriers the PermaFrost molecules can further increase thermal conductivity by accelerating the heat transfer rate of the system. The PermaFrost can be easily injected into the chiller system and no mechanical modification is required. A one-time treatment of PermaFrost can last the life of the chiller.

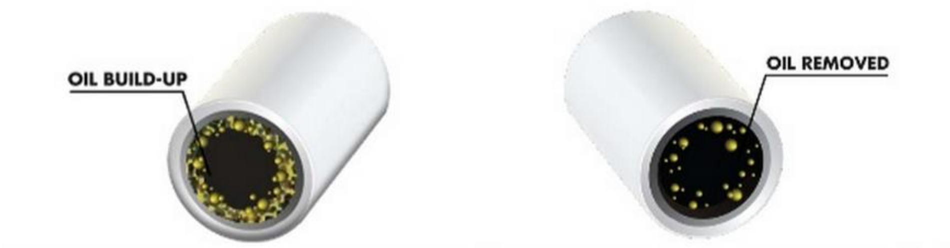


Figure 7 Metal tubes inside chillers before and after the use of PermaFrost (source: Powertron Global)

5.3.3. Savings Calculations

PermaFrost was developed between the 1990s and 2002 and it has been successfully applied in the USA and across Europe. The technology has proven to bring a market improvement in cooling performance, with energy savings of between 10% and 30%. Wattblock has used a typical 16% savings guidance for calculating the energy savings of the chiller compressors at XXXXX XXXXXX.

The current energy consumption of the chillers is based on their kW ratings and electrical current flow rate (Ampere). The data was collected with the assistance of the chiller maintenance staff using a clamp meter-reading device. The results revealed that the chiller is running at 100 to 120 Ampere on average and at 140 Ampere on full load. The hours of operation of the four chillers is estimated to be 8 hours per day, with an energy consumption of 392,448 kWh per annum. This is a medium accuracy estimate as per the Standard.

The use of permafrost has the additional benefit of extending the lifespan of the chillers. This is due to the system operating hours being reduced as a result of the improvement in heat transfer efficiency. However, the additional maintenance savings are difficult to estimate with sufficient accuracy and have not been included in the financial analysis.

Capital costs have been estimated at $35,960. This has been calculated based on estimates of component costs and installation services. The project is estimated to deliver a 3.9 year payback with annual savings estimated at $9,129. Air conditioning systems are also expected to contribute to peak energy demand the savings. Therefore savings are comprised of both an 11% reduction in energy usage fees and a 5% reduction in peak demand fees.

Table 8 Financial analysis of PermaFrost technology

Measure	Injection of PermaFrost into chillers
Annual energy consumption saving	62,792 kWh
Annual energy usage cost saving	$6,429
Annual peak demand cost saving	$2,700
Annual maintenance savings	Further benefits not estimated
Total Savings	$9,129
Capital cost	$35,960
Pay back	3.9 Years

Both the savings from reduction in energy usage and peak demand charges should pass directly to the common area bills paid by the Owners Corporation. As discussed previously this depends on the commercial agreement with the embedded electrical network operator.

5.4. Variable Speed Drive Retrofit to Water Pumps

5.4.1. Background

Besides chillers, the central air conditioning system also consumes energy in pumping chilled water around the building. A separate condenser water loop is used to circulate water from the chiller to the cooling tower located on the roof for heat rejection to the external environment. The recommended project in this section focuses on improving the efficiency of these water pumps. There are two chiller water pumps and two condenser water pumps located in the ground floor chiller plant room (**Figure 8** and **Figure 9**).

Figure 8 TECO water pump

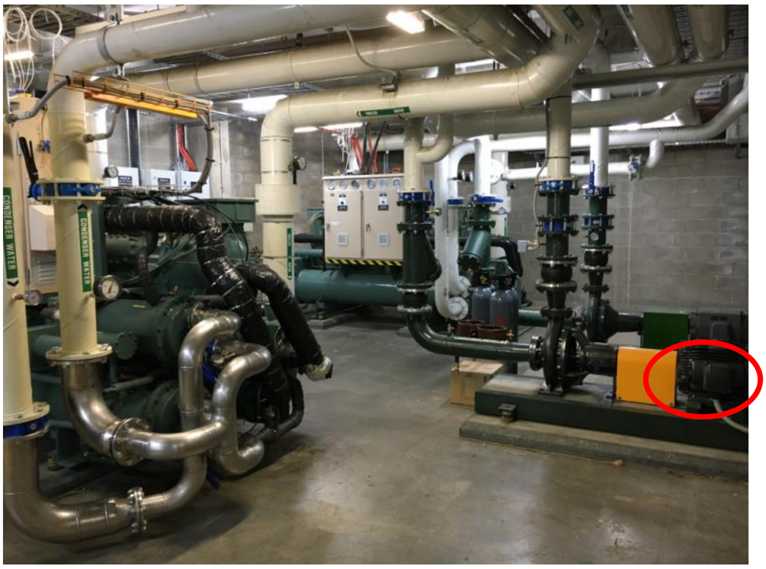


Figure 9 TECO water pump in plant room on ground floor

The current water pumps are equipped with soft starters, which provide a gentle ramp-up to full speed during the start-up of the pump. Otherwise there will be an initial power surge which can result in mechanical shock and reduce equipment life for the pump overtime. The additional benefit of soft starters is a reduction in both energy usage and peak demand.

Nevertheless, the four water pumps in the system still consume a large amount of energy. Firstly, the rated capacity of the pumps is significant with chiller water pumps rated at 15 kW and condenser water pumps at 18.5 kW. Secondly, the pumps can only operate at full capacity regardless of the demand for cooling.

5.4.2. Recommendations

Energy savings can be achieved with the retrofit of Variable Speed Drives (VSDs) into existing water pumps. The variable speed drive allows the water pump to operate at different speeds depending on the level of cooling demand. Any reduction in speed would result in a drop in energy consumption.

Wattblock recommends the retrofit of 4 variable speed drives into the chiller water pumps and condenser water pumps of the central air-conditioning system. The variable speed drives should be sized such that the input wattage matches the rated wattage of the existing water pumps. In additional, pressure sensors and controllers also need to be installed to manage the operation of the variable speed drives.

5.4.3. Savings Calculations

The retrofit of variable speed drives commonly results in a 10% - 20% reduction in speed, which correlates to a 20% - 50% drop in energy consumption. The current energy consumption of the water pumps is based on their kW ratings and the hours of operation of the pumps is estimated at 8 hours per day.

For the financial analysis we have used a conservative energy savings estimate of20%. However, as air conditioning operates during peak usage periods the financial savings are much higher. Cost savings are estimated to include both a 14% reduction in energy usage fees and a 6% reduction in peak demand charges. Total annual savings is estimated at $6,258. This is a medium accuracy estimate as per the Standard.

In addition, the use of variable speed drives has the benefit of improved system reliability. Any reduction in speed achieved has major benefits in reducing pump wear and thus extending equipment life. To be conservative, the maintenance benefits to the water pump are not considered in the financial analysis.

Capital cost is based on an estimate of the equipment purchase cost and hourly rates for project installation. Project management costs have been included to ensure the new system is compatible with the existing central cooling system. **Table 9** provides a financial analysis of the project, which is estimated to achieve a payback on investment of approximately 3.6 years.

Table 9 Financial analysis of variable speed drives on water pumps of central cooling system

Measure	Retrofit of variable speed drives
Annual energy consumption saving	39,128 kWh
Annual energy usage cost saving	$4,407
Annual peak demand cost saving	$1,851
Annual maintenance savings	Further benefits not estimated
Total savings estimate	$6,258
Capital cost	$22,696
Pay back	3.6 Years

Both the savings from reduction in energy usage and peak demand charges should pass directly to the common area bills paid by the Owners Corporation. As discussed previously this depends on the commercial agreement with the embedded electrical network operator.

6. Longer Payback Measures (Over 4 Years Payback)

6.1. Gas Boosted Heat Pump Hot Water Heating

6.1.1. Background

A common gas hot water heating system located on the roof of the building is used to supply hot water for residents at XXXXX XXXXXX. The Owners Corporation pays the gas bill on behalf of all residential hot water users. The operating costs of the system would be recovered through strata levies to unit owners. Historically gas has been a cheap energy resource in Australia. However, average wholesale prices have more than doubled in recent years. In addition, gas hot water heating is inefficient. The current annual gas bill is $32,709 for a total usage of 1,383,297 MJ which is equivalent to 9,673 MJ per apartment. Any savings achieved will accrue directly to the Owners Corporation in achieving return on investment.

6.1.2. Recommendations

Wattblock recommends retrofit of the existing gas hot water system to a gas boosted electric heat pump system. Heat pump hot water heating systems are about five times more efficient than conventional gas hot water heating. Heat pump systems work by absorbing heat from the surrounding air and transferring it to heat water. They work on the same principle as a refrigerator, but instead of pumping heat out of the fridge to keep it cool, they pump heat into the water. The proposed system is to use a heat pump to heat the mains cold water up to 55° , which would then be boosted by the existing gas hot water system for hot water storage in pressurized energy bank vessels.

Heat pumps use electricity to operate which is favourable for XXXXX XXXXXX due to the low electricity rates. The heat pumps can be set up to operate during hours that optimise the cost economics and the efficiency of the system. Considerations include peak usage times of hot water, ambient temperature modeling to optimise heat transfer, and favouring off peak or shoulder periods for electricity usage.

6.1.3. Savings Calculations

The implementation of the heat pump system would result in an increase in common area electricity costs. However, this is more than offset by a significant reduction in gas billing. Savings figures can vary depending on the level of gas boosting required after the installation of a heat pump system. A gas boosting of 10% has been assumed in the financial analysis. The average usage rate for gas used in the calculation is $0.0233/MJ and the average usage rate for electricity is $0.0877/kWh. We have considered the heat pumps would be set up to operate outside of peak demand periods and will not have an impact on demand fees. According to our modeling we estimate a 1,244,967MJ reduction in gas usage offset by a 81,653kWh increase in electricity usage. In dollar terms this translates to a $29,007 reduction in gas billing and a $7,161 increase in electricity usage fees for a net $21,864 annual savings (**Table 10**).

Capital cost is estimated at $91,000 including the cost of the heat pump system together with installation cost estimates. A crane maybe required to lift the equipment to the roof. This cost has not been included in the estimate. Based on net savings estimates this project is therefore expected to achieve a payback of 4.2 years.

Table 10 Financial analysis of a gas boosted heat pump hot water system

Measure	Gas boosted heat pump system
Annual energy consumption impact	1,244,967MJ Gas Savings 81,653 kWh Electricity Increase
Annual electricity cost increase	$7,161
Annual gas cost savings	$29,007
Net energy cost saving	$21,864
Annual demand cost saving	N/A
Capital cost	$91,000
Pay back	4.2 Years

6.2. Solar Energy System

6.2.1. Background

Solar energy systems collect energy from the sun via solar panels which are typically installed on rooftops. An inverter system converts DC current from the panels to AC current which supplements the normal electricity supply coming from the electricity network or 'grid' power.

An embedded electricity network is set up for the strata complex at XXXXX XXXXXX. Residential apartments, commercial units and the common area of the complex are connected to a single electricity 'gate' meter. As a result, the installation of a solar energy system could connect to the gate meter and supplement energy supply to all parties within the embedded network.

6.2.2. Recommendations

Wattblock recommends installation of a 40 kW solar energy system on the roof of XXXXX XXXXXX. The roof of the main hotel structure is relatively unshaded and will produce good solar energy output. The available space for consideration of a solar energy system is 450 square meters which is sufficient to hold approximately 150 panels.

It may be possible to increase the size of the solar energy system up to 100 kW by utilizing the roof area above "XXXXXX" function center. This building, located next to the main hotel, has a massive roofspace of approximately 1,000 square meters. However, this area is less suitable for solar as it has significant shading during the late afternoon from the hotel as shown in **Figure 10** below. In addition, some parts of the function center roof are curved and may not be suitable for installing solar panels as shown in **Figure 11**.

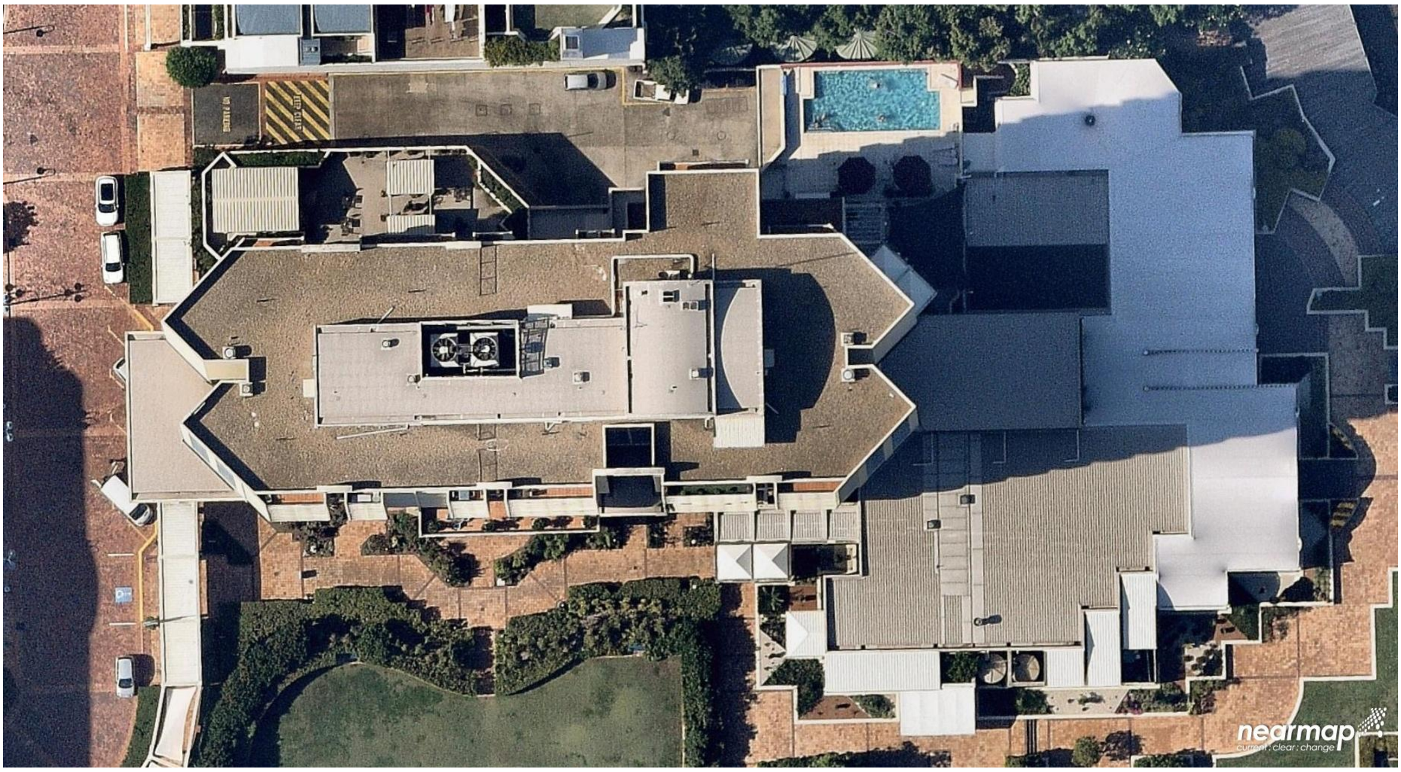


Figure 10 XXXXX XXXXXX aerial image

Figure 11 "XXXXXX" Function Centre

If XXXXX XXXXXX wants to increase the size of the solar system up to 100 kW, further modelling is required to determine the best location for the panels. Residential installations of solar generally do not exceed 100 kW as anything larger would be subject to additional regulations as a power generation plant.

6.2.3. Savings Calculations

Solar energy works to offset electrical energy consumption from the grid. So it is also important to understand the future energy demands to estimate the impact of installing solar energy. At present the average cost for electricity supply to the building is $0.15/kWh and the total consumption is 2,446 MWh per year. If all the projects identified in this report were to be implemented, it is estimated that the total consumption would be reduced to 2,121 MWh per year. Through modeling the expected future energy consumption profile over the hours of the day and seasons of the year it is possible to calculate the savings (**Figure 12**).

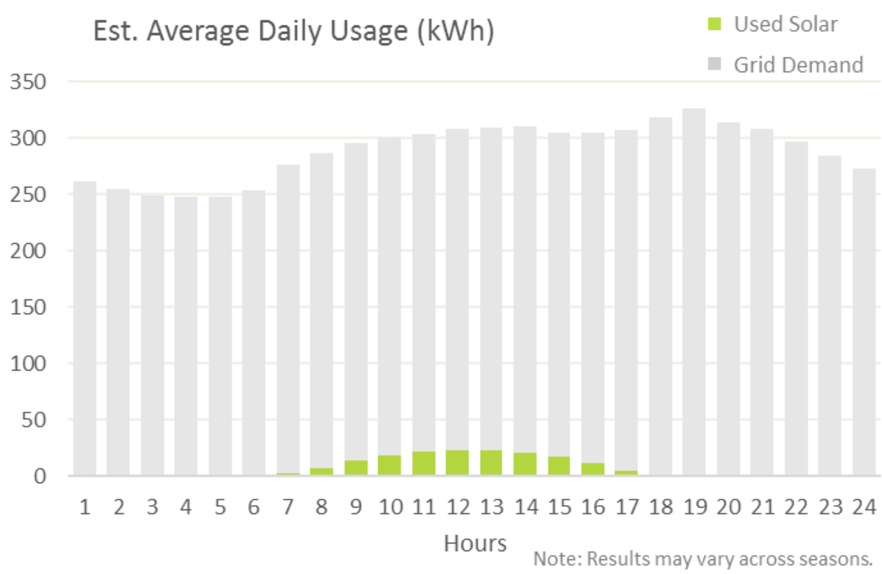


Figure 12 Solar contribution of a 40kW solar energy system

Without batteries, solar energy can only be used during the daytime. However, XXXXX XXXXXX is a large energy user and would use all the solar energy generated from a 40 kW solar energy system. The solar energy generated is estimated to offset 2.5% of the total energy use of the strata complex.

The annual energy bill savings are estimated at $6,515 including both a 2.5% reduction in energy usage and lower peak demand fees. These benefits have been estimated taking into account both peak and off-peak electricity rates. Most of the energy offset by the solar panels will occur during off-peak hours during the daytime. The energy savings estimates have also been offset by an annual maintenance cost allowance of $800 for cleaning the panels and ensuring the system is operating at the optimal state. Net savings is estimated at $5,715 p.a.

Capital costs have been estimated at approximately $52,000 including the cost of the 40 kW solar energy system, installation and project management. A crane maybe required to lift the equipment to the roof. This has not been included in our estimate. Based on these calculations the project would deliver a payback of 9.1 years (**Table 11**).

Table 11 Financial analysis of a 100kW solar energy system

Measure	Solar Energy
Annual energy consumption saving	60,240 kWh
Annual energy usage cost savings	$6,094
Annual peak demand cost saving	$421
Less maintenance costs	$800
Net cost saving	$5,715
Capital cost	$52,000
Pay back	9.1 Years

The proposed solar energy system would be connected to the gate meter of the embedded electrical network. Therefore the energy produced will be used by common areas, commercial premises, and apartments. However, the existing sub metering system in the building will not be affected. The sub metering system will still record the overall energy usage of each customer and will not distinguish any solar energy use.

Under the commercial agreement with XXXXXX XXXXX the net benefits of the reduced energy billing should all go to the common area bill paid by the Owners Corporation. This means that the Owners Corporation will benefit directly from the capital investment to realise the payback. While this may be ideal, it should be confirmed prior to further investigation of any solar energy investment as alternative treatments may also be possible.

Due to the strata scheme having an embedded electrical network, a Type 3 energy audit focused on solar would be advised prior to implementation of the solar energy system. This would cover different commercial models available and ensure the benefits are distributed in the most equitable manner.

7. Energy Management Measures

7.1. Energy Management Program Enhancements

7.1.1. Background

Effective energy management can drive organisations to achieve continual improvement in energy performance. An audit report is a tool that can assist in assessing energy performance. However it needs to be supported by systems and cultural awareness for it to be effectively implemented. In addition, energy management in strata buildings is getting more and more complex as the years go by. The coming 2-5 years will see the arrival of mass market electric vehicles and the need to provide recharging facilities for residents. Battery technology and costs are also converging to allow solar energy to be stored economically for usage at nighttime and in the event of blackouts to provide energy security.

7.1.2. Recommendation

Wattblock recommends the following energy management action to help improve energy efficiency at XXXXX XXXXXX over time.

- Appoint an executive committee member, strata manager or building manager to be the 'energy manager' with responsibility to implement and monitor energy reduction projects.
- Put up energy posters and notices at relevant places such as the strata notice board.
- Inform building residents of energy efficiency upgrades and programs.
- Include energy management in minutes of committee meetings, annual reports, and AGM agenda.
- For big energy projects, install sub metering on major plant and track energy data.
- Establish a formal process for reviewing tariffs and contracts on a periodic basis and use an energy broker to optimise tariff changes.
- Make enquiries with an energy advisory company about receiving a low cost quarterly tracking report for review by the strata committee at strata meetings.

7.1.3. Savings Calculation

No direct savings can be calculated. However, these measures will help to facilitate implementation of the savings identified in this report.

7.2. Type 3 Energy Audit for Central Heating and Cooling System

7.2.1. Background

The largest energy consuming assets for XXXXX XXXXXX is the central air-conditioning system. Analysis of energy consumption in Section 4 shows that central cooling and heating for residents accounts for an estimated 59% of the total energy use of the common area billing. Currently there is only one measure of electricity usage for the common areas of XXXXX XXXXXX. Therefore the contribution from the central air-conditioning can only be estimated within an 80% accuracy. This is sufficient for a Type 2 energy audit, but there are benefits from more accurate analysis.

A Type 3 energy audit involves installation of electricity sub-meters which would enable accurate monitoring of the energy use for the central cooling system. This type 2 energy audit has focused on two projects which commonly result in fast paybacks. The central air-conditioning system at XXXXX XXXXXX is complex and completing a full detailed review of the system can assist to identify further energy efficiency opportunities. A Type 3 review will also improve the accuracy of project costs and savings identified in section 5.3.3 and section 5.4.3. In addition, a permanent sub-metering installation will help in maintaining the site energy performance into the future and provide baseline data for analyzing the impact of energy efficiency upgrades.

7.2.2. Recommendations

Perform a Type 3 energy audit with energy sub-metering on the central cooling and central heating systems. A Type 3 energy audit, including installation of a sub-metering or monitoring system is expected to cost approximately $15,000. This is an average cost for a Type 3 energy audit.

A Type 3 energy audit would be conducted in the context of supporting the previously identified common air-conditioning projects which have been covered in sections 5.3 and 5.4. The audit can assist in further optimizing the outcomes.

7.2.3. Savings Calculations

A combined project for central air-conditioning would cost approximately $73,656, including a Type 3 energy audit together with estimated Permafrost project costs of $35,960 and variable speed pump project costs of $22,696.

Permafrost is expected to deliver cost savings of $9,129 and variable speed pumps are expected to deliver $6,258 in annual savings. If we assume that a Type 3 energy audit is able to deliver a 10% optimisation in energy cost savings across the combined projects, this would translate to total annual savings of $16,926. This would lead to an overall payback on investment of approximately 4.4 years (**Table 12**). Furthermore, the building would benefit from having a sub-metering system in place to enable tracking of common air-conditioning energy usage for better facility management.

Table 12 Financial analysis of a Type 3 energy audit on HVAC system

Measure	HVAC with Type 3 Audit
Annual energy consumption saving	112,112 kWh
Permafrost savings estimate	$9,129
Variable speed pumps savings estimate	$6,258
Assumed 10% optimization benefit	$1,539
Total annual savings	$16,926
Type 3 energy audit	$15,000
Permafrost & VSD projects	$58,656
Total Capital cost	$73,656
Pay back	4.4 Years

This analysis is provided for illustrative purposes. It shows the cost and potential value of a Type 3 audit in the context of the overall savings opportunity. The level of savings optimization that can be achieved will be subject to completion of the Type 3 audit itself. However, the analysis demonstrates that a small optimization benefit produces a large financial savings. Wattblock therefore recommends a Type 3 audit as likely to improve overall financial returns and payback for the central heating and cooling systems projects.

8. Conclusions

Wattblock has completed a Type 2 energy audit for the residential common areas of the XXXXX XXXXXX, Strata Plan CTS XXXX. The audit has been conducted with a medium level of accuracy according to the guidelines set forth in AS/NZS3598:2014. In conclusion several opportunities have been highlighted for consideration including estimates of project costs, savings and payback. The recommended projects include:

- Tariff review for electricity and gas supply
- Power factor correction
- Common area LED lighting upgrades
- VSD pumps and Permafrost for central air-conditioning
- Heat pump for central hot water heating
- Installation of rooftop solar energy
- Energy management improvements

There are other energy systems in the buildings that can benefit from improved energy efficiency. These include the escalator and toilet ventilation fans. However, these have not been included as recommended projects due to project cost and complexity relative to energy savings benefits. For further information on these systems refer to Appendix 2.

XXXXXX Apartments is a large energy user and the energy systems are complex. While this audit has focused on assessment of the residential common areas, by necessity it has also covered certain aspects of the commercial premises, internal apartments, and reception and back office areas. Notably the existence of an embedded electrical network means all electricity supply comes under the same energy supply contract. Consequently any review of electricity supply tariffs may benefit all users and requires review of the commercial terms in place with the embedded electrical network operator. The common hot water and common air conditioning systems are also services for which the beneficiaries are the apartments and commercial tenants. Never the less, these services are under the management of the Body Corporate and any savings should accrue directly in achieving payback on investment.

Given the size and complexity of the air-conditioning savings opportunity it is further recommended to conduct a deeper dive Type 3 energy audit. If these initiatives are pursued further, a Type 3 audit should provide additional value by way of optimising the outcomes of interrelated projects. A Type 3 audit is also recommended if further consideration is given to a rooftop solar energy initiative to investigate equitable commercial models. While this Type 2 audit provides a medium level of accuracy across a broad range of energy consuming assets, Type 3 audits provide a much more detailed investigation of specific systems. Type 3 audits are generally recommended for large and complex systems to achieve the best results.

If the Body Corporate were to implement all the recommended projects, the total project costs are estimated to be $285,951. With estimated annual savings of $84,741 this would result in an overall payback of 3.4 years. This excludes energy supply tariff review which could deliver over $40,000 in additional annual savings without any major project costs. **Table 13** provides a summary of energy projects and further supporting calculations are provided in the appendices.

Table 13 Energy project summary

Energy Project	Annual Energy Savings	Total Annual Financial Savings	Total Project Cost	Payback
Shorter Payback Measures (up to 4 years)				
Power Factor Correction	N/A	$15,688	$13,330	0.8 Years
Lighting Upgrade	124,234 kWh	$26,087*	$55,965	2.1 Years
Permafrost Injection into Chillers	62,792 kWh	$9,129	$35,960	3.9 Years
Retrofit Variable Speed Drives	39,128 kWh	$6,258	$22,696	3.6 Years
Longer Payback Measures (4 years+)				
Heat Pump Hot Water Heating	1,244,967MJ Gas -81,653 kWh	$21,864	$91,000	4.2 Years
Solar Energy	60,240 kWh	$5,715	$52,000	9.1 Years
Energy Management Measures				
Energy Management Program Enhancement	N/A	N/A	N/A	N/A
Energy Sub-metering	N/A	N/A	$15,000 **	N/A
Total	**204,741 kWh** **1,244,967MJ Gas**	**$84,741**	**$285,951**	**3.4Years**

*lighting project includes maintenance savings

** Estimated cost of Type 3 energy audit

Appendix 1: Energy Consumption Characteristics

A1.1. Electricity

A1.1.1. Embedded Electricity Network

There is one electricity supply account for the XXXXX XXXXXX strata complex and it supplies multiple lots via an embedded network, including:

- Lot 1: Reception, back-of-house, and manager's unit
- Lot 2: XXXXXX function centre
- Lot 3: XXXXX XXXXXX
- Lots 4-146: individual units
- Common area electricity

The diagram below illustrates the concept. In most residential apartment buildings, individual residents purchase electricity directly from the energy retailers at standard electricity rates. In an embedded network scenario, the residential meters are first connected to a single "gate" meter. The Owners Corporation normally engages a service provider, such as XXXXXX XXXXX, to act on the behalf of all residents in the block to purchase electricity from a single retailer. This arrangement provides benefits for the Owners Corporation and/or residents as the bulk buying of electricity offers an incentive for energy retailers to provide a cheaper energy rate.

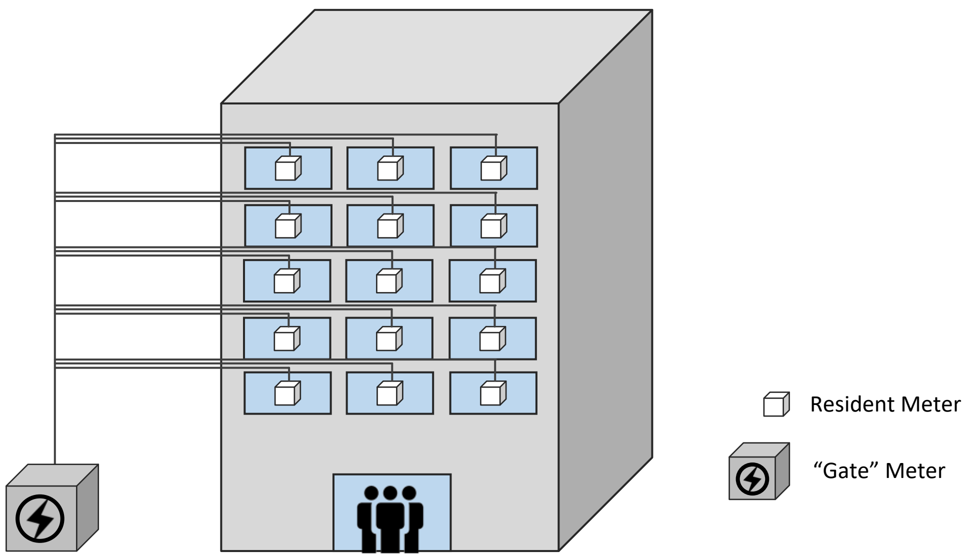


Figure 13 Embedded network diagram

The embedded electrical network at XXXXX XXXXXX is managed by XXXXXX XXXXX. There is an electrical supply contract in place with energy retailer XXXXXXX Energy for the overall electricity supply. It is understood that XXXXXX

XXXXX pays this bill on behalf of XXXXX XXXXXX. XXXXXX XXXXX then recovers this cost through a sub metering and billing service which enables each of the lots to pay for their respective energy usage.

The commercial lots are billed monthly and currently pay a fixed Daily Access Fee of $1.3017 and an energy usage fee of 25.97c per kWh. The energy usage fee increased by 15.5% during 2016.

The residential lots are billed quarterly and currently pay a fixed Daily Access Fee of $0.5022 and an energy usage fee of 24.61c per kWh. The energy usage fee increased by 10.7% during 2016. There are additional charges applicable for set-up and termination of $25 and $15 respectively. Furthermore government rebates are passed through to residents where applicable.

These commercial rates for the energy usage of the Lots differs from the XXXXXXX retail contract. Wattblock understands that the common area electricity amount is calculated based on the difference between the XXXXXXX Energy billing and the net payments received from the Lots.

A1.1.2. Electricity Account

The details of the main electricity supply account are presented in **Table 14**.

Table 14 Electricity account information

NMI	XXXXXXXXXXX
Supplier	XXXXXXX
Customer site number	XXXXXXXXXXXX
Account holder	XXXXX XXXXXX CTS XXXX
Meter number	XXXXXXXXXXX
Coverage	Whole site

A1.1.3. Electricity Usage Profile

The monthly consumption chart is presented in **Figure 14**. The average profiles for different seasons and weekdays have also been developed using utility interval data. It is noted that the average profile is for the whole site including common area, apartment units and commercial units. The average profiles are presented in **Figure 15** and **Figure 16**.

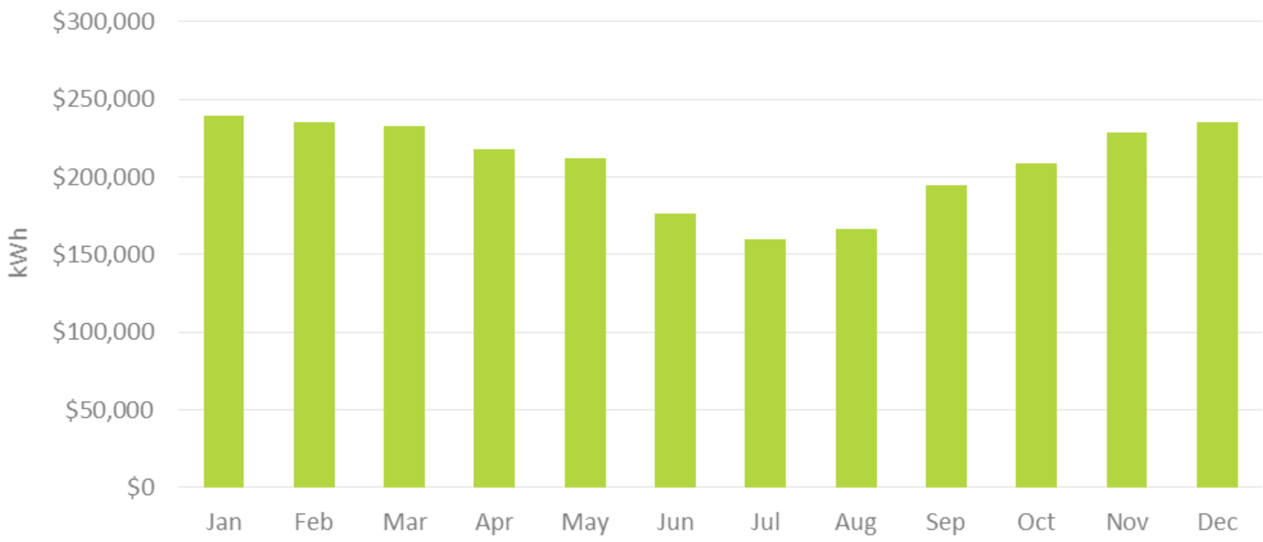


Figure 14 Monthly electrical usage in 2016

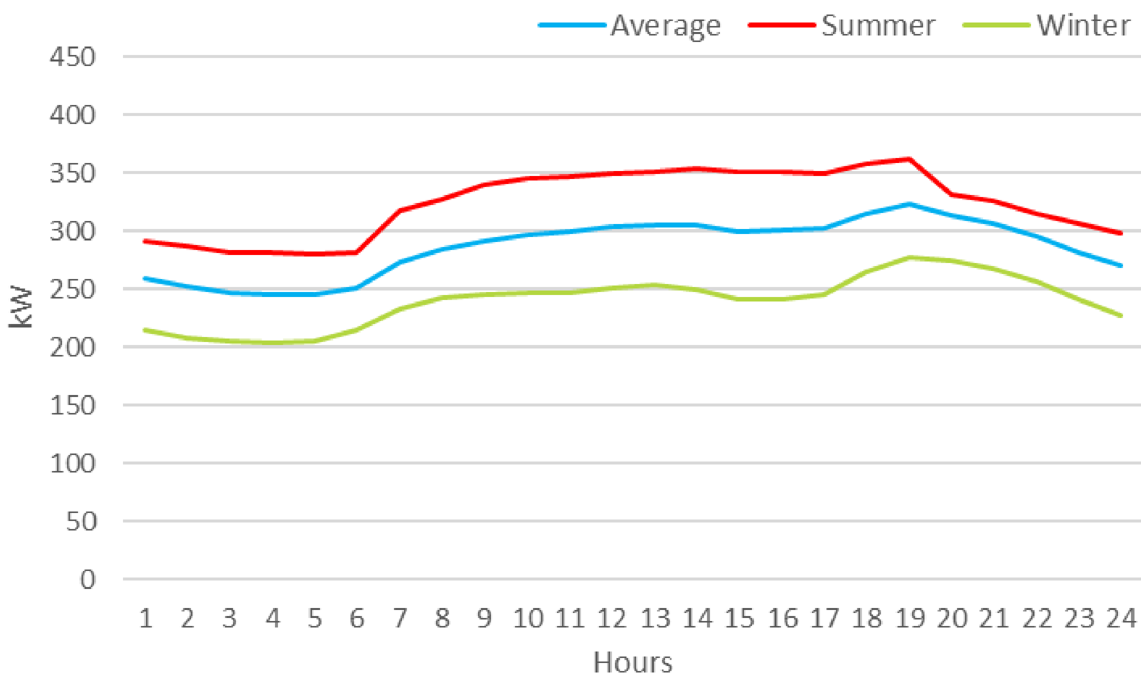


Figure 15 Average daily electricity usage - seasonal variance

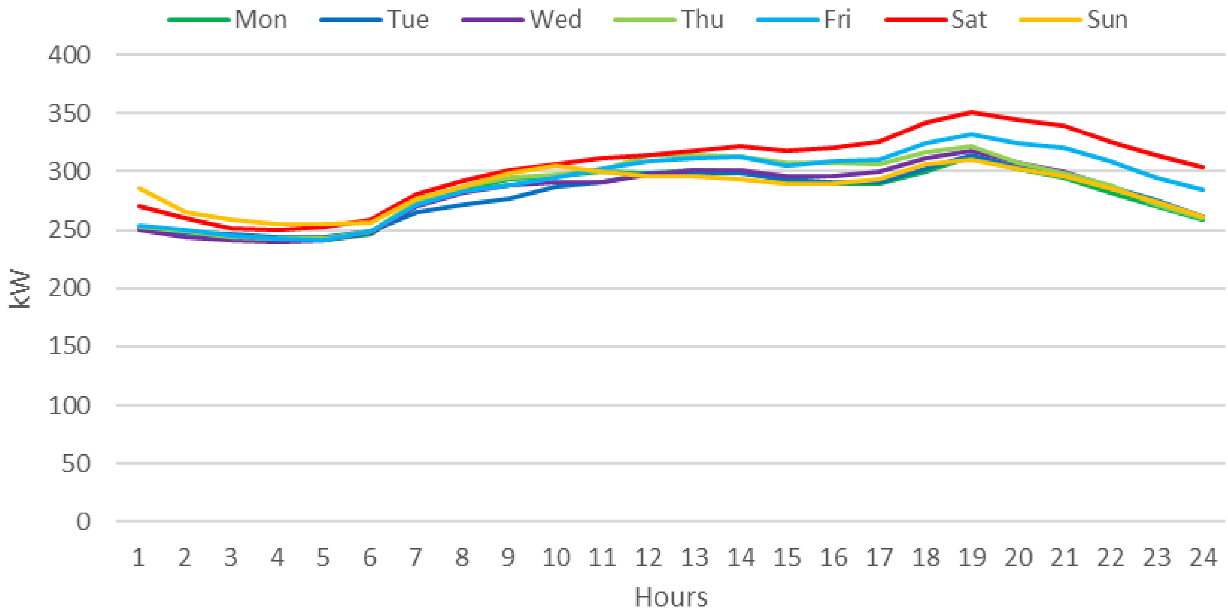


Figure 16 Average daily electricity usage - weekday variance

Key points to draw from these profiles are:

- Seasonal variance on energy usage is evident for XXXXX XXXXXX. The peak load in summer was approximately 360 kW and the peak load in winter is 280kW. This is most likely due to higher use of air-conditioning in summer.
- The average base load for the building was approximately 240 kW. The base load for other seasons ranged from 200-280 kW.
- No significant variance is identified for average load profiles. Energy usage is slightly higher during Friday and Saturday nights. The commercial function centre “XXXXXX” is likely to be contributing to the higher energy usage on Friday and Saturday nights.

A1.2. Gas

A1.2.1. Gas Account

There is one gas supply account for the XXXXX XXXXXX strata complex and it is used to heat up hot water for apartment units, commercial units and the common area. The Owners Corporation pays this bill on behalf of all usage in the building. The gas account detailed information is presented in **Table 15**.

Table 15 Gas account information

Retailer	XXXXX
Account number	XXXXXXXX
Account holder	XXXXX XXXXXX CTS XXXX
MIRN	XXXXXXXXXXX
Meter number	XXXXXXXXXXX
Coverage	Whole site

A1.2.2. Gas Consumption

The consumption from the 04/06/15 to 02/06/16 was 1,383,297 MJ and the average cost for gas was approximately $0.0236/MJ. The peak gas consumption occurred during winter months and the base load was evident during summer months (**Figure 17**). The higher gas usage in winter is typically due to a higher rate of heat loss for the hot water as it circulates around the building, and from people taking more frequent or longer hot water baths or showers.

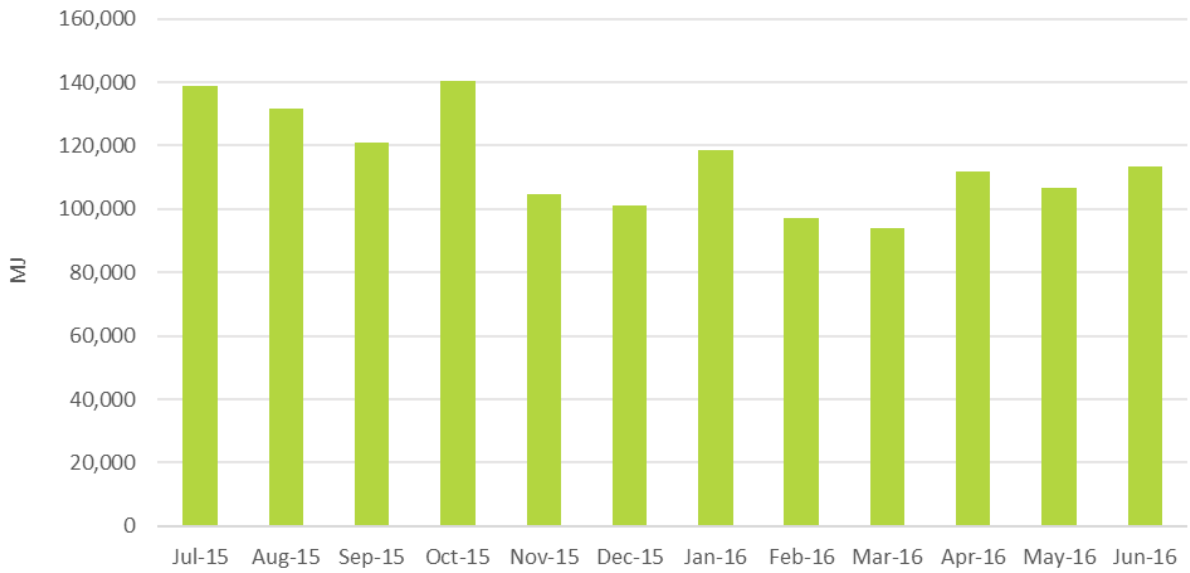


Figure 17 Normalised monthly gas consumption in 2015-16

Appendix 2: Site Description

A2.1. Improvement History

The XXXXX XXXXXX has already adopted a number of energy efficiency initiatives in an effort to reduce the energy consumption and subsequently the cost of electricity at the site. This includes installing variable speed drives on the rooftop cooling towers, soft starters on the circulating pumps, and thermostat control on the fan in the lift motor room. XXXXX XXXXXX has also already begun replacing some of the lights with LED. This includes the large 250 Watt mercury vapour fittings in the external entrance portico, a number of the halogen dichroic 'essential service' downlights in apartment entrances, and some of the 'green running man' exit signs. XXXXXX also has installed solar heating for the outdoor pool, which is the sole method of heating the pool.

A2.2. Lighting Review

The current lighting for common areas is summarized as follows

- **Fire stair lighting** – two main fire stairwells lit with a total of 58 x single T8 1200mm36W emergency battens. These lights were connected to a pneumatic switch, but currently run 24 hours per day.
- **Corridor lighting**- consists of 156 x single 18W compact fluorescent down light fittings, and 120 x single 15W compact fluorescent bulbs in decorative wall fittings and run 24 hours per day.
- **Ground and Level 1 reception lighting**- including 57 x 80W recessed mercury vapour down lights, 4 x 250W recessed mercury vapour down lights, a total of 78 x 15W compact fluorescent bulbs in recessed down lights, 4 x 18W compact fluorescent bulbs in wall lights, and 30 x single T8 1200mm 36W tubes used as decorative ceiling lighting with another 12 that appeared to be out at the time of the site assessment. These lights all run 24 hours per day, except the 250W mercury vapour bulbs which are expected to be on the same timer as the external lights.
- **External lighting**- including 6 x 80W smaller recessed mercury vapour down lights at the front main lobby, and 9 x 15W compact fluorescent bulbs in bunker wall lights on the sides of the building. At the time of the first visit there were 15 x 250W recessed mercury vapour down lights in the entrance portico, which have since been replaced with a 30W LED down light. These lights are all connected to a timer which runs during the evening according to season.
- **Pool and BBQ area lighting** – 9 x 15W compact fluorescent bulbs in bunker wall lights, 6 x single T8 1200mm battens. These lights are all connected to a timer which runs during the evening according to season.
- **Various exit lights** – 5 x 3W LED and 25 x 10W fluorescent. These run 24 hours per day.
- **Garbage room lights** – each residential floor had a garbage room with T8 fluorescent batten lights on a switch – 2 x single T8 1200mm36W, 11 x single T8 1200mm 36W emergency, and 4 x double T8 1200mm 36W emergency lights. These were all attached to a switch, and were off at the time of the site visit.

A2.3. Mechanical Review

A2.3.1. Lift Services

Three passenger lifts are used to service the residents at XXXXX XXXXXX from ground floor to level 13. The lift shells have been renovated recently, but there has been no upgrade to the original motors on the roof. The lift motors are nearing the end of their useful life with an age of above 30 years and with a kW rating of 16.5kW.

A2.3.2. Escalator

A Kone escalator runs from the entrance of the building to the reception on the first floor. The escalator was built in 1989. It runs 24 hours per day and does not have a sensor control to save energy. The annual energy consumption was estimated to be 15,000 kWh.

The energy use can be reduced by upgrading to a modern escalator with a sensor to slow down or stop the operation of escalator when no occupants are using the escalator. Sensor driven escalators typically save over half the energy consumption where an escalator is currently running 24 hours a day.

The question of upgrading the escalator may be influenced by several other factors. Firstly the potential savings will dependent on occupant traffic rates which warrants further analysis. The amenity of this facility should also be considered as well as the condition and efficiency of its operation. Typically escalators have a useful life of more than 20 years. XXXXX XXXXXX’s escalator is approximately 27 years old. Upgrading the escalator is likely to be a major undertaking and the capital costs may include a substantial site works component.

Based on an assumed 50% reduction in power consumption, upgrading to a sensor driven escalator could save approximately $1,090 per year in electricity costs. The Owners Corporation can take this into account in the broader considerations around upgrading the escalator.

A2.4. Heating Ventilation and Air-Conditioning (HVAC)

A2.4.1. Air-Conditioning System

There are two main types of air-conditioning system available for apartment buildings. The split cycle air-conditioning system in **Figure 18** is the most common and is usually driven off the apartments individual electricity supply.

For XXXXX XXXXXX a central cooling air-conditioning system has been integrated into the building. A central cooling system supplies air to apartments via ducting and vents in the apartments, such as shown in **Figure 19**. Under this model the Owners Corporation pays for the air conditioning cost of all apartments. As a result, it's the responsibility of the Owners Corporation to implement energy efficiency projects and the benefits accrue directly to the Owners Corporation. Savings might then be passed on to apartment owners via a lower strata levy once project costs have achieved payback.

Figure 18 Split cycle air-conditioning system

Figure 19 Ducted central air-conditioning system

The major components of the central cooling system at XXXXX XXXXXX include: four chillers, two chiller water pumps, two condenser water pumps, two cooling towers, 14 air handling units, and electric duct heaters. The operation of the system is summarized below and in **Figure 20**:

1. Chillers located on ground floor produce chilled water which is then pumped to the Air Handling Units (AHU) on level 1 with chiller water pumps.
2. Air Handling Units pull warm air in from the building using fans and ducting. The chilled water absorbs the heat and the intake air becomes cooler before being released back into the building. The chilled water becomes warmer and is circulated back into the chiller.
3. There are two cylinders inside a chiller and a refrigerant moves in between to transfer heat from the chiller water loop to the condenser water loop. The chiller water loop is described in step 1 and step 2.
4. The warm condense water is pumped to the cooling tower located on the roof using condenser water pumps, where heat is dissipated to the external environment with evaporative cooling using the cooling tower fans. The condense water becomes cooler and will be circulated back down the building and inside the chiller, completing the cooling cycle.
5. During winter there will be a reverse in system operation and warm air will be produced instead of cool air using electric duct heaters.

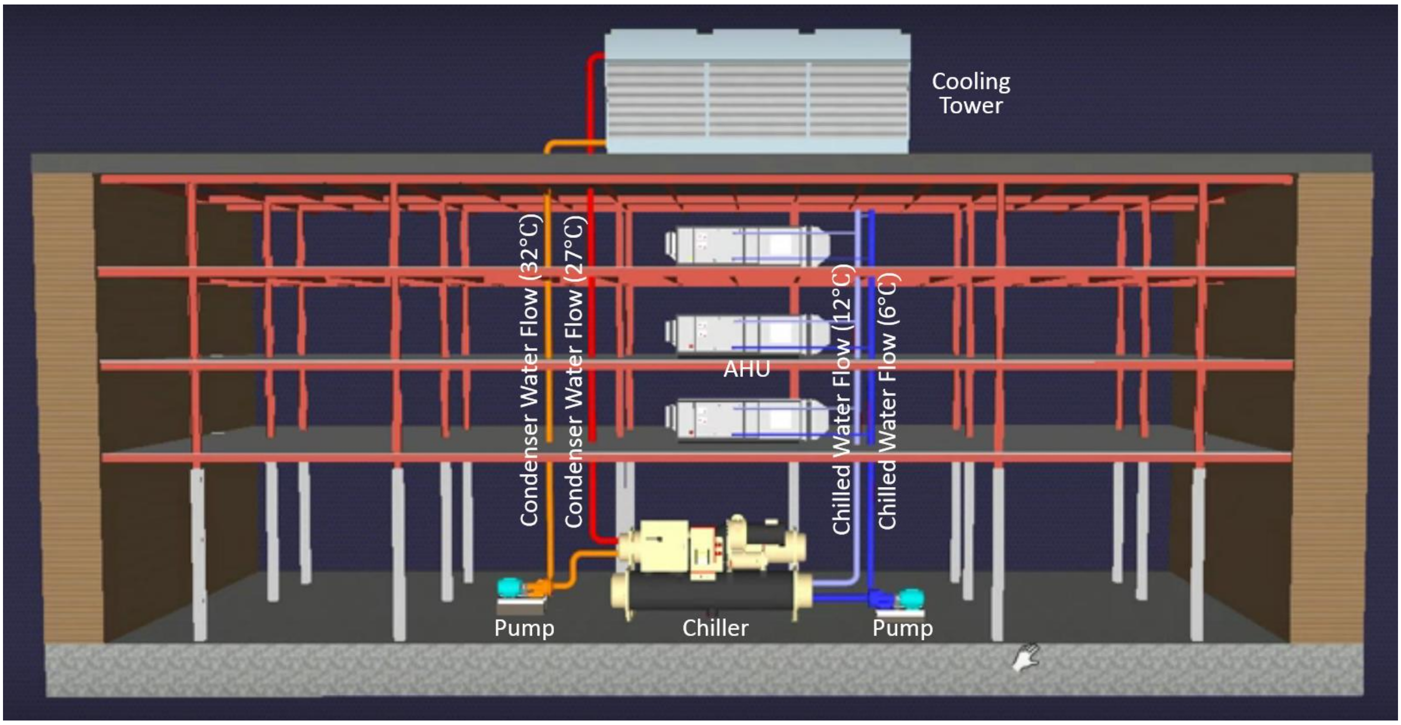


Figure 20 Central heating and cooling systems (source: The Engineering Mindset)

The detailed ratings of the equipment are listed in the tables below:

Table 16 Chiller compressors specification

Equipment	Count	Full Load Current (A)	Rated Power (kW)
Chiller-1A, Chiller-1B, Chiller-2A, Chiller-2B	4	140	34

Table 17 Chiller water pumps specification

Equipment	Count	Full Load Current (A)	Rated Power (kW)
CHWP-1, CHWP-2	2	33	15

Table 18 Condenser water pumps specification

Equipment	Count	Full Load Current (A)	Rated Power (kW)
CWP-1, CWP-2	2	36.3	18.5

Table 19 Cooling tower fans specification

Equipment	Count	Full Load Current (A)	Rated Power (kW)
CT-1, CT-2	2	2.6	1.1

There are 14 air handling units in the system but only the large units were accessible during the site visits. The smaller units are built into the ceiling and were inaccessible.

Table 20 Air handler units specification

Equipment	Count	Full Load Current (A)	Rated Power (kW)
AHU-1A	1	9.9	2.2
AHU-12	1	13.8	7.5
AHU-2 to AHU-11, AHU 13 to AHU-14	12	N/A	N/A

Similarly, the specifications for electric duct heaters are also not accessible.

A2.4.2. Toilet Exhaust Fans

There are two groups of toilets at XXXXX XXXXXX, common area toilets and private apartment toilets. 13 toilet exhaust fans located on the roof are used for ventilation of the residential toilets. The ducting of these fans runs vertically through all 12 residential floors. Therefore each fan services 12 apartment toilets. Three of the toilet exhaust fans have been upgraded to new 0.77 kW Fantech fans. However, the specifications for the rest of the old fans are unknown due to improper labeling. In addition to the 13 toilet exhaust fans for apartments, there are 3 additional fans that are used to ventilate staff and public toilets. The specifications of these were not accessible. All toilet exhaust fans operate 24 hours a day, 7 days a week.

Because the fans are configured to drive ventilation vertically through the building there is limited opportunity to optimise hours of operation. Each fan services 12 apartment bathrooms any of which may require ventilation at any time to maintain amenity. While there may be energy savings achievable through upgrading the remaining ventilation fans, the relative savings opportunity and payback will not be as good as other projects considered. However, new efficient fans should be used when upgrading the fans as they age.

Table 21 Toilet exhaust fans specification

Equipment	Count	Full Load Current (A)	Rated Power (kW)
TEF-10, TEF-11, TEF-12	3	1.47	0.77
TEF-1 to TEF-9, TEF-13 to TEF-15	12	N/A	N/A

A2.5. Water Supply Pumps

Water supply pumps include hot water supply and cold water supply to individual apartments. Cold water pumps operate in response to demand by applying more pressure when residents open their cold water taps. Hot water pumps on the other hand operate 24hours a day. Hot water needs to be circulated continuously around the building so that hot water is available immediately when someone turns on a hot water tap.

There are two pumps for cold water supply and one of them was operating during a site-visit. The other pump is expected to be a back-up pump or the two pumps may alternate on a duty cycle.

Table 22 Cold water supply pumps specification

Equipment	Count	Full Load Current (A)	Rated Power (kW)
Pump1&2	2	7.63	20

Table 23 Hot water supply pumps specification

Equipment	Count	Full Load Current (A)	Rated Power (kW)
Pump1&2	2	0.96	4

A2.6. Leisure Facilities

The leisure facilities within the assessed strata plan include a swimming pool. A water pump is used to circulate and filter the pool water 24 hours a day, 7 days a week. Pool heating is also available 365 days a year and a solar pool heating system is used to supply the hot water. The solar heating system uses available roof area beside the pool area for collecting the solar energy. This system uses solar radiation to directly heat water in an array of pipes on the roof which then flows into the pool. A separate water pump is required to provide circulation of the hot water loop.

Table 24 Swimming pool water pumps specification

Equipment	Count	Full Load Current (A)	Rated Power (kW)
Pump-1 – Pool Filter	1	7.2	1.65
Pump-2 – Solar pool heating	1	2.75	0.65

A2.7. Hot Water Heating

A centralised gas hot water heating system located on the roof is used to supply hot water for the residents at XXXXX XXXXXX. The existing system comprises of 2 x 250L storage tank and 3 x Rinnai HD200E water heater. The thermostat setting for the hot water storage tanks were both set at 65°C and the nameplate capacities of the three water heaters were recorded at 46kW each.

Table 25 Gas hot water specification

Equipment	Count	Ratings
Water storage tank	2	250 L
Gas water heater	3	46 kW

Appendix 3: Lighting Upgrade Financial Calculations

Energy Savings Estimates and Project Costs

The following tables contain the calculation methodology used to derive the estimated energy savings and costs shown in the report. In accordance with AS/NZS 3598:2014, savings and cost estimates are estimated to be a medium level of accuracy and can be used to create budgets for business cases. Project costs include an allocation for project management.

Project costs are determined by the following:

1. Cost of actual fitting to be included. The costs Wattblock uses are provided by wholesalers and/or manufacturers under commercial in confidence agreements and are to be used as a guide only.
2. Installation costs. Wattblock applies a labour charge based on the expected time it will take to install the designated work. For example electrician labour rates are set at $80 per hour and total labour is calculated on how many fittings can be replaced in an hour.
3. Project management allocations for costing purposes are set at a gross margin percentage of 10%.

Energy Savings

Energy costs savings shown in the following site tables are calculated by deducting the new energy consumption from the old energy consumption. Energy consumption is calculated by multiplying the existing equipment usage in watts by the number of hours it is operational throughout the year and then multiplied again by the applicable tariff rate to provide a cost savings. All savings are annual savings and exclude GST.

Maintenance Savings

LED lamps have a significantly longer lifespan to that of traditional incandescent, halogen and fluorescent lamps. The calculation of the cost of ownership should therefore take into account not only the energy cost of running the different lamp types but also the cost of changing over or replacing them regularly.

Fluorescent tubes last approximately 10,000 to 12,000 hours. Cheaper units may last as few as 8,000 hours. In contrast, LED lamps have an expected life of over 50,000 hours. Based on an annual running time of 8,760 hours per annum, fluorescent tubes would need to be replaced every year. Alternative LED lamps should last 5 or 6 years. In calculating the resulting maintenance savings Wattblock includes estimates for both the cost of replacement light fittings and labour costs.

Table 26 Annual savings for common area lighting upgrade

Energy Conservation Description		Area	Quantity	Existing Wattage	Proposed Wattage	Operating Hours Per Year	Annual Energy Savings	Annual Maintenance Savings	Total Annual Savings
Existing Fitting	Proposed Fitting								
15W Compact fluorescent	7W LED bulb	Corridors (Foyer – lv 13)	160	15	7	8760	$1,630	$800	$2,430
18W Compact fluorescent	7W LED bulb	Corridors (Foyer – lv 13)	198	18	7	8760	$2,613	$990	$3603
Emergency exit sign	LED exit sign	Corridors (lv 2 – lv 13)	25	10	3.4	8760	$210	$500	$710
35W Essential service lights	7W LED downlight	Corridors (lv 2– lv 13)	120	35	7	8760	$4,279	$2,400	$6,679
80W Mercury vapour bulb	19W LED downlight	Foyer& External	62	80	19	8760	$4,817	$1,240	$6,057
250W Mercury vapour bulb	30W LED downlight	Foyer	4	250	30	8760	$1,121	$80	$1,201
T8 1200mm fluorescent tube	LED tube	Foyer	42	40	16.5	8760	$1,275	$840	$2,097
T8 1200mm fluorescent fitting (emergency)	LED batten fitting with sensors (emergency)	Fire stairs	58	40	11.4	8760	$2,113	$1,160	$3,273
T8 1200mm fluorescent tube	LED tube	Swimming pool	6	40	16.5	4380	$22	$15	$37
Total			**675**				**$18,062**	**$8,025**	**$26,087**

Disclaimer

Wattblock is not affiliated with, nor does it receive any compensation from the named providers of any product or service that has been included in this audit report. Project Management services under which Wattblock manages the implementations of the solutions are available and where noted the costs for these services have been included to show a more accurate cost estimate of implementation costs.

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Who is Wattblock?

Wattblock was founded in NSW by Brent Clark and Ross McIntyre in 2014 to assist residential strata schemes reduce energy waste by up to 80%. The team has expanded into Queensland with Scott Witheridge environmental engineer and Jacky Zhong, data analyst plus a team of solar and low energy buildings specialists. Visit wattblock.com

What is Wattblock's mission?

The energy wasted in Australia's strata buildings has a bigger impact on carbon emissions than the cars driving on the roads. Wattblock aims to **crowdsource** the achievement of Australia's national carbon emission reduction target.

How many strata buildings has Wattblock assisted?

Wattblock has assisted approximately 1,000 strata buildings across Australia with energy reports. Wattblock has also directly project managed the upgrade of 19 buildings with LED lighting, solar, ventilation and hot water. To date it has identified over $25m of annual energy waste across townhouses to high-rise residential skyscrapers.

Who is partnering with Wattblock?

NSW Innovate, Advance Queensland, City of Sydney local government, Microsoft CityNext, Telstra's muru-D, the University of NSW, Griffith University, University of Queensland and Queensland University of Technology.

Who is covering Wattblock in the media?

SBS, North Shore Times, Foxtel, BRW, The Australian, Business Insider, Computerworld, Startup Smart, Startup Daily, Lookup Strata, Technode, Fifth Estate.

Wattblock Awards

Innovation of the Year 2016 - Strata Community Australia (NSW), Best Social Change Entrepreneur 2015 (Start-up Smart), Energy Winner at 1776 Challenge Cup Sydney, CeBIT Community Support Finalist.

Who is backing Wattblock?

Wattblock has received investment from muru-D as part of Telstra's startup accelerator program, Eastern Hill Investments, an Asian-based environmental engineer, a UK-based energy company consultant, a U.S.-based hi-tech investor, a NZ sustainability funds manager, a Sydney-based environmental impact investor, a Sydney-based clean tech consultant, a Sydney-based clean technology finance consultant and an innovation laboratory research director.

Where is Wattblock located?

Wattblock is based at Michael Crouch Innovation Centre at UNSW in Sydney and at River City Labs in Brisbane.

Where can I find out more about Wattblock?

wattblock.com