Aotearoa Park Shopping Centre

Sample Type 1 Energy Audit

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EXECUTIVE SUMMARY

This report presents an energy audit for Aotearoa Park Shopping Centre for Aotearoa Park Ltd. The findings of this report are based upon a Type 1 energy audit, compliant with the requirement of AS/NZS3598.1:2014. This report was commissioned by Hone Smith, the building manager for the site.

The audit period in this study is from 01/06/2013 to 31/05/2014, with site work undertaken on 26/6/2014. This audit is limited to the base building services for the site, comprising common area air-conditioning and lighting, car park services, and the central condenser water loop servicing the tenant water cooled package units (which are outside the scope of the audit). The base building electricity consumption for the shopping centre was 929,370 kWh p.a. at an approximate cost of $85,000 and the gas consumption for the shopping centre was 692,393 MJ p.a. at a cost of $9,600.

While there are no local comparative indicators of performance, comparison against the Australian NABERS for Shopping Centres indicates average performance. Implementation of all measures in this report would move the estimated rating to the upper end of the performance scale.

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

- HVAC control optimisation
- Skylight pelmet lighting control

Successful implementation of these measures has the potential to achieve annual savings of 104,000 kWh of electricity (11%), and 80GJ of gas (11%) at a cost of approximately $17,000 giving an overall payback of 1.5 years. A further 142,000kWh (16%) electricity savings has been identified on paybacks longer than 2 years.

Additional measures of longer payback have been identified covering common area lighting fittings and control, exterior lighting fittings, and improvements to the site's energy management systems. Potential for significant energy savings outside the scope of the audit have also been identified in association with the replacement of the tenant package units.

A summary of measures is provided in Table 1. The expected improvement to the end-use energy consumption of each building sub-systems is shown in Figure 1. All dollar figures in this report exclude GST.

Measure	Annual Energy Savings	Total Annual Financial Savings	Cost	Payback years
Shorter Payback Measures (up to 2 years)				
HVAC control optimization	90,000 kWh (elec) 80GJ (gas)	$10,000	$15,000	1.5
Skylight pelmet lighting control	14,000 kWh	$1,400	$2,000	1.4
Longer Payback Measures (2 years+)				
Mall common area lighting upgrade	130,000 kWh	$13,000	$50,000	4
Exterior mercury vapour lighting replacement	12,000 kWh	$1,200	$12,500	10
Lighting control measures	NA	NA	NA	5-10 years
Energy Management Measures				
Energy Management Program Enhancements	NA	NA	NA	NA
Sub-total	**246,000 kWh (elec) 80GJ (gas)**	**$25,600**	**$79,500**	**3.1**

Table 1 Energy saving measures summary

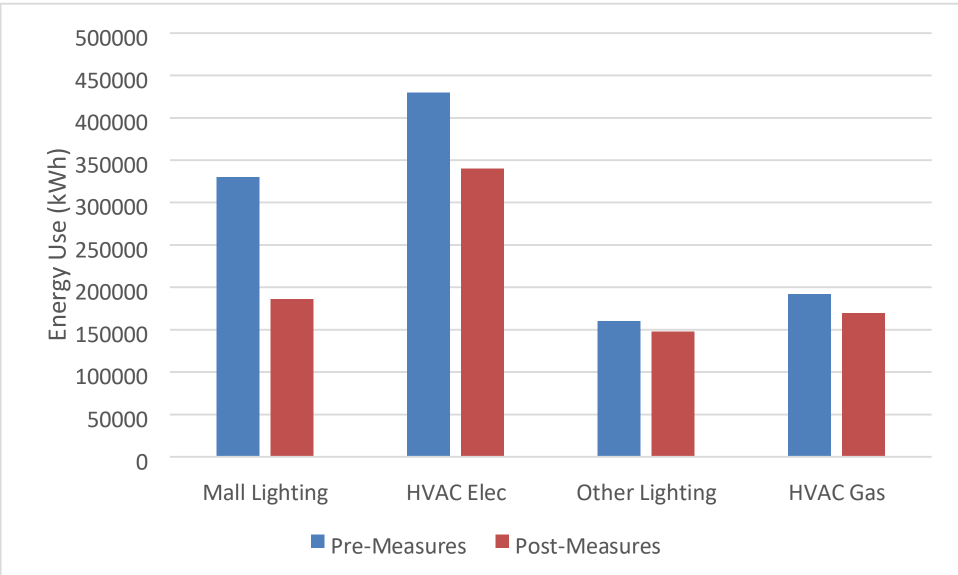

Figure 1 Pre-upgrade and Post-upgrade energy use breakdown. All figures in kWh.

1 Introduction

1.1 Project Background

This report details a Type 1 energy audit for Aotearoa Park Shopping Centre located at the corner of First and Second Streets in Motutapu, Auckland. This shopping centre is owned by Aotearoa Park Ltd. It is a single storey shopping centre with a tenancy area of 17,978.9 m^2.

Aotearoa Park Ltd's aspiration to become a leading sustainable company is reflected in their efforts to measure and report their buildings' performance. The overriding objective of this audit was to improve the site's energy performance as a means of substantially improving the site's environmental footprint as well to help attract and retain higher profile tenants.

This audit was carried out in accordance with a Type 1 requirements of AS/NZS 3598.1:2014 (referred to as the Standard elsewhere in this report).
The aims of this audit are as follows:

- Conduct an analysis of the base building energy consumption and develop a breakdown of the consumption.
- Identify shorter payback energy efficiency upgrade measures with estimated costs and benefits.

All dollar figures quoted in this report are exclusive of GST.

1.2 Scope of works undertaken

The scope of works is based on the findings of a one day site visit and subsequent analysis of consumption data and site documentation. The site visit was conducted by Alan Bloggs on 26th June 2014. The site visit included the following key tasks:

- Site staff and contractors were interviewed to determine basic parameters of the facility's operation, characterise occupancy and scheduling patterns, and these were cross-checked against scheduling on the BMS
- Technical documentation including the key electrical and mechanical drawings were reviewed
- An inventory of base building energy using equipment was developed, including a lighting count and inspection of the mechanical services
- The on-site reticulation of electricity was investigated. Utility meters for gas and electricity were observed

The scope of the audit was limited to the base building only, covering:

- Car parks
- Services (lighting, HVAC) to common areas
- Condenser water loop

Lighting and power within tenancies were not included within the scope of this audit. Tenant air-conditioning units were connected to the associated tenant meter and thus were also not part of the scope of this audit.

2 Shorter Payback Recommendations (<2 year payback)

2.1 HVAC control optimisation

2.1.1 Background

The air-conditioning in the common area in the shopping centre is provided by six aircooled package units and one water-cooled packaged unit. The centre also provides condenser water to the tenant package units, with a cooling tower for heat rejection and a condensing boiler for heating.

Initial inspection of the operation of the BMS yielded the following observations:

- Packaged air conditioning units in common areas were rapidly oscillating between heating and cooling.
- Temperature control, pump staging and cooling tower control appeared to be poorly coordinated.
- The cooling tower fan had no VSD.

2.1.2 Scope

- Optimise the control of HVAC, with focus on:
  - Deadbands between heating and cooling for common area packaged units, which should be increased to 2°C or more.
  - Temperature control and staging of pumps and the cooling tower for the tenant condenser water loop. In particular:
    - Primary pump staging should be adjusted to prioritise cooling tower fan operation ahead of additional flow as load increases.
    - Condenser water loop temperatures should be controlled within the range 20-29.5°C.
    - Boiler staging needs to be revised to ensure that the boilers only stage up when fully loaded and stage down as soon as the next stage down can handle the load.
  - Lock out boiler operation when outside air temperatures are greater than 18°C.
- Install a VSD on the cooling tower and integrate with the controls above.

2.1.3 Savings calculations description

Estimated savings are 15% of total HVAC energy. This is a broad estimate in terms of the Standard. Costs are based on an allowance of:

- $3,500 to review and respecify key control algorithms and review postimplementation.
- 50 hours of controls company time @ $85/hour to implement controls.
- $7,000 to install and commission the cooling tower fan VSD.

Measure	Common area zone temperature control
Annual energy consumption saving	90,000 kWh 80GJ gas
Annual energy cost saving	$ 10,000
Capital cost	$ 15,000
Pay back	1.5 Years

2.2 Skylight pelmet lighting control

2.2.1 Background

Some of the common area in the mall is illuminated with a mixture of artificial lighting and daylight through skylight. Linear fluorescent 58W T8 lamps are installed in pelmets around the skylights. The pelmet lighting was observed to be on even when the ambient lighting level is sufficient. Daylight control and time control for this pelmet lighting is also recommended.

2.2.2 Scope

- Install on/off control of lighting using one PE cell per skylight.

2.2.3 Savings calculations

- A reduction of 6 hours per day in run time for 100 fittings has been assumed.
- Cost is based on $500 per PE cell for 4 units.

Measure	Skylight pelmet lighting control
Annual energy consumption saving	14,000 kWh
Annual energy cost saving (including demand saving)	$ 1,400
Capital cost	$2,000
Pay back	1.4 Years

3 Longer Payback Measures (>2 year payback)

3.1 Mall common area lighting upgrade

3.1.1 Background

The general mall common areas are illuminated by 150 W metal halide down lights and 50W halogen downlights. The lighting levels measured at the time of the site visit ranged from 220 lux to 340 lux. The recommended lighting level in the space is 160 lux according to AS1680. We recommend that the metal halide down lights are replaced by lower output lamps.

The halogen lighting should be replaced with quality high output LED downlights.

3.1.2 Scope

- Replace the 150 W metal halide down lights with 70 W metal halide down lights.
- Replace the 50W halogen downlights with quality high output LED downlights.

3.1.3 Savings calculations description

We have based savings on a 40% reduction in mall lighting energy use, in line with the approximate reduction in wattage of the fittings. We have estimated capital costs based on 250 fittings at an average $200 per fitting replacement cost.

Measure	**Mall common area lighting upgrade**
Annual energy consumption saving	130,000 kWh
Annual energy cost saving (including demand saving)	$ 13,000
Capital cost	$ 50,000
Pay back	4 Years

3.2 Exterior mercury vapour pendant lighting replacement

3.2.1 Background

There are a number of mercury vapour pendant lights near the entrance of the shopping mall. These luminaires are old and deteriorated and need to be upgraded. Quality LED replacements for these luminaires are recommended.

3.2.2 Scope

- Replace the pedant 400W mercury vapour lights with 160 W LED high bays, approx. 25 off.

3.2.3 Savings calculation description

- A reduction of 60% in lamp wattage is expected with 12 hour run time per day.

- $500 per fitting replacement cost.

Measure	Exterior mercury vapour pendant lightings replacement
Annual energy consumption saving	12,000 kWh
Annual energy cost saving	$ 1,200
Capital cost	$12,500
Pay back	10 Years

3.3 Lighting control measures

3.3.1 Background

Based on operating schedules for lighting circuits, most lighting in the mall and back of house runs. Complete turn off after hours is not practical because of the need to provide security lighting, but a combination of continuous background lighting and occupancy/time scheduled lighting is likely to yield significant savings

3.3.2 Scope

- Develop control solutions for lighting in the mall areas, the toilets and the back of house. This requires a more specific study of each area to determine the best solution.

3.3.3 Savings calculation description

- We expect that savings of around 30% of current lighting energy should be possible via this measure. Costs at this stage are not known, and will depend on more specific design solutions being developed for each area.

4 Energy Management Measures

4.1 Energy management program enhancements

4.1.1 Background

The site has an aggressive energy efficiency target of a 25% reduction in energy use relative to 2010 by 2016, although to date consumption has only reduced by 5%. This audit has identified significant savings and the required 25% reduction would appear achievable following a more detailed audit and the implementation of suitable measures.

4.1.2 Scope

The energy management program should be enhanced with specific emphasis on the following:

- Improved monitoring: Monthly monitoring should be expanded to include a review of the daily electricity consumption profile.
- Sub-metering. Additional sub-metering should be installed to enable monitoring of base building plant, and particularly to enable separation of major sub-categories such as package units, condenser water plant and lighting.
- The criteria for energy efficiency investment need to be reviewed as the current 3 year payback threshold appears in conflict with the proposed target, especially given the level of deferred capital and maintenance expenditure on site.
- Measures should be put in place to improve, over time, the accessibility of tenant air-conditioners to ensure that these can be properly maintained. This should occur in parallel with the end-of-life replacement of these units.
- Procurement policies. Procurement policies should be improved to include minimum standards for package unit air-conditioners and lighting.

4.1.3 Savings calculation description

No direct savings can be imputed against this measure, but it will facilitate implementation of the savings identified in this report.

5 Appendix 1: Energy consumption characteristics

5.1 Electricity

5.1.1 Electricity account

There is one utility electricity supply for the shopping centre and it supplies both the house and tenant consumption. The tenant consumption has been passed onto the tenants via an embedded network.

The site uses an embedded network to measure tenant electricity consumption for oncharging. The sub-metered base building consumption during the same period was 929,370 kWh. The monthly detailed reconciliation of utility and sub-meter consumption is shown in Table 2; figures appear to reconcile closely.

Note that the % difference between the utility and embedded network ranges from 1 to 12%.

Month	**Total utility consumption (kWh)**	**Base building submetered consumption (kWh)**	**Tenant sub-metered consumption (kWh)**
Jun-13	267,066	86,743	177,285
July-13	276,802	89,905	181,564
Aug-13	280,924	86,142	172,410
Sep-13	260,465	74,559	181,217
Oct-13	265,184	65,606	180,572
Nov-13	249,393	60,405	219,778
Dec-13	295,273	83,925	202,255
Jan-14	308,814	84,155	251,678
Feb-14	274,558	75,076	181,933
Mar-14	284,461	76,386	221,741
Apr-14	258,093	72,249	178,765
May-14	269,785	74,220	192,228
Total	**3,290,819**	**929,370**	**2,341,426**

Table 2 Electricity sub-metered consumption

5.1.2 Electricity tariff description

The site is on a contract tariff. Annual energy cost was $320,000 for the period Jun-13 to May 14, giving an average tariff of 9.7c/kWh. For the purposes of calculations in this audit an average electricity cost of 10c/kWh has been used.

5.1.3 Electricity time of use profile

The monthly consumption chart is presented in Figure 2. The average profiles for different seasons have also been developed using utility interval data and presented in Figure 3.

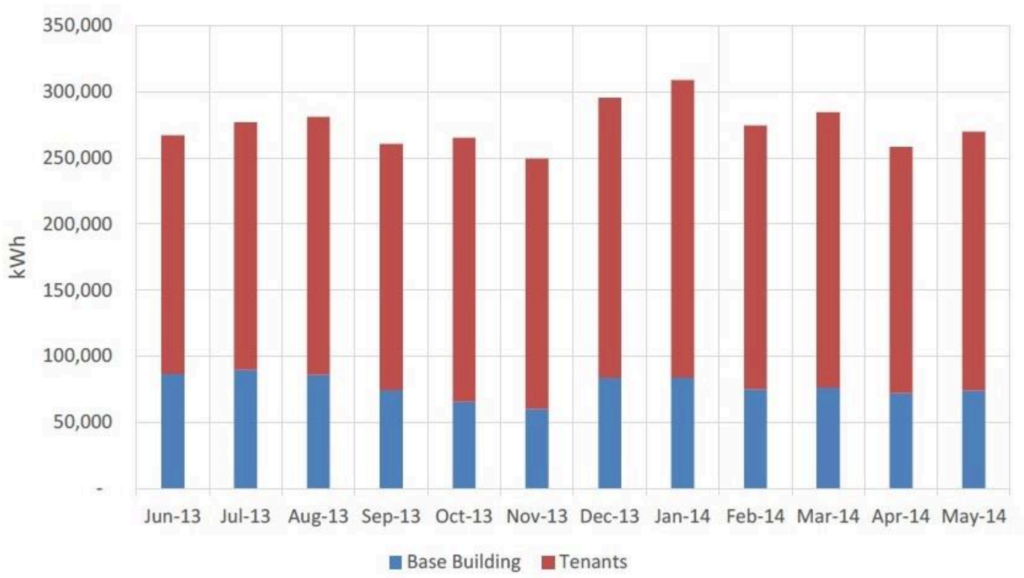

Figure 2 Electricity monthly use

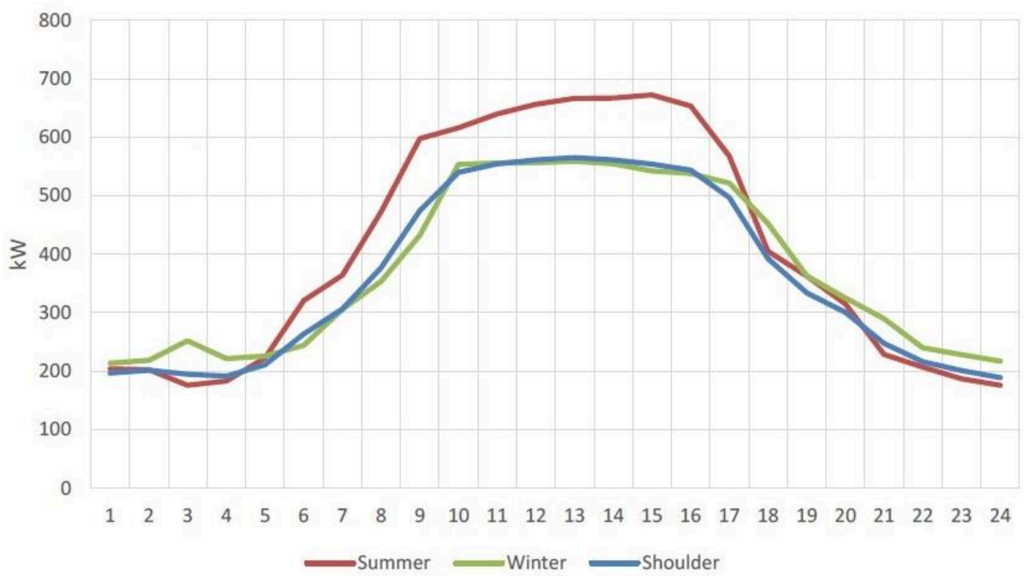

Figure 3 Average seasonal whole building profiles

Key points to draw from these profiles are:

- Seasonality was evident for the shopping centre. The peak load in summer was approximately 680 kW and the peak load for other seasons ranged from 520-600 kW. The seasonal variations are consistent for both the base building and the tenants.

- The average base load for the building was approximately 200 kW. The base load in winter was slightly higher than other seasons.

5.1.4 Comparison with available benchmarks

The nature of shopping centre base building energy use, for which the coverage varies significantly from site to site, means that there are no readily available comparison indicators for energy intensity. As the nearest alternative, we have estimated the site's performance using the Australian NABERS for Shopping Centres rating, obtaining a rating of 3 stars. This indicates – in so far as the application of the tool in New Zealand is sensible – that the site's energy performance is close to average.

5.1.5 Electricity use breakdown

The electricity use breakdown was estimated based on a rough breakdown of the observed equipment and identified hours.

The energy use breakdown table and the pie chart is shown below.

Category	**Consumption (kWh)**	**Percentage**
Mall lighting	330,000	36%
Other Lighting	160,000	17%
HVAC	430,000	46%
Total	920,000	100%

Table 3 Electricity use breakdown

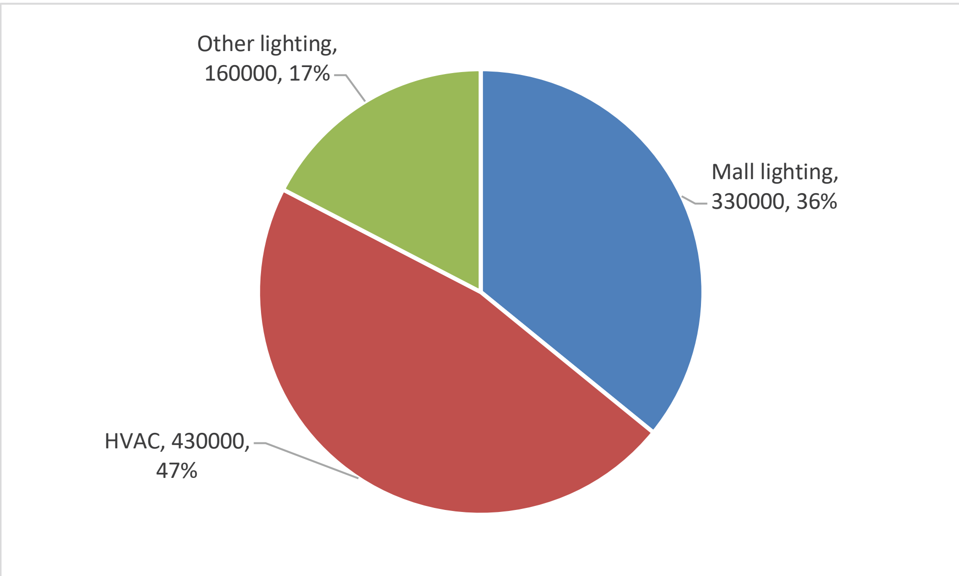

Figure 4 Electricity use breakdown

5.2 Gas

5.2.1 Gas account

There is only one gas account for the base building, which is for the condensing boilers in the condensing water loop.

The consumption from the 1/03/2013 to 28/02/2014 was 692,363 MJ. The average cost for gas was approximately $0.014/MJ. The normalized monthly gas consumption is presented in Figure 5.

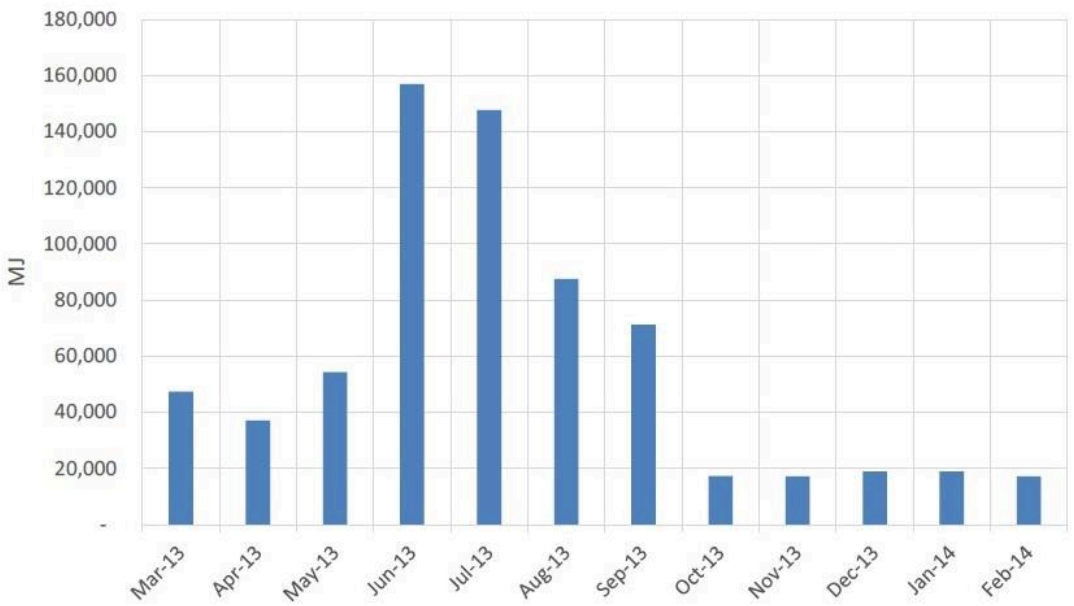

Figure 5 Normalized monthly gas consumption

5.2.2 Gas use breakdown

The shopping centre has one gas account for the house consumption and several other accounts for the tenant consumption use. The detailed gas account information is presented in the Appendix section. The house gas use is for the condensing boilers as auxiliary heat source only.

6 Appendix 2: Site Description

6.1 HVAC system

The air-conditioning in the shopping centre is provided by a mix of water-cooled package units, air-cooled package units and air-cooled split units. The base building airconditioning does not provide services, other than condenser water, to any of the tenants.

There is one centralised condenser water loop in a primary - secondary configuration providing heat rejection for both the base building and the tenant water-cooled package units. Two condensing boilers provide heat injection to the condenser water loop for winter operation. These operate in duty/standby configuration and are connected to the secondary side of the condensing water loop via plate heat exchangers.

The mall units and a few tenant package units have been recently upgraded. However, most of the other units are 15-20 years old, use R22 refrigerant and are reaching the end of their economic life.

6.2 Lighting

The general mall lighting is provided by a mix of 150 W metal halide and 50 W halogen down lights. There are some skylights in the mall providing daylight to the general mall area as well. Pelmet lighting provided by 58W T8 fluorescent lamps is present around the skylight and some shops. According to the site manager, the mall lights are scheduled to run from 5AM to 3AM the next day.

The car park is illuminated by pole-mounted mercury vapour lights. Car park lighting is controlled through BMS and is scheduled to switch on at 5:30 PM and switch off at 7:30 AM. The exterior lighting is a mix of CFL oyster lights, mercury vapour down lights, metal halide down lights and metal halide wall flood lights.

The back of house lighting is present in the north mall corridor and the south mall corridor to the centre management office. These spaces are illuminated by a total of eight 2×36 W T8 bare battens with magnetic ballasts. The schedule for back of house lighting is the same as the mall lighting.

The lighting in some of the toilets has recently been upgraded to LED with occupancy sensor control. The remaining toilets use 14W T5 lighting on the mall lighting time schedule control.

7 Appendix 3: Energy Management Practices

Aotearoa Park Ltd has a proactive stance on energy efficiency, with a goal to reduce energy consumption from 2010 levels by 25% by 2016. The building manager (Hone Smith) is responsible for the achievement of this target, and reports to the environmental manager of Aotearoa Park's parent company Global Retail Enterprises. Global Retail Enterprises maintains Corporate Social Responsibility reporting under GSREB.

We interviewed Hone Smith regarding the practices on site and note the following findings:

- Monitoring practices. Sub-meters are read manually by the embedded network operator and are largely used for on-charging. Metering is not adequate for systems monitoring purposes.

- Process for energy efficiency investment. Aotearoa Park have a policy of considering all investments of less than 3 years payback. The proposed measures, in aggregate come close to this figure. However, longer term investment driven by the need for capital plant replacement needs to be considered outside this limited criterion.

- Existing site energy efficiency activity. At present site energy efficiency activity is largely operational, i.e. management of time of use and rectification of obvious errors. The Site manager has also undertaken some ad-hoc improvements, particularly in the area of lighting.

- Maintenance. Maintenance standards on site were generally good, except in relation to tenancy air-conditioners, which were often difficult or impossible to access. As a result, the standard of maintenance for these units is expected to be poor.

- Procurement policies. The site has no particular procurement policies in relation to energy efficiency.

Recommendations for the improvement of the energy management practices on site are provided in Section 4.