Energy Audit

Whakatāne District Council

November 2019

1 Executive Summary

Whakatane District Council's facilities were audited in June 2018 for energy cost saving opportunities. Each of its 182 electricity and natural gas accounts were included in the audit. The energy audit identified larger energy savings at its larger accounts, such as the Civic Centre, Aquatic Centre, Te Kōputu Library, and three largest Pump Stations, than for its smaller accounts.

Annual reductions in carbon emissions of 408,000 kgCO2e have been identified, which is a 35% saving. Energy cost savings of $315,000 a year have been identified with investment paybacks varying from 0.2 years to 33.0 years. Many of these options are achievable by adopting formal energy efficiency practices, increasing maintenance and investing in technology upgrades.

Electricity usage from June 2017 to May 2018 was 7,233,584kWh and gas usage was 1,170,282 in this same 12-month period. Carbon emissions attributed to the Whakatane District Council's energy consumption were 1,185,000kgCO_2e in the 12 months to May 2018.

One of the Whakatāne District Council's primary drivers for commissioning this report was to understand how its carbon emissions were influenced by its energy use and what opportunities exist to reduce carbon emissions that contribute to climate change. The report includes a pie chart (refer to figure Figure 5-3) illustrating the percentage of carbon emissions from each facility. Section 7 also includes a model of expected and actual carbon emissions per month for each of the main facilities. This model should be used as part of an energy management programme to measure and report future carbon emissions savings each month.

Figure 1-1 below is a carbon emissions Marginal Abatement Cost Curve (MACC) for the opportunities identified in this audit (a larger version is available in the appendices). The vertical axis shows the marginal cost (negative is a saving) of avoided carbon emissions and the horizontal axis shows the annual carbon reduction of each option in kgCO_2e.

Note, all options are below the horizontal axis because only options with positive cost savings were considered for this audit. Not all carbon abatement options result in cost savings. For example, replacing a gas boiler with an electrode boiler would reduce carbon emissions and result in an increase in operating costs due to the higher price of electricity compared to natural gas.

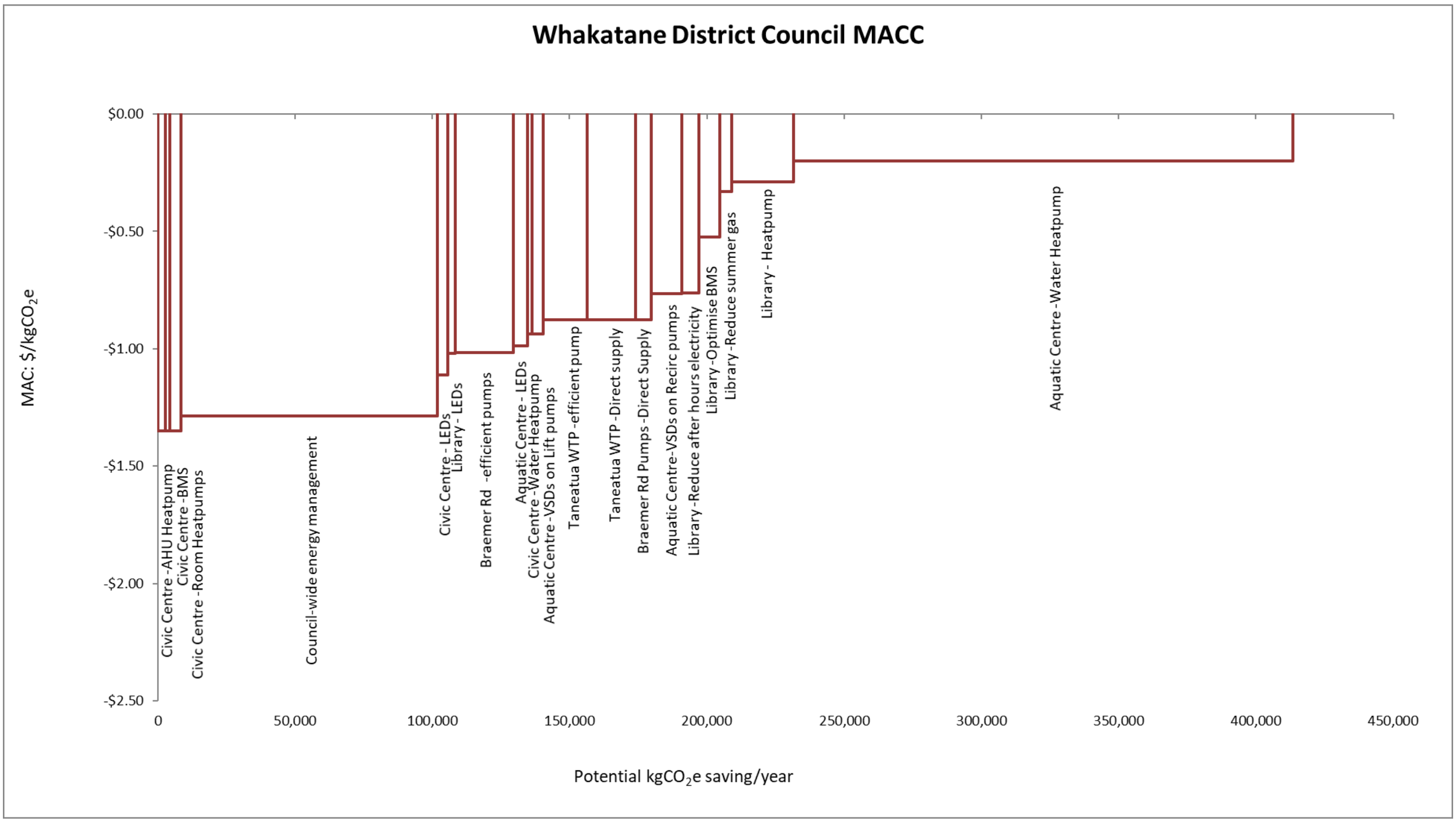


Figure 1-1 MAC curve showing the carbon savings and abatement costs of opportunities identified

Shown below in Table 1-1 is a summary of energy cost saving opportunities, which are listed in order from the shortest payback period to longest. Also included is an estimated cost of implementation, as well as annual carbon savings for each opportunity.

Table 1-1 - Summary of energy and carbon saving opportunities identified

Section Reference and Description		**Estimate Cost**	**Energy reductions** [kWh/year]	**Carbon Savings** [kgCO$_2$e/yr]	**Net Cost* savings** [$/year]	**Simple* Payback** [years]
8.3.3.1	Library - Reduce after hours electricity by reducing air handling and switching off lighting and other equipment not required	$0	49,157	6,341	$4,800	-
8.3.3	Library - Reduce summer gas use by switching off gas heating in warmer months	$0	20,000	4,336	$1,400	-
9	Council-wide adopt a formal energy management programme	$66,500	840,387	93,313	$120,000	0.6

Section Reference and Description		Estimate Cost	Energy reductions [kWh/year]	Carbon Savings [$kgCO_2e$/yr]	Net Cost* savings [$/year]	Simple* Payback [years]
8.3.3.2	Library - Optimise BMS including improving control and reducing introduced fresh air	$5,000	41,786	7,433	$ 3,900	1.3
8.2.4	Aquatic Centre - Install VSDs on Recirculation pumps and slow down speed overnight	$12,000	86,103	11,107	$ 8,400	1.4
8.4.2.1	Water Treatment Plant - Install high efficiency duty pump and motor for high lift pump	$23,000	123,277	15,903	$ 13,900	1.7
8.4.2.2	Water Treatment Plant - Supply direct to town rather than via reservoirs 80% of the time	$30,000	136,934	17,665	$ 15,400	1.9
8.2.4	Aquatic Centre -Install VSDs on Lift pumps and use level sensor instead of float valves	$7,500	31,670	4,085	$ 3,800	2.0
8.5.2.1	Braemer Rd Pumps - Install high efficiency pumps and motors	$46,000	164,331	21,199	$ 21,500	2.1
8.5.2.2	Braemer Rd Pumps - Supply direct rather than via reservoirs 80% of the time	$24,000	44,507	5,741	$ 5,000	4.8
8.1.3	Civic Centre -Use heatpump technology for hot water heating	$8,000	13,212	1,704	$ 1,500	5.0
8.3.3.4	Library - Use heatpump technology instead of gas boiler	$36,000	95,186	22,565	$ 6,500	5.5
8.2.2	Aquatic Centre - Replace existing lighting with LEDs	$30,200	39,010	5,032	$ 4,900	6.1
8.1.2	Civic Centre - Replace Fluorescent lights in Civic Centre with LEDs	$37,200	29,736	3,836	$ 4,200	8.7*
8.3.2	Library -Replace existing lighting with LEDs	$24,400	21,038	2,714	$ 2,700	8.8
8.2.3	Aquatic Centre - Use heatpump technology for pool heating instead of gas	$327,000	735,717	181,864	$ 36,600	8.9

 All costs excl. GST

Section Reference and Description		Estimate Cost	Energy reductions [kWh/year]	Carbon Savings [$kgCO_2e/yr$]	Net Cost* savings [$/year]	Simple* Payback [years]
8.1.4.3	Civic Centre - Install Heatpumps in place of electric heaters	$59,600	31,573	4,073	$ 5,500	10.8
8.1.4.2	Civic Centre - Use heatpump technology instead of electric elements in AHUs	$48,000	21,375	2,757	$ 3,700	12.9
8.1.4.1	Civic Centre - Install Building Management System	$75,000	13,061	1,685	$ 2,600	33.0
	TOTAL (not all savings are mutually exclusive)	**$880,000**	**2,530,000**	**408,000**	**$317,000**	**2.8**

* Individual areas within the building have a quicker payback period

Estimated costs are based on budget prices received by suppliers. Further investigation of some energy saving opportunities is required where suggested in the report.

Note, not all project calculations are mutually exclusive. For example, energy savings achieved from installing occupancy sensors for lighting would change depending if the lights were upgraded to LEDs or not.

 All costs excl. GST

2 Glossary

Remove non-relevant ones

ASTM – American Society for Testing and Materials

CDD – Cooling Degree Days

CIP – Clean in process

ETS – Emissions Trading Scheme

EUI – Energy Use Index

GCV – Gross Calorific Value

GXP – Grid Exit Point

HDD – Heating Degree Days

HVAC – Heating Ventilation and Air-conditioning

kgCO_2e – equivalent kilograms of carbon dioxide

LFG – Land Fill Gas

NCV – Net Calorific Value

RH – Relative humidity

TOU – Time of Use

3 Contents

4 Introduction

Charlotte Haeusler, Strategic Policy Analyst for the Whakatāne District Council, commissioned Energy Management Solutions Ltd (Emsol) in May 2018 to carry out a Type Two Energy Audit of its council facilities. The Whakatāne District Council's Civic Centre is located on Commerce Street, Whakatāne in the Eastern Bay of Plenty. Carl Newby and Erin Roughton from Emsol surveyed the facilities, analysed energy saving opportunities and completed this report. Site maps for facilities are included for reference; refer to Appendix 10.4 - Site .

The objective of the energy audit was to identify the sources of energy provided for the site, the quantity of energy supplied, and what the energy is used for. Furthermore, the Whakatane District Council expressed a desire to understand its carbon emissions associated with energy use with a goal to minimise its contribution to climate change. During the process of collecting this data, areas of potential energy and carbon savings were identified. Potential saving quantities and the cost of implementing these savings were calculated; the results of these calculations are presented in this report.

A desk-top audit of energy use and tariff analysis of electricity contracts was undertaken in October 2018; these were based on energy supply records for the period from Jun 2017 to May 2018. Emsol personnel carried out surveys of facilities for the energy audit as described in Table 4-1 below.

Table 4-1 - Facilities Surveyed during audit

Date	Facilities Surveyed
12th July 2018	Aquatic Centre, Te Kōputu Library
16th August 2018	Water Treatment Plant, Paul Rd Pump Station, Braemar Rd Pump Station, Shaw Rd Oxidation Ponds
10th September 2018	Civic Centre

The following people assisted with providing information for the audit:

- Charlotte Haeusler, Strategic Policy Analyst, Whakatāne District Council
- Cashy Ball, Manager Strategy and Community Development, Whakatāne District Council
- Dean Finlay, Places and Open Spaces Asset Officer, Whakatāne District Council
- Neal Yeates, Team Leader Water Treatment Plant, Whakatāne District Council
- Ian Bowen, Water Treatment Plant Operator, Whakatāne District Council
- Lee Colquhoun, Manager Aquatics and Recreation, Whakatāne District Council
- Steve Piper, Servicing and Maintenance, Aquaheat

Other Staff members from Council facilities also provided useful information on operation practices and ideas for improving energy efficiency.

5 Overview of Requirements for Energy

At the Whakatāne District Council, energy is required to provide services to the district, as well as for office buildings. The largest users of energy are:

- Water supply plants
- Waste treatment
- Street lighting (Note, street lighting electricity consumption is not shown in Figure 5-1 due to consumption data not being available on invoices. LED replacement lighting is already underway for Whakatāne District Council's street lights).
- Facilities and office buildings

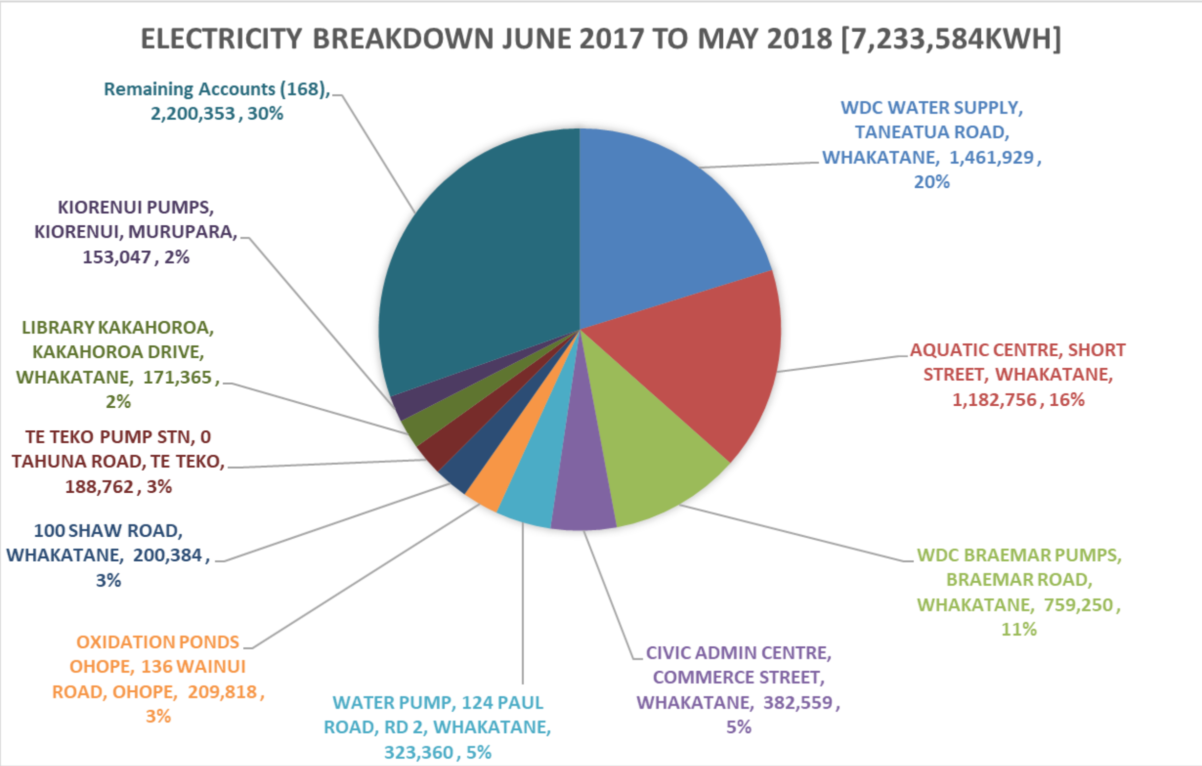


Figure 5-1 - Pie chart showing breakdown of electricity used by Whakatāne District Council accounts, year to May 2018

The majority of energy used is electricity, and natural gas is used at a small number of facilities. The Whakatāne District Council has 178 separate electricity accounts, of which the five largest are listed in Table 5-1. These account for close to 60% of the total annual consumption at the Council.

Table 5-1 - Five highest electricity accounts at Whakatāne District Council, Jun 2017 to May 2018

Description	Annual Consumption (kWh)	Carbon Emissions due to electricity generation (kg of CO_2e)
Whakatāne Water Treatment Plant	1,461,929kWh	188,150
Aquatic Centre	1,182,756kWh	152,221
Braemar Rd Pump Station	759,250kWh	97,716
Civic Centre	382,559kWh	49,235
Paul Rd Pump Station	323,360kWh	41,616

The Whakatāne District Council also has four natural gas accounts. The Aquatic Centre is the largest gas account, using 990,388kWh of gas in the 12 months from Jun 2017 to May 2018. This was 85% of the total gas used by the four accounts in this period. It is also the third largest single area of energy use at WDC.

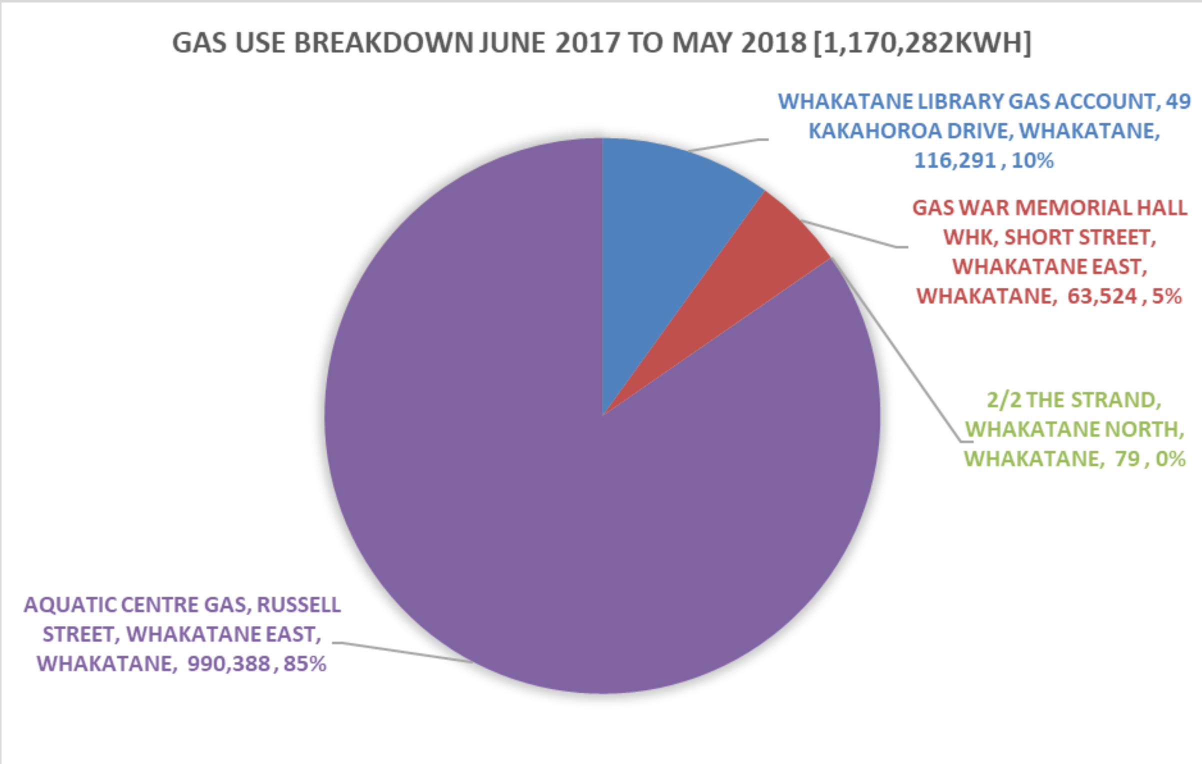


Figure 5-2 Pie chart showing breakdown of natural gas use at the Whakatāne District Council, year to May 2018

Figure 5-3 below shows a breakdown of carbon emissions by facility at the Whakatāne District Council. These emissions are those associated with electricity and natural gas consumption. The Aquatic Centre has the highest carbon emissions at 31% of the total for the council. This is due to being a large energy user and having a high proportion of this energy derived from natural gas. The Whakatāne Water Treatment Plant is the second largest user at 16%. This facility uses electricity only, however it is a large energy user. The ten largest accounts contribute 75% of the council's total emissios.

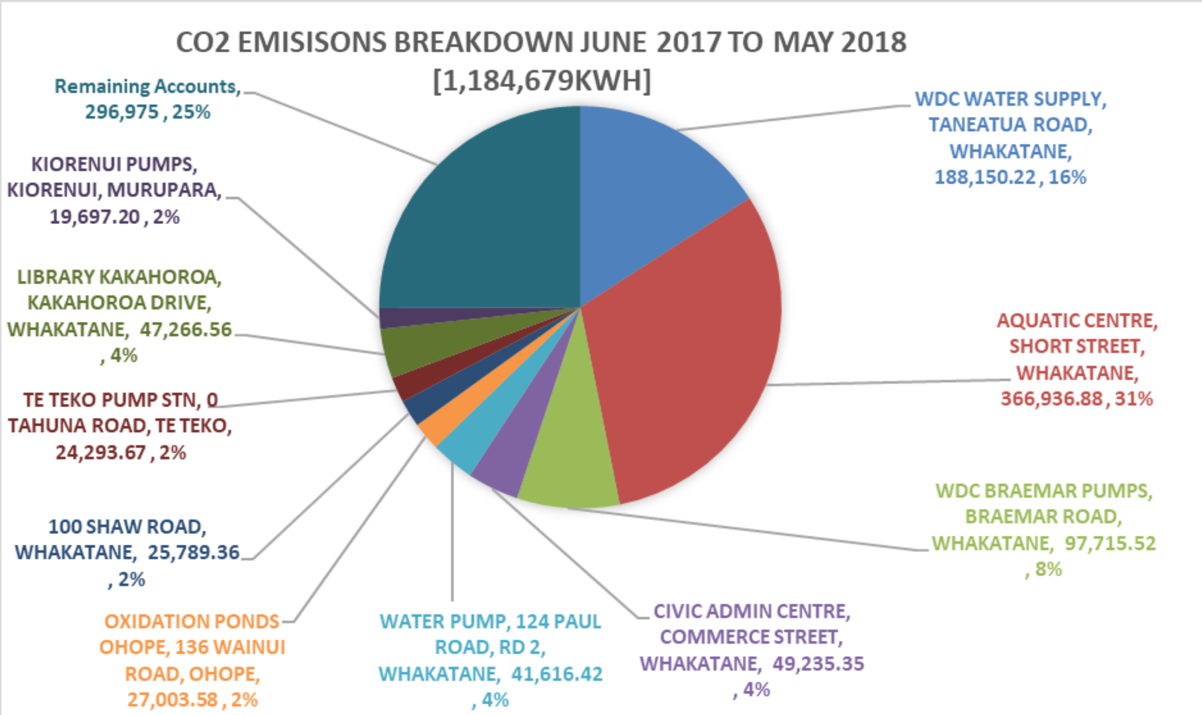


Figure 5-3 - Pie chart showing breakdown of CO_2 emissions attributed to energy use by facility

6 Historic Energy Costs and Use

6.1 Gross Energy Costs

During the June 2017 to May 2018 year, Whakatāne District Council's energy use was 8,403,866kWh. A breakdown of Whakatāne District Council's energy consumption by fuel type is shown below in Table 6-1.

Table 6-1 - Energy use and costs for June 2017 to May 2018

Fuel Type	**Energy** [kWh]	**Carbon Emissions (kg of CO_2e)**
Electricity	7,233,584	930,962
Natural Gas	1,170,282	253,705
Total	**8,403,866**	**1,184,668**

Electricity is a high-grade form of energy that is able to be easily converted into useful work, without many of the efficiency limitations associated with other fuels. Due to electricity's high-grade form, the price per unit of energy [c/kWh] is usually higher compared to other fuel sources.

Approximately 80% of New Zealand's electricity is generated using renewable sources. As a result, the carbon emissions per kWh associated with electricity use is lower than fossil fuels which produce carbon dioxide as a by-product of combustion. EECA's CO_2 emissions calculator specifies 0.1287kg CO_2e/kWh for electricity and 0.2168 kg CO_2e/kWh for natural gas. Natural gas has higher CO_2 emissions per kWh. However, because a higher proportion of Whakatāne District Council's energy is from electricity than natural gas, the highest total CO_2 emissions are from electricity use.

https://www.eecabusiness.govt.nz/tools/wood-energy-calculators/co2-emission-calculator/

6.2 Electricity

6.2.1 Monthly Consumption

6.2.1.1 Civic Centre

Shown below in Figure 6-1 is Whakatāne District Council's monthly electricity consumption at the Civic Centre and average monthly 9am temperature at Whakatāne. There is a clear trend showing increased electricity consumption in months of decreased ambient temperatures. Electricity use was highest in July 2017 and lowest in Feb 2018 and December 2017. These two summer months are also affected by lower occupancy of the building.

The relationship between electricity use and ambient temperature is discussed further in Section 6.4.1.1.

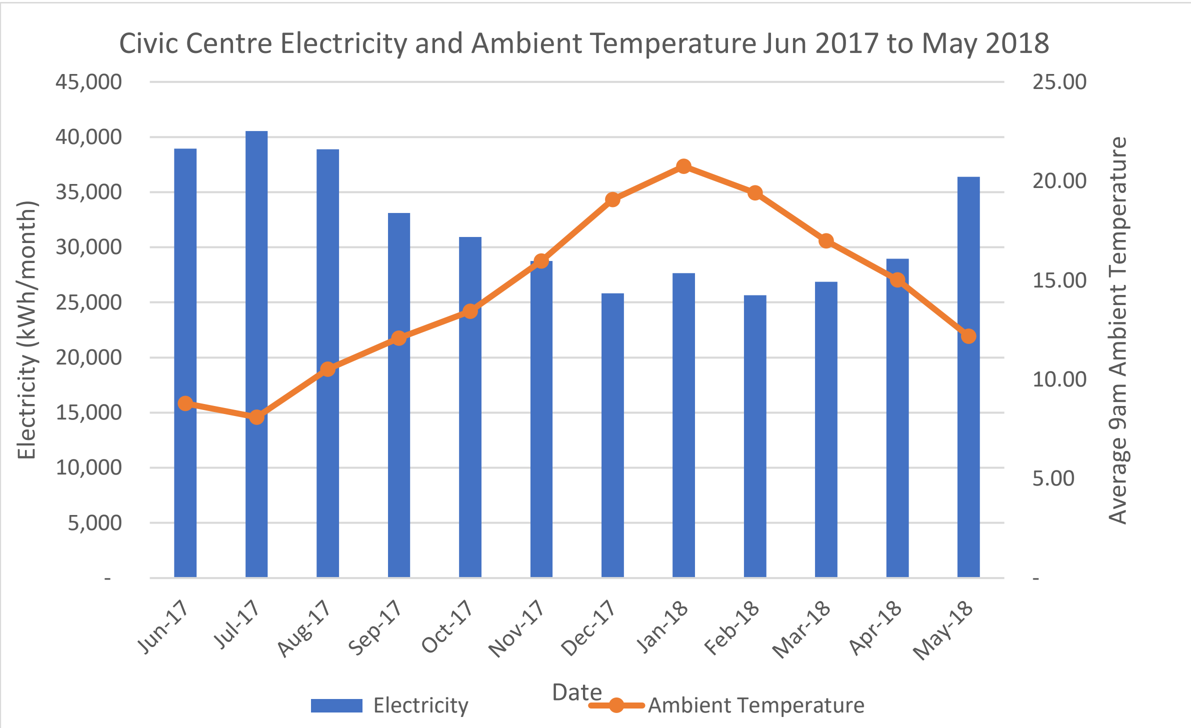


Figure 6-1 - Electricity usage at the Civic Centre for the period Jun 2017 to May 2018

6.2.1.2 Aquatic Centre

Shown below in Figure 6-2 is Whakatāne District Council's monthly electricity consumption at the Aquatic Centre and average monthly 9am temperature at Whakatāne. Electricity is lowest in Jun-Aug and is constant across these three months. This coincides with when the outdoor pool is not in use. It is also not in use for some days in May. From Sep to Apr, when the outdoor pool is in use, electricity is also relatively constant each month and is approximately 30,000kWh higher each month than when the outdoor pool is not used. Feb and Dec are slightly lower than other months due to the Aquatic Centre being open less days in those months.

There is no obvious relationship between ambient temperature and electricity use. This is discussed further in Section 6.4.2.1.

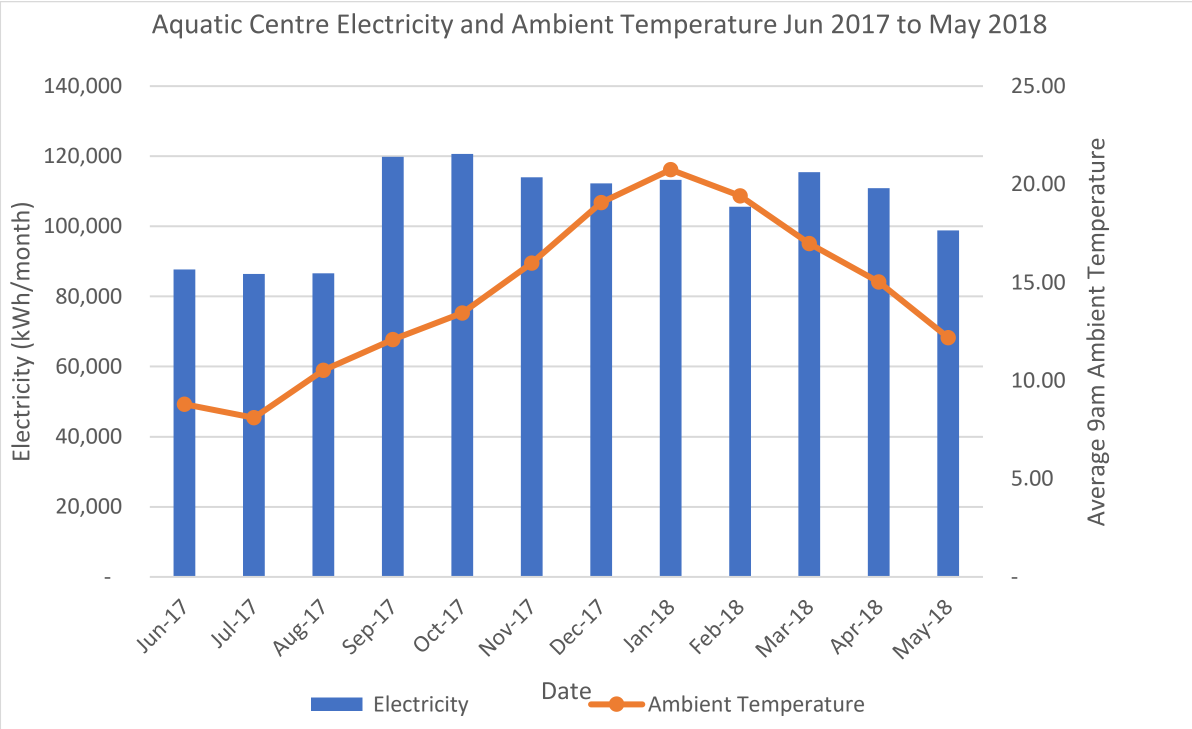


Figure 6-2 - Electricity usage at the Aquatic Centre for the period Jun 2017 to May 2018

6.2.1.3 Library

Shown below in Figure 6-3 is Whakatāne District Council's monthly electricity consumption at the Library and average monthly 9am temperature at Whakatāne. There does appear to be a relationship between electricity and ambient temperature, with winter months on average using more electricity and Aug being the highest usage month. The difference between summer and winter months' electricity use is not that pronounced; this is because gas is used for central heating.

The relationship between electricity use and ambient temperature is discussed further in Section 6.4.3.1.

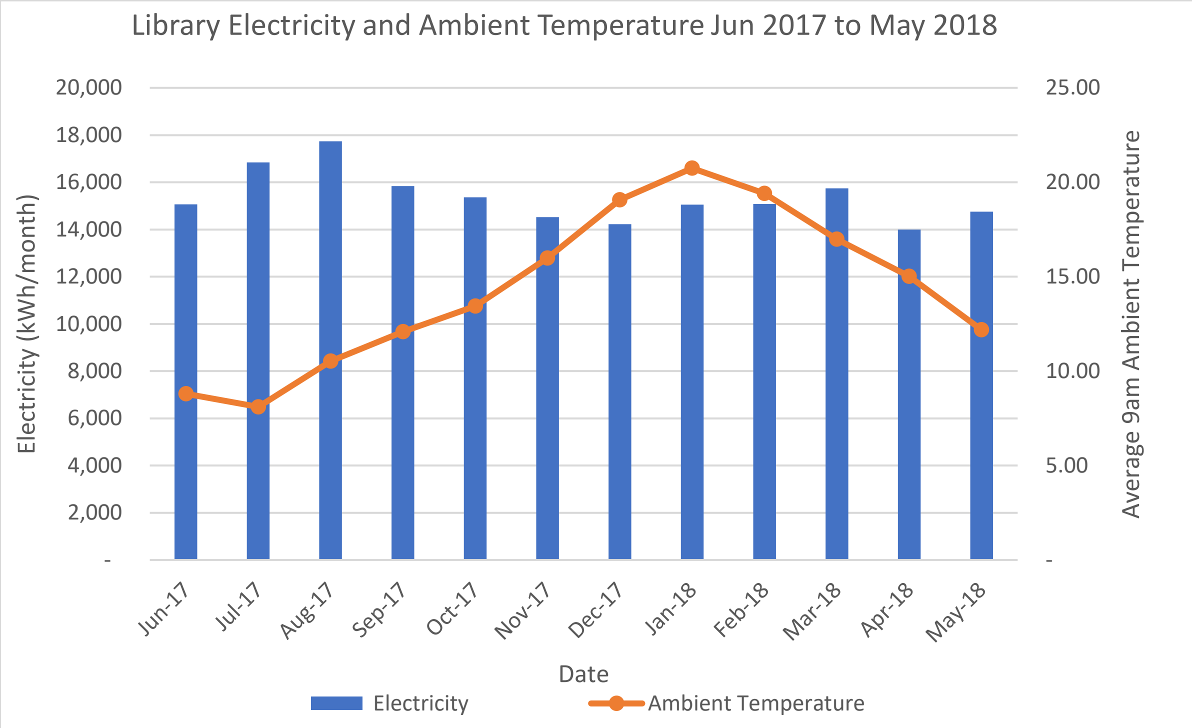


Figure 6-3 - Electricity usage at the Library for the period Jun 2017 to May 2018

6.2.2 Daily Load Profiles

6.2.2.1 Civic Centre

The Civic Centre's electricity use over a single working day is shown below in Figure 6-6; Thursday the 15th of February 2018 was arbitrarily selected to represent a typical summer day's electricity use.

The graph shows a peak load of 86.0 kVA, which occurred at 15:00 hours. The electricity load was at its minimum of 18.6 kVA at 05:00 hours. The electrical load rises during the day from 08:00 and remains relatively flat while offices are occupied until 17:00 when it begins decreasing. From 20:00 until 05:00 (overnight) the load is also flat at approximately 20kVA.

There is little difference between the kW load and kVA load throughout the day. This indicates that there is no opportunity to improve the power factor during this period. The power factor varied from 0.97 to 1.00 throughout the day and was 0.97 at peak load. Power factor should be kept at 0.95 or greater, which it is.

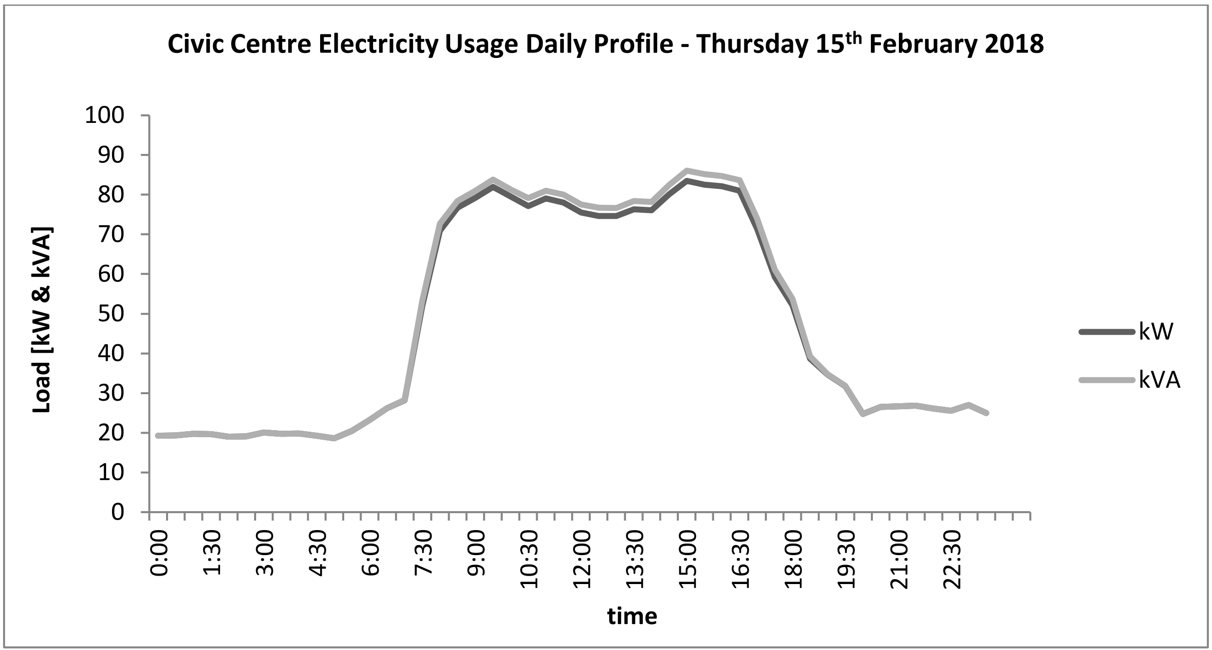


Figure 6-4 - Daily electricity profile for Thursday the 15th of February 2018.

Shown below in Figure 6-7 is the daily electricity usage profile for Thursday the 13th of July 2017, this day was arbitrarily selected to represent a typical winter electricity use profile. Electrical load was lowest after operating hours from 18:00 to 05:30, and highest in the morning between 08:00 and 10:00 due to some electrical space heating. The peak load was 164 kVA, which occurred at 09:00. The minimum load was 29 kVA which occurred at 00:00.

Power factor ranged between 0.99 and 1.00 throughout the day and was 1.00 at peak load. There is no opportunity to improve power factor during this period.

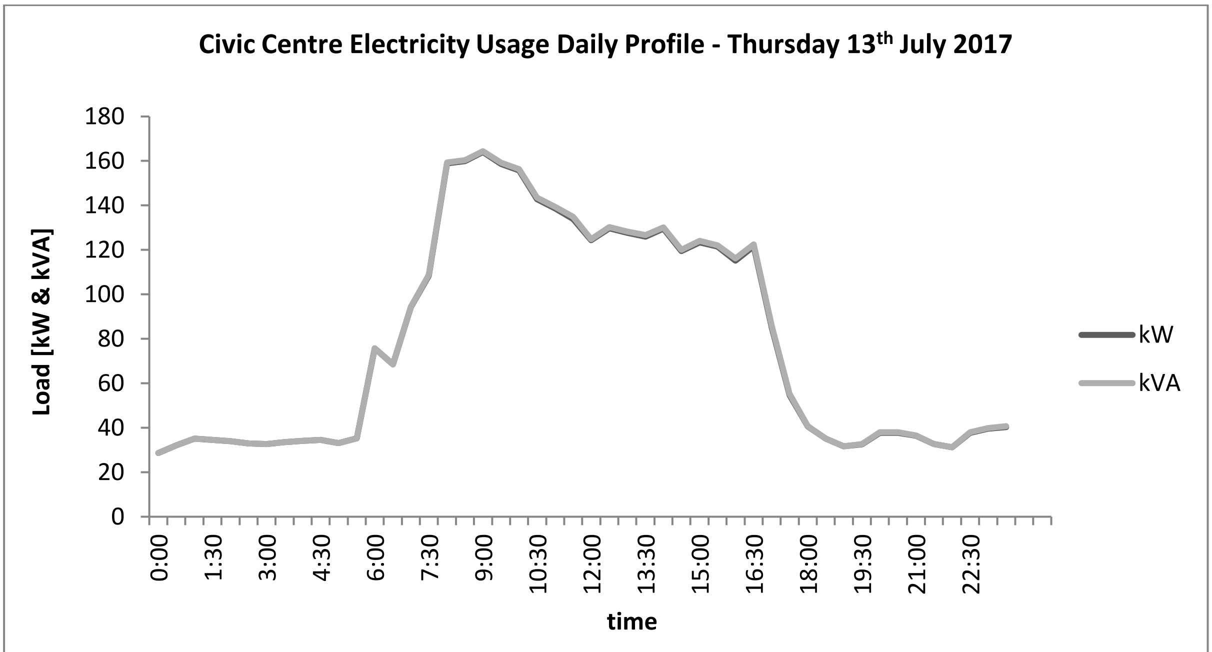


Figure 6-5 – Daily electricity usage profile for Thursday the 13th July 2017.

6.2.2.2 Aquatic Centre

The Aquatic Centre's electricity use over a single operating day is shown below in Figure 6-6; Tuesday the 16th of January 2018 was arbitrarily selected to represent a typical summer day's electricity use.

The graph shows a peak load of 196.6 kVA, which occurred at 12:00 hours. The electricity load was at its minimum of 117.2 kVA at 03:30 hours. Electricity demand after-hours is 60% or more of the peak demand during opening hours. This is high and indicates there is an opportunity to reduce after-hours electricity by switching off non-essential equipment.

There is a difference between the kW load and kVA load throughout the day, this indicates that there is some opportunity to improve the power factor during this period. The power factor varied from 0.93 to 0.96 throughout the day and was 0.95 at peak load. The power factor should be kept at 0.95 or greater.

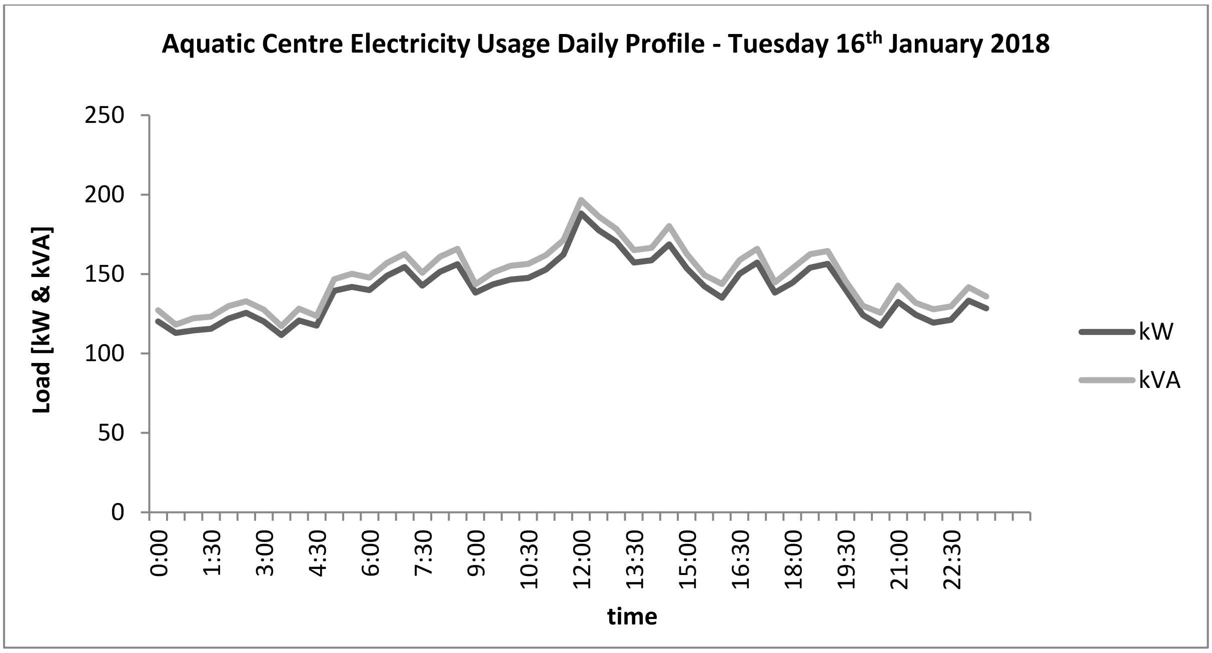


Figure 6-6 - On-season daily electricity profile for Tuesday the 16th of January 2018.

Shown below in Figure 6-7 is the daily electricity usage profile for Thursday the 13th of July 2017, this day was arbitrarily selected to represent a typical off-season electricity use profile. Electrical load was lowest after operating hours, and highest toward the middle of the day. The peak load was 150 kVA, which occurred at 12:00. This is lower than the summer peak due to the outdoor pool not operating in winter months. The minimum load was 90 kVA which occurred at 22:00.

Also shown in Figure 6-7 is the kW load, the discrepancy between the kW load and kVA load indicates the power factor is less than 1. The power factor at peak load for this site was 93%. This indicates that there is room to improve this to 95% or higher, which will result in cost savings from reduced demands and no power factor charges.

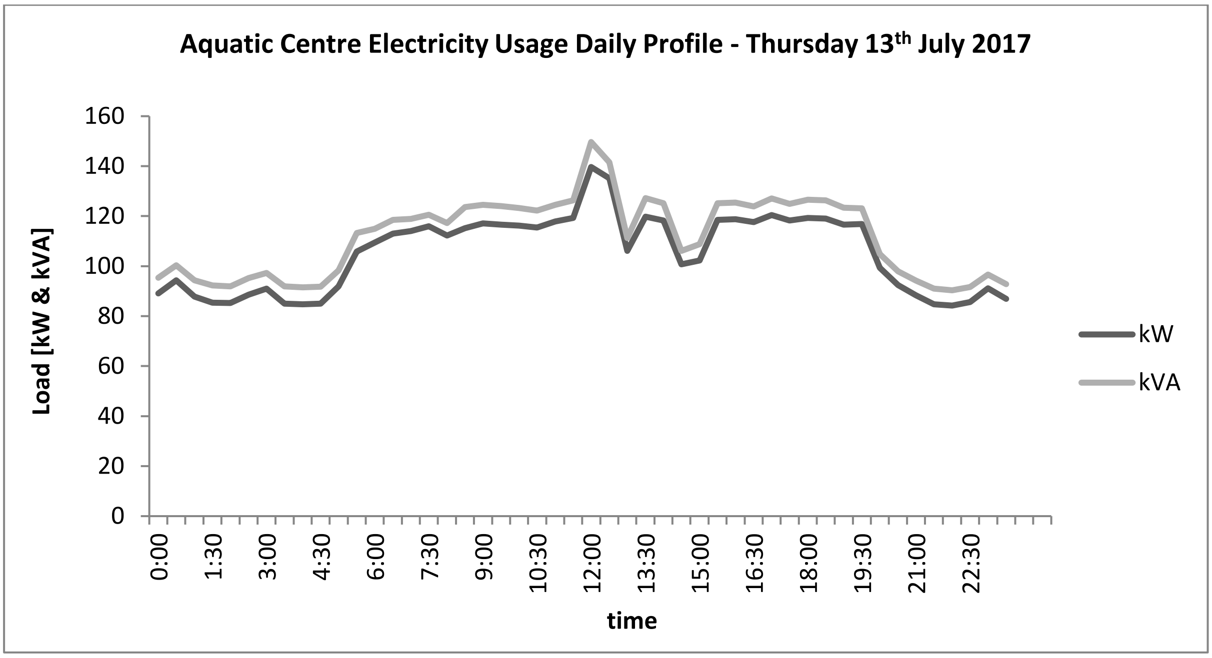


Figure 6-7 – Off-season daily electricity usage profile for Thursday the 13th July 2017.

6.2.2.3 Library

The Library's electricity use over a single production day is shown below in Figure 6-8; Tuesday the 16th of January 2018 was arbitrarily selected to represent a typical on-season production day's electricity use.

The graph shows a peak load of 31.8 kVA, which occurred at 13:30 hours. The electricity load was at its minimum of 5.6 kVA at 0:00 hours. The electrical load rises during the day during opening hours to reach the peak load at noon, then decreases to minimum loads during the night and early morning when the building is vacated.

There is a small difference between the kW load and kVA load throughout the day, this indicates that there is little opportunity to improve the power factor during this period. The power factor varied from 0.96 to 1.00 throughout the day and was 0.99 at peak load. The power factor should be kept at 0.95 or greater.

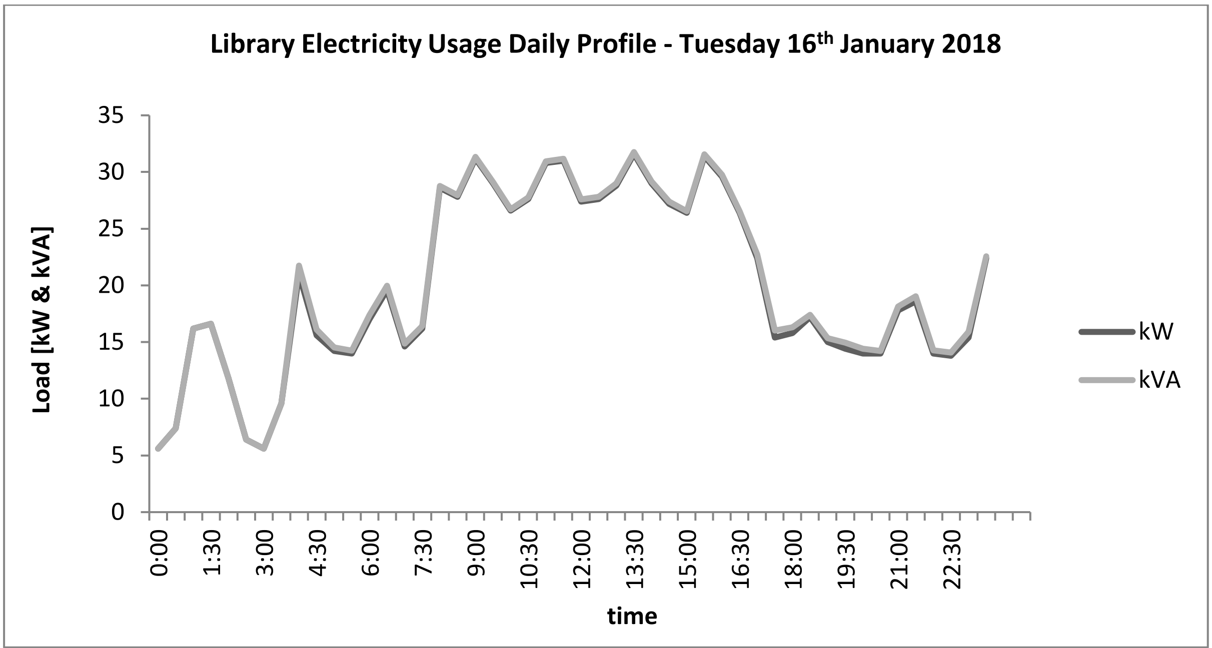


Figure 6-8 - On-season daily electricity profile for Tuesday the 16th January 2018.

Shown below in Figure 6-9 is the daily electricity usage profile for Tuesday the 11th of July 2017, this day was arbitrarily selected to represent a typical winter electricity use profile. Electrical load was lowest after operating hours, and highest in the late afternoon. The peak load was 38 kVA, which occurred at 15:30 and 18:00. The minimum load was 18 kVA which occurred at 01:30. The pattern of electricity use is not smooth, moving up and down at least ten times per day, every two to three hours. This is most likely caused by the heating system and indicates poor control.

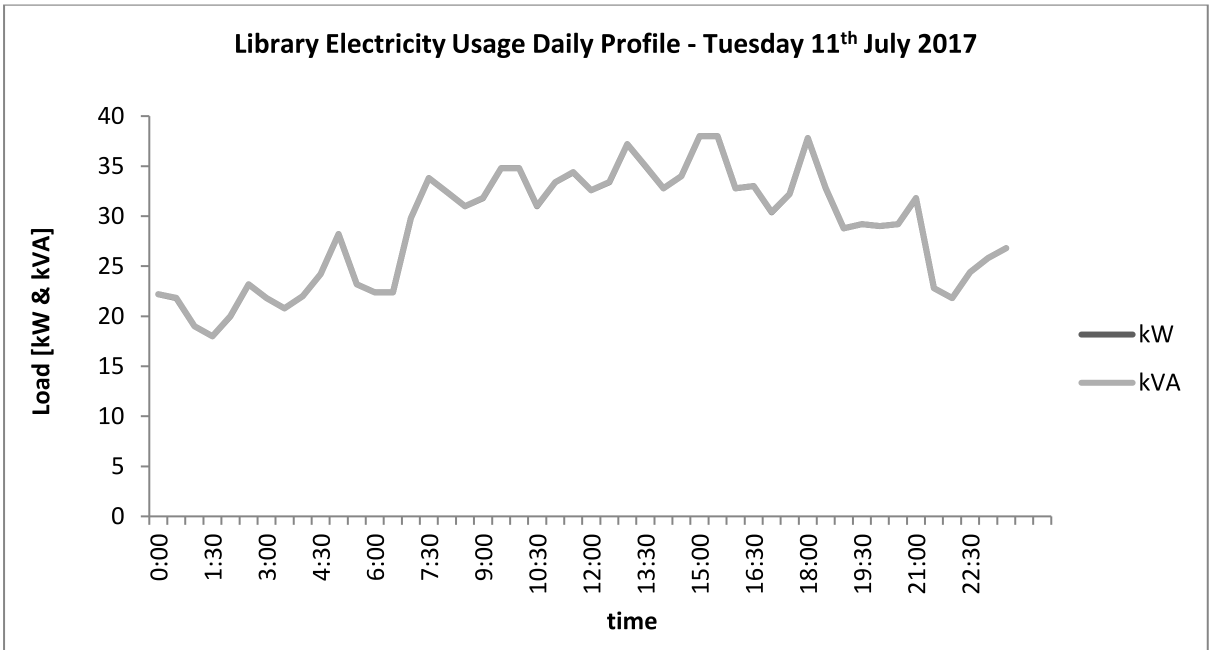


Figure 6-9 – Winter daily electricity usage profile for Tuesday the 11th July 2017.

6.2.2.4 Pump Stations

6.2.2.4.1 Whakatāne Water Treatment Plant

The Whakatāne Water Treatment Plant supplies water to the Whakatane township and to Ohope. The plant's electricity use over a single day is shown below in Figure 6-8; Tuesday the 9th of January 2018 was arbitrarily selected to represent a typical peak season day's electricity use.

The graph shows a peak load of 250.4 kVA, which occurred at 12:00 hours. The electricity load was at its minimum of 119.8 kVA at 04:30 hours. The electrical load shows a pattern of operating at a fixed load for certain periods of time to meet water demands firstly at approximately 230 kVA, then switching to 120 kVA at 3:00 hours, then back up to 230 kVA at 10:30 hours. This represents high lift pumps being used to fill the reservoirs and then being switched off.

There is little difference between the kW load and kVA load throughout the day, this indicates that there is little opportunity to improve the power factor during this period. The power factor was 0.99 throughout the day and was 0.99 at peak load. The power factor should be kept at 0.95 or greater.

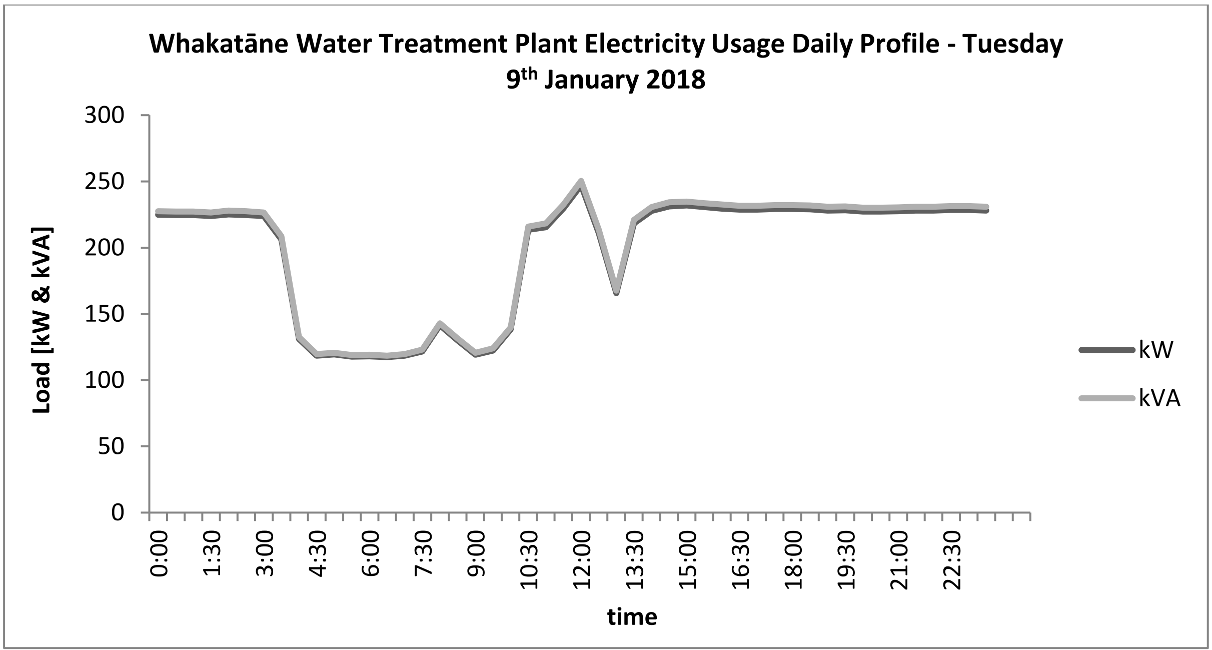


Figure 6-10 - Whakatāne Water Treatment Plant on-season daily electricity profile for Tuesday 9 January 2018.

Shown below in Figure 6-11 is the daily electricity usage profile for Monday the 7th of August 2017, this day was arbitrarily selected to represent a typical off-peak electricity use profile. The electrical load was approximately 120 kVA from 2:30 hours to 18:30 hours, after which the electrical load increased to approximately 200 kVA. The peak load of 198 kVA occurred at 20:00 hours and the minimum load of 118 kVA occurred at 4:30 hours. Compared to summer months, there are less hours during the day that the load is at its peak, and the loads are slightly less than during summer too. These are due to less demands on water use during the winter than in the summer.

Also shown in Figure 6-11 is the kW load, there is little difference between the kVA and the kW loads indicating that power factor is higher than 0.95. The power factor at peak load was 0.99.

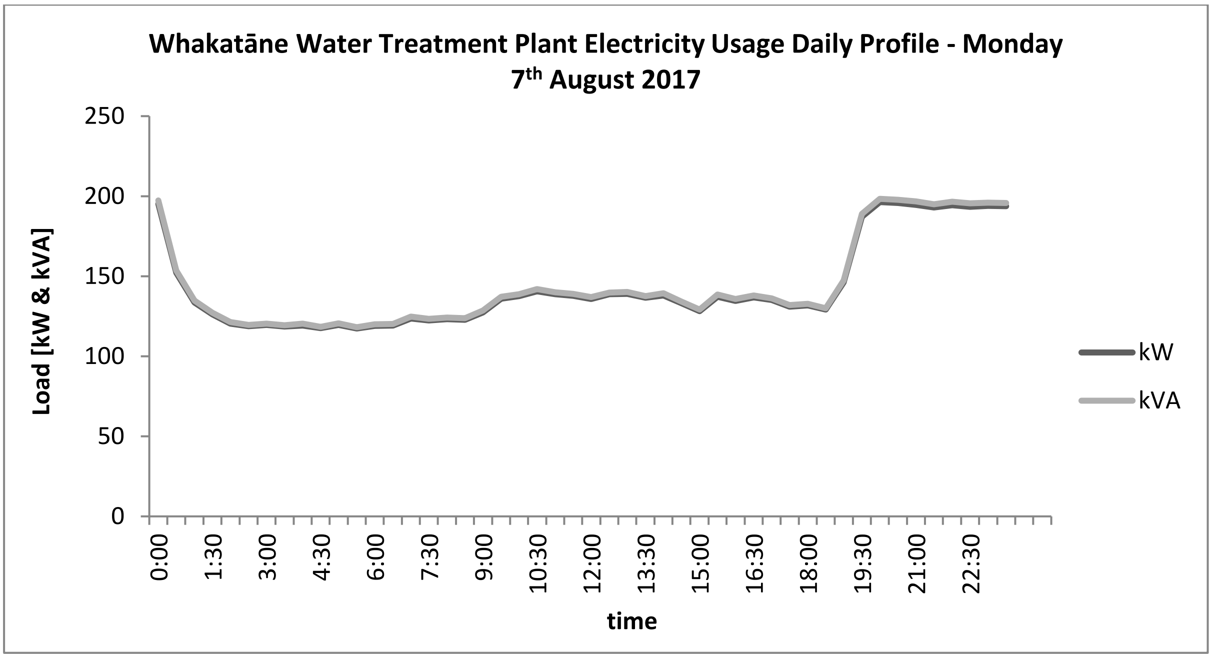


Figure 6-11 – Whakatāne Water Treatment Plant off-season daily electricity usage profile for day Monday 7th August 2017

6.2.2.4.2 Braemar Road Pumps

Braemar Road Pump Station supplies water to the Plains. Electricity use over a single day is shown below in Figure 6-8; Tuesday the 6th of February 2018 was arbitrarily selected to represent a typical day's electricity use.

The graph shows a peak load of 235.7 kVA, which occurred at 14:30 hours. The electricity load was at its minimum of 0 kVA between the hours of 2:00 to 7.00, 11:30 to 16:00 and 18:00 – 23:30. The electrical load shows discrete periods of operation, when the pump is switched on and off to meet demands for water.

There is a significant difference between the kW load and kVA load throughout the day, this indicates that there is an opportunity to improve the power factor during this period. The power factor varied from 0.85 to 0.88 throughout the day and was 0.87 at peak load. The power factor should be kept at 0.95 or greater.

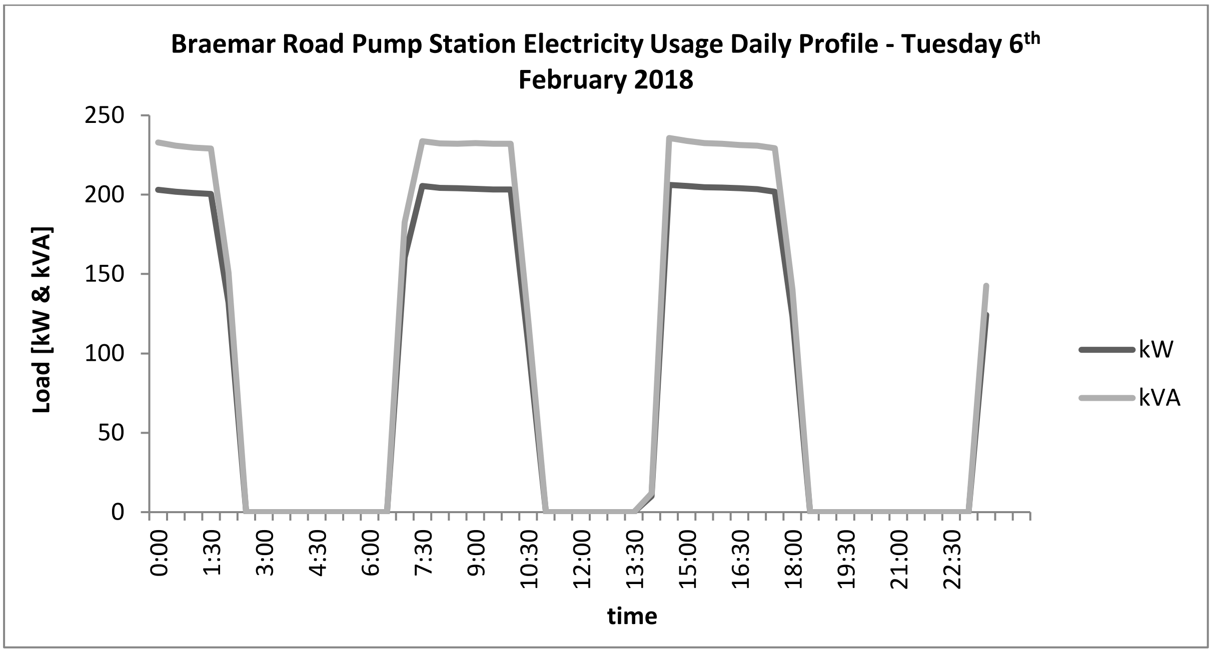


Figure 6-12 - Typical daily summer electricity profile for Braemar Rd Pump Station

Shown below in Figure 6-13 is the daily electricity usage profile for Monday the 7th of August 2017, this day was arbitrarily selected to represent a typical off-peak electricity use profile. The electrical load is periodic with two operating conditions; one pump on or both pumps off. When one pump is operating the load reaches 118kVA, and when the pumps are off and supply is from the reservoirs only the load is zero. Power factor is similarly poor during winter, typically operating at 0.88 when the pumps are on.

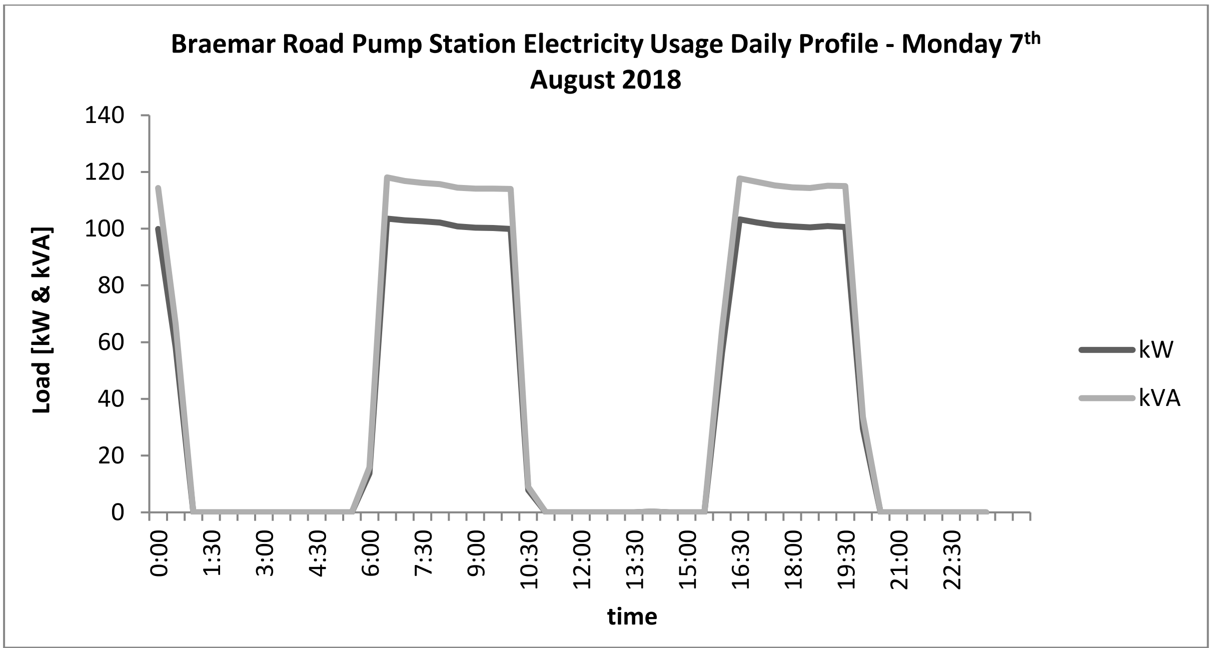


Figure 6-13 - Typical daily winter electricity profile for Braemar Rd Pump Station

6.2.2.4.3 Paul Road Pumps

Paul Road Pump Station supplies water to Edgecumbe and Te Teko. Electricity use over a single production day is shown below in Figure 6-8; Monday the 26th of February 2018 was arbitrarily selected to represent a typical day's electricity use.

The graph shows a peak load of 94.6 kVA, which occurred at 19:30 hours. The electricity load was at its minimum of 25.4 kVA at 4:00 hours. The electrical load is periodic throughout the day, varying between the minimum load of 25.4 kVA and the maximum load of 94.6 kVA. The periods occur approximately once every 1.5 to 2 hours. This represents the bore pump turning off and on.

There is a small difference between the kW load and kVA load throughout the day, this indicates that there is little opportunity to improve the power factor during this period. The power factor varied from 0.99 to 1.00 throughout the day and was 0.99 at peak load. The power factor should be kept at 0.95 or greater.

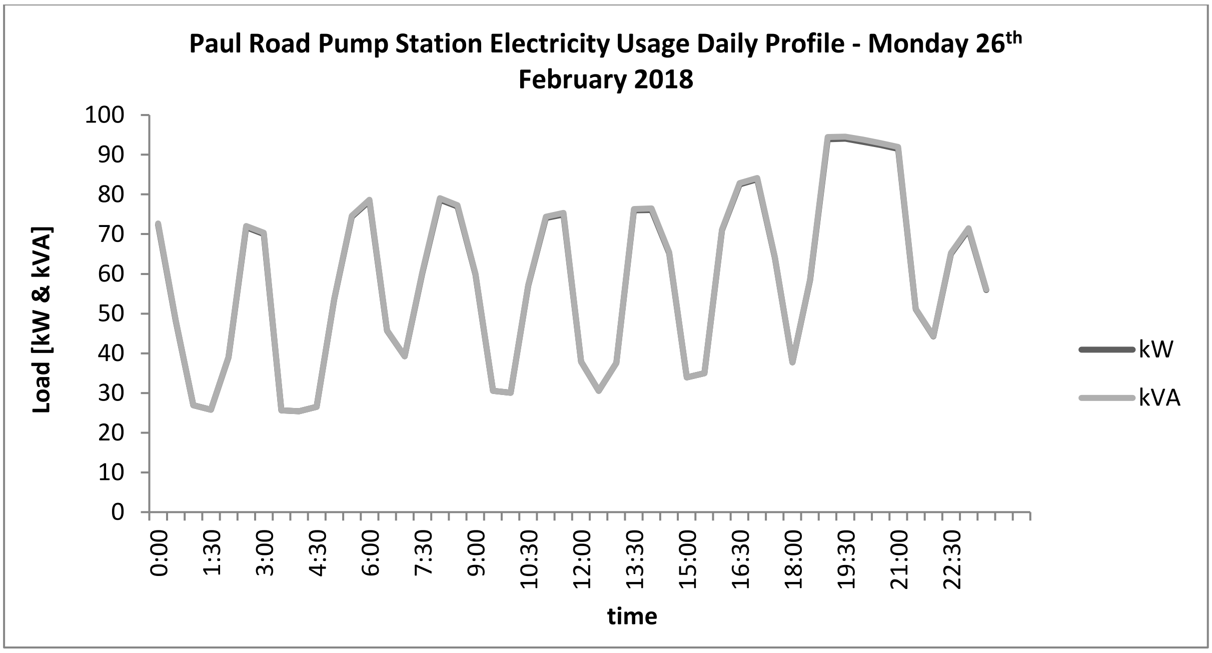


Figure 6-14 - On-season daily electricity profile for Paul Rd Pump Station.

The Paul Rd Pump Station is a relatively new installation and has been in operation since September 2017. At the time of this audit, electricity data was only available to the end of May 2018, which means winter loads were unavailable. A daily profile from May 30th was chosen as the closest approximation and is shown in Figure 6-15 below.

The graph shows a peak load of 79.1kVA occurred at 15:30 in the afternoon, however there were a number of similar cyclical peaks throughout the day. The lowest demand of 22.0kVA occurred at 03:30. Power factor was 0.99 - 1.00 through the day which is excellent.

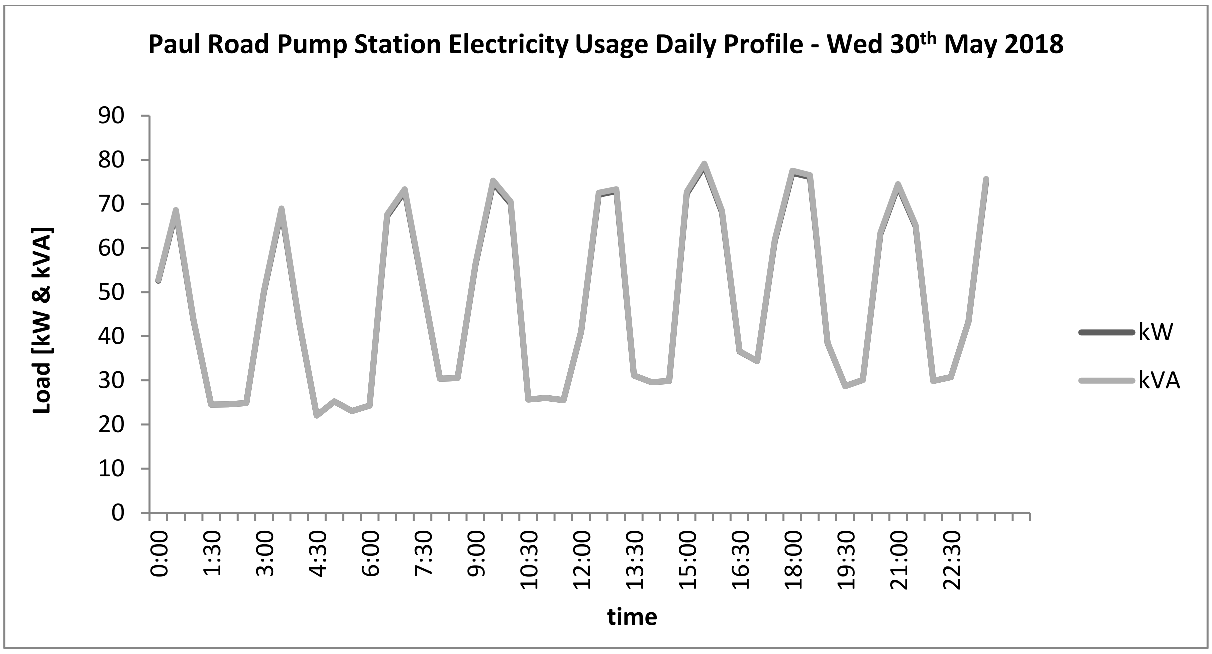


Figure 6-15 - Off season daily electricity profile for Paul Rd Pump Station

6.2.3 Weekly Load Profiles

6.2.3.1 Civic Centre

Figure 6-18 shows the summer weekly electricity profile for the week starting Monday the 12th of February 2018. The graph shows that the week's peak load of 90 kVA occurred at 09:30 hours on Monday the 12th. Excluding the power outage at 06:00 on Tuesday the 13th, the minimum observed load during the period was 18.6 kVA which occurred on Thursday at 05:00 hours.

Each day the load increases from 8:00 until 17:00am which corresponds to office hours. Between these hours for Monday to Friday the load is relatively constant and varies between 74kVA and 90kVA. After hours and weekend demand are similar with a load of approximately 25kVA which is also relatively constant. On Wednesday night/Thursday morning the after-hours demand was less than other nights at 20kVA. This is likely due to some equipment being switched off that is usually left on.

The average power factor for the period was 0.99 while the range was 0.97 to 1.00 which is excellent and there is no opportunity to improve this.

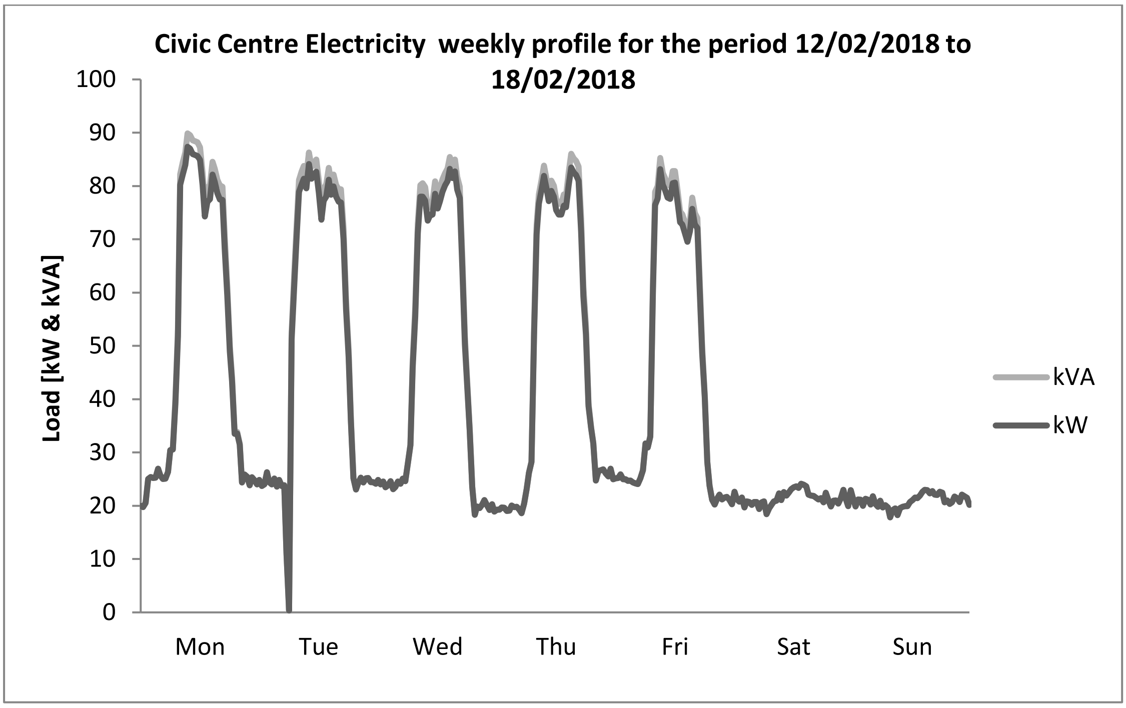


Figure 6-16 - Summer weekly electricity usage profile

Below in Figure 6-19 is the winter electricity profile for the week starting Monday the 10th of July 2017. The graph shows that the week's peak load of 164 kVA occurred at 09:00 hours on Thursday the 13th, while the minimum load of 15 kVA occurred at 23:00 hours on Sunday the 16th.

Electricity demand begins increasing from 06:00 on weekdays, reaches its peak by 8am and then decreases to between 110kVA and 120kVA from 11:00 until 16:30. From 16:30 the load begins to decrease towards its overnight demand of 20-40kVA. Morning peaks are due to space heating, which does not occur during summer months.

The power factor during the sample week in the winter season is similar to that of the summer season power factor, operating between 0.98 and 1.00.

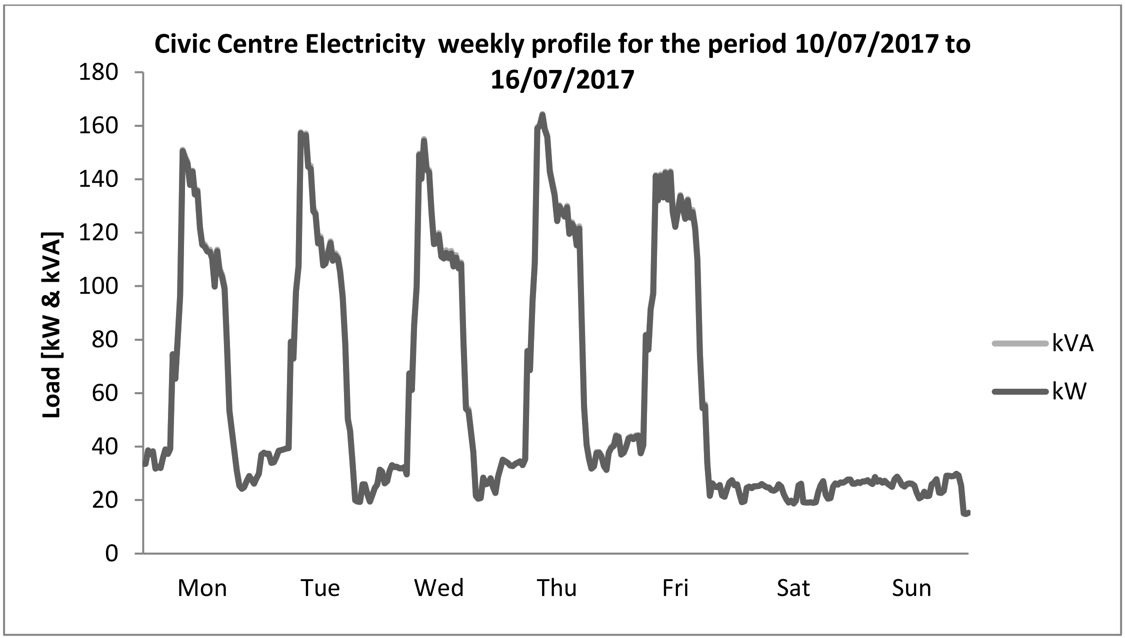


Figure 6-17 – Winter weekly electricity usage profile

6.2.3.2 Aquatic Centre

Figure 6-18 shows the on-season weekly electricity profile for the week starting Monday the 15th of January 2018. The graph shows that the week's peak load of 197 kVA occurred at 12:00 hours on Tuesday the 16th. The minimum observed load during the period was 116 kVA, this occurred on Monday at 22:00 hours.

Each day the peak load occurs at or near 12:00 hours. This corresponds to the time of peak activity at the aquatic centre. The load profile for each day shows a sharp increase in electrical load at 5:00 hours. The load then gradually increases until it reaches its peak at or near 12:00. After this time, the load follows a gradual decrease until 19:30 hours, when there is a sharp decrease in load. After hours baseload is significant at approximately 120 kVA. This is due to pumps and some fans being left switched on 24/7.

The average power factor for the period was 0.95, while the range was 0.93 to 0.97. It can be seen from the graph that the power factor tended to drop the most during high load periods, as shown by the distance between the kVA load and corresponding kW load.

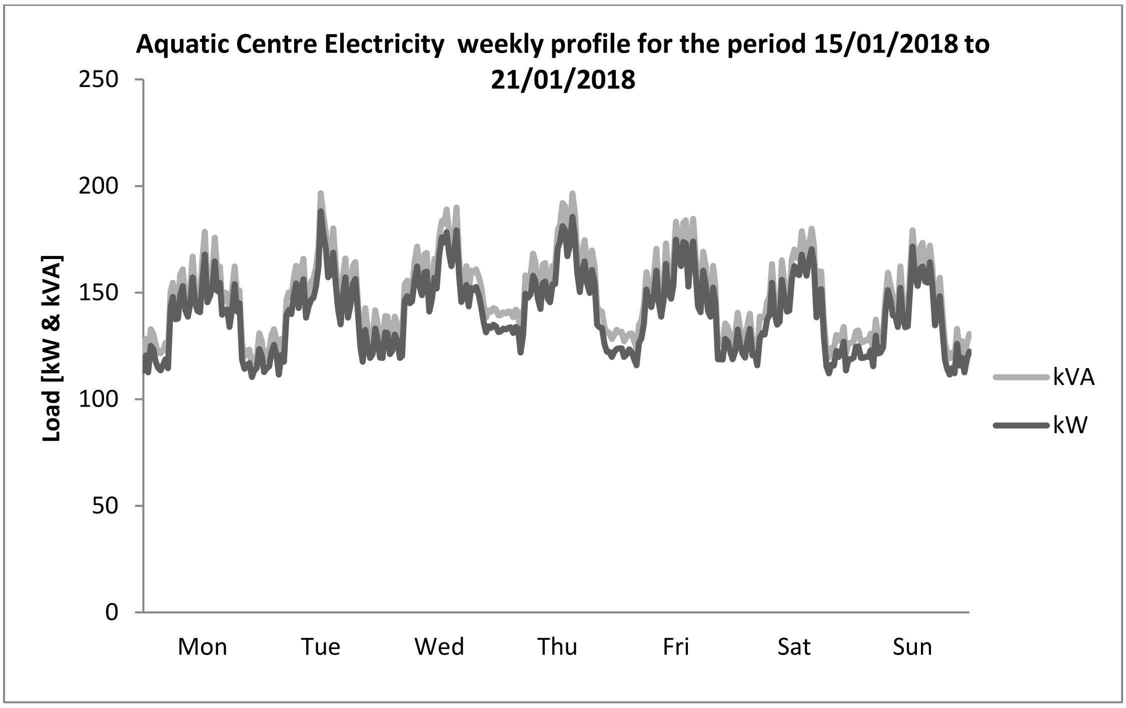


Figure 6-18 - Summer weekly electricity usage profile

Below in Figure 6-19 is the off-season electricity profile for the week starting Monday the 10th of July 2017. The graph shows that the week's peak load of 150 kVA occurred at about 12:00 hours on Thursday the 13th, while the minimum load of 76 kVA occurred at 00:00 hours on Monday the 10th. Similar to the on-season weekly profile; the electricity use profile follows a re-occurring pattern, however the peak and after-hours loads are less due to the outside pool not being used.

The power factor during the sample week in the off-peak season is similar to that of the on-season power factor, averaging 0.94 for the week and ranging from 0.92 to 0.97.

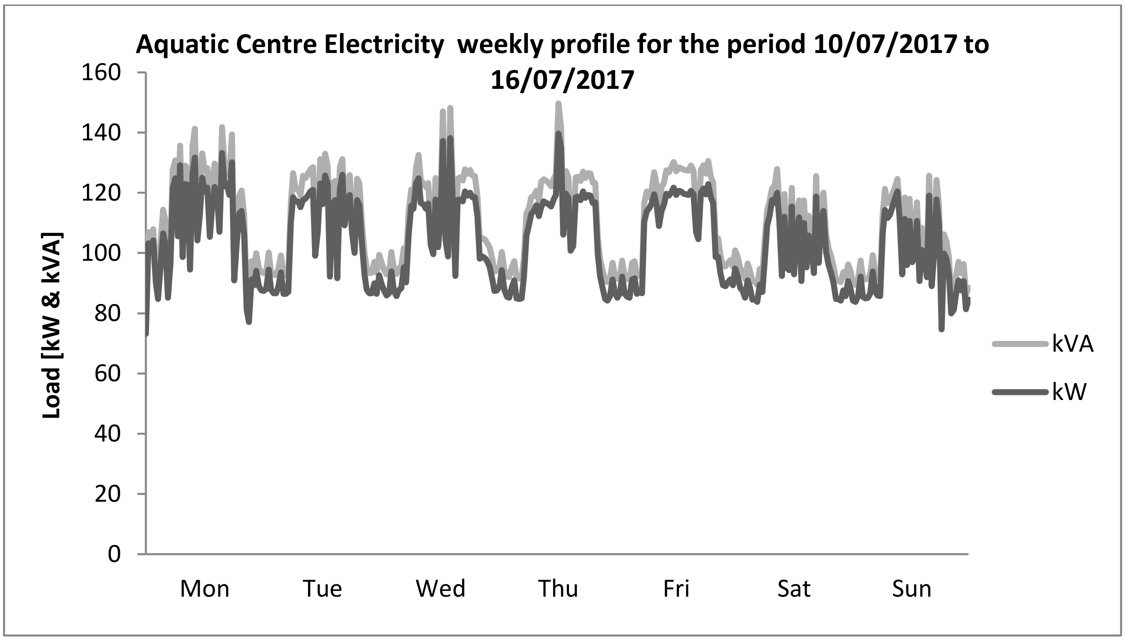


Figure 6-19 – Winter weekly electricity usage profile

6.2.3.3 Library

Figure 6-20 shows the summer weekly electricity profile for the week starting Monday the 15th of January 2018. The graph shows that the week's peak load of 35kVA occurred at 15:00hours on Friday the 19th. The minimum observed load during the period was 4kVA, this occurred on Sunday at 19:00hours.

Each day demand reaches between 30 and 35kW during opening hours. Opening hours on week days are 9am to 5pm and on weekends opening hours are 10am to 2pm. There are two modes of energy use during after-hours periods; immediately after-hours electricity demand reduces to 15 to 20kW. Most nights this reduces again to 5kW, however on Tuesday night the demand remained at 15 to 20kW right through to Wednesday opening hours. Avoiding this load is an energy savings opportunity included in Section 8.3.3.1.

The average power factor for the period was 0.99, while the range was 0.94 to 1.00. This is excellent and there is little opportunity to improve it.

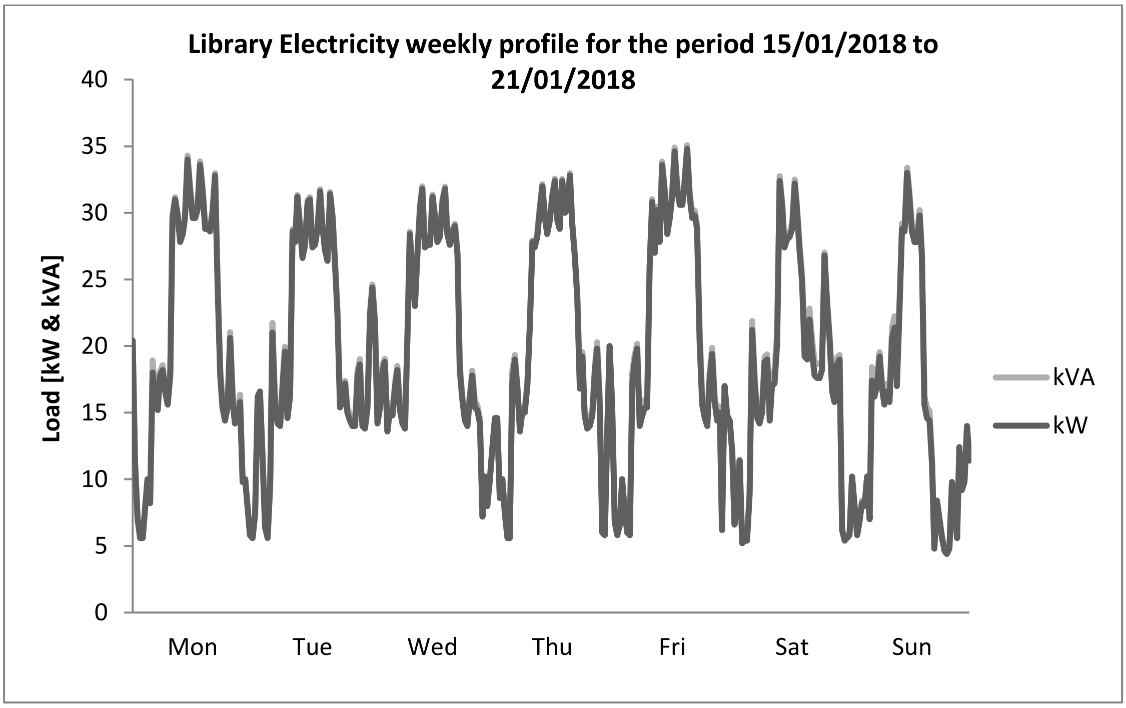


Figure 6-20 - Summer weekly electricity usage profile

Below in Figure 6-21 is the off-season electricity profile for the week starting Monday the 10th of July 2017. The graph shows that the week's peak load of 39kVA occurred at about 19:00 hours on Wednesday the 12th, while the minimum load of 11kVA occurred at 00:00 hours on Monday morning. During winter the after-hours load never decreases to the 5kW that was seen during summer. Instead it decreases to 15-20kW overnight.

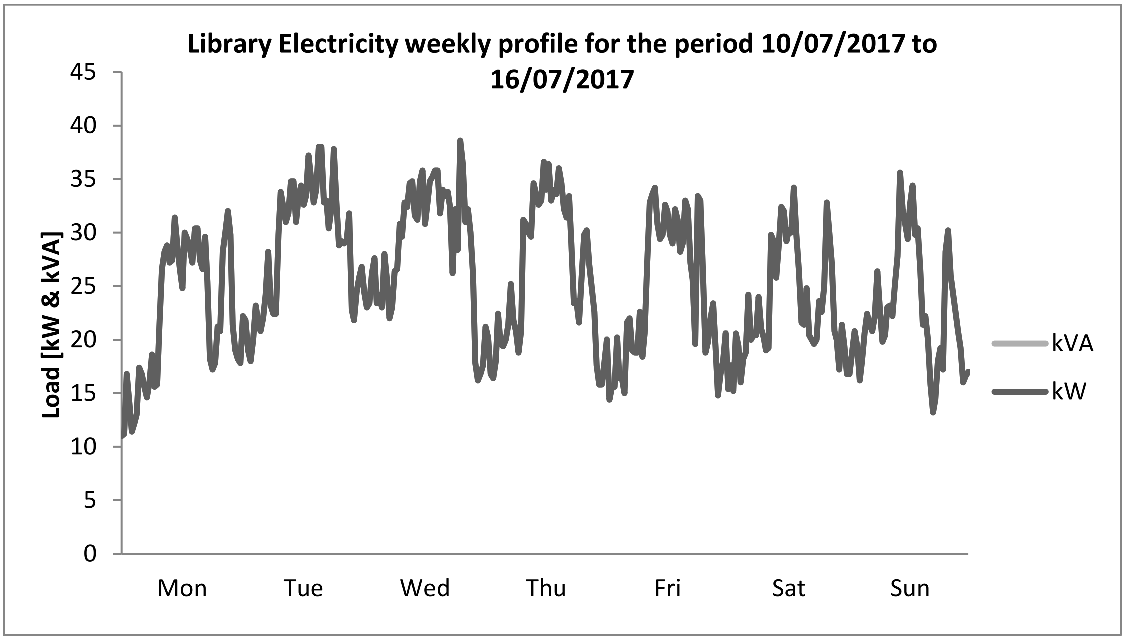


Figure 6-21 –Library off-season weekly electricity usage profile

6.2.3.4 Pump Stations

6.2.3.4.1 Whakatāne Water Treatment Plant

Figure 6-22 shows the on-season weekly electricity profile for the week starting Monday the 8 of January 2018. The graph shows that the week's peak load of 261 kVA occurred at 12:00 hours on Sunday the 14th. The minimum observed load during the period was 17 kVA, this occurred on Friday at 10:30 hours.

There is a large 130 kVA load reduction that occurs each workday between 3:00 am and 10:00 am. This is the result of a high lift pump turning off and using the stored head in the reservoirs to provide pressure for the town supply.

On weekends, the loading is more sporadic, but oscillates between a high-power mode of 250 kVA (which is higher than the load during the week), and low power mode of 130 kVA.

The average power factor for the period was 0.99, while the range was 0.94 to 0.99. The decrease to 0.94 occurred on Friday morning when the demand decreased to its minimum. At peak demand the power factor was 0.99.

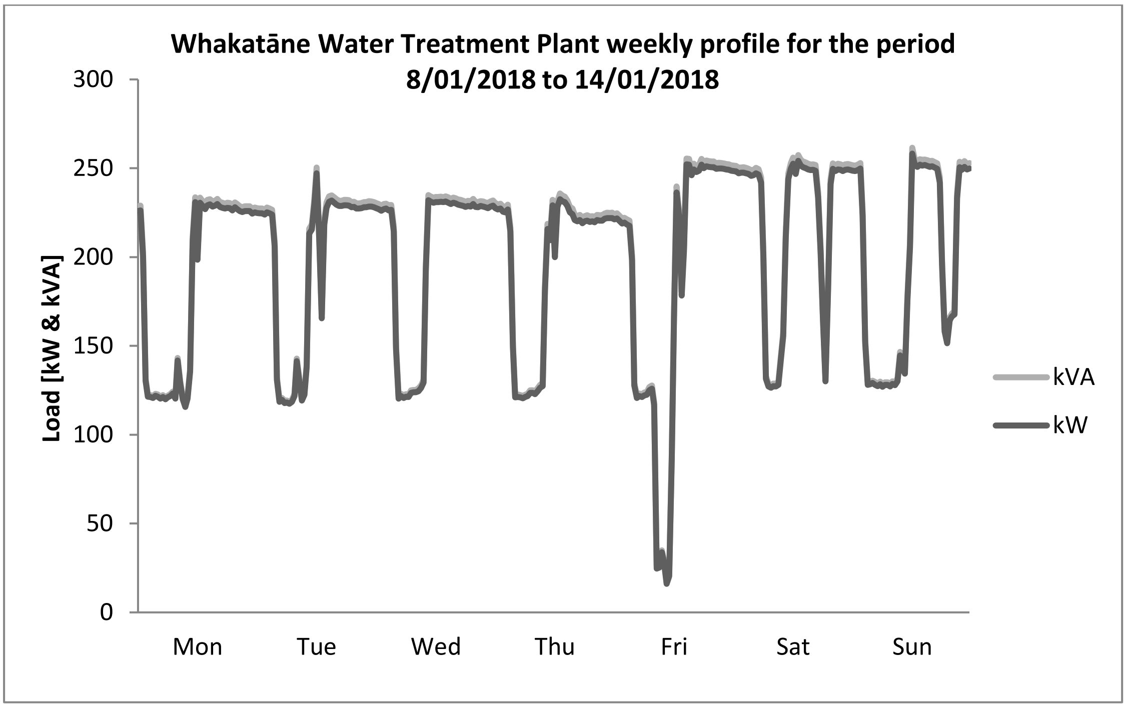


Figure 6-22 – Whakatāne Water Treatment Plant summer weekly electricity usage profile

Below in Figure 6-23 is the off-season electricity profile for the week starting Monday the 7th of August 2017. The graph shows that the week's peak load of 214 kVA occurred at about 12:00 hours on Thursday the 10th, while the minimum load of 11 kVA occurred at 12:00 hours on Wednesday the 8th. The electricity use profile follows a re-occurring pattern of high and low load levels, similar to the summer period but at lower loads. However, the times duration of load high load use is reduced; the high load usually begins in the late afternoon and switches off around 3 am.

The power factor during the sample week in the winter season averaged 0.99 and ranged from 0.987 to 0.992.

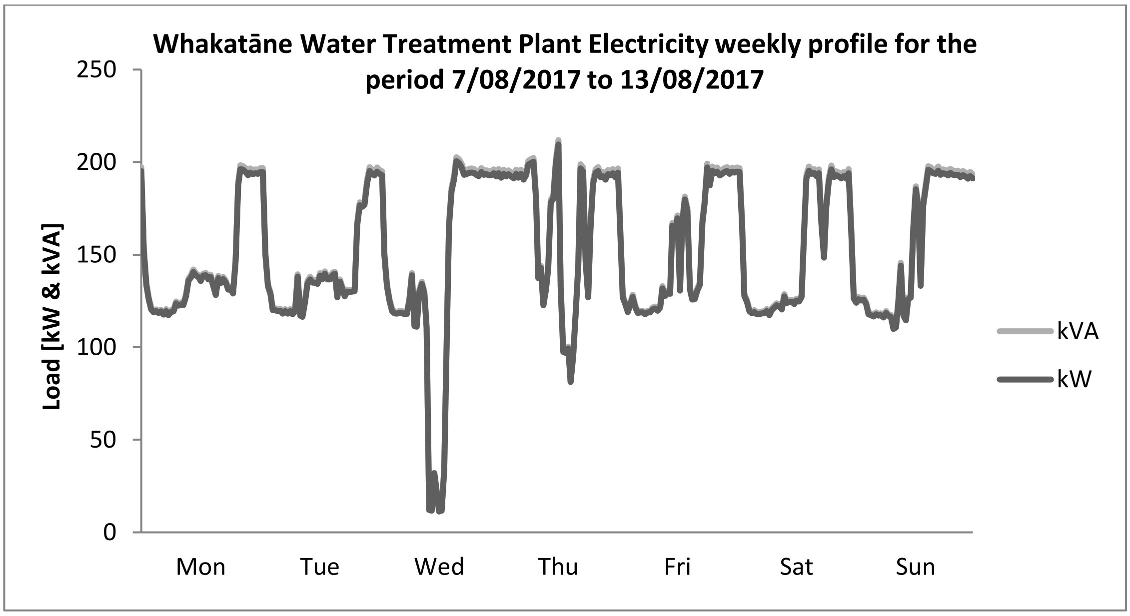


Figure 6-23 – Whakatāne Water Treatment Plant winter weekly electricity usage profile

6.2.3.4.2 Braemar Road Pumps

Figure 6-24 shows the on-season weekly electricity profile for the week starting Monday the 5th of February 2018. The graph shows that the week's peak load of 233 kVA occurred at 12:30 hours on Tuesday the 6th. The minimum observed load was 0 kVA, this occurred regularly during off cycle times.

The load profile over the course of the week oscillates between a loaded and zero load state with a period of approximately 7 hours on average per cycle. During the loaded state the load is at 230 kVA for approximately 2-5 hours, and then the plant becomes unloaded at 0 kVA for 2-5 hours. The duration of on cycle and off cycle times varies without an obvious pattern and is demand driven. The duty cycle for the week was 47.5%, meaning the pumps were on for 47.5% of the time during the week analysed.

The average power factor for the period was 0.89, while the range was 0.70 at maximum load to 1 at very low loads. It can be seen from the graph that the power factor tended to drop the most during high load periods, as shown by the distance between the kVA load and corresponding kW load.

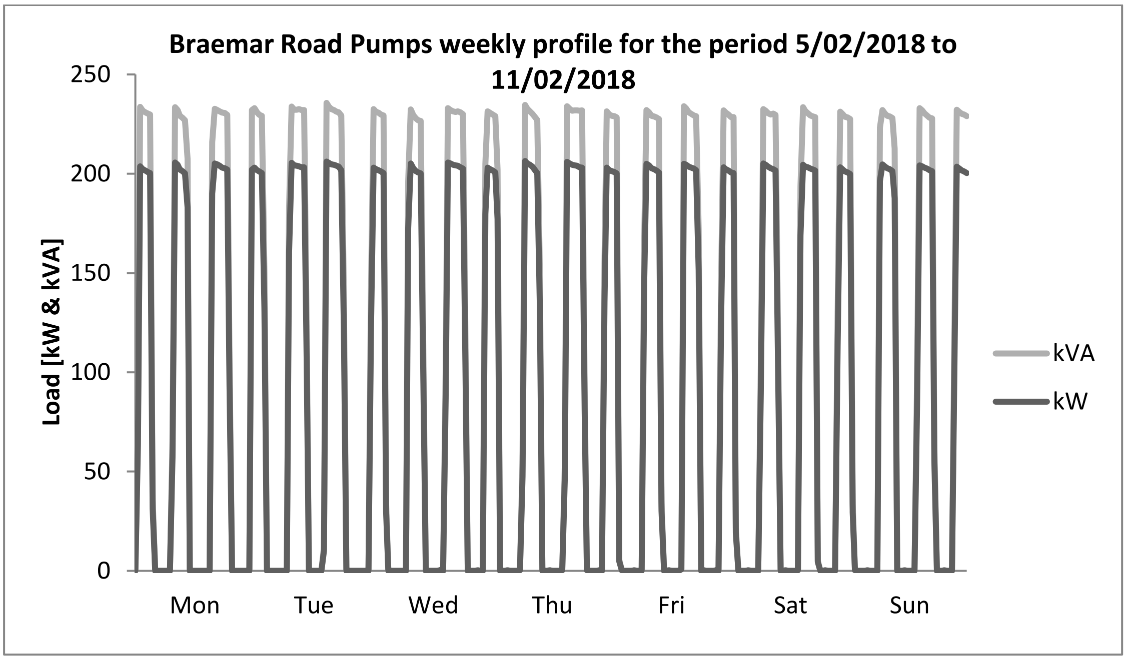


Figure 6-24 – Braemar Road On-season weekly electricity usage profile

Below in Figure 6-25 is an off-season electricity profile for the week starting Monday the 7th of August 2017. The graph shows that the week's peak load is 118kVA, half of the peak load in summer. This is due to only one pump operating, instead of two. The load reduces to zero at similar frequency to the summer time trend.

The power factor during the sample week in the winter season averaged 0.88 and ranged from 0.86 to 0.89 which is poor.

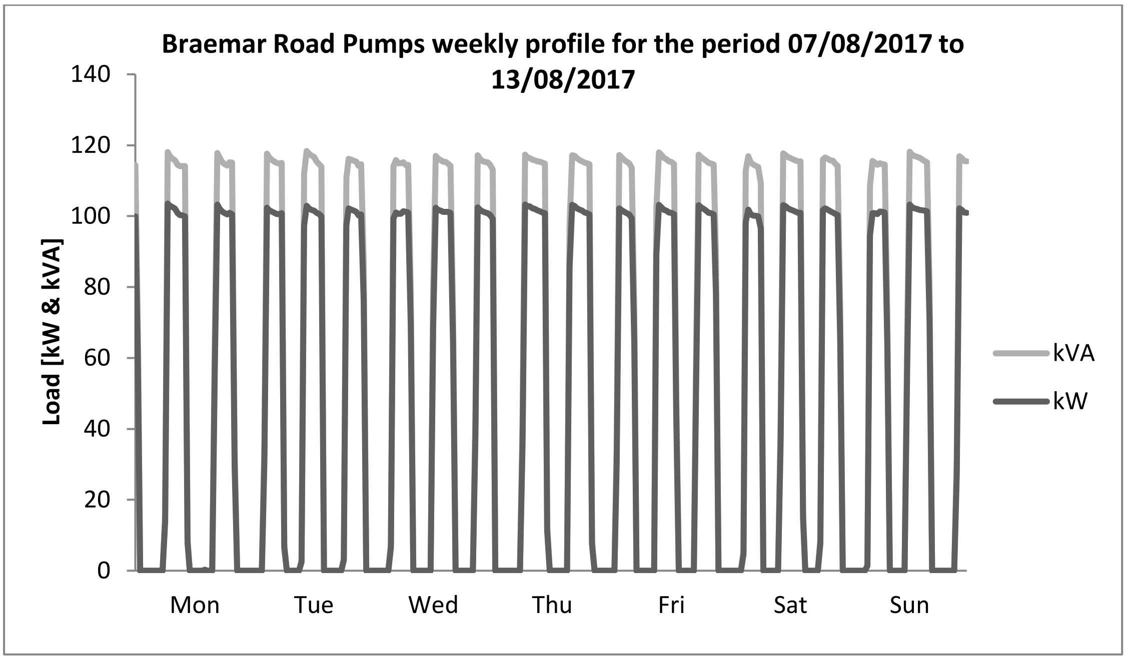


Figure 6-25 - Off-season weekly electricity profile at Braemar Rd Pump Station

6.2.3.4.3 Paul Road Pumps

Figure 6-26 shows the on-season weekly electricity profile for the week starting Monday the 26th of February 2018. The graph shows that the week's peak load of 95 kVA occurred at 17:30hours on Monday the 26th. The minimum observed load during the period was 13 kVA, this occurred on Wednesday at 12:30hours.

Each day load varies cyclically between a high limit of approximately 80 kVA, and a low limit of approximately 30 kVA. On average there are 8 cycles per day. The load ramps on and off gradually and has varying peaks (unlike the Braemar pump station). This indicates pump controls are more adaptive to load requirements and thus more energy efficient.

During the week there were three periods of sustained high energy use on Monday (18:00- 21:00), Wednesday (1700-1800) and Thursday (0700-0830).

The average power factor for the period was 0.998, while the range was 0.994 to 1. This power factor is excellent, and no corrective measures are required.

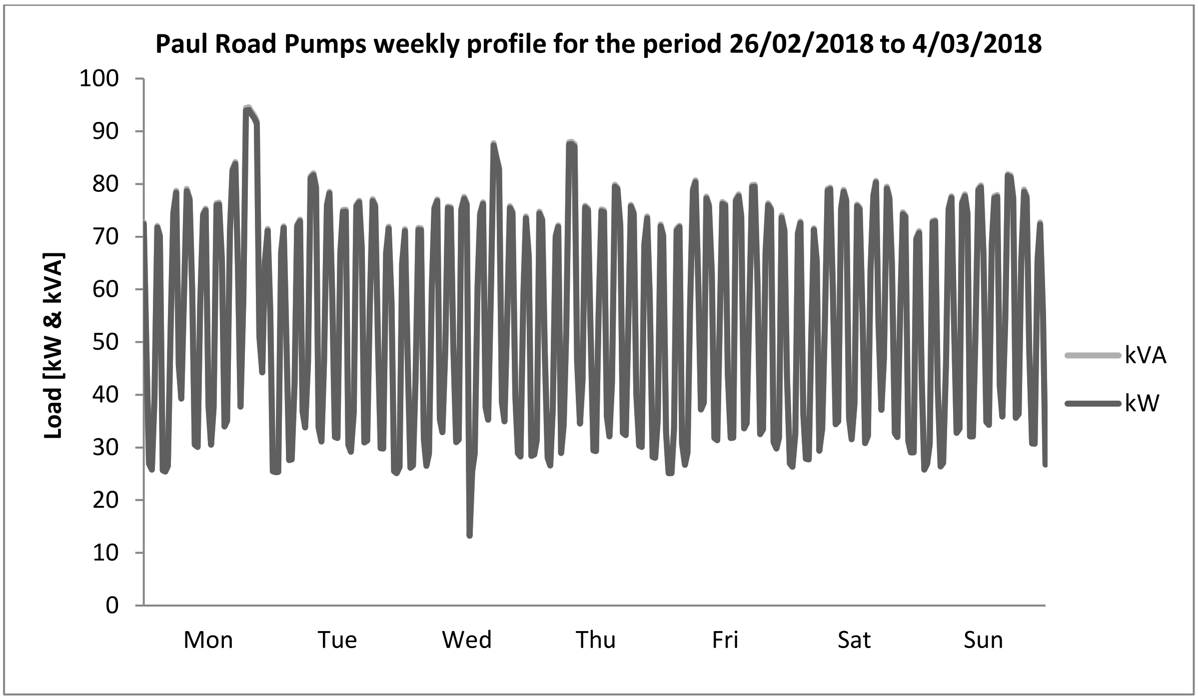


Figure 6-26 – Paul Road Pumps On-season weekly electricity usage profile

Below in Figure 6-27 is the off-season electricity profile for the week starting Monday the 14th of May 2018 (winter TOU data was not available at the time of the audit). The graph shows that the week's peak load of 39 kVA occurred on at 1130hours on Sunday morning, however there were numerous times of similar load throughout the week. The minimum load of 10.8 kVA occurred at 0130hours on Thursday morning. The pumps operate between a low load and high load condition; this is due to the bore pump switching on and off. The supply pumps run constantly and are VSD controlled.

The power factor during the sample week in the off-peak season is similar to that of the on-season power factor, averaging .999 for the week and ranging from 0.991 to 1.00.

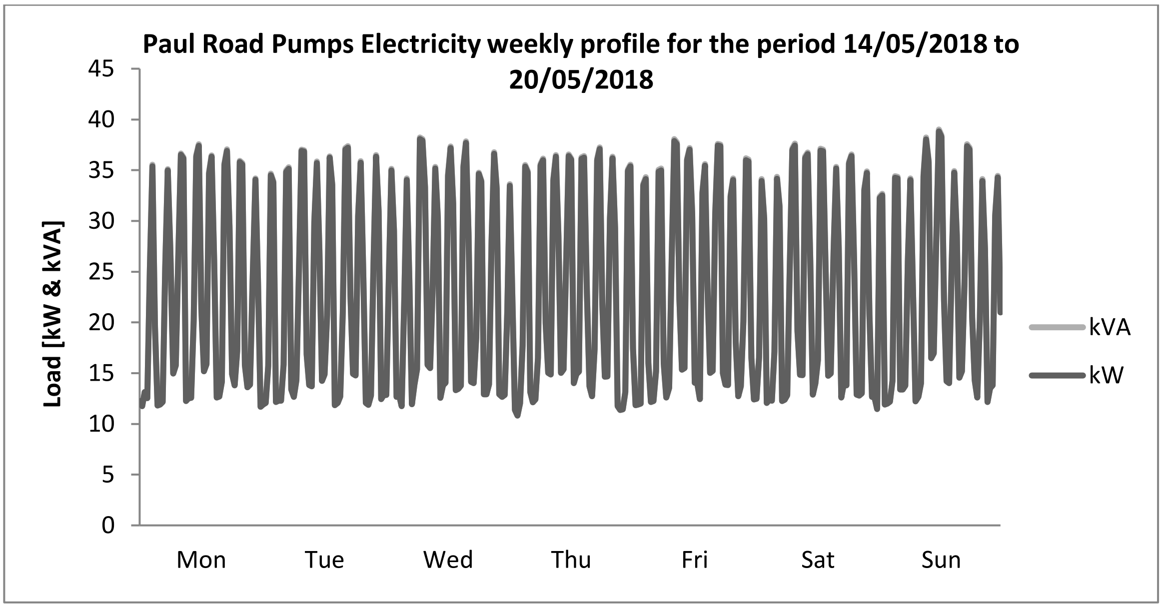


Figure 6-27 – Paul Road Pumps Off-season weekly electricity usage profile

6.2.4 Load Distribution

6.2.4.1 Civic Centre Load Profile

The frequency load distribution curve shown in Figure 6-28 illustrates the number of hours per year that a given load or greater occurs. For example the 'tail' on the left of the graph shows that loads of 100 kVA or more occurred in more than 2000 half hour periods between June 2017 and May 2018. The loads varied between 100 kVA and 200 kVA, with 1830 half hour periods drawing 100 - 150 kVA and 170 periods drawing 150 - 200 kVA loads. The large tail above a base load can likely be explained by high demands on cold winters mornings. WDC would benefit from some load control in the higher use periods.

Controlling peak loads helps to minimise electricity and network 'demand' charges. In addition to the direct savings on electricity and network 'demand' charges, being aware of the implications of high peak loads and implementing strategies to reduce these occurrences aids in improving the efficiency of electricity utilisation.

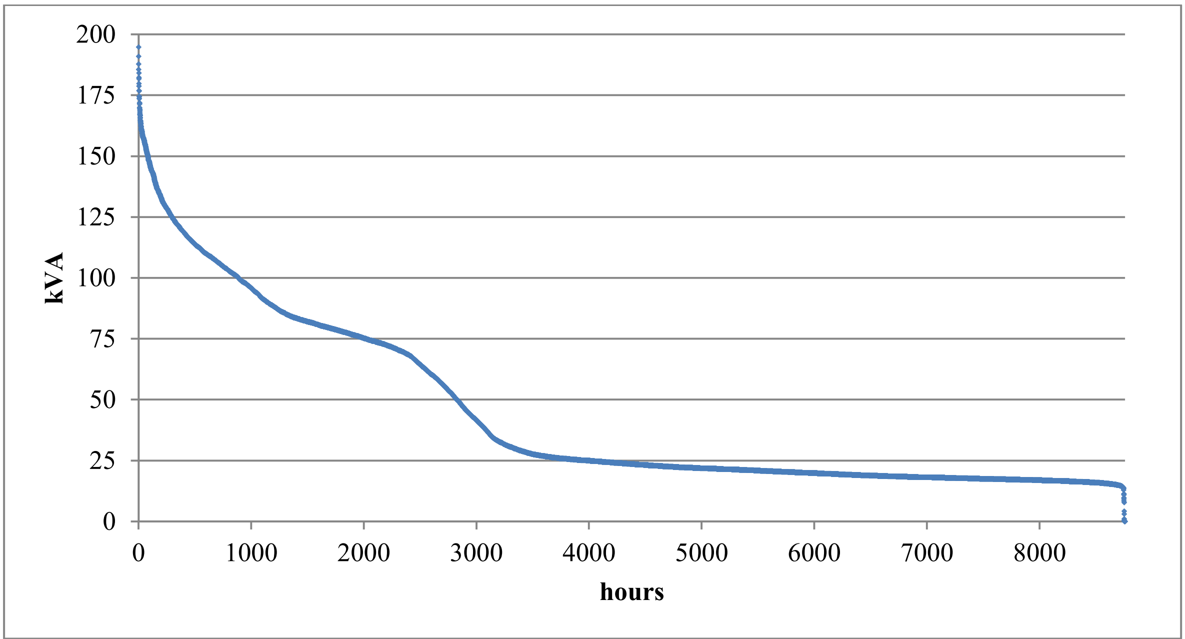


Figure 6-28 – Civic Centre annual electricity frequency distribution June 2017 to May 2018

6.2.4.2 Aquatic Centre Load

The frequency load distribution curve shown in Figure 6-29 illustrates the number of hours per year that a given load or greater occurs at the Aquatic Centre.

Loads at the Aquatic centre varied between 75 kVA and 225 kVA during normal operations. Unlike the Civic centre, there is not a clear bimodal distribution between operating hours and after hours use. This on its own indicates that there is equipment that could be shut off after hours to save on total electrical consumption.

Peak load periods between 220 kVA and 235 kVA occurred in only 13 half hour periods between June 2017 and May 2018. Better control of the peak 0.01% of loads will reduce peak demand by 26kW and reduce charges by $1,700 a year at the Aquatic centre throughout the year at little cost. This saving would be implemented as part of an energy management programme.

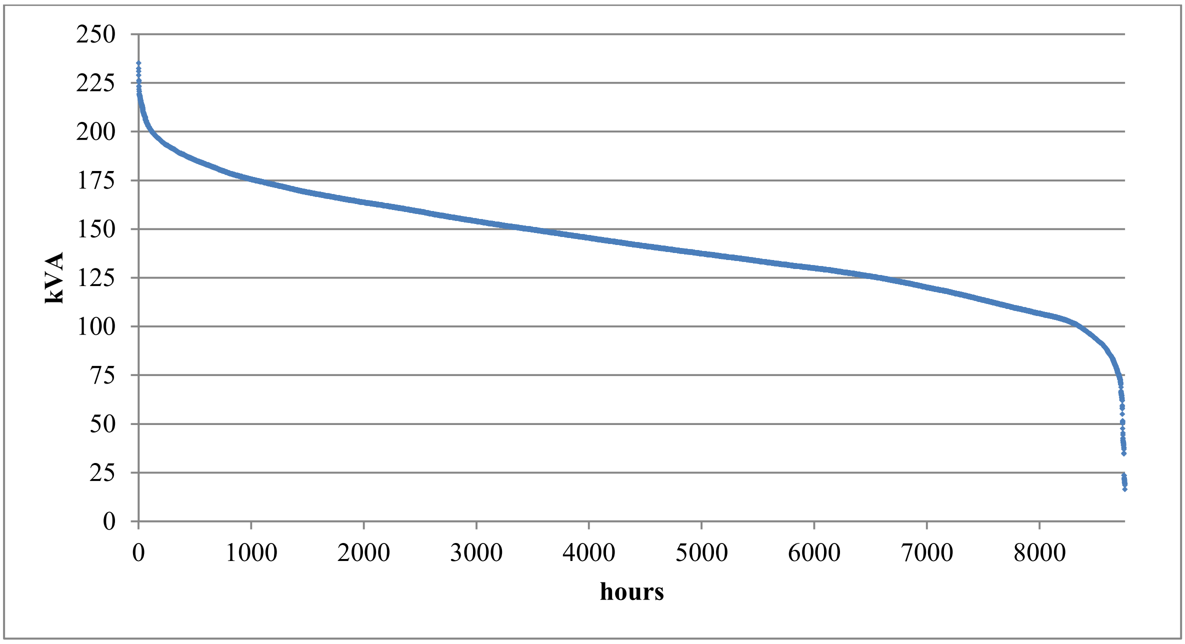


Figure 6-29 – Aquatic Centre annual electricity frequency distribution June 2017 to May 2018

6.2.4.3 Library Load Profile

The frequency load distribution curve shown in Figure 6-30 illustrates the number of hours per year that a given load or greater occurs at the Library.

Loads at the Library range from 20 kVA to 50 kVA during normal operating hours. There are 6 half hour periods through the year where load is greater than 40 kVA which is the large tail at the left of the graph indicating poor load control at the Library. The Library's transformer is 111kVA and under Horizon's lines fee structure the demand charge is at minimum 60% of transformer capacity which is 67kVA. Reducing half hour peak loads will therefore not result in a cost saving, unless the transformer is down-sized.

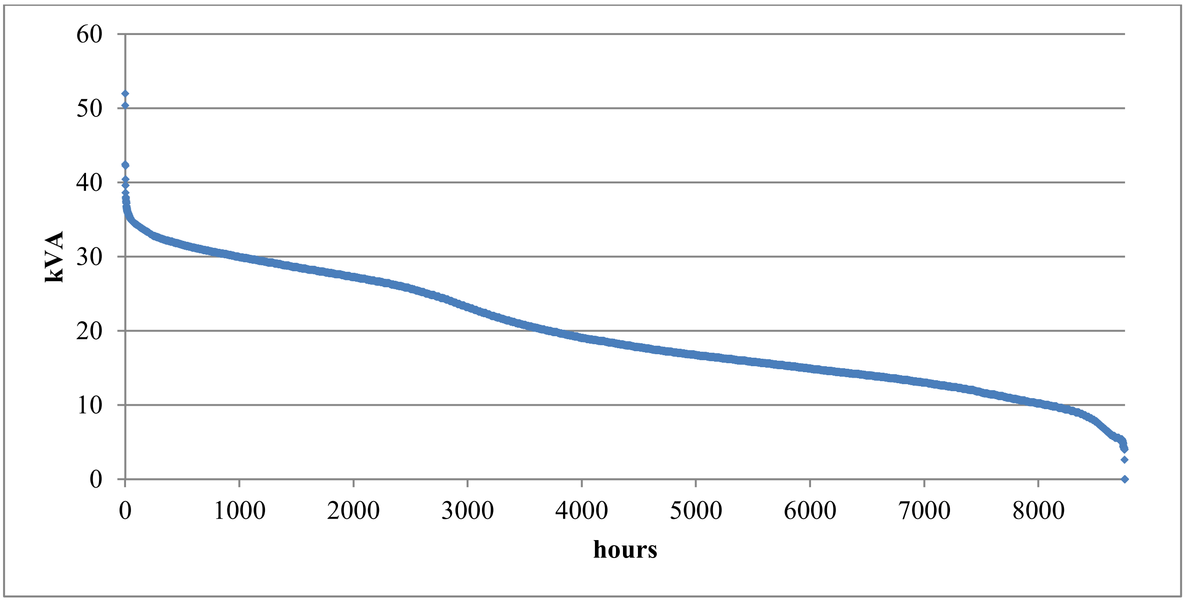


Figure 6-30 – Library annual electricity frequency distribution June 2017 to May 2018

6.3 Natural Gas

6.3.1 Monthly Consumption

Whakatāne District Council's natural gas consumption for the year ending May 2018 was 1,170,282 kWh. It has four gas accounts as shown in Table 6-2. The Aquatic Centre uses 85% of the Council's gas use while the three other accounts range between 0% and 10% of use.

Table 6-2 Natural gas use at WDC from Jun 2017 to May 2018

Location/Account	Consumption (kWh/year)
WHAKATANE LIBRARY GAS ACCOUNT, 49 KAKAHOROA DRIVE, WHAKATANE	116,291
GAS WAR MEMORIAL HALL WHK, SHORT STREET, WHAKATANE EAST, WHAKATANE	63,524
2/2 THE STRAND, WHAKATANE NORTH, WHAKATANE	79
AQUATIC CENTRE GAS, RUSSELL STREET, WHAKATANE EAST, WHAKATANE	990,388
Total	1,170,282

Figure 6-31 below shows average daily gas use at the Aquatic Centre for each month in the period from Jun 2017 to May 2018, as well as average 9am ambient temperature for the same months. Average daily gas data is used because time of use data is not available and the length of time between meter readings varied between 22 day and 43 days.

Natural gas is used primarily as heating for the outdoor pool at the Aquatic Centre, and as a back-up for heating indoor pools. September 2017 had the highest average daily natural gas consumption which corresponds to the first month of the season that the outdoor pool is used.

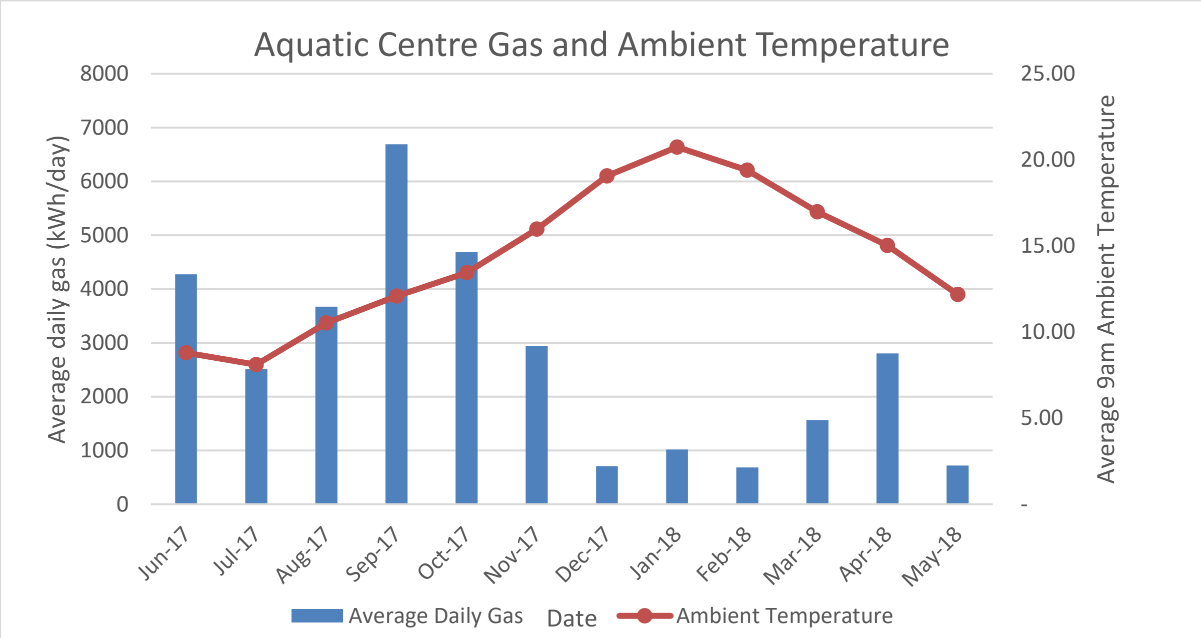


Figure 6-31 Aquatic Centre average daily gas use and average ambient temperature for Jun 2017 to May 2018

Figure 6-32 shows average daily gas use for the Library and ambient temperature for Jun 2017 to May 2018 on a monthly basis. Natural gas use is highest in the months from Jun to Sep which corresponds with the lowest ambient temperature months. This is to be expected since gas is used for space heating at the Library. Gas is not used for any other purpose at the Library.

Gas is used in each month throughout the year, including summer months. Library staff commented that the main Library area was too hot during summer months. There is therefore an opportunity to reduce or stop gas use over summer months, refer to Section 8.3.3.3.

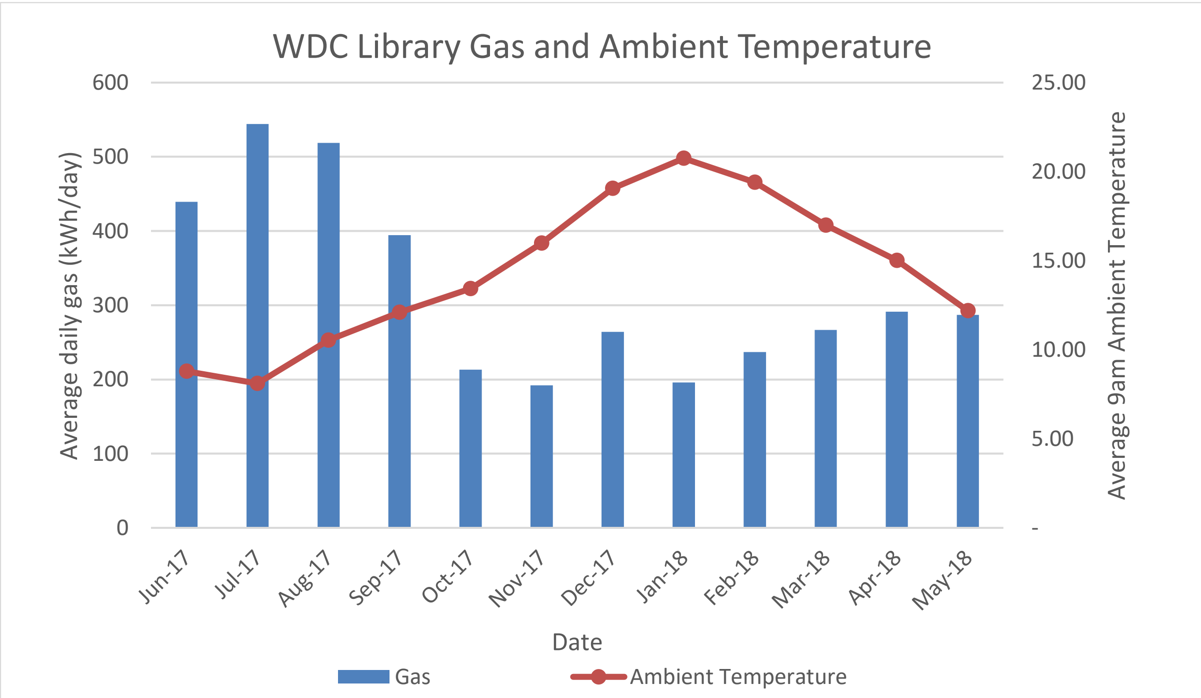


Figure 6-32 WDC Library average daily gas use and average ambient temperature for Jun 2017 to May 2018

Figure 6-33 below shows average daily gas use and average ambient temperature for the Whakatāne District Council's War Memorial Hall between Jun 2017 and May 2018. Gas use cost $8,467 a year and was highest in Jun-Aug and decreased significantly from Sep 2017 to May 2018. A gas boiler was used for heating the sports stadium in Jun-Aug 2017. Gas is also used for cooking during other months.

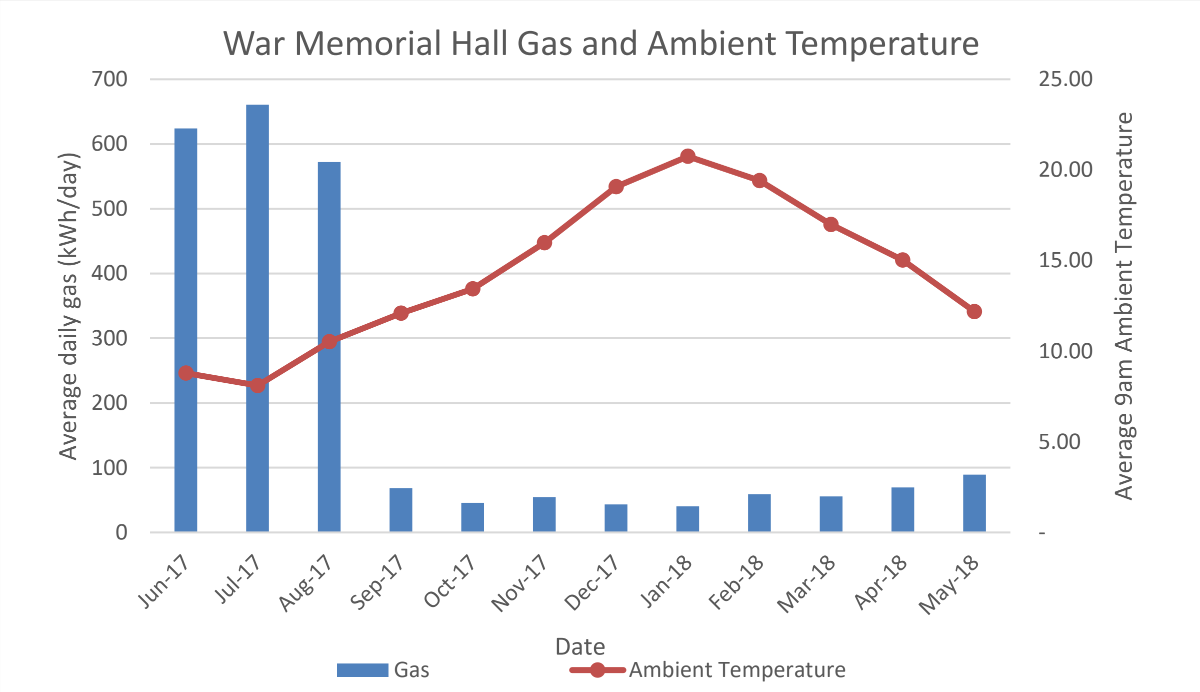


Figure 6-33 War Memorial Hall average daily gas use and average ambient temperature for Jun 2017 to May 2018

Figure 6-34 below shows monthly gas use for the Whakatāne District Council's account at 2/2 The Strand. This is a small gas account with just 79kWh used for the year and costing $446. Use is also sporadic, with seven months of the year having zero use. This account has a high gross cost for gas at $5.64/kWh, due to fixed monthly costs making up a high proportion of the invoiced amount. **Most of the $446 could be saved each year by using bottled LPG instead**, or using an alternative for gas-using appliances. This would be implemented as part of a formal energy management programme, refer to Section 9.

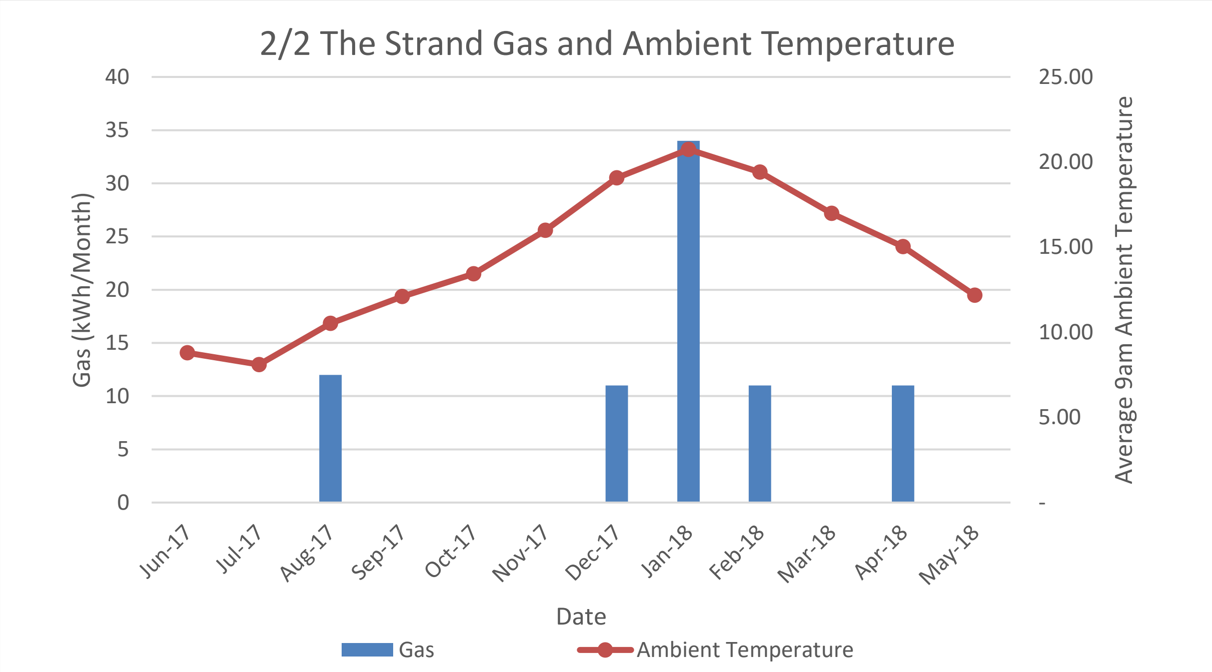


Figure 6-34 Monthly gas use at 2/2 The Strand from Jun 2017 to May 2018

6.4 Energy Use Index

The energy use index (EUI) is a measure of how energy efficient a building or site is relative to a particular metric. The EUI is calculated by dividing the energy use for a particular building or site by the chosen metric over a fixed period of time. When compared to results of other similar buildings or sites, the EUI provides an indication of how it is performing in terms of energy use for its particular metric. The metric used varies depending on the site and the nature of its activities. For Office buildings the metric used is usually net lettable area in m^2.

6.4.1 Civic Centre

The Civic Centre's EUI for the year ended May 2018 was 152kWh/m^2/year of Net lettable area. This EUI is electricity only as this is the only energy source used at the Civic Centre. Table 6-3 below compares the EUI at the Civic Centre with benchmarks for a range of New Zealand commercial buildings (NLA is Net Lettable Area, which is typically 70% of a building gross floor area).

Table 6-3 – Benchmark EUI data for various building types

Building Type	Energy Use Index - (kWh/m^2 of NLA)		
	Low	Typical	High
Banks (electricity only)	130	230	330
Hospitals	200	440	600
Hotels (large)	180	330	670
Libraries	120	162	200
Offices (with HVAC)	200	280	400
Office (naturally ventilated)	100	210	300
Office(Tenant Electricity only)	60	150	200
Polytechnics	90	160	200

The Civic Centre's EUI is less than average for a commercial building, owing partly to the limited active cooling done in the Civic Centre. When compared to EUI benchmarks for passively cooled buildings (naturally ventilated), the Civic Centre's EUI is within the expected range and towards the low end. This suggests that, despite having an antiquated control system for its heating, the Civic Centre's energy efficiency is acceptable. The EUI does not consider whether or not the temperatures achieved in the building are acceptable.

It is important that energy use is monitored regularly and targets set, to determine both why energy use has changed over time and to ensure consistency whilst collecting data. Note that while the data shown above provides useful indicators of performance, a properly designed and implemented monitoring and targeting solution can result in improved energy efficiency performance over time.

6.4.1.1 Electricity EUI Analysis

Shown below in Figure 6-35 is a comparison of monthly electricity energy use and heating degree days (HDD) for the Civic Centre. Heating degree days are a measure of the demand for heating on a building and are relative to a reference temperature. In this case 16°C has been used; this means a day where the average temperature was 15°C had one heating degree day of heating demand.

The plotted data points show the raw data, while the linear trend line represents a 'line of best fit', showing the trend of the data. The equation of the trend line; y=58.492x + 26,750 informs the reader that:

- The Civic Centre's variable component of electricity use is 58.5 kWh/HDD
- The electricity base load at the site is 26,750kWh/month

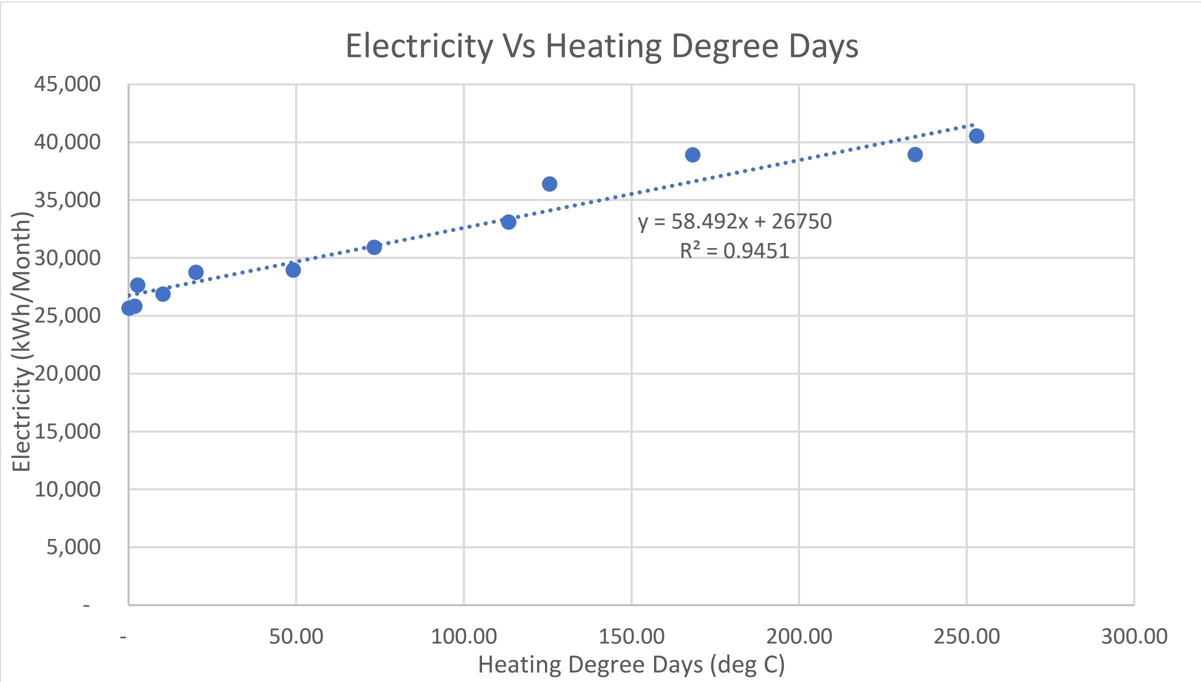


Figure 6-35 – Monthly electricity use versus heating degree days for the Civic Centre, year to May 2018

The trend line has an R^2 correlation of 0.9451, this means that 94.51% of the variation in the electricity use at the Civic Centre can be attributed to changes in heating degree days. The high correlation indicates that heating degree days is the main driver for fluctuations in electricity use, and that the Civic Centre has good process control in terms of utilisation of electricity energy for heating.

The base load is illustrated by the point where the line of best fit intercepts the vertical axis of the graph. Base load refers to the monthly energy usage that is not attributable to the level of heating required, and therefore represents the current minimum level of energy consumption. Electricity use not associated with heating the building contributes to this baseload; eg computers, lighting, appliances etc.

6.4.2 Aquatic Centre

The Aquatic Centre's EUI for the year ended May 2018 was 14.3GJ/m^2/year; here the m^2 refers to square meters of pool area. The Aquatic Centre has two main pools, one outdoor and one indoor, and these are 400m^2 and 300m^2 respectively. This EUI includes both electricity and gas as both are used at the Aquatic Centre. Table 6-3 below compares the EUI at the Aquatic Centre with a benchmark from EECA's energy efficiency guide for swimming pools.

Table 6-4 –EUI data for the Aquatic Centre compared to benchmarks

Site	**EUI** [kWh/m^2/year]	**EUI** [GJ/m^2/year]
Whakatāne District Council Aquatic Centre	3,976	14.3
Benchmark for indoor pools and facilities in New Zealand	2,550	9.2

This shows that the Aquatic Centre EUI is poorer than the New Zealand benchmark for indoor pools. The Aquatic Centre does have an outdoor pool which differs from the benchmark, however during months when the outdoor pool was not in use the EUI ranged from 17.5 to 31.1GJ/m^2/year (using indoor pool area only), which was poorer still and of concern given it is using heat pump technology with heat recovery. The annual EUI uses the average pool surface area in use throughout the year to account for the outdoor pool being in use some months only.

Figure 6-36 below shows energy use indices for indoor pools with different heating technologies. This shows heat pump systems use between 3GJ/m^2/year and 8GJ/m^2/year, whereas gas boiler systems use between 10GJ/m^2/year and 15GJ/m^2/year. The Aquatic Centre uses a mixture of heat pumps and gas boilers for water heating.

Opportunities for energy savings at the Aquatic Centre are in Section 8.2. It was also noted earlier in Section 6.2.2.2 that the Aquatic Centre has high after-hours energy use that could be addressed as part of a wider energy management programme.

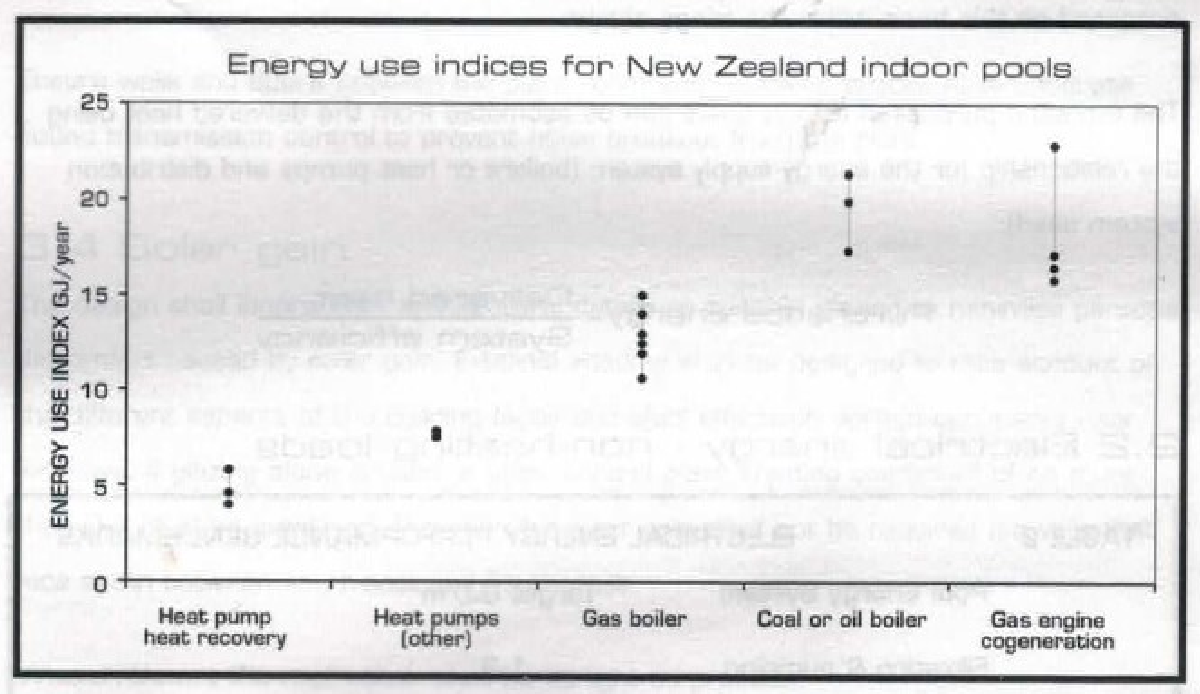


Figure 6-36 - Benchmark energy use for indoor swimming pools

6.4.2.1 *Electricity EUI Analysis*

Shown below in Figure 6-37 is a comparison of total monthly electricity use and heating degree days (HDD) for the Aquatic Centre. Heating degree days are a measure of the demand for heating on a facility and are relative to a reference temperature, in this case 16°C has been used.

The plotted data points show the raw data, while the linear trend line represents a 'line of best fit'; showing the trend of the data. This has been split into two parts as the energy pattern is different depending if the outdoor pool is in use or not. The outdoor pool is not used from May to August.

The equation of the blue trend line for when the outdoor pool is in use; y=83.758x + 111,146 informs the reader that:

- The Aquatic Centre's variable component of energy use is 83.8kWh/HDD
- The energy base load at the site is 111,146kWh/month

The equation of the orange trend line for when the outdoor pool is not in use; y=-78.6x + 105,263 informs the reader that:

- The Aquatic Centre's variable component of energy use is -78.6kWh/HDD. The negative value is caused by the left-most point which is slightly higher than the other three. This is the point for May 2018, when the outdoor pool was in use for part of the month. Based on the other three points the variable load is effectively zero, which means heating degree days has no influence on electricity use when the outdoor pool is not in use.
- The trend line suggests the energy base load at the site is 105,263kWh/month. Note, however, that three of the points have a similar value of approximately 85,000kWh, and the fourth point is from May 2018 which is slightly higher because of some days with the outdoor pool in use still. 85,000kWh/month appears to be the true baseload when the outdoor pool is not in use.

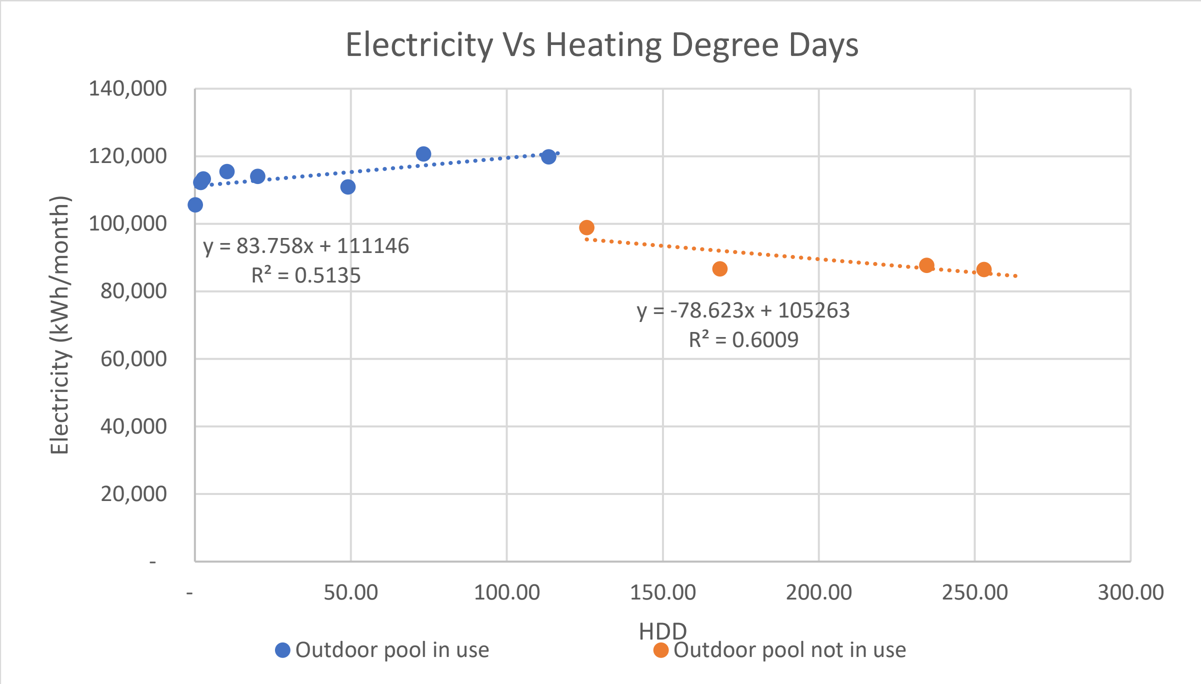


Figure 6-37 – Monthly total electricity use versus heating degree days for the Aquatic Centre, year to May 2018

The trend line when the outdoor pool is in use has an R2 correlation of 0.5135, this means that 51.35% of the variation in the energy use at the Aquatic Centre can be attributed to changes in heating degree days. The correlation is low, even though visually the trend line fits the data well. This is because of the high baseload and relatively small variable load, resulting in a flat trend line relative to heating degree days. This means the demand for heating has only a small influence on electricity used, which indicates potentially poor process control, but also reflects the fact that gas is used for heating at the aquatic centre as well.

The base load is illustrated by the point where the line of best fit intercepts the vertical axis of the graph. Base load refers to the monthly electricity usage that is not attributable changes in heating degree days, and therefore represents the current minimum level of energy consumption. When the outdoor pool is in use the electricity baseload is 111,146kWh/month, which accounts for 98% of total electricity during these months. This reiterates that electricity use does not vary much with the requirement for heating.

6.4.2.2 Thermal Energy EUI Analysis

Shown below in Figure 6-37 is a comparison of total monthly gas use and heating degree days (HDD) for the Aquatic Centre. Heating degree days are a measure of the demand for heating on a facility and are relative to a reference temperature, in this case 16°C has been used.

The plotted data points show the raw data, while the linear trend line represents a 'line of best fit'; showing the trend of the data. This has been split into two parts as the energy pattern is different depending if the outdoor pool is in use or not.

The equation of the blue trend line for when the outdoor pool is in use; y=1525x + 28,257 informs the reader that:

- The Aquatic Centre's variable component of gas use is 1525kWh/HDD
- The energy base load at the site is 28,257kWh/month

The equation of the orange trend line for when the outdoor pool is not in use; y=439.89x informs the reader that:

- The Aquatic Centre's variable component of gas use is 439.9kWh/HDD.
- There is no gas baseload when the outdoor pool is not in use.

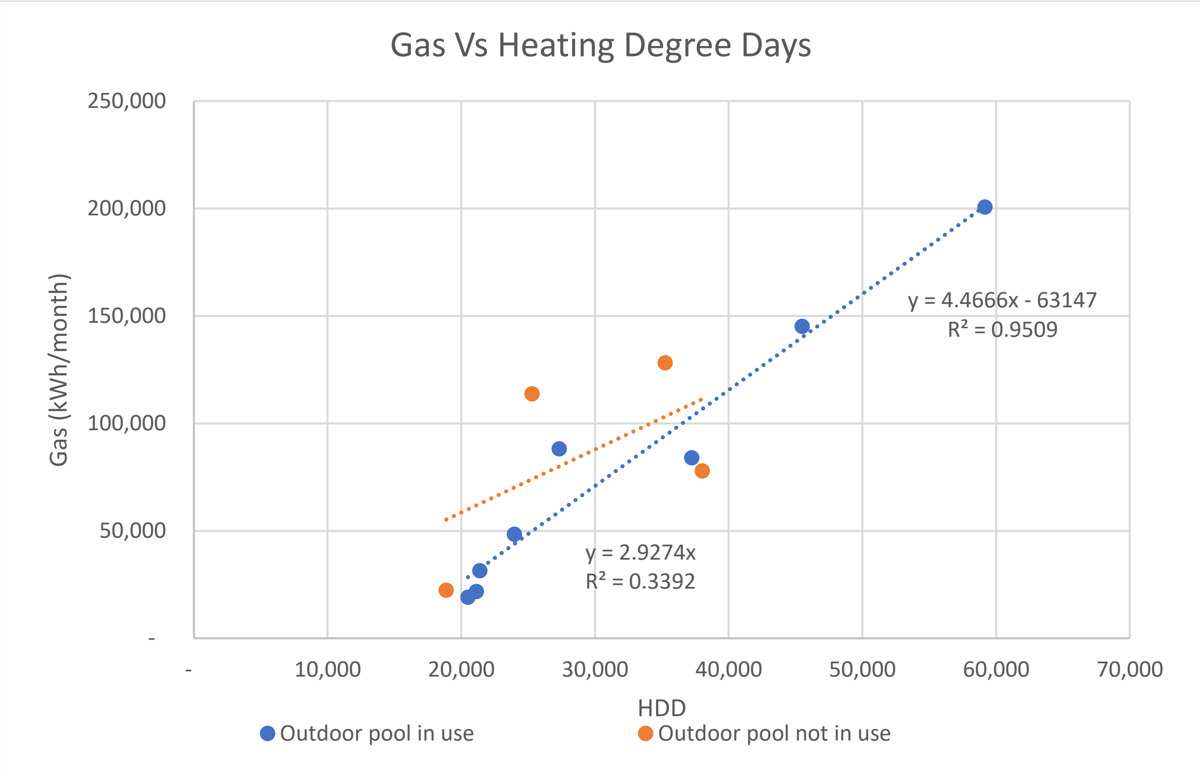


Figure 6-38 - Monthly total gas use versus heating degree days for the Aquatic Centre, year to May 2018

The blue trend line for when the outdoor pool is in use has an R^2 correlation of 0.9509, this means that 95.09% of the variation in the gas use at the Aquatic Centre can be attributed to changes in heating degree days. The high correlation indicates that ambient temperature is the main driver for fluctuations in gas use, and that the Aquatic Centre has well controlled processes for using gas.

The base load is illustrated by the point where the line of best fit intercepts the vertical axis of the graph. Base load refers to the monthly energy usage that is not attributable to the level of production, and therefore represents the current minimum level of energy consumption.

During months of no outdoor pool use gas use can be more than when the outdoor pool is used. This implies a large opportunity for gas savings when the outdoor pool is not used. This should be investigated as part of a wider energy management programme.

6.4.3 Library

The Whakatāne District Council Library's EUI for the year ended May 2018 was 230kWh/m^2/year using Net lettable area. This EUI is for electricity and gas, as both are used at the Library. Table 6-3 below compares the EUI at the Library with benchmarks for similar buildings.

Table 6-5 –Commercial building EUI benchmark data

Building Type	Energy Use Index - (kWh/m^2 of NLA)		
	Low	Typical	High
Banks (electricity only)	130	230	330
Hospitals	200	440	600
Hotels (large)	180	330	670
Libraries	120	162	200
Offices (with HVAC)	200	280	400
Office (naturally ventilated)	100	210	300
Office(Tenant Electricity only)	60	150	200
Polytechnics	90	160	200

The Library's EUI (230 kWh/m^2/year) is considerably higher than the Civic Centre's EUI (152 kWh/m^2/year). When compared to EUI benchmarks for libraries, the Whakatāne District Council Library is high. The Library has an exhibition area that is controlled to a temperature setpoint with both active cooling and active heating. The remainder of the Library is passively cooled.

It is important that energy use is monitored regularly and targets set, to determine both why energy use changes over time and to ensure consistency whilst collecting data. Note that while the data shown above provides useful indicators of performance; a properly designed and implemented monitoring and targeting solution can result in improved energy efficiency performance over time. Refer to Sections 6.4.3.1 and 6.4.3.2 for models that could be used to monitor ongoing energy use.

6.4.3.1 Electricity EUI Analysis

Shown below in Figure 6-35 is a comparison of monthly electricity energy use and heating degree days (HDD) for the Library. Heating degree days are a measure of the demand for heating on a building and a relative to a reference temperature; in this case 16°C has been used.

The plotted data points show the raw data, while the linear trend line represents a 'line of best fit'; showing the trend of the data. The equation of the trend line; y=6.644x + 14,769 informs the reader that:

- The Library's variable component of electricity use is 6.6 kWh/HDD
- The electricity base load at the site is 14,769kWh/month

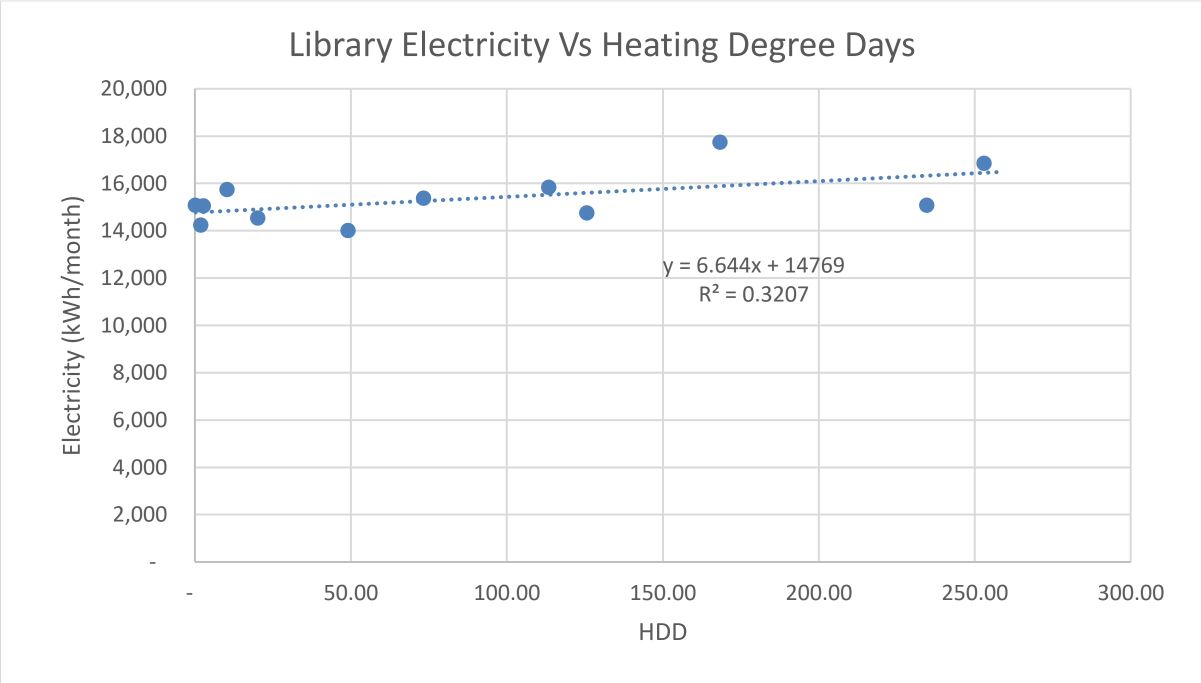


Figure 6-39 – Monthly electricity use versus heating degree days for the Library, year to May 2018

The trend line has an R^2 correlation of 0.3207, this means that 32.07% of the variation in the electricity use at the Library can be attributed to changes in heating degree days. This correlation is low and indicates that heating requirements account for a relatively small amount of electricity used by the Library. This is because the Library primarily uses gas for its space heating.

The base load is illustrated by the point where the line of best fit intercepts the vertical axis of the graph. Base load refers to the monthly energy usage that is not attributable to the level of heating required, and therefore represents the current minimum level of energy consumption. Electricity use not associated with heating the building contributes to this baseload; eg computers, lighting, and appliances.

6.4.3.2 Thermal Energy EUI Analysis

Shown below in Figure 6-40 is a comparison of gas energy use and heating degree days for Whakatane District Council's Library. The plotted data points show the raw data, while the linear trend line represents a 'line of best fit'; showing the trend of the data. The equation of the trend line; y=036.958x + 6521.5 informs the reader that:

- The Library's variable component of gas energy use is 36.958 kWh/HDD
- The gas base load at the site is 6,522kWh/month

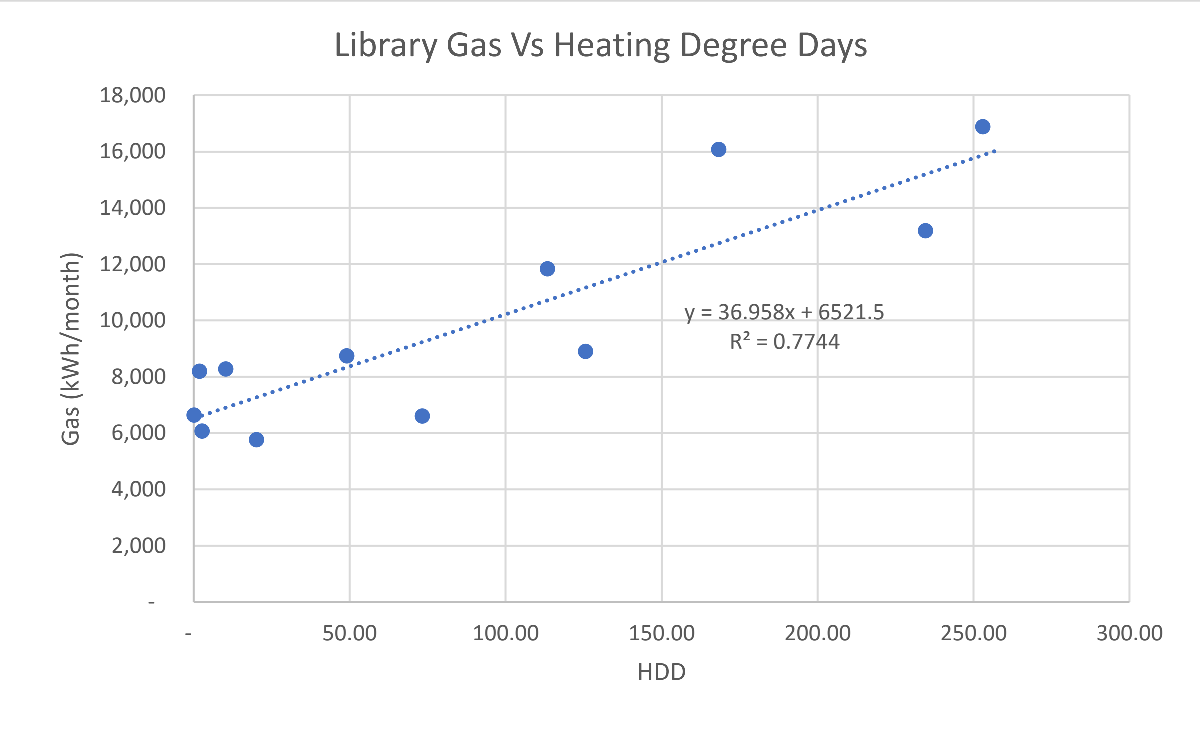


Figure 6-40 - Monthly electricity use versus heating degree days for the Library, year to May 2018

The trend line has a R2 correlation of 0.7744, this means that 77% of the variation in the gas energy use at the Library can be attributed to changes in heating requirements. The correlation is reasonable and indicates that most of the change in gas energy used from month to month can be explained by changes in heating degree days. The trend appears visually to be somewhat bi-modal, with a higher and lower trendline for different modes of operation. There is an opportunity to reduce gas use by monitoring regularly as part of an energy management programme to understand better the reason for the difference when it occurs. The energy audit has identified this is likely due to poor control heating or unreliable gas use data.

The base load is illustrated by the point where the line of best fit intercepts the vertical axis of the graph. Base load refers to the monthly energy usage that is not attributable to heating degree days, and therefore represents the current minimum level of energy consumption.

6.4.4 Whakatāne Water Treatment Plant

6.4.4.1 Electricity EUI Analysis

Shown below in Figure 6-41 is a comparison of daily electricity energy use and water volume for the Whakatāne Water Treatment Plant. Only two months of data were available for this report; June 2017 (winter) and January 2018 (summer). **It is recommended daily volume of water supplied to town is recorded in an easily accessible format for future monitoring.** The plotted data points show the raw data, while the linear trend line represents a 'line of best fit'; showing the trend of the data.

The equation of the trend line; y=0.6337x informs the reader that:

- The Whakatāne Water Treatment Plant's variable component of electricity use is 0.6337 kWh/m^3
- There is no electricity baseload. Note, initially the regression analysis gave a negative intercept value which is not a sensible result and it was therefore set to zero. Outliers in the data may have caused this. A small baseload is expected, however this is likely to be negligible compared to the electricity that varies with water flow, due to the pumps.

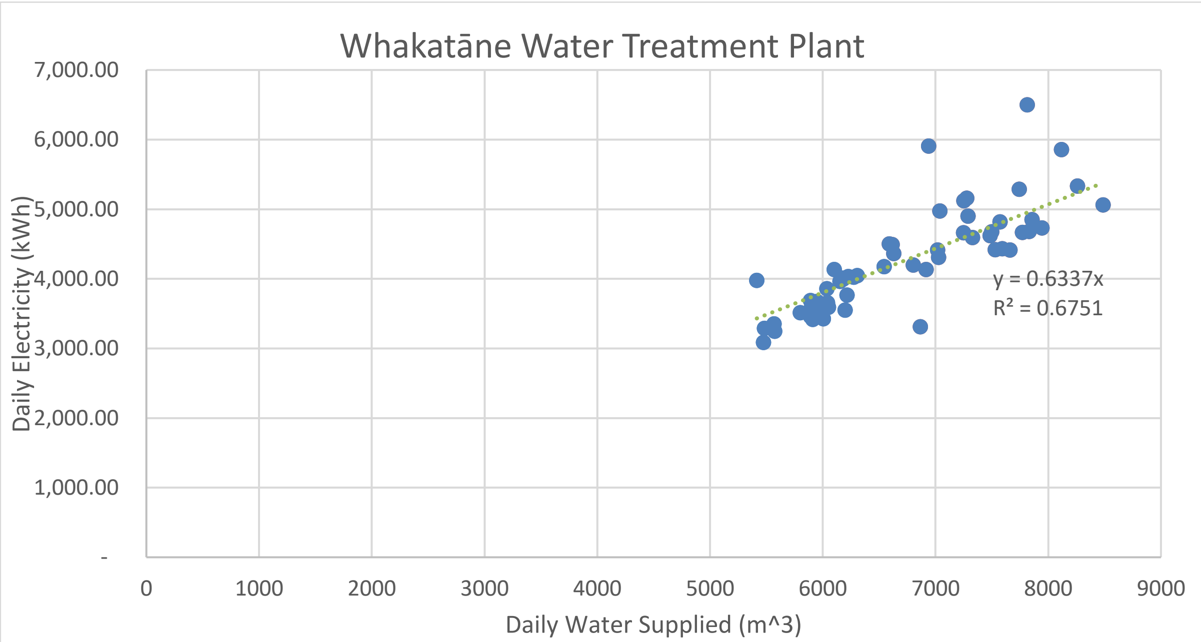


Figure 6-41 – Daily electricity use versus water volume for June 2017 to May 2018 at the Whakatāne Water Treatment Plant

The trend line has an R^2 correlation of 0.6751, this means that 67.15% of the variation in the electricity used by the Whakatāne Water Treatment Plant is due to changes in the volume of water pumped. This correlation is reasonably strong and would likely be strengthened further if a full year of data is used for the analysis. There are some outliers in the data; from January 28th-30th 2018 there appeared to be some sort of fault at the plant that caused higher energy use and inflows to the plant without an increase in water supplied to town.

6.4.5 Paul Rd Pumps

6.4.5.1 Electricity EUI Analysis

Shown below in Figure 6-42 is a comparison of daily electricity energy use and water volume for the Paul Rd pump station. The plotted data points show the raw data, while the linear trend line represents a 'line of best fit'; showing the trend of the data.

The equation of the trend line; y=1.2032x + 137.9 informs the reader that:

- The Paul Rd pump station's variable component of electricity use is 1.2032 kWh/m^3
- The electricity base load at the site is 137.9kWh/day

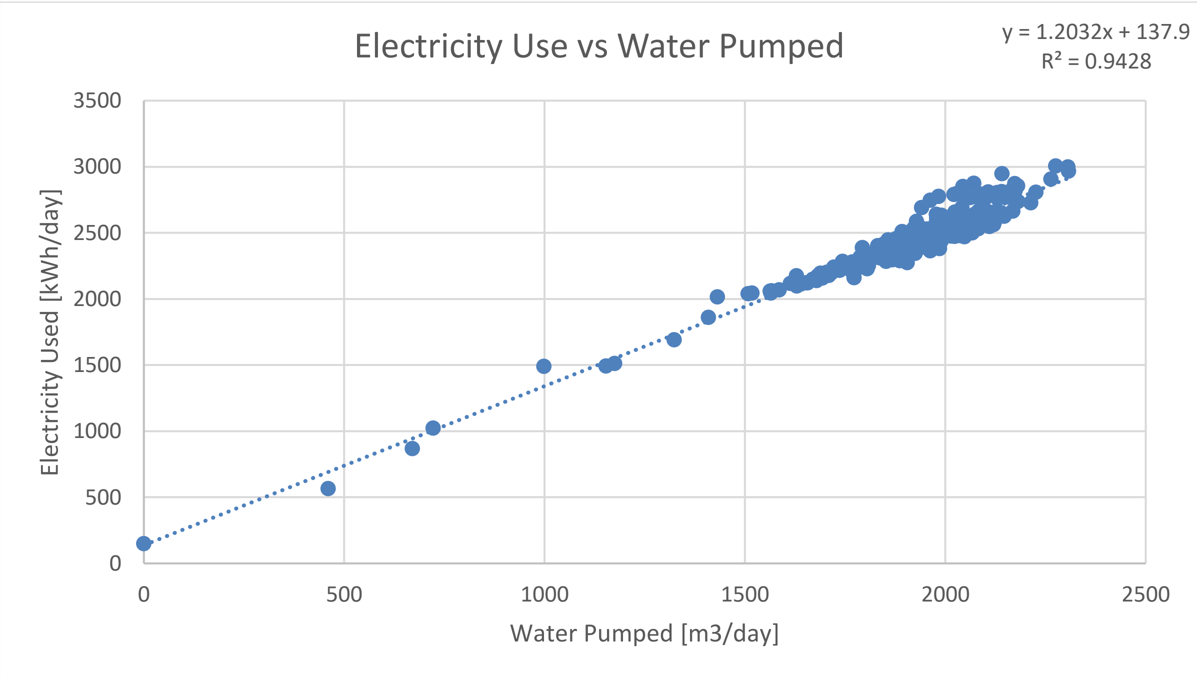


Figure 6-42 – Daily electricity use versus water volume for September 2017 to May 2018

The trend line has an R^2 correlation of 0.9428, this means that 94.28% of the variation in the electricity used by the Paul Rd pump station is due to changes in the volume of water pumped. This correlation is strong and means that almost all of the daily changes in energy use are due to changes in water volumes pumped.

The base load is illustrated by the point where the line of best fit intercepts the vertical axis of the graph. Base load refers to the daily energy usage that is not attributable to the volume of water pumped, and therefore represents the current minimum level of energy consumption. This is made up of loads such as lighting, VSD losses, control and metering equipment etc.

6.4.6 Braemer Rd Pumps

6.4.6.1 Electricity EUI Analysis

Shown below in Figure 6-43 is a comparison of daily electricity energy use and water volume for the Braemer Rd pump station. The plotted data points show the raw data, while the linear trend line represents a 'line of best fit'; showing the trend of the data.

The equation of the trend line; y=0.3733x + 66.126 informs the reader that:

- The Braemer Rd pump station's variable component of electricity use is 0.3733 kWh/m^3
- The electricity base load at the site is 66.126kWh/day

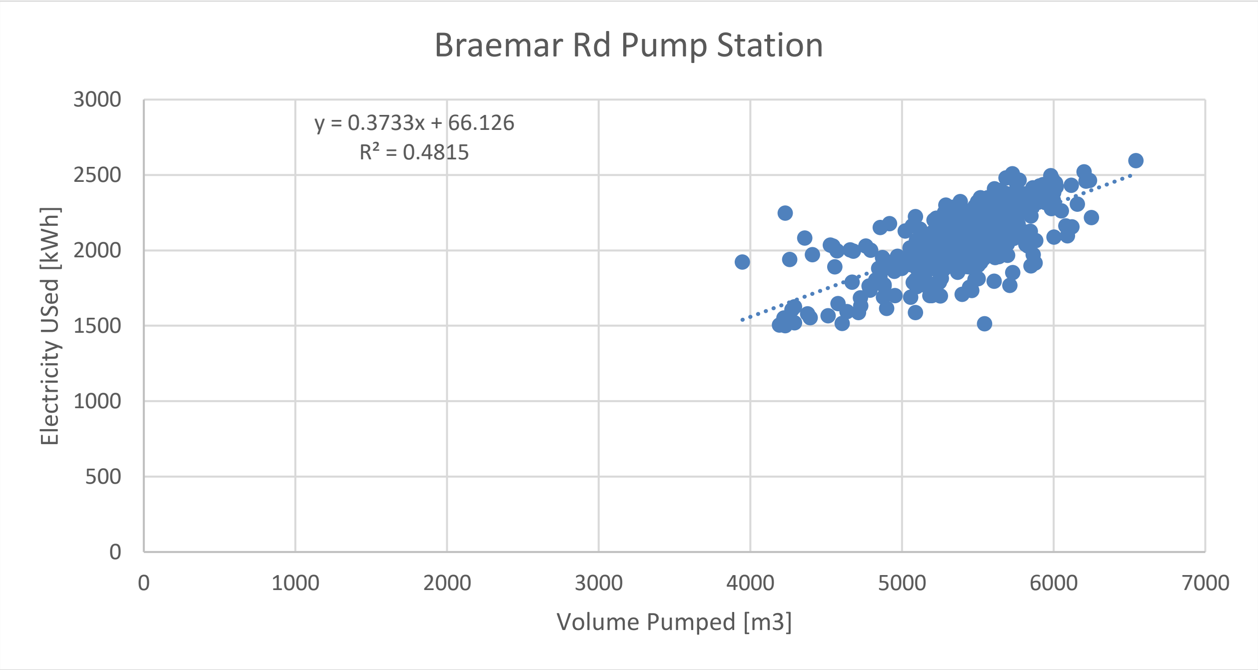


Figure 6-43 – Daily electricity use versus water volume for June 2017 to May 2018

The trend line has an R^2 correlation of 0.4815, this means that 48.15% of the variation in the electricity used by the Braemar Rd pump station is due to changes in the volume of water pumped. This correlation is relatively weak, partly because the volume of water pumped does not change significantly from day to day, but there is also some scatter in the data indicating poor process control or other factors affecting pumping energy such as where the water is pumped to eg different reservoirs at different heights.

The base load is illustrated by the point where the line of best fit intercepts the vertical axis of the graph. Base load refers to the daily energy usage that is not attributable to the volume of water pumped, and therefore represents the current minimum level of energy consumption. This is made up of loads such as lighting, control and metering equipment etc.

6.4.7 Pump Station Comparisons

The patterns of energy use for the three largest pump stations established in Sections 6.4.4 to 6.4.6 can be used to compare the relative efficiencies of each plant. This is useful to understand if a plant is operating particularly poorly or efficiently and what reasons might be behind the performance.

Table 6-6 - Relative efficiencies of three largest pumping stations

Site	EUI (kWh/m^3)
Whakatāne Water Treatment Plant	0.6337kWh/m^3
Paul Rd Pump Station	1.203kWh/m^3
Braemar Rd Pump Station	0.3733kWh/m^3

Table 6-6 Shows that the newest pump station at Paul Rd has the highest energy use per cubic metre of water supplied. The supply pump system at Paul Rd is an efficient arrangement with VSD control and modern pumps. It is the only site of the three that uses a bore pump. It is also the only supply of the three that does not use reservoirs, which should make it more efficient. Its supply pressure should be investigated compared to any pressure reducing valves.

The Whakatāne Water Treatment Plant has the second highest EUI, using 0.6337kWh/m^3 of water supplied. This plant does not have a bore but does have low lift pumps that take water from the river through the treatment plant. High lift pumps then supply water to reservoirs in the hills above the plant.

Braemar Rd has the lowest EUI despite having relatively aged pumps and motors. There are two supply pumps only and no bore or low lift pumps. These also supply direct to reservoirs.

7 Carbon Emissions Baselines

In Section 6, relationships between energy use and key independent variables such as heating degree days or water supplied were established. Building on these relationships, this section considers the carbon emissions attributed to energy use at the Whakatane District Council's six largest users. Using data from Jun 2017 to May 2018 as a baseline, statistical models have been developed using regression techniques based on IPMVP (International Performance, Measurement and Verification Protocol) to predict monthly carbon emissions for these six facilities based on input variables.

These models allow ongoing carbon monitoring and will enable measurement of carbon reductions related to energy saving measures. These models will also reflect favourably on transitions to lower carbon technologies, even where energy savings are not achieved.

7.1 Civic Centre

The Civic Centre's monthly expected carbon emissions attributable to its electricity consumption can be modelled using the following equation:

Expected Monthly CO_2 (kg) = 7.5279*HDD + 3,443

Here, Heating Degree Days (HDD) are used as the independent variable. Figure 7-1 below shows the expected monthly CO_2 emissions, as predicted by the baseline model, compared to the actual monthly CO_2 emissions for May 2017 to June 2018. The model tracks well the actual carbon emissions and will be useful moving forward for measuring changes in energy related carbon emissions.

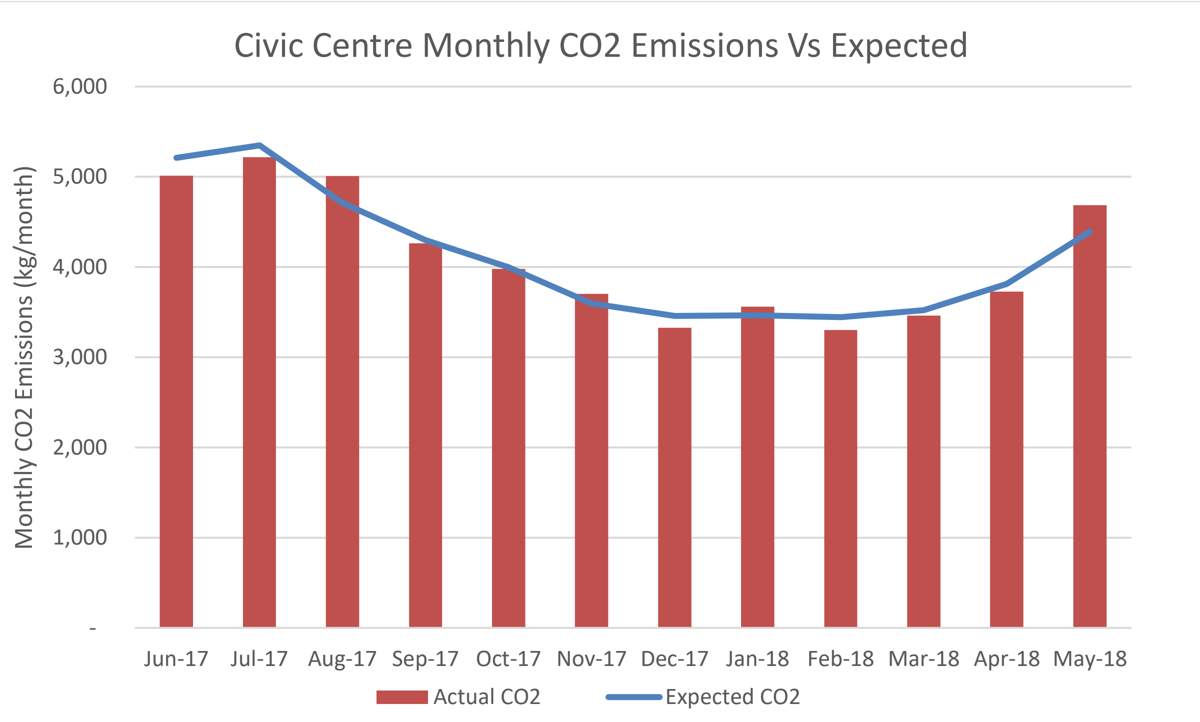


Figure 7-1 - Expected versus actual carbon emissions for the Civic Centre Jun 2017 to May 2018

7.2 Aquatic Centre

The Aquatic Centre's monthly expected carbon emissions attributable to its electricity and natural gas consumption can be modelled using the following equation:

Expected Monthly CO_2 (kg) = 341.41*HDD + 20,464 (When outdoor pool is in use)

Expected Monthly CO_2 (kg) = 150.27*HDD (When outdoor pool is not in use)

Heating Degree Days (HDD) are used as the independent variable. Figure 7-2 below shows the expected monthly CO_2 emissions, as predicted by the baseline model, compared to the actual monthly CO_2 emissions for May 2017 to June 2018. The model tracks well the actual carbon emissions and will be useful moving forward for measuring changes in energy related carbon emissions.

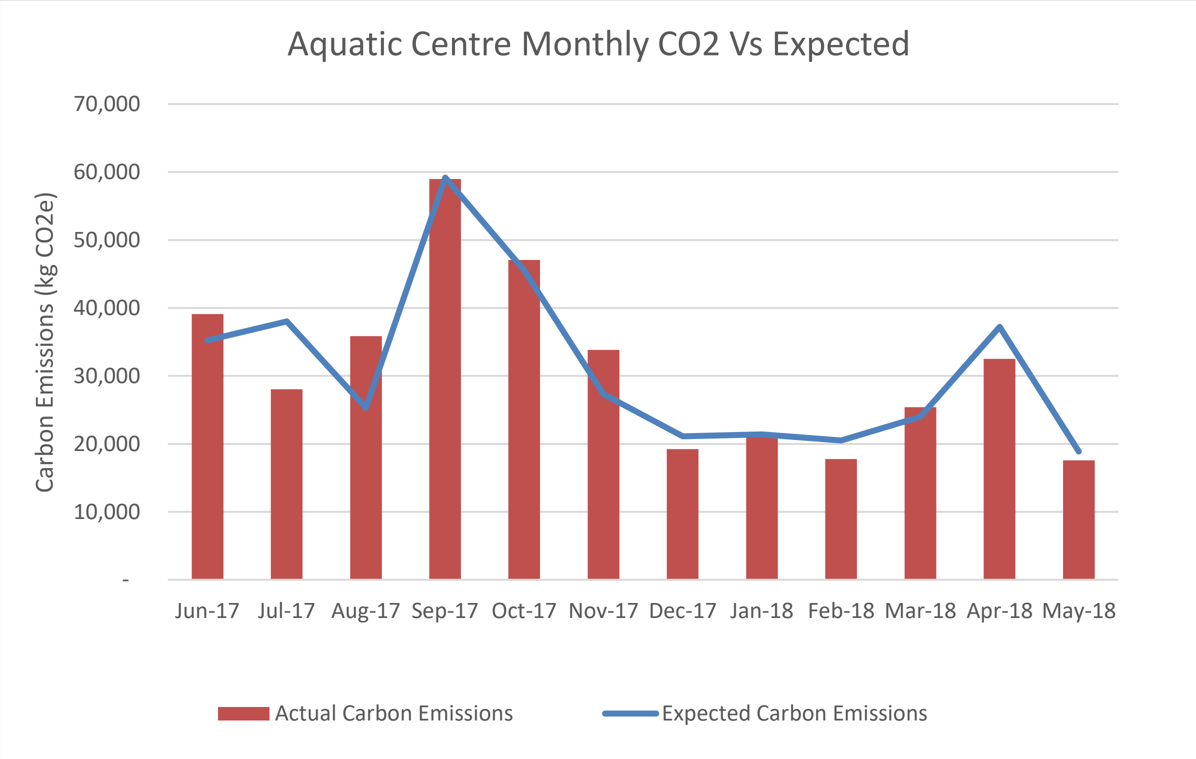


Figure 7-2 - Aquatic Centre monthly carbon emissions versus expected Jun 2017 to May 2018

7.3 Te Kōputu Library

The Library's monthly expected carbon emissions attributable to its electricity and natural gas consumption can be modelled using the following equation:

Expected Monthly CO_2 (kg) = 8.8695*HDD + 3,319

Heating Degree Days (HDD) are used as the independent variable. Figure 7-3 below shows the expected monthly CO_2 emissions, as predicted by the baseline model, compared to the actual monthly CO_2 emissions for May 2017 to June 2018. The model tracks well the actual carbon emissions and will be useful moving forward for measuring changes in energy related carbon emissions.

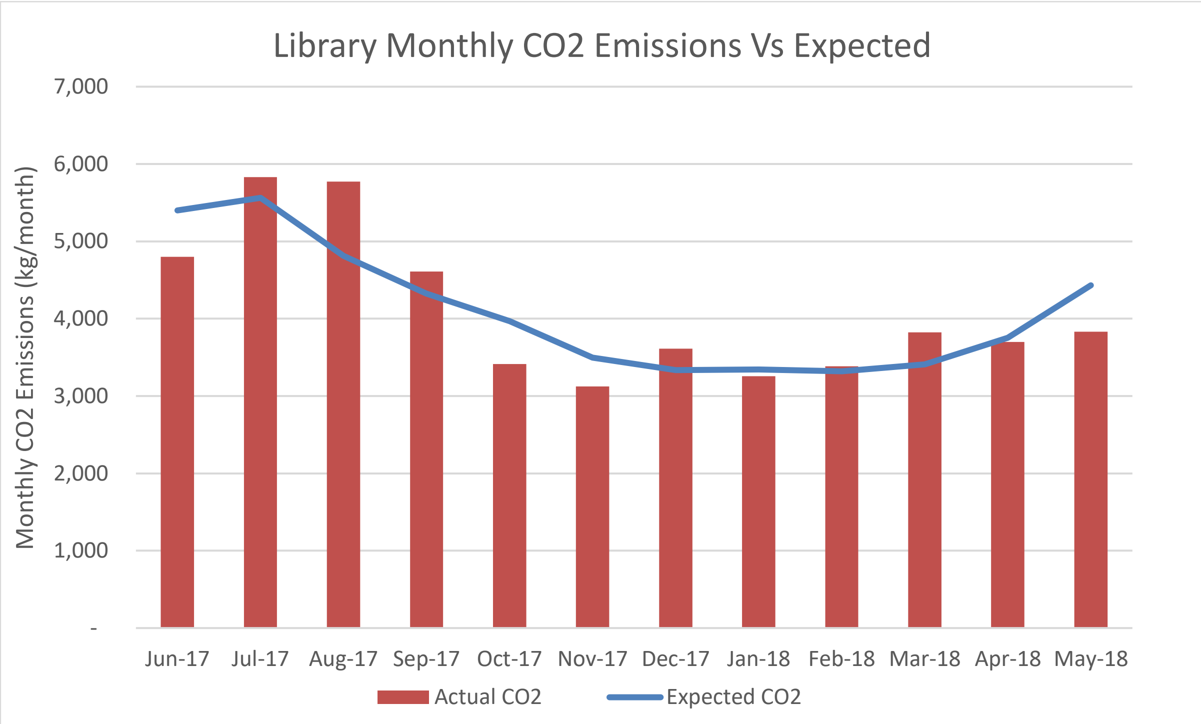


Figure 7-3 - Library monthly carbon emissions versus expected Jun 2017 to May 2018

Braemar Rd Pump Station

The Braemar Rd Pump Station's monthly expected carbon emissions attributable to its electricity consumption can be modelled using the following equation:

Expected Monthly CO_2 (kg) = 0.0457*Water supplied (m^3) + 639.45

Volume of water supplied (m^3) is used as the independent variable. Figure 7-4 below shows the expected monthly CO_2 emissions, as predicted by the baseline model, compared to the actual monthly CO_2 emissions for May 2017 to June 2018. The model tracks well the actual carbon emissions and will be useful moving forward for measuring changes in energy related carbon emissions.

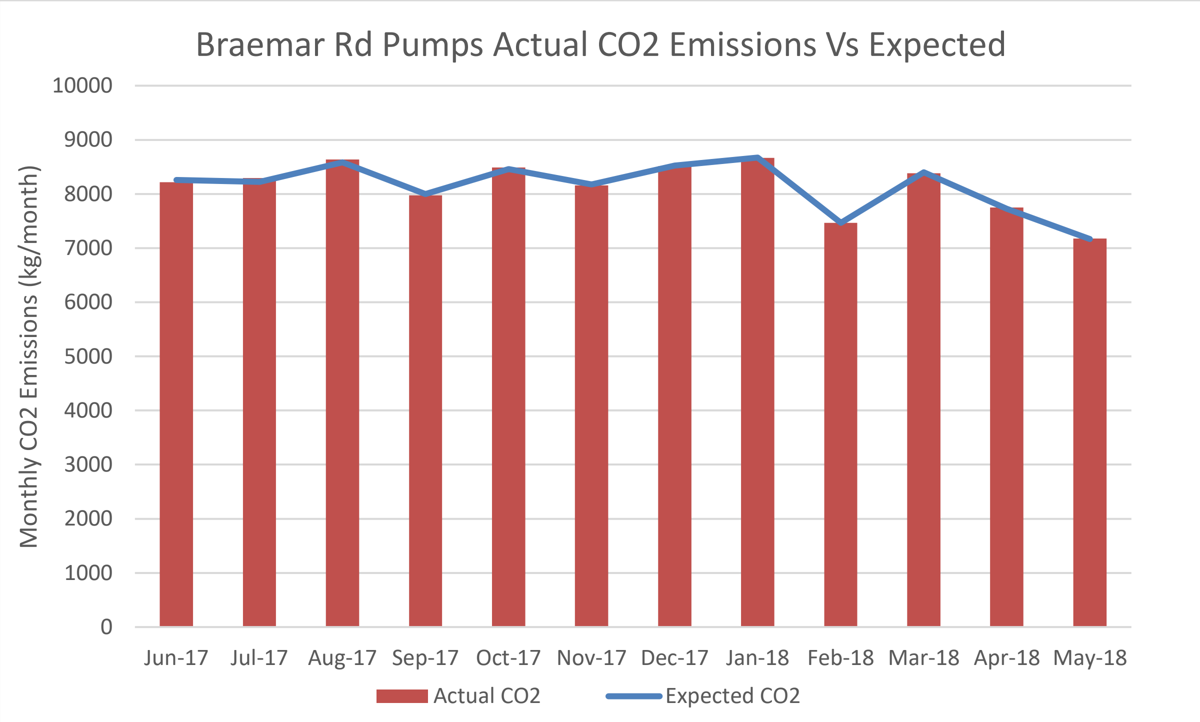


Figure 7-4 - Braemar Rd Pump Station monthly carbon emissions verses expected Jun 2017 to May 2018

7.4 Paul Rd Pump Station

The Paul Rd Pump Station's monthly expected carbon emissions attributable to its electricity consumption can be modelled using the following equation:

Expected Monthly CO_2 (kg) = 0.1545*Water supplied (m^3) + 549.1

Volume of water supplied (m^3) is used as the independent variable. Figure 7-5 below shows the expected monthly CO_2 emissions, as predicted by the baseline model, compared to the actual monthly CO_2 emissions for October 2017 to June 2018. The model tracks well the actual carbon emissions and will be useful moving forward for measuring changes in energy related carbon emissions.

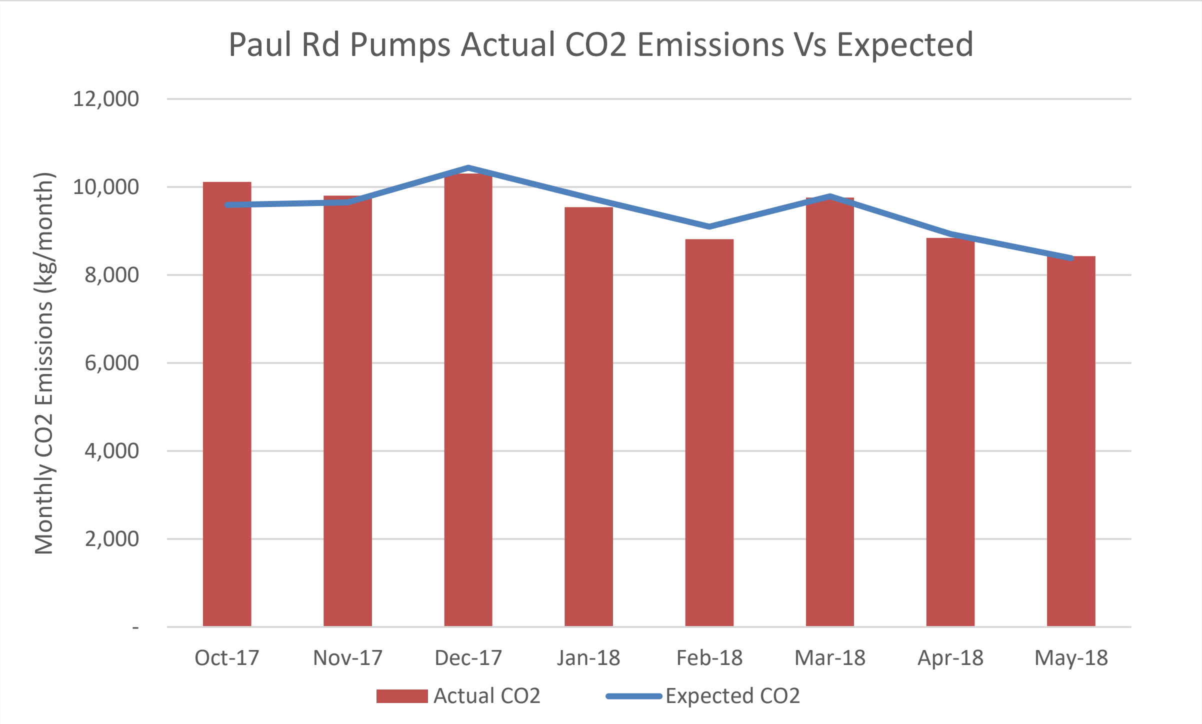


Figure 7-5 - Paul Rd Pump Station monthly carbon emissions versus expected Oct 2017 to May 2018

7.5 Whakatāne Water Treatment Plant

At the time of this report limited water supply data was available from the Whakatāne Water Treatment Plant. Two months' worth of flow data was obtained as a sample; these were Jun 2017 and Jan 2018. These represent one winter month and one summer month. A model was developed using data from these two months:

Expected Monthly CO_2 (kg) = 0.08156*Water supplied (m^3)

This model could be used in the interim, but it is recommended it is updated once more water supply data becomes available. This should be at least a year's worth.

8 Study of End Uses

The Whakatāne District Council has a mix of modern equipment as well as older, less efficient equipment. For the most part equipment is well maintained and some consideration has been given to energy efficiency. Despite this, there are still opportunities for improvement with current energy consumption and associated costs; by adopting a large number of small changes as part of improved energy management practices the Whakatane District Council can expect to see further energy savings.

Some of the Whakatāne District Council's facilities have relatively high hours of operation which will help energy saving projects to have quicker payback periods. Facilities that that have equipment operating for business hours only can be more difficult for opportunities to achieve quick paybacks.

8.1 Civic Centre

8.1.1 Energy Balance

An Energy Balance is a reconciliation of energy use by each end use technology with the site's invoiced energy consumption. The energy balances in the following sections were generated using information from:

- Electricity invoices and TOU data
- Information about end use equipment load ratings [kW]
- Office/facility opening hours and equipment running hours

8.1.1.1 Electrical Energy Balance

Shown below in Figure 8-1 is the energy balance for electricity consumed at the Civic Centre; the energy balance has been broken down into categories based on end use technology group. The most notable results are:

- The server room accounts for 32% of the electricity consumption at the civic centre, with 23% heat load and 9% cooling load. This is unusually high, and is in part due to its 24/7 operation. This is an energy saving opportunity and should be reviewed as part of a wider energy management programme.
- Lighting contributes 14% of the total electrical load. The civic centre has an installed lighting power density of 10.8 W/m^2 which is in line with industry normal values. Opportunities to reduce lighting electricity consumption are discussed in Section 8.1.2.
- HVAC energy use totals 31% of total energy use including fans, heaters, domestic heat pumps and the central HVAC system.
- Other significant users are office equipment (16%) and hot water (5%).

Figure 8-2 shows typical energy use breakdown's for a variety of commercial buildings. The Civic Centre's consumption profile is similar to most office buildings, with the notable exception of the server room.

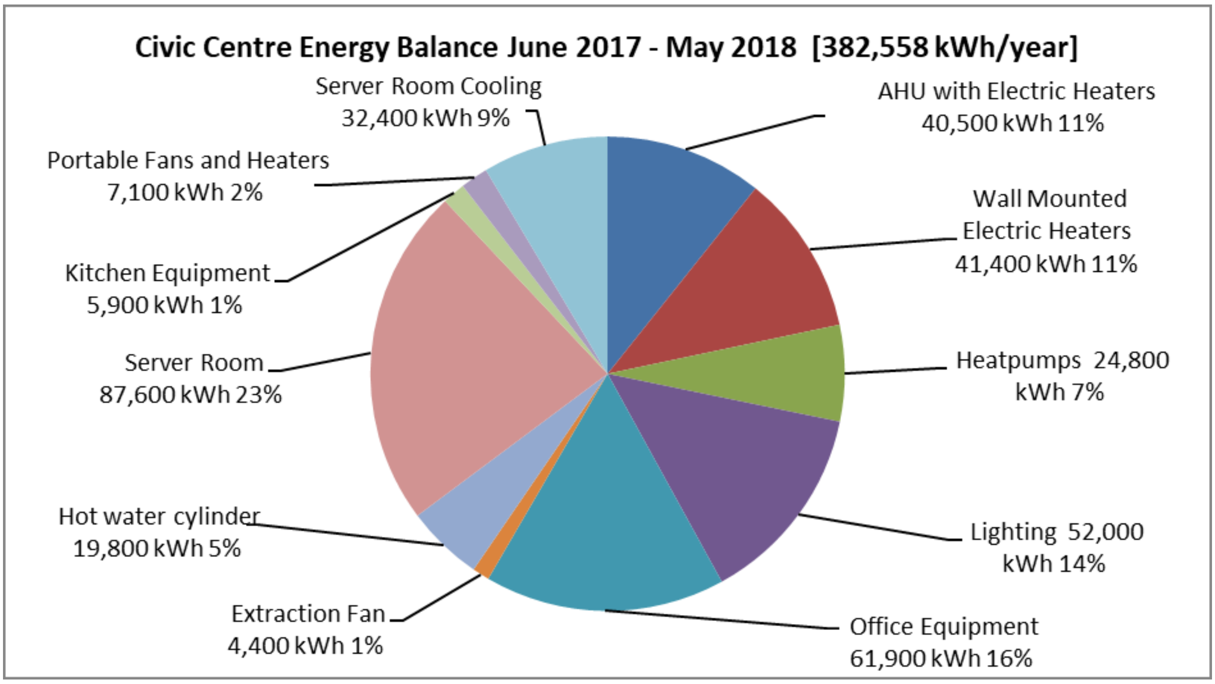


Figure 8-1 - Energy balance for Civic Centre, electrical energy use only

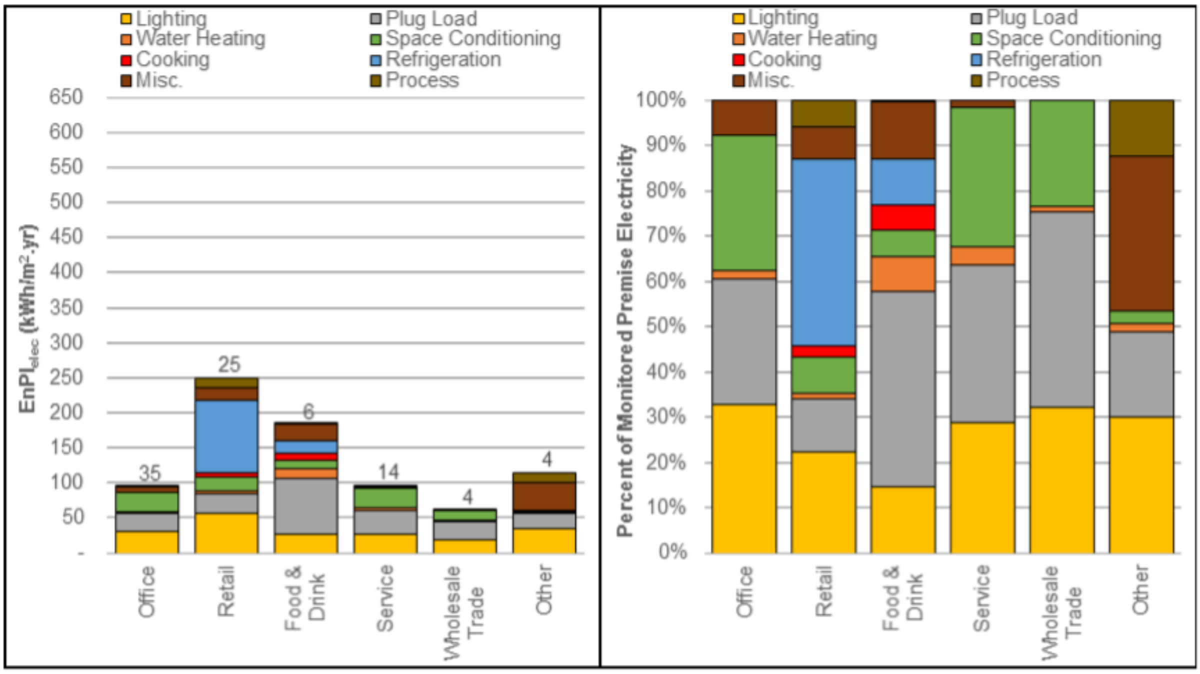


Figure 8-2 - Typical energy use profiles for different building types

8.1.2 Lighting

Lights are a noticeable user of electricity at the Civic Centre, accounting for approximately 14% of electricity use annually, which is a small percentage for an office building. Most of the lighting at the Civic Centre is fluorescent tubes with panel covers (three tubes per panel), approximately 240 panels in total. These operate during business hours, approximately 2,250 hours per year, and it is estimated that an average of 70% of all lights are switched on at any one time during business hours.

There is an opportunity to reduce energy consumption by changing to LED lighting which uses approximately half the amount of electricity as a fluorescent light for similar light output.

Table 8-1 Civic Centre LED lighting energy saving calculations

	Existing Fittings	Replacements
Type	Fluorescent	LED
Power per fitting (W)	140	60
Number of fittings total	236	236
Average % in operation	70%	70%
Annual operating hours	2250	2250
Annual Energy (kWh)	52,038	22,302
Energy Saving (kWh/year)	29,736	
Demand Saving (kW)	13.22	

Recommendation

Convert all fluorescent lighting to LEDs at its Civic Centre. Save 29,700kWh and $4,300 per year and a CO_2 reduction of 3,800kg annually. Cost $37,300, giving a payback period of 8.6 years.

Emsol estimates a cost of $158 per LED panel replacement based on recent prices received from suppliers. This includes an estimated $30 installation cost per fitting replaced. To replace all 236 fittings at the Civic Centre would require a capital outlay of $37,300, giving a payback period of 8.6 years. Emsol recommends receiving quotes from multiple suppliers before proceeding further with this option.

The Whakatāne District Council may elect to replace some of its lights only. To achieve the best payback, lights that are in high occupancy areas or with high annual running hours should be replaced first.

8.1.2.1 Lux Levels

Emsol took a range of lux readings on the second floor of the Civic Centre during a visit on September 10th 2018. These were taken mid-morning on a partly cloudy/partly sunny day. Lux readings should be taken at night to see if lighting levels meet requirements in all areas, however the daytime readings are useful to show if any areas are over-lit on a typical day.

Table 8-2 - Lux readings taken on the second floor of the Civic Centre

Type of reading	Lux levels
Directly under light, away from external windows	630, 440, 600, 420, 770
Between lights, away from external windows	315, 560, 370, 370, 190 (beneath failed fitting)
Near external windows	970, 530, 470, 920

Recommended lux levels for office work is 400lux at desk level. Other than directly under a failed light fitting, lux levels were near or above 400 in all locations. In some locations near windows lux levels were significantly higher than required.

Depending on the level of upcoming upgrades at the Civic Centre, lighting circuits could be separated so that those near windows with high natural light could be turned off on sunny days. Note, natural lighting in actively cooled areas can increase the demand for energy due to solar heat gains.

8.1.3 Hot Water Cylinders

Emsol located two 3kW hot water cylinders in the roof-space of the Civic Centre. The cylinders are insulated and most of the hot water pipework is insulated; there are some areas where this could be improved as shown in Figure 8-3 and Figure 8-4 below.

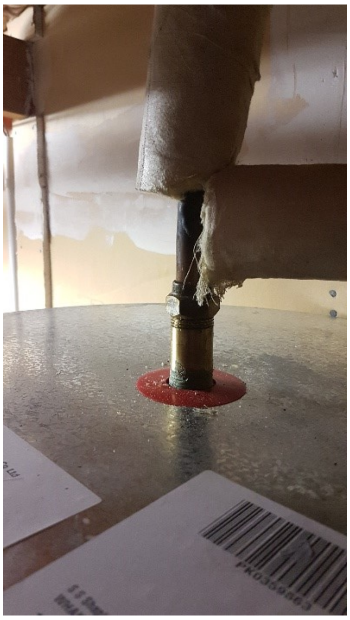


Figure 8-3 -Hot water cylinder pipe

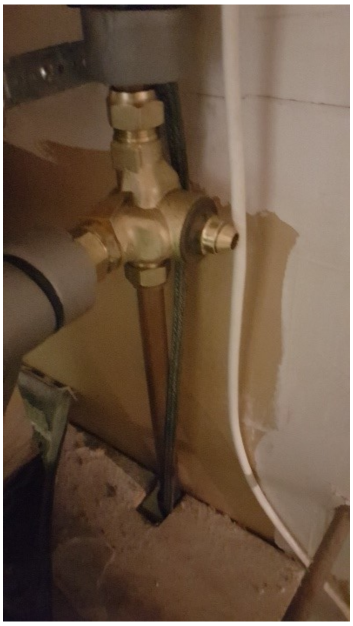


Figure 8-4 -Hot water cylinder pipe

Electricity used for hot water cylinders accounts for 5% of annual energy use, due to 24/7 operation. Demand for energy is highest when hot water has been used and must be replenished. There is also an amount of heating required to counteract heat that is continually lost, particularly from uninsulated surfaces.

Heat pump technology is becoming more common for hot water heating in domestic applications. There are units available that can be retrofit to existing hot water cyliners.

Table 8-3 - Parameters used for hot water heat pump energy calculations

Annual electricity used for hot water (kWh/year)	19,818
COP of heat pump system	3.0
Annual energy saving (kWh/year)	13,212
Demand saving (kW)	1.51

Recommendation

Install a heat pump water heater in place of direct electric heating elements for producing hot water. This will save 13,200kWh in annual electricity, resulting in a cost saving of $1,600 per year and an annual CO_2 reduction of 1,700kg. The cost for retrofitting two heat pump units is $8,000, resulting in a payback period of 4.9 years.

This cost is based on quotations Emsol has received in 2018 for similar projects. Note, this cost is approximate because final quotations will vary.

8.1.4 Heating, Ventilation & Air Conditioning

Heating, ventilation and air conditioning is usually the largest user of energy for a commercial building. At the Whakatane District Council's Civic Centre this accounts for approximately one third of annual energy use.

8.1.4.1 Upgrade Building Management System (BMS)

The Civic Centre does not have a Building Management System as such, instead it has time-based control on electric heating elements in its air handling units. Because of concerns about overloading the site transformer, heating elements are controlled to only ever have a certain number of areas on at any one time. Heating will turn off in one area before turning on in the next. This has actually had a positive effect on the energy efficiency of the building, however it has come at the cost of the effectiveness of the heating. Staff have complained that there are times where some rooms or areas are particularly cold whilst others are rather warm. The existing system also has a manually controlled 'boost' button for its heating system. It's not known how often this is used or how much this increases demand.

Figure 8-5 - Time based building services control system

As part of any upgrade to the Civic Centre's central heating system, an upgrade to installing a BMS system should be considered. This will have a large impact on the performance of the heating system and will improve energy efficiency provided it is commissioned correctly. Annual energy used for air handling and cooling at present is 65,300kWh/year (excludes wall heaters and portable heaters).

Table 8-4 - Civic Centre BMS energy saving calculation parameters

Annual electricity used by AHU's and Heat pumps (kWh/year)	65,306
Improvement with BMS system	10%
Annual energy saving (kWh)	6,531
Demand Reduction	5.80

Recommendation

Upgrade the Civic Centre's BMS system to improve performance and energy efficiency. This will reduce annual energy use by 6,500kWh and result in a cost saving of $1,150 per year and an annual CO_2 reduction of 840kg. Cost $75,000 resulting in a payback period of 33 years plus improvement in staff member comfort.

The cost of $75,000 is based on a recent BMS upgrade at the Te Koputu Library.

8.1.4.1.1 Recirculated Air

Heating systems that introduce a high proportion of fresh air compared to recycled air operate with poor energy efficiency at times when ambient temperature is particularly cold or warm. This is because they are heating or cooling more air than is required. NZS 4303 specifies 10 l/sec of outside air per person, which keeps CO_2 concentrations below 1000 ppm. Steve Piper from Aquaheat (contractors who service the Civic Centre) commented that the Civic Centre's central heating introduces more fresh air than is required, though it is not known by how much. A BMS upgrade would be required to optimise this and increase energy savings further.

This improvement would normally reduce HVAC energy costs by 15% - 40% and should be added to a list of projects as part of an energy management programme.

8.1.4.2 Air Handling Units (AHUs)

The Civic Centre's central heating system uses direct electric heating elements to heat air. There are six of these elements and the manufacturers ratings were 24kW, although a separate label had been added with hand written text saying 8-16kW. An average of 12kW has been used for analysis.

Table 8-5 - Parameters for AHU energy calculations

Type	Electric Element	Heat pump
Power per Heater (kW)	12.0	N/A
COP	1.0	4.8
Number of units total	6	N/A
Average load %	100%	65%
Annual operating hours	375	375
Annual heat output (kWh)	27,000	27,000
Annual Energy (kWh)	27,000	5,625
Energy Saving (kWh/year)	21,375	
Demand Saving (kW)	19.00	

Heating is currently controlled to only ever have some areas on at any one time, not all. This has reduced the annual operating hours of each heating unit and made it more difficult to achieve a quick payback.

Recommendation

Upgrade the central heating system and replace existing direct electric heating elements with heat pump technology. This will reduce annual electricity use by 21,300kWh and result in a cost saving of $3,700 per year and an annual CO_2 reduction of 2,700kg. Cost is $48,000 which would result in a 12.9 year payback, however it is recommended quotes are sought to make this more accurate.

This cost is based on quotations Emsol has received in 2018 for similar projects, which equate to approximately $400 per kW plus cost of modifications to the system.

8.1.4.3 Wall Mounted Electric Heaters

The Civic Centre has 30 wall mounted direct electric heaters that are 3kW each, and one larger 6kW heating unit. Direct electric heating gives 1kW of heat for 1kW of electricity used. Modern heat pumps have a COP (coefficient of performance) of around 4.8 when heating. This means they deliver 4.8kW of heat while using only 1.0kW of electricity.

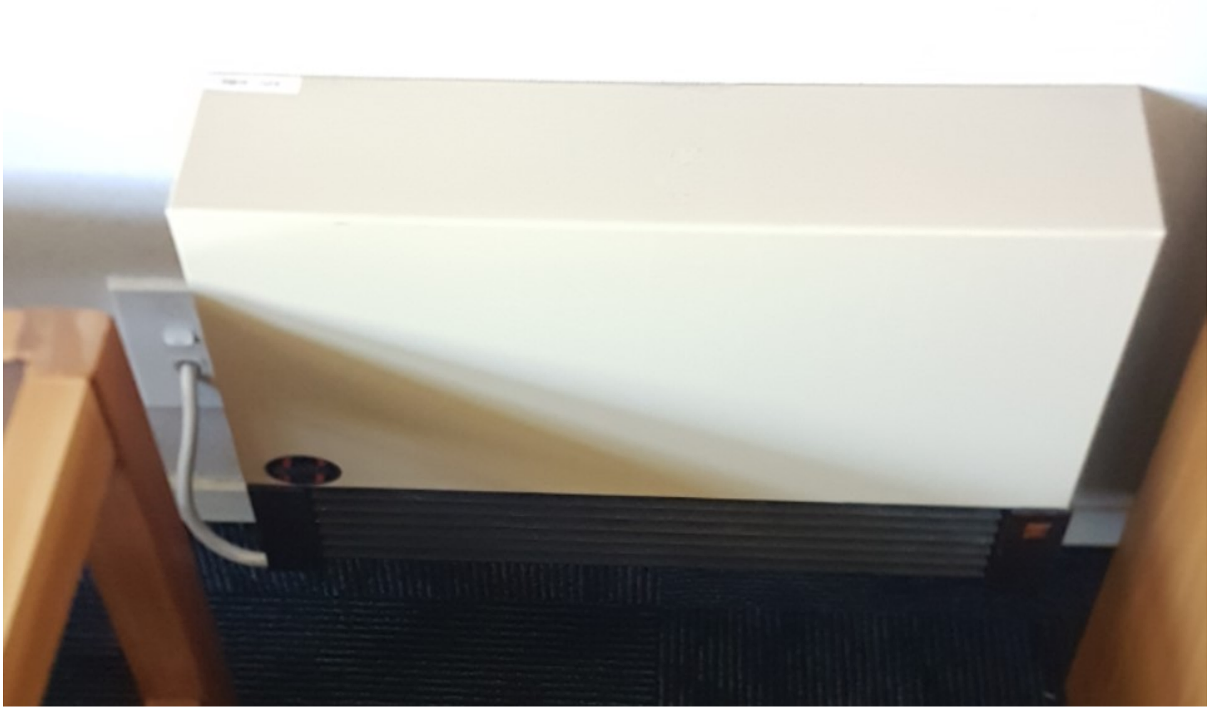


Figure 8-6 - Wall mounted 3kW electric heater at the Civic Centre

Table 8-6 - Parameters used for calculating energy savings with heat pumps instead of electric heaters

	Existing heating	Replacements
Type	Electric	Heat pump
Power per Heater (kW)	3.0	0.8
COP	1.0	4.8
Number of units total	30	30
Average % in operation	100%	85%
Annual operating hours	375	375
Annual heat output	33,750	34,425

Annual Energy (kWh)	33,750	7,172
Type	Electric	Heat pump
Power per fitting (kW)	6.0	2.4
COP	1.0	4.0
Number of units total	1	1
Average % in operation	100%	65%
Annual operating hours	1125	1125
Annual heat output	6,750	7,020
Annual Energy (kWh)	6,750	1,755
Energy Saving (kWh/year)	31,573	
Demand Saving (kW)	28.07	

Recommendation

Replace electric heating elements with wall mounted heat pumps. This will save 31,500kWh in electricity annually and result in a cost saving of $4,300 per year and an annual CO_2 reduction of 4,000kg. This will require a capital investment of $60,000, resulting in a payback of 10.7 years.

Based on quotations received for other projects, the cost of 30 small heat pumps installed is approximately $2,000 each.

8.1.4.4 Ceiling Space Insulation

Emsol noted during a site visit on September 10th 2018 that there was no ceiling insulation in the roof-space above the second floor. Figure 8-7 below, however, shows that there is in fact some insulation on the underside of the roof. This is less effective than insulating the level two ceiling as the roof space can be draughty and will lose heat through the vertical walls. It may have been done this way to allow better access to certain area of the roof-space for servicing equipment.

Although the payback period would normally be more than 10 years for this type of energy saving project, any uninsulated wall in this loft space should also be considered for insulating as part of a long term energy management programme.

Figure 8-7 - Civic Centre roof-space showing there is no insulation on the second-floor ceiling, but there is on the underside of the roof.

8.2 Aquatic Centre

8.2.1 Energy Balance

An Energy Balance is a reconciliation of energy use by each end use technology with the site's invoiced energy consumption. The energy balances in the following sections were generated using information from:

- Electricity invoices and TOU data
- Information about end use equipment load ratings [kW]
- Office/facility opening hours and equipment running hours

8.2.1.1 Electrical Energy Balance

Shown below in Figure 8-8 is the energy balance for electricity consumed at the Whakatāne District Council's Aquatic Centre; the energy balance has been broken down into categories based on end use technology group. The most notable results are:

- Air handling is the largest category and accounts for 32% of annual electricity use at the aquatic centre. There are four air handling units in total, and the main electrical loads are fans and a heat pump system at AHU3.
- Water heating is the second largest electrical load and accounts for 27% of demand. Water heating is provided by a heatpump system and the main electrical loads are two compressors and some pumps. Additional water heating is done using two gas boilers.
- Excluding heating, the main electrical loads associated with operating each of the pool areas are the pump systems. Annual consumption ranges from 4% at the outdoor pool (which only operates from Sept to April) to 9% at the main indoor pool.
- Lighting accounts for 7% of annual electricity at the aquatic centre.

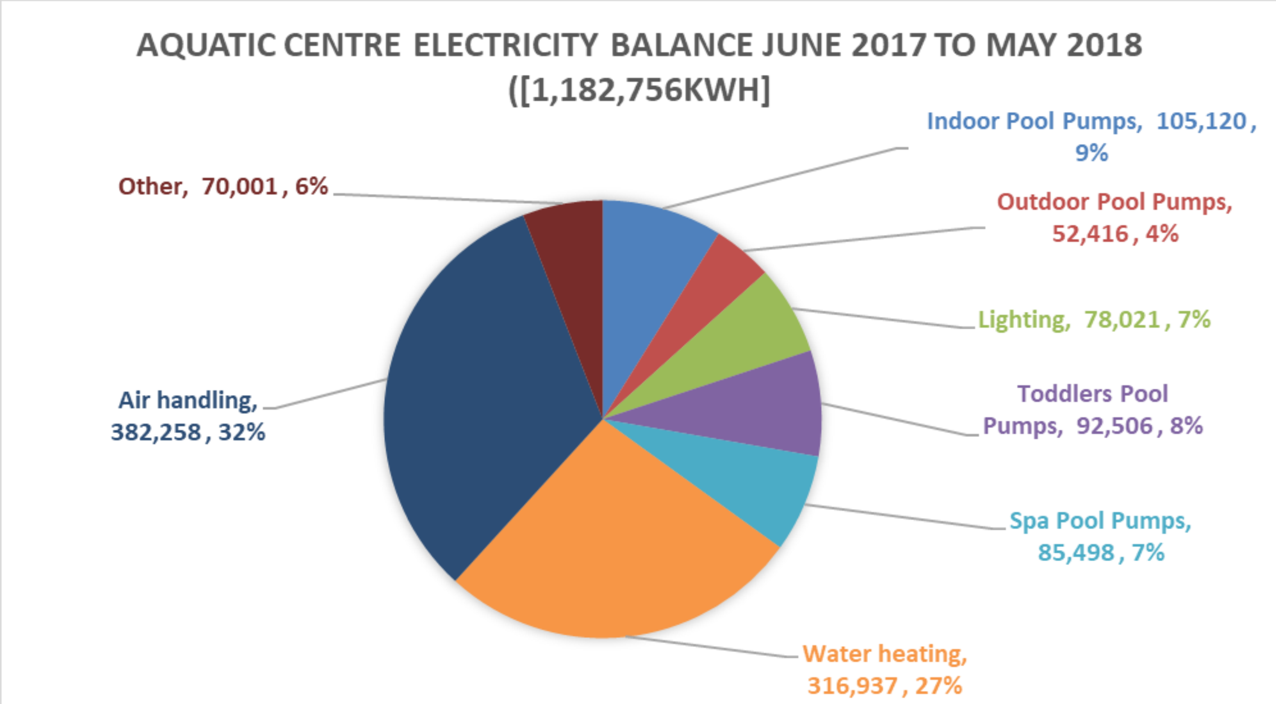


Figure 8-8 - Energy balance for the Aquatic Centre, June 2017 to May 2018

8.2.1.2 Natural Gas Energy balance

All natural gas used at the Aquatic Centre is for water heating via two 170kW boilers. These are used as a supplement to a heat pump system. Natural gas use is 990,388 kWh per year and equates to 46% of the Aquatic Centre energy use.

8.2.2 Lighting

The Aquatic Centre has numerous variants of fluorescent lighting and metal halides in use as shown in Table 8-7 below. Modern LED replacements are available for most fitting types and typically use 50% less energy for the equivalent lumen output of other lighting types.

Table 8-7 - Aquatic Centre lighting annual electricity consumption

Lighting Type	Number of fittings	Annual Consumption (kWh/year)	Annual hours of use	Electricity demand per fitting (kW)
Type B	9	34,070	4732	1.000
Type Y	13	3,445	4732	0.070
Type D	13	1,772	4732	0.036
Type K	17	1,673	4732	0.026
Type T	4	757	4732	0.050
Type I	14	3,816	4732	0.072
Type U	15	1,476	4732	0.026
Type V	1	273	4732	0.072
Type C	10	1,363	4732	0.036

Type A	10	15,142	4732	0.400
Type L	10	2,650	4732	0.070
Type R	8	787	4732	0.026
Type AL	4	545	4732	0.036
Type S	3	295	4732	0.026
Type AM	8	1,090	4732	0.036
Type M	1	212	4732	0.056
Type N	6	454	4732	0.020
Type E1	6	3,784	8760	0.072
Type E2	7	4,415	8760	0.072
Totals	**159**	**78,021**		
% reduction with LEDs	50%			
Annual saving (kWh)	**39,010**			
Demand saving (kW)	**8.24**			

Recommendation

Upgrade lighting at the Aquatic Centre to LEDs to reduce annual electricity consumption by 39,000kWh. This will result in electricity cost savings of $4,900 annually and reduce annual carbon emissions by 5,000kg. This will require an estimated capex of $30,200, resulting in a payback of 6.1 years.

This would not need to be done as a single project; it could be done in stages or on a replacement basis as existing luminaires fail. If staged, shorter payback lighting should be replaced first. This would include lights with longer operating hours such as emergency lights or in the gym area, as well as larger fittings such as 1000W metal halides, depending on the price of replacements available.

During the energy audit site visit some lights were noted to be left switched on outside when there was sufficient day light. These energy saving opportunities would be included in an energy management programme refer to Section 9.

Light illuminance levels inside the pool hall were recorded to range from 150 lux near the hall centre to 2,000 lux near windows. Lux levels should be 150 lux or more. There is also an opportunity to switch off some of the lights inside during daylight hours or install daylight sensor control switch on some lights after upgrading to LED. Existing metal halide lamps have a seven-minute restrike time and cannot be switched off and on practically.

8.2.3 Water Heating

Water heating is the single largest user of energy at the Aquatic Centre. Approximately half of the heating energy is supplied by a heat pump system that uses 316,000kWh of electricity annually. Two 170kW gas fired boilers provide the remainder of the heat and use 990,000kWh of gas energy annually. The outdoor pool currently is heated by the gas boilers only. This is the Whakatane District

Council's single highest user of natural gas and represents an opportunity to significantly reduce CO_2 emissions if an alternative technology is implemented.

Annual gas use (kWh)	990,388
Maximum demand for Gas (kW)	300
Boiler system efficiency (%)	90%
Annual heating demand (kWh)	891,349
Heat pump COP	3.5
Annual electricity use (kWh)	254,671
Increase in electricity demand (kW)	77.14
Increase in electricity cost ($/year)	$ 34,084
Marginal gas saving ($/year)	$ 70,714
Saving if Gas removed completely ($/year)	$ 74,824

One option is for the Aquatic Centre to expand the capacity of its heat pump system. Because heat pumps used recovered heat (either from the outside air or a waste heat stream) they can have a coefficient of performance (COP, effective efficiency) of 3 to 5 in this type of installation. A COP of 3 means 1kWh of electrical energy is required to provide 3kWh of heating energy.

Recommendation

Utilise heat pump technology to meet all heating requirements at the Aquatic Centre and use the boilers as backups only. This will save 735,700kWh of energy per year and result in an annual cost saving of $36,600 and reduce annual carbon emissions by 181,800kg. The existing heat pump system cost $327,000 to install. Assuming a similar cost to upgrade the system to operate off the heat pump only, this project would have a payback period of 8.9 years.

Note, the existing heat pump system was over-specified when installed. Further work is needed to determine what would be required to meet all heating demands. Retiring the boilers completely and discontinuing the gas connection will save a further $4,100 per year, however there would be no redundancy.

8.2.4 Pumps

It was noted in section 6.2.2.2 that the after-hours electricity loads at the Aquatic Centre were not much less than during opening hours. This is in part due to recirculation pumps that operate 24-7. There are three direct online (DOL) recirculation pumps for indoor pools. Two of these have 9.2kW motors (spa pool and toddlers pool), and the main indoor pool recirculation pump has a 15.0kW motor. Because the pools are not in use after hours, the recirculation rate could be reduced significantly. This would require a VSD for each pump motor.

	Main pool recirc pump	Toddlers pool recirc pump	Spa pool recirc pump	**Total**
Annual electricity use (kWh)	105,120	64,474	64,474	234,067
Annual after-hours usage (kWh)	48,336	29,646	29,646	107,628
% reduction in energy if pump speed reduced to 30Hz	80%	80%	80%	
Annual energy saved after hours (kWh)	38,669	23,717	23,717	**86,103**

Recommendation

Install VSDs on recirculation pumps for the toddler's pool, spa pool and main indoor pool and reduce after-hours pump speeds to a minimum (eg 30Hz). This will reduce annual electricity consumption by 86,100kWh and will save $8,400 and 11,100kg of CO_2e per year. Based on recent prices received, the capital required for installing three appropriately sized VSDs would be approximately $12,000, resulting in a payback of 1.4 years.

The toddlers pool, spa pool and main indoor pool each have a second pump as part of the recirculation loop. These are referred to as lift pumps and these lift water from a return sump underground and feed into a filtration system. The spa pool lift pump motor is 3kW, toddlers pool is 4kW and the main indoor pool has a 7.5kW lift pump motor. These are direct online and run constantly, however there is a float valve that restricts the flow based on the water level in the filter pools (refer to Figure 8-9 below).

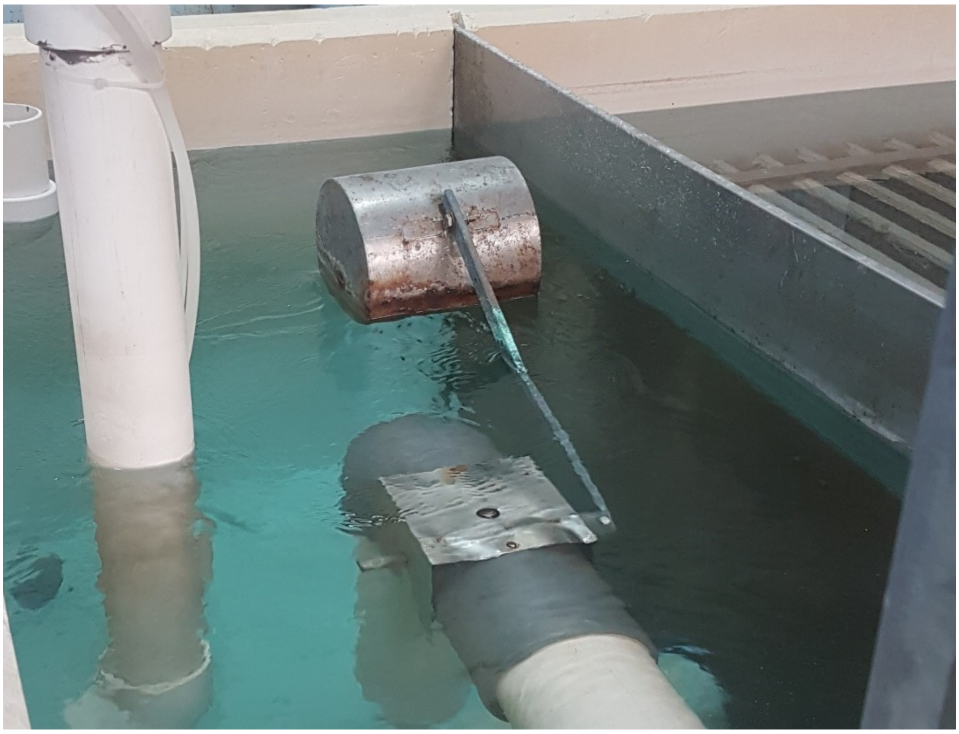


Figure 8-9 - Lift pump float control valve

Using a restriction to control flow rates results in wastage of energy. A more efficient method is to modulate pump speed with a VSD to match the required flow rate.

	Main pool lift pump	Toddlers pool lift pump	Spa pool lift pump	**Total**
Annual electricity use (kWh)	52,560	28,032	21,024	101,616
Average pressure rise across pump (kPa)	140	90	225	
Actual head required (m)	5	5	5	
proportion of total pressure drop that occurs across control valve	50%	50%	50%	
Annual % energy saving with VSD control	32%	23%	39%	
Annual electricity saving (kWh)	**17,073**	**6,377**	**8,220**	**31,670**
Demand saving (kW)	**1.95**	**0.73**	**0.94**	**3.62**
After hours electricity use (kWh/year)	24,288	12,954	9,715	
Reduction in after hours energy (%)	80%	80%	80%	
After hours energy saved with lift pumps reduced to 30Hz (kWh)	11,541	7,416	3,974	22,931
Annual energy saved	28,614	13,793	12,194	**54,601**

Recommendation

Install VSDs on three lift pumps and use a level sensor setpoint to control the modulation of pump motor speeds, rather than the float control valve. This will reduce annual electricity by 31,600kWh, resulting in a cost saving of $3,800 and carbon reduction of 4,000kg per year. Capital required to implement this is estimated to be $7,500, resulting in a 2.0 year payback.

Note, if VSDs are fitted to slow the recirculation pumps to 30Hz overnight as described earlier in this section, there would be greater savings at the lift pumps also. Assuming the lift pumps also reduce by to 30Hz after-hours, annual energy savings would be 54,600kWh. This would increase savings by a further $2,200 per year and reduce annual carbon emissions by a further 2,900kg.

8.3 Te Kōputu Whakatāne Library

8.3.1 Energy Balance

An Energy Balance is a reconciliation of energy use by each end use technology with the site's invoiced energy consumption. The energy balances in the following sections were generated using information from:

- Electricity invoices and TOU data

- Information about end use equipment load ratings [kW]
- Office/facility opening hours and equipment running hours

8.3.1.1 Electrical Energy Balance

Shown below in Figure 8-10 is the energy balance for electricity consumed at the Whakatane District Council's Te Kōputu Library; the energy balance has been broken down into categories based on end use technology group. The most notable results are:

- Air conditioning is the largest electricity user, accounting for 50% of electricity used at the facility. Ventilation fans account for 8% of electricity used.
- Lighting accounts for 26% of electricity used. The power density of lighting at the Library is 5.98Watts/m^2 which is relatively low but could be improved further with LEDs.

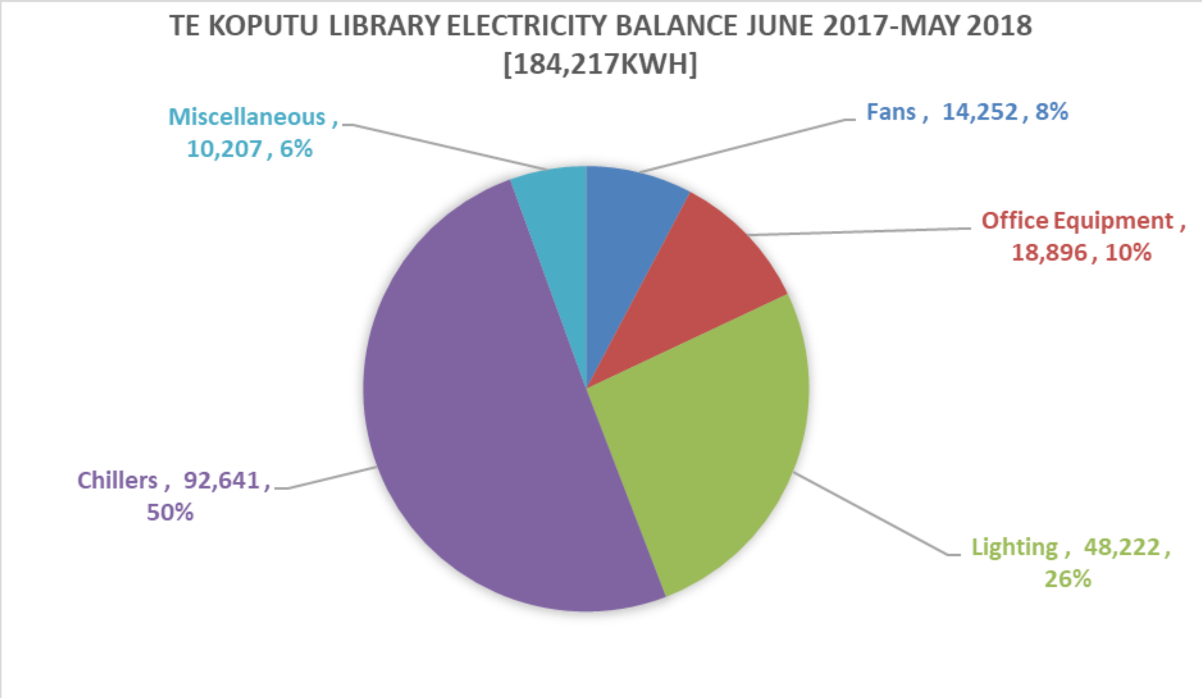


Figure 8-10 - Electricity energy balance at the Library for June 2017 to May 2018

8.3.1.2 Natural Gas Energy balance

All natural gas used at the Library is for space heating via a 90kW boiler.

8.3.2 Lighting

Existing luminaires at the Library are predominantly fluorescents tubes, as described in Table 8-8 below and Appendix 10.2. This include 1200mm twin tube batten fittings and 600mm 4-tube T5 recessed fittings. Upgrading these to modern LEDs will reduce electricity consumption for lighting by approximately 50%.

The museum display rooms use mostly LED lights. Note, UD2 and WU1 in Appendix 10.2 are 35W and 70W metal halide lamps that have already been replaced with 7W LED lamps.

Table 8-8 - Lighting types and electricity consumption at the Library

Lighting Type	Number of fittings	Annual Consumption (kWh/year)	Annual hours of use	Electricity demand per fitting (kW)
D3	35	6,814	3744	0.052
R2	4	839	3744	0.056
R1	39	8,177	3744	0.056
D1	22	4,283	3744	0.052
S1	18	4,717	3744	0.07
S1	20	5,242	3744	0.07
S3	20	5,242	3744	0.07
D2	7	734	3744	0.028
UD2	11	2,883	3744	0.07
UD1	12	3,145	3744	0.07
Totals	**188**	**42,075**		
% reduction with LEDs	50%			
Annual saving (kWh)	**21,038**			
Demand saving (kW)	**5.62**			

Recommendation

Replace existing fluorescent lighting with LEDs. This will reduce annual electricity consumption by 21,000kWh and result in electricity cost savings of $2,700 annually. Annual carbon emissions will reduce by 2,700kg. The cost to replace all existing lights is estimated to be $24,400, resulting in a payback of 8.8 years.

Light illuminance levels inside main Library area recorded to range from 280 lux near the bottom of book shelves up to 1,300 lux near a window. Areas for reading should be 400 lux, which they are. In the museum they ranged from 10 to 30 lux, which enhanced displays at 150 – 300 lux. There is also an opportunity as part of energy management to switch off some of the lights inside and near windows during daylight hours or install daylight sensor control switch on some lights after upgrading to LED.

8.3.3 Heating, Ventilation & Air Conditioning

8.3.3.1 Reduce after hours electricity

In section 6.2.2.3, an analysis of weekly load profiles showed that there were some after-hours periods where electrical demand reduced to 5kW, however there were other after-hours periods where demand remained above 15kW. Higher after-hours demand was more common in winter.

After-hours electricity can be reduced by switching off all non-essential equipment at the end of the day. Timers can be used on portable heaters if they need to be turned on a period of time before staff arrive. It is also worth reviewing how the BMS is controlling overnight in case there is unnecessary heating or cooling being done.

Recommendation

Reduce after hours electricity consistently throughout the year. This will reduce annual electricity use by 49,100kWh and result in a cost saving of $4,800 per year and a reduction of 6,300kg of CO_2 annually.

8.3.3.2 BMS Optimisation

In section 6.2.2.3 , an analysis of daily electricity profiles showed a 'saw tooth' shaped profile for the Library, indicating potentially poor process control. This is most likely related to air conditioning since it is the largest electrical load and there is no other obvious cyclical activity at that frequency at the Library.

Electricity used for air handling (kWh/year)	92,641
Gas used for air handling (kWh/year)	116,291
% improvement with optimised BMS	20%
Electricity savings (kWh/year)	**18,528**
Gas savings (kWh)	**23,258**
Electricity demand saving (kW)	**2.12**

Optimising the BMS control, including keeping introduced fresh air to a minimum and avoiding simultaneous heating and cooling would save in the order of 20% or more of the energy used for air conditioning.

Recommendation

Optimise the Library BMS to minimise energy use. This would save 20% of air conditioning energy which includes both electricity (chilling) and natural gas (heating). This equates to 41,700kWh of energy saved annually, resulting in a cost saving of $3,800 annually and a reduction in carbon emissions of 7,400kg per year.

8.3.3.3 Reduce gas used in summer months

The Library uses gas for space heating. In summer months staff complained of the building becoming excessively hot, particularly since the main Library part of the building has no active cooling. In these warmer months, there is still significant gas being used. For example, in January 2018 the Library used 6,072kWh of gas; the average monthly gas use across a year is 9,700kWh. Gas use should be minimal or zero in summer months. The BMS parameters should be investigated to find out when this gas is being used and why. It may be that it is being used at night when the building is unoccupied, or it could be that there is simultaneous heating and cooling occurring.

Recommendation

Modify BMS control or switch off gas boiler to minimise gas used during summer months. This will reduce annual gas consumption by 20,000kWh and result in a cost saving of $1,400 annually and reduce CO_2 emissions by 4,300kg per year.

8.3.3.4 Replace boiler with heat pump technology

The Library currently uses a 90kW boiler to provide heat to heating coils inside air handling units for the purpose of space heating. This is the Whakatāne District Council's second largest user of natural gas (the Aquatic Centre is the largest) and there is an opportunity to reduce carbon emissions by using an electric based technology such as a heat pump instead.

Annual gas use (kWh)	**117,152**
Boiler system efficiency (%)	90%
Annual heating demand (kWh)	105,437
Heat pump COP	4.8
Annual electricity use (kWh)	**21,966**
Increase in electricity demand (kWh)	**5.87**

Recommendation

Replace the gas boiler at the Library with a heat pump system for space heating. This will save 95,000kWh of energy annually and result in cost savings of $6,500 per year and an annual reduction in carbon emissions of 22,500kg CO_2e. Cost $36,000 resulting in a payback of 5.5 years.

A cost estimate of $36,000 is based on recent prices for similar projects in 2018 of approximately $400/kW. It is recommended at least two quotations are obtained before proceeding. Note also that gas prices are expected to increase at a faster rate than electricity prices in the future due to the emissions trading scheme as well as decreasing supply which will improve the payback.

8.4 Whakatāne Water Treatment Plant

8.4.1 Energy Balance

An Energy Balance is a reconciliation of energy use by each end use technology with the site's invoiced energy consumption. The energy balances in the following sections were generated using information from:

- Electricity invoices and TOU data
- Information about end use equipment load ratings [kW]
- Office/facility opening hours and equipment running hours

8.4.1.1 Electrical Energy Balance

Shown below in Figure 8-11 is the energy balance for electricity consumed at the Whakatane District Council's Whakatāne Water Treatment Plant located at 60 Te Tahi Street; the energy balance has been broken down into categories based on end use technology group. The most notable results are:

- High lift pumps make up almost 80% of annual electricity used by the Whakatāne Water Treatment Plant.

- Low lift pumps account for 18% of annual electricity use.
- All other loads are small in comparison to pumps.

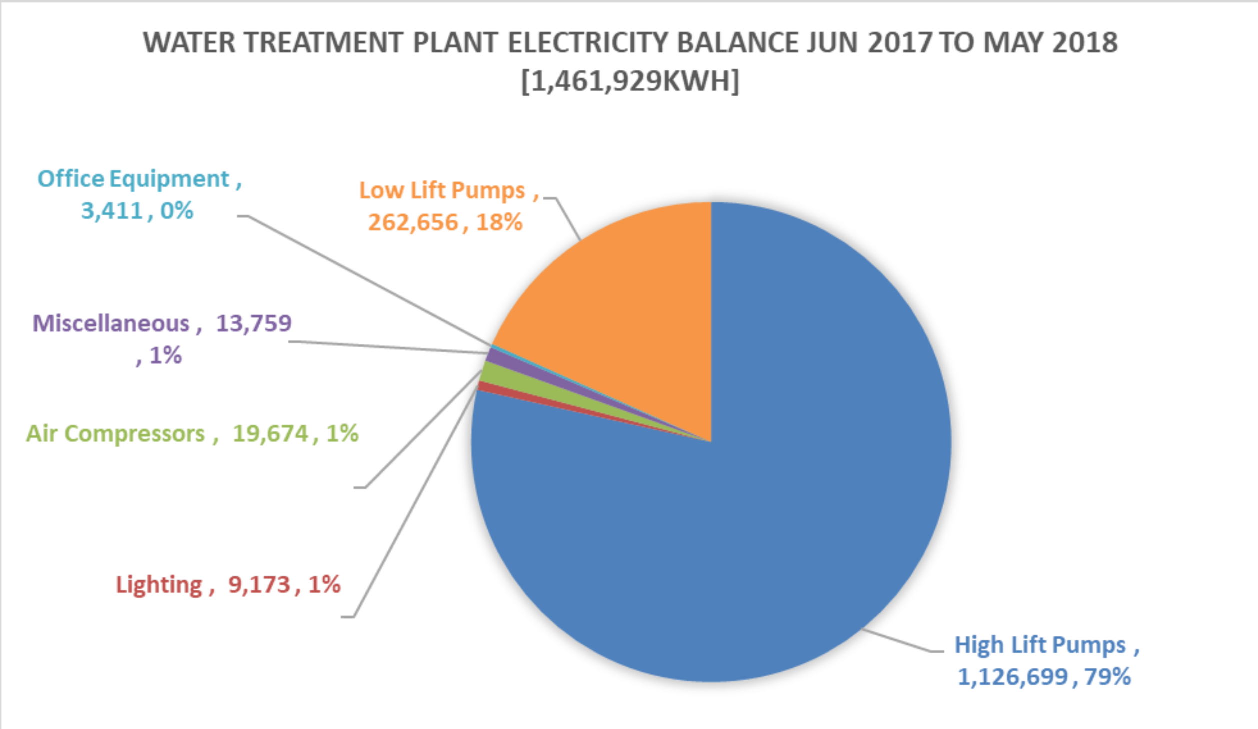


Figure 8-11 - Whakatāne Water Treatment Plant electricity balance, June 2017 to May 2018

8.4.2 Pumps

8.4.2.1 High efficiency pumps and motors

The Whakatāne Water Treatment Plant has three high lift pumps that account for 79% of electricity used by the plant. These are VSD driven and are fitted with 132kW motors. No more than two pumps run at once, with the third there as redundancy. Often only one pump is required to meet demand, particularly during winter months.

All three motors and pumps are older equipment and would improve in efficiency with more modern technology designed to operate at their Best Efficiency Point (BEP). The duty pump does 75% of high lift pumping at the Whakatāne Water Treatment Plant and therefore significant energy savings could be achieved by replacing just this pump. This would minimise the capital requirement.

Annual use of duty pump (kWh)	780,754
Estimated efficiency of existing pump	80%
Estimated efficiency of existing motor	90%
New pump efficiency	90%
New motor efficiency	95%
Annual energy used by upgrading both (kWh)	657,477
Annual energy saving (kWh)	**123,277**
Demand saving (kW)	**14.07**

Install a high efficiency pump and motor with a VSD and use as the duty high lift pump. This will reduce annual electricity consumption by 123,000kWh, resulting in a cost saving of $13,900 per year and an annual carbon reduction of 15,900kg. A new pump and VSD will cost approximately $23,000 to install, resulting in a payback period of 1.7 years.

8.4.2.2 Direct supply

The Whakatāne Water Treatment Plant high lift pumps send water up approximately 90m to three reservoirs in the hills above the plant. This requires 9bar pressure to overcome the elevation. Supply to town is directly from the reservoirs, using the stored elevation (head) to provide pressure to town. This pressure is too high for town supply, so it is throttled down using a pressure reducing valve to 7.5bar. This process converts some of the energy imparted by the pumps into wasteful heat.

Annual electricity (kWh)	1,039,738		delta u = (P1-P2)*v1
Elevation of reservoirs (m)	90		
gravity (m/s^2)	9.8		u = internal energy
Pressure to reservoirs P1, (kPa)	882		v = specific volume
Pressure regulated to town P2 (kPa)	750		
specific volume of water v1 (m^3/kg)	0.0011		
Increase in internal energy (kJ/kg)	0.1452		
Specific energy added by pump (kJ/kg)	0.882		
% of energy converted to heat	16%		
temperature increase of water (degC)	0.03		
% of time supply can go direct to town	80%		
Annual energy saving (kWh)	**136,934**		
Demand Saving	**15.63**		

The Whakatāne Water treatment plant has a direct supply line to town that bypasses the reservoirs, however this is only used in emergencies. It would be more energy efficient to supply direct to town at a lower pressure and use a VSD to modulate pump speed based on demand for water. There are some challenges around this though, as there is a period of time that water needs in a storage to be chlorinated. This is easily achieved by using the reservoirs but would be more difficult with a direct supply.

Investigate the option of using direct supply to town at a lower pressure setpoint, and using the reservoirs as storage only, replenished periodically. If feasible this would save 136,000kWh annually, resulting in a cost saving of $15,000 annually and an annual reduction in carbon emissions of 17,600kg.

There is potential for additional energy savings associated with further pressure reduction when water is not needed to be pumped up a hill to a neighbouring housing area. There is currently insufficient information readily available on water pressure and requirements. It is recommended this would be a project to be included in a long-term energy management programme.

8.5 Braemar Rd Pump Station

8.5.1 Energy Balance

Braemar Rd has two pumps that consume all of the 759,000kWh of electricity used annually; all other loads are negligibly small. No fuel or other energy form is used.

8.5.2 Pumps

The Braemar Rd pump station has two pumps that are Weir DRD15 models and are each fitted with a 150HP (112kW) motor. The motors are direct online and the pumps turn on and off periodically as was discussed in section 6.2.2.4.2. When the pumps are running, they supply water to reservoirs as well as directly to town. Once the reservoirs are full the pumps turn off and the stored elevation in the reservoirs is used to provide pressure to the town supply.

8.5.2.1 High efficiency pumps and motors

In Section 6.4.6.1 daily electricity use was trended against volume of water pumped. By knowing the pressure supplied by the pumps, as well as the flow volume and electricity, the efficiency of the system can be estimated. This was found to be 67%.

Annual energy use (kWh)	758,259
Electricity to flow ratio (kWh/m^3)	0.3733
Electricity to flow ratio (kJ/m^3)	1343.88
Pressure change supplied by pump (kPa)	900
Efficiency of pump + motor system	67%
Efficiency of new pump + motor system	86%
Annual energy with new pumps + motors	593,928
Annual energy saving (kWh)	**164,331**
Annual hours of operation	3800
Demand saving (kW)	**43.25**

Recommendation

Replace the existing pumps at Braemar Rd with high efficiency pumps and motors. This will reduce annual electricity used by 164,000kWh, resulting in an annual cost saving of $21,500 and a carbon emissions reduction of 21,100kg-CO_2e per year. This would require a capex of $46,000, including VSDs, giving a payback period of 2.1 years.

Note, the Braemar Rd pumps do not operate with modulating speed at present as they are direct on line (DOL). If new pumps were installed to operate in the same manner, soft starters would be preferred compared to VSDs, since VSDs consume up to 4% of the power themselves. If speed modulation is to be used, then at least one VSD would be needed for the trim pump.

8.5.2.2 Direct supply

The Braemar Rd pumps operate at 8bar pressure whenever they are running. This is because the pumps only run when the reservoirs are low to top up the reservoirs. 8bar pressure is required to overcome the elevation of the reservoirs relative to the pumps. This pressure is maintained and is effectively what is available to the town supply from the reservoirs. This pressure is much higher than is needed and is reduced via control valves at numerous locations. By reducing pressure with control valves, a portion of the energy that was imparted by the pumps is lost as heat.

A more efficient method is to supply direct to town at a lower pressure setpoint and use a VSD to modulate the pump speed based on demand for water. The reservoirs would be used as backup storage only and replenished periodically.

Annual electricity (kWh)	758,259		delta u = (P1-P2)*v1
Elevation of reservoirs (m)	82		
gravity (m/s^2)	9.8		u = internal energy
Pressure to reservoirs P1, (kPa)	803.6		v = specific volume
Pressure regulated to town P2 (kPa)	750		
specific volume of water v1 (m^3/kg)	0.0011		
Increase in internal energy (kJ/kg)	0.05896		
Specific energy added by pump (kJ/kg)	0.8036		
% of energy converted to heat	7%		
temperature increase of water (degC)	0.01		
% of time supply can go direct to town	80%		
Annual energy saving (kWh)	**44,507**		

Recommendation

Supply direct to town on a pressure setpoint using VSD speed modulation and use the reservoirs as backup storage only. This will reduce losses across pressure reducing valves and save 44,500kWh per year in electricity. This is a cost saving of $5,000 annually and will result in a reduction in carbon emissions of 5,700kg per year. This would cost $24,000 if a VSD was fitted to each motor, resulting in a 4.8 year payback.

One option is to use one VSD only on the 'trim' pump, with the other used as a baseload that is either turned off or is running at 100%. This would result in uneven run hours and maintenance but would require less capital.

8.6 Paul Rd Pump Station

8.6.1 Energy Balance

An Energy Balance is a reconciliation of energy use by each end use technology with the site's invoiced energy consumption. The energy balances in the following sections were generated using information from:

- Electricity invoices and TOU data
- Information about end use equipment load ratings [kW]
- Office/facility opening hours and equipment running hours

8.6.1.1 Electrical Energy Balance

Shown below in Figure 8-12 is the energy balance for electricity consumed at the Whakatane District Council's Paul Rd pump station; the energy balance has been broken down into categories based on end use technology group. The most notable results are:

- Supply pumps are the largest user of electricity at 59%. This consists of three VSD driven pumps, two with 37kW motors and one with an 11kW motor.
- The bore pump uses the remaining 41% of electricity; all other loads are negligible.

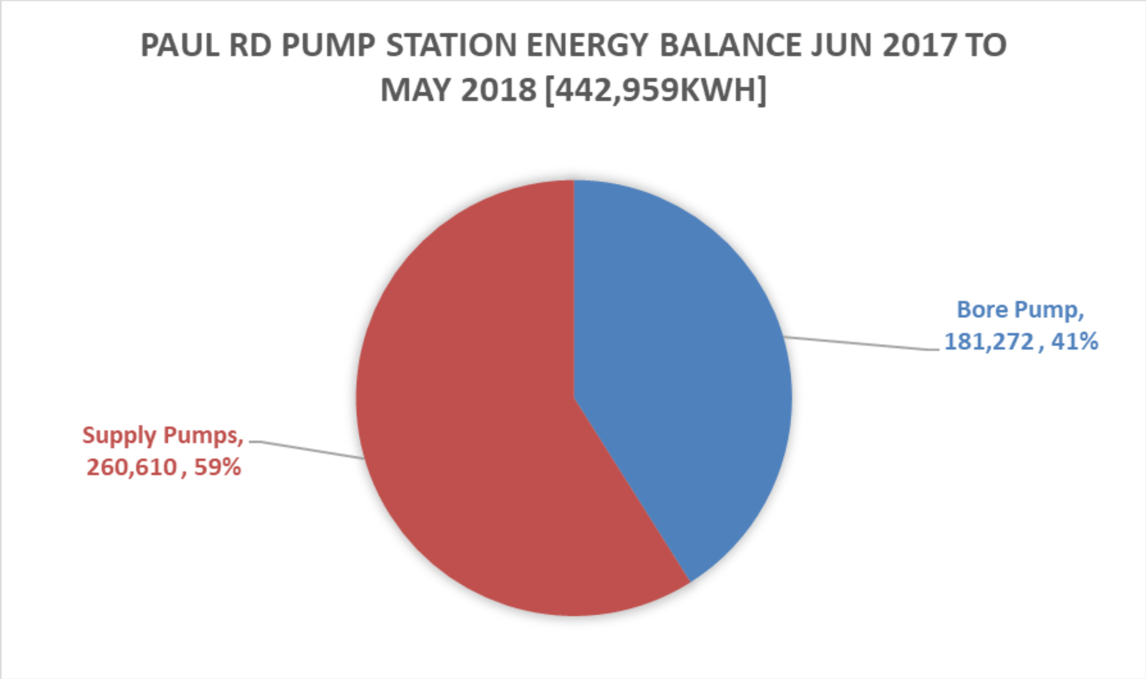


Figure 8-12 - Paul Rd pump station electricity balance Jun 2017 to May 2018

8.6.2 Pumps

The supply pump system installed at Paul Rd is modern with high efficiency pumps that are VSD driven and there is little scope to improve these.

The bore pump similarly is a modern motor and pump, however there was an issue when the pump was installed. The pump that was originally specified ended up being to large to fit in the bore and so a different pump was installed in its place. Details of the actual pump installed could not be found during the audit process and it remains an unknown if the bore pump is operating at its best efficiency point.

Further investigation is needed to understand what pump was installed in the bore and if it has been appropriately sized.

9 Energy Management Programme

Whakatane District Council has a desire to be proactive in mitigating the environmental impacts of its facilities and operations, with a special interest in reducing CO_2 emissions that contribute to climate change. The Whakatāne District Council has commissioned this energy audit as part of this process and to gain a deeper understanding of its energy use and identify and implement energy saving projects that meet its investment criteria.

Furthermore, the Whakatāne District Council aims to be a leader within the Whakatāne district with its energy efficiency and climate change mitigation activities. It has recently obtained a proposal to install photovoltaic solar panels on some of its buildings.

The Whakatāne District Council does not currently have an Energy Management Policy, however its Sustainability Policy notes that there is an intention to have one established. An Energy Action Plan will be incorporated into a Sustainability Policy review in 2019. Whakatāne District Council is fortunate to have a team interested in improving energy efficiency. A number of staff members have an awareness of the processes and technologies involved with energy management, as well as the importance of gathering key energy usage data.

Whakatāne District Council initiated its energy management programme by commissioning this energy audit. Areas for immediate improvement include adopting a site wide energy management policy, formalising roles in energy management, committing appropriate resources, increasing staff awareness and training, and commissioning energy monitoring and reporting.

The potential for savings from improved energy management alone is in the order of 10% or $120,000 a year. This is in addition to savings that otherwise are achieved from an ad hoc approach.

9.1 Policy/ Plan

There is no formal Energy Management Policy and plan in place for Whakatāne District Council sites. Competitive energy prices are sought and energy is primarily paid as another fixed cost as part of council operations.

The introduction of a formal and approved energy management policy (one to two pages only) demonstrates to Councillors, senior management, staff, and the public an on-going commitment to improving energy efficiency. It provides the person, who would be an energy manager for Whakatāne District Council, with the necessary direction to commit appropriate resources for achieving cost effective energy savings.

A policy delivered effectively with support from senior leadership helps motivate management and staff, increasing involvement in helping save energy. It should define the size and resources allocated to ensure that achieving savings comes without the risk of adding an unnecessarily high cost.

An annual energy saving action plan with specific tasks helps ensure ongoing progress. Any energy policy introduced by Whakatāne District Council needs to be totally supported by the Councillors and senior management.

An energy management policy and plan would save in the order of 2% in energy and costs. It is difficult to quantify savings directly attributable to introducing an energy policy and plan; however, based on Emsol’s experience and energy management guides published by EECA, that organisations that have five key energy management principles in place will save 10% more than organisations that do not. A plan should be consistent with ISO 50001, Energy Management Systems.

This will save at Whakatāne District Council $24,000 a year more with an energy management policy and comprehensive energy savings action plan.

Initial costs to produce such a policy would be in the order of $1,500 in time spent and $1,000 a year for maintenance thereafter. Emsol can provide examples of policies and could help make this happen. Contracting Emsol to customise a plan for the Whakatāne District Council would also include ensuring successful implementation.

The recommendations in this audit can be used to help formulate an energy savings action plan.

Recommendation

Produce and activate an approved site energy management policy with a 12 month action plan. Cost $1,500 and savings net $24,000 a year.

9.2 Organisation

“Organisation” is about ensuring the appropriate personnel structure is in place for Whakatāne District Council to deliver improved energy savings in the most efficient manner. Central to any successful energy management programme is a coordinator and driver that makes it happen; otherwise it won’t happen. Whakatāne District Council staff have an interest in this topic, although do not have it as part of their formal responsibility. It is important they have appropriate time available to commit to energy projects as well as their normal day to day responsibilities.

A rule of thumb advised by EECA is to commit one hour of staff time for every $2,000 spent annually on energy. At Whakatāne District Council, this equates to a person spending two days a week in this role. Unless a person/s have the allocated time and resources, energy management will not be enough of a priority among daily activities to happen.

Emsol recommends Whakatāne District Council formalise part time a position in energy management and promote this facilities-wide. This will help achieve the potential savings at Whakatāne District Council. In addition, Whakatāne District Council could commission an energy management specialist to assist the person in this role and provide direction and technical input where required.

This person would:

- Develop a comprehensive and brief energy management plan,
- Formulate a suitable action plan and apply for the requisite funding essential for the energy management policy to be effective
- Raise staff awareness
- Commission monitoring, targeting and reporting achievements
- Coordinate savings projects
- Work with agreements between Whakatāne District Council and maintenance contractors
- Work closely with an energy champion at each facility

The list of recommendations in this energy audit would be used to establish an action list.

In addition, a team involving a member from each main facility site should meet every three months to encourage communications and sharing of ideas across departments. Emsol could also have input to provide guidance.

It would cost approximately $30,000 a year for an energy manager and involvement by other staff at 600 hours a year. These roles are necessary to realise the potential of $60,000 savings a year (5% of annual energy costs, which is a rule of thumb for savings achieved by formalising responsibilities with committed time available). Examples of the types of savings that would be realised include:

- Ensuring equipment and lights operate only when needed
- Reviewing the size and or/control of water pumps
- Fitting automatic controls to control space heating and cooling
- Reducing the water pumping pressure at times by modifying water supply system
- Upgrading lights to LED
- Change temperature set points to match each season

The initial cost to employ and set up this role would be approximately $5,000 in advertising, interviews, training and office equipment.

Recommendation

Whakatāne District Council should formalise the role of one person to be a Council champion for energy management. Sample job descriptions and responsibilities are available from EECA or Emsol. It is recommended this person has management and motivational skills and be the main energy coordinator/ manager. Saving net $30,000 a year and cost $5,000 to set up.

The energy manager needs to implement management and motivating skills, which is as important for this role as applying technical/engineering skills. Alternatively, these skills could be shared amongst a team or supplemented by commissioning an energy management specialist.

9.3 Monitoring

Energy monitoring, targeting and reporting is a key element to any savings programme. This needs to be central to all other aspects of improving energy management.

The potential savings by adopting an improved energy monitoring, targeting and reporting programme at Whakatāne District Council would be in the order of $60,000 a year.

Whakatāne District Council has an extensive number of separate sites and electricity accounts, which can be used to track monthly electricity and natural gas usage over multiple areas. Section 7 contains details on account types and highlights some accounts with inefficient pricing structures.

A key step with using this energy use data is checking it against an expected energy use amount each month. This provides the necessary information to know improvement in energy performance is being achieved.

Emsol recommends Whakatāne District Council monitors energy usage in conjunction with a formalised programme that targets electricity and natural gas usage by departments and areas, further identifying areas of inefficiency and electricity wastage. These need to be evaluated with relevant independent variables, such as ambient temperature and water volume pumped, at least monthly; ideally weekly or daily. Examples are included in section 6.4 for some of the Whakatāne District Council's largest facilities.

Energy monitoring, targeting (M&T) and reporting would save in the order of 5% in energy and costs. It is difficult to quantify savings directly attributable to improving M&T; however, EECA advise that "implementing an M&T programme will lead to savings of 5-25% of the annual energy expenditure. EECA base this estimate on international experience with similar systems. It is assumed at least 5% could be attributed to improved M&T.

Whakatāne District Council will save $60,000 a year more with a comprehensive energy M&T initiative than without one.

The cost to enhance an M&T system with reporting would be in the order of $60,000 including meters and $20,000 a year to maintain and operate it.

Recommendation

Install and train staff in the use and capabilities of an Energy Management M&T System. Cost $60,000. This would contribute to $60,000 net savings a year.

It would be appropriate to summarise energy performance reports in key areas of Whakatāne District Council energy use, and present these to management and staff at least quarterly.

However, these systems do not generate savings on their own; they rely on a commitment from management to examine the information provided and to take action based on the information to reduce energy costs. Data collection mechanisms include:

- Using monthly utility invoices
- Manual meter readings and data entry
- Fully automated data acquisition systems

Recommendation

The first and second mechanisms should be done immediately as a follow on from the data prepared in this report. The six largest energy using sites should be hand-picked and an in-depth energy performance monitoring report provided at least monthly using the principles from IPMVP (International Performance, Measurement, and Verification Protocol).

It is recommended to establish the third using a Proprietary Energy Monitoring and Targeting Software.

This is appropriate for energy bills more than $250,000 per year and/or has more than 10 energy meters.

The advantage of this is that the software supplier customises it and provides support as required. It will be easier to complete advanced data analysis techniques. It will also be simple, for software with the capability to compare energy costs under different tariff scenarios. Proprietary software will also have standard reporting templates established making it easier to produce user-friendly reports that communicate energy use information in a clear and concise way.

A small number of energy management systems, software and hardware exist that can provide this service. A list of features in such a system and in decreasing order of priority for this site is:

- Load monitoring, alarms and control
- Determine energy performance/efficiency
- Highlight performance problems in equipment or systems
- Check the accuracy of energy invoices
- Allocate energy costs to specific departments

- Record energy use, so that projects intended to improve energy efficiency can be checked
- Highlight opportunities for potential energy efficiency improvements
- Tariff analysis
- Energy and cost prediction

9.4 Marketing

There is little formal awareness arising to encourage staff to identify or implement energy efficiency opportunities. For example seeking savings ideas through group problem solving is rarely carried out.

Some individuals are good with closing doors and switching off equipment and lights when not needed; however there are still many opportunities with improving these procedures. This is especially so in vacated rooms, outside canopy, and support service areas, where unnecessary lighting loads add to energy costs.

Seeking ideas, using notice boards, raising awareness at staff meetings and events helps easily and cheaply achieve “buy-in” to the energy efficiency message. Approaching this systematically through group planning and training will increasing the awareness of operators with energy using equipment and result in improved energy savings.

Formally launching an energy savings programme would help start developing an energy saving culture and maintain input from staff. Departmental “brainstorming” following immediately from the formal launch will create innovative ideas and give the staff a sense of belonging to the energy savings programme. Recommendations in this report should be included in this process.

Energy usage charts should be displayed in some staff newsletters or notice boards in the cafeteria. Energy charts should show energy index (energy use/cost per kg product) trends for each month; particularly if the effort by staff is showing a difference. A Business-As-Usual (BAU) line would be included.

Key staff or department supervisors should attend an energy saving workshop or alternately Whakatāne District Council organises internal training workshops for these staff only.

Recommendation

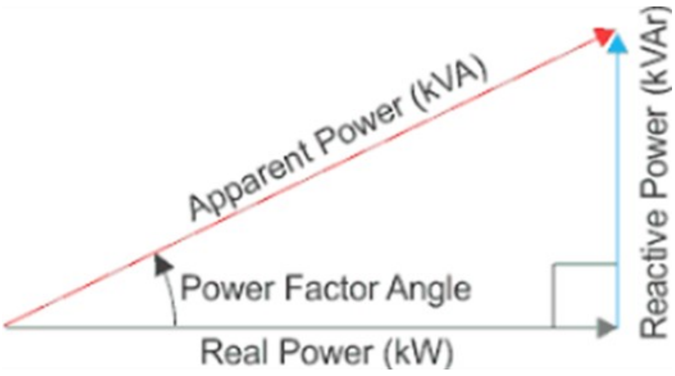
Adopt a formal energy management programme. This would include the following:

- **Announcement of programme plan and person with main role of “Energy Manager”**
- **Hold group brainstorming/planning meetings (perhaps by department)**
- **Include ideas from this report if not already mentioned**
- **Adopt savings ideas**
- **Report back energy use and cost by month and relative to relevant independent variables (eg water supplied, and energy savings should not adversely affect quality)**
- **Possibly introduce a competition across departments**

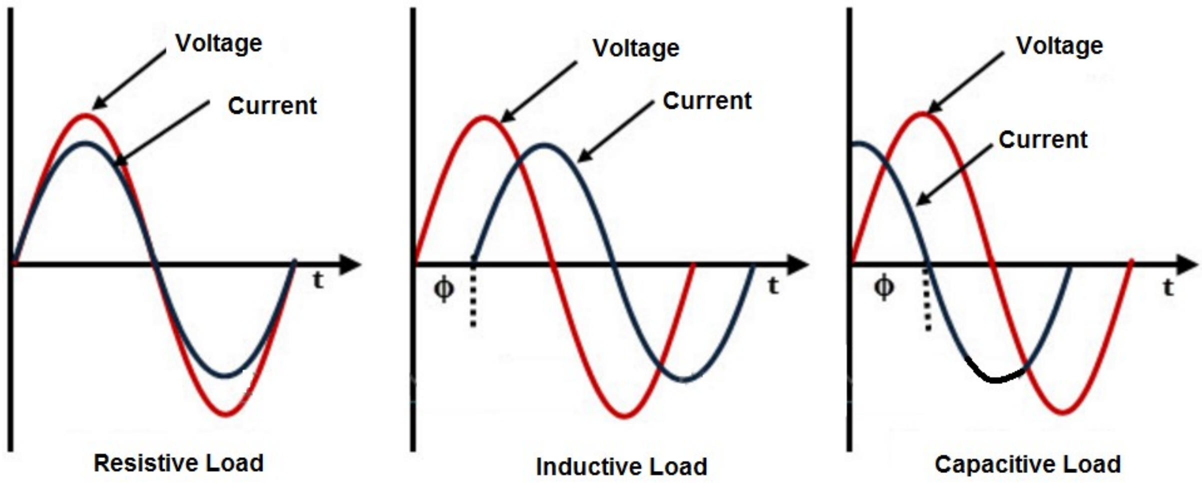
10 Appendices

10.1 Power Factor

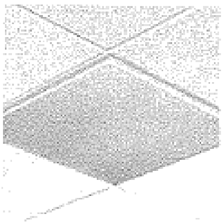
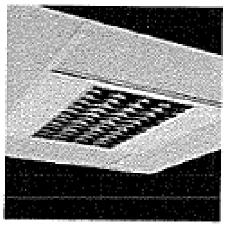
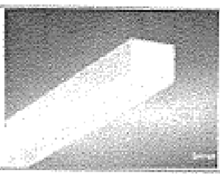
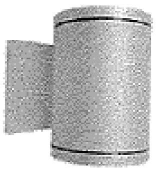
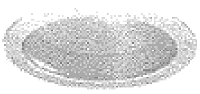
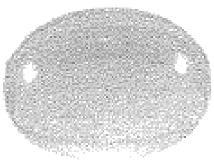
Power Factor is defined as the ratio of Real Power (measured in kW) to Apparent Power (measured in kVA). In AC circuits, when voltage and current are in phase Power Factor is equal to 1. When Power Factor is 1 it means the minimum current is needed to deliver the required electrical energy; as soon as the power factor decreases below 1, a higher current will be needed to deliver the same amount of electrical energy. This causes a small increase in the amount of energy lost as heat from the current carrying wires, but also constrains the electrical network infrastructure. This is why network companies often charge penalties if consumers have power factor below 0.95.

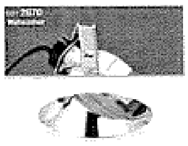
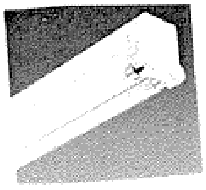
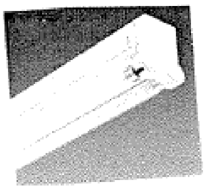
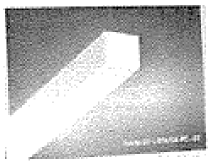
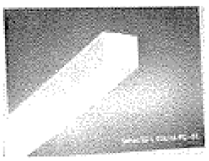


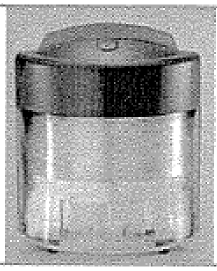
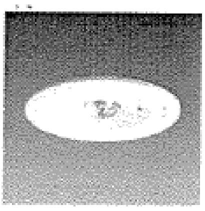
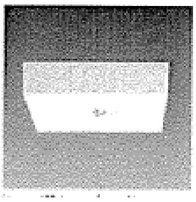
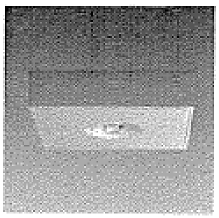
Inductive loads such as motors and some lighting causes voltage to lead current in AC circuits, decreasing the Power Factor. To correct this, banks of capacitors are often installed to return the power factor closer to 1. This is called Power Factor Correction.



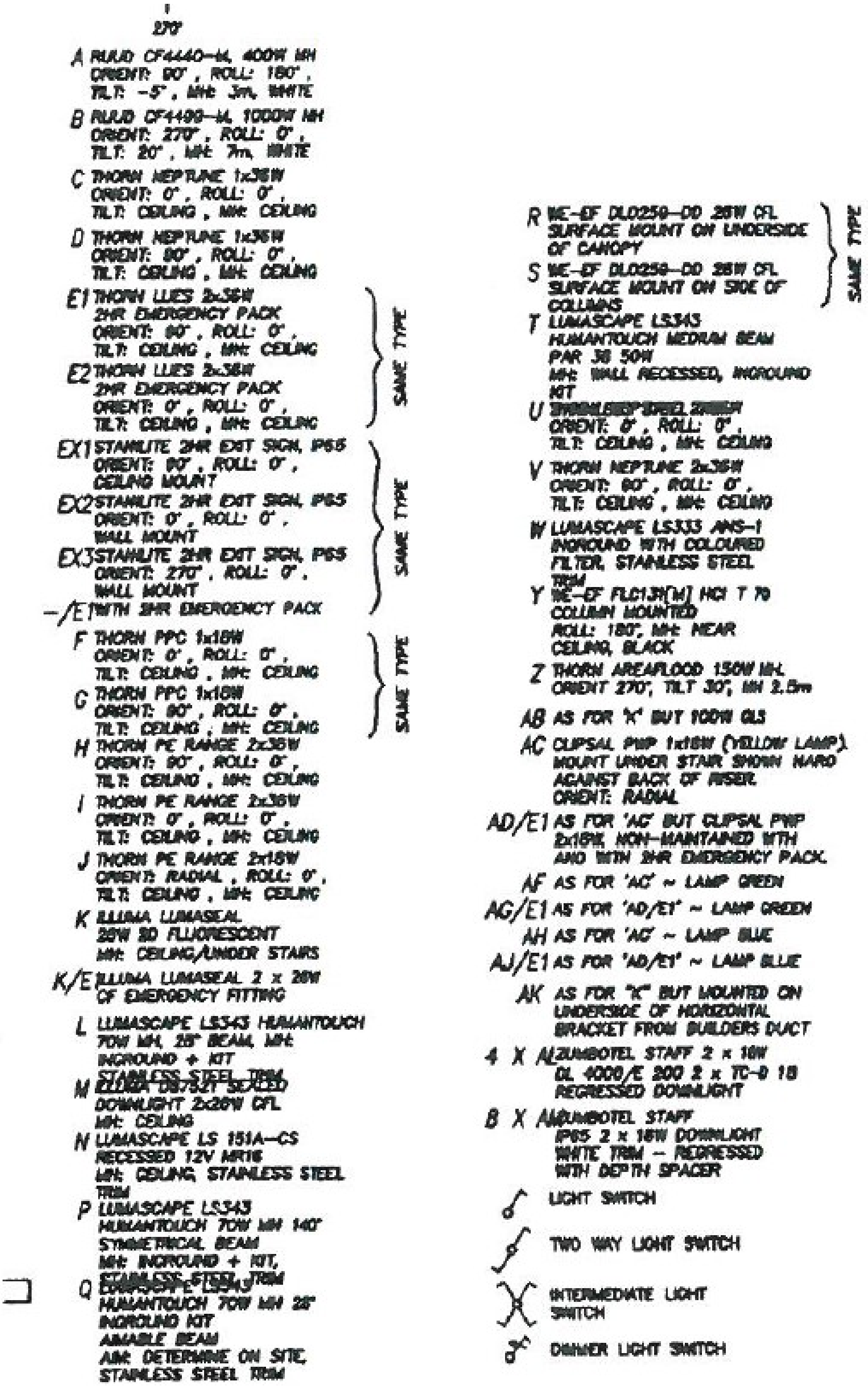
10.2 Te Kōputu Library Lighting Schedule

Type	Image	Supplier	Reference	*Description*
R1		Thorn or approved equivalent from: • Rexel • Philips • Pierlite • Trilux	Quattro T5	4 x14W T5 recessed 600x600 pan module fitted with prismatic diffuser for glare control.
R2		Thorn or approved equivalent from: • Rexel • Philips • Pierlite • Trilux	Quattro T5	4 x14W T5 recessed 600x600 pan module fitted with Louvre for glare control.
UD1		Trilux or approved equivalent from: • Thorn • Rexel • Philips • Pierlite	Solvan H2-L OTA/E	2x35W very slender suspended direct/indirect with plexiglas diffuser. 70(D) x 101 (W). 1-10V dimmable ballast.
UD2		Pelucchi or approved equivalent from: • Thorn • Rexel • Philips • Trilux • Pierlite	pelucchi	1x70W metal halide direct/indirect wall light.
D1		Nimbus or approved equivalent from: • Thorn • Rexel • Philips • Pierlite	DOT1250/02	2x26W TC-D/E recessed round downlight with polished reflector.
D2		Thorn or approved equivalent from • Rexel • Philips • Pierlite • Trilux	1 X 28W TC- HF OP RD WHI	1 x 28W Surface-mounted circular bulkhead with white opal diffuser.

D3		Nimbus or approved equivalent from: • Thorn • Rexel • Philips • Pierlite	Dot 2870	2x26W TC-D/E recessed round wall washer with polished reflector.
F1		Superlux or approved equivalent from: • Thorn • Rexel • Philips • Pierlite	GT5626 GL	1x26W, IP55, wall-mounted under seat fluorescent with opal diffuser. 323L x 116 x 116
S1		Thorn or approved equivalent from: • Trilux • Philips • Pierlite	Arrowslim AST 5235	2 x 35W surface mounted batten fluorescent luminaire. Luminaire spine and lamp holder in black painted finish for Exhibition Gallery 01 to 03. .
S1/E		Thorn or approved equivalent from: • Trilux • Philips • Pierlite	Arrowslim E3STAST5235	2x35W surface-mounted batten fluorescent maintained emergency luminaire
S3		Trilux or approved equivalent from: • Thorn • Rexel • Pierlite	Solvan D2-L OTA 235/E	2x35W very slender surface mounted with plexiglas diffuser. 1-10V dimmable ballast.
P1		Trilux or approved equivalent from: • Thorn • Rexel • Pierlite	Solvan D2-L OTA 235/E complete with wire suspension kit.	2x35W very slender suspended with plexiglas diffuser.

WU1		Trilux or approved equivalent from: • Rexel • Thorn • Pierlite	1 x HIT 35W	1x35W metal halide wall-mounted floodlight.
GR1		Thorn or approved equivalent from: • Rexel • Trilux • Pierlite	Mica L 35W HIT	***Ground recessed uplight. C/W Frosted glass cover and stainless steel frame. IP65***
FL1		Thorn or approved equivalent from: • Phillips	Piazza 2	***18W CFL exterior bulkhead IP65***
E3		Thorn or approved equivalent from Legrand	Voyager LED area MRE	***Recessed-mounted, non-maintained LED area emergency lighting***
E4		Thorn or approved equivalent from Legrand	Voyager LED area MCE	***Wall-mounted, non-maintained emergency lighting***
E5		Thorn or approved equivalent from Legrand	Voyager LED area MCE	***Surfaced-mounted, non-maintained area emergency lighting. Silver Coloured.***

10.3 Aquatic Centre Lighting Schedule



10.4 Site Maps

WHAKATĀNE District Council

whakatane.govt.nz

Aquatic Centre

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Scale: 1:500

Date of issue: 7/06/2018

Author: CB

Library/ Museum

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Date of issue: 7/06/2018 | Author: CB

WHAKATANE District Council

whakatane.govt.nz

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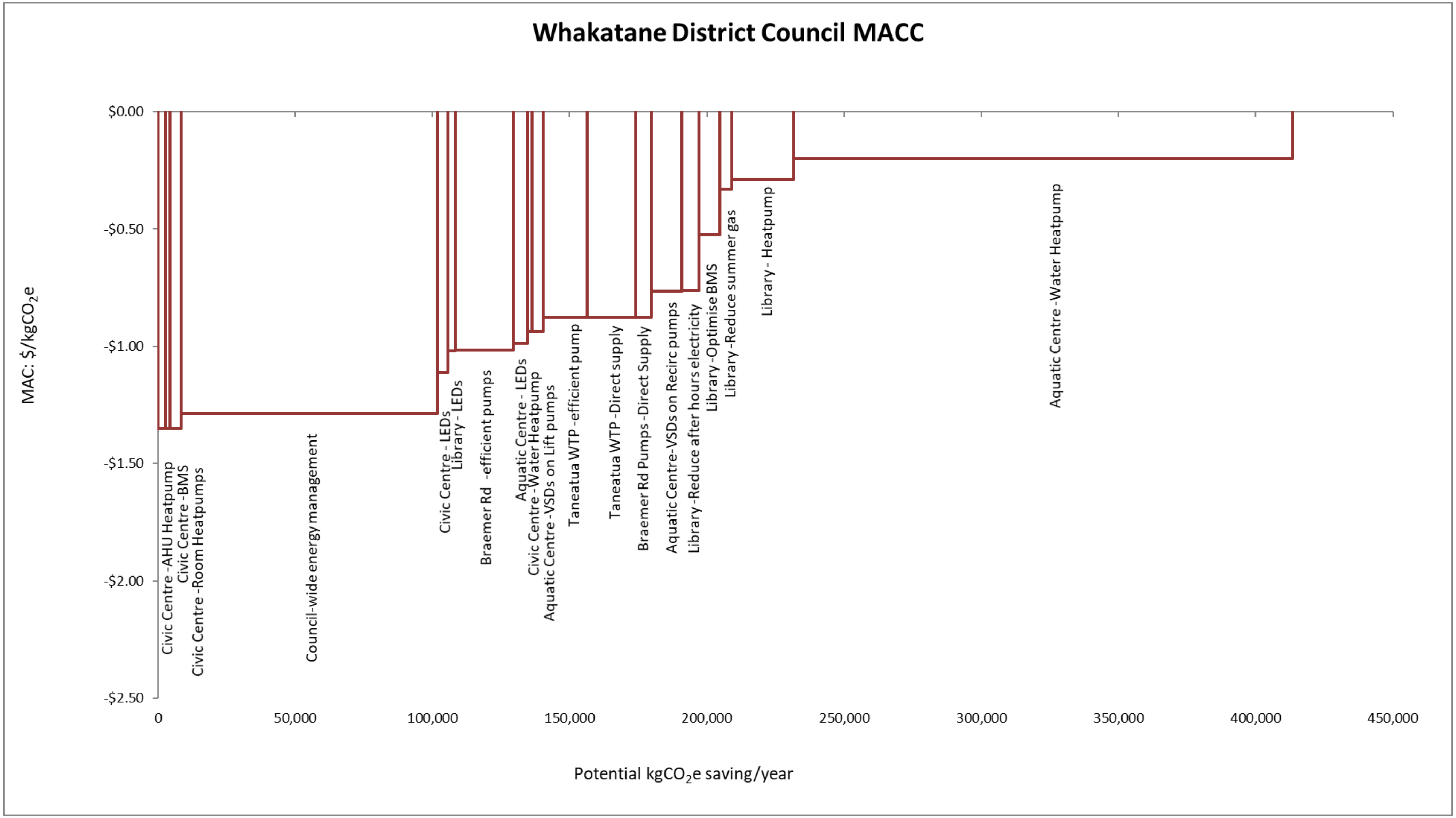

All costs excl. GST

10.5 Energy Balance

10.5.1 Civic Centre

12	Department	Technology	Description	No. of items	kWh/yr	ave load kW	Hours/ year	After hrs (kW)	After hours % load	Process hrs (kW)	Process % load	kW rating per item	After hours/ year	Process hours/ year	Processing hours / week	Hrs/ wk outside process hrs	weeks per year	Days/wk	Hours/ day
13	Level 1	AHU with Electric Heater	WDCAHU1	1	4,500	12.0	375	0.0	0%	12.0	50%	24.0	8385	375	15	153	25	5	3
14	Level 1	AHU with Electric Heater	WDCAHU2	1	4,500	12.0	375	0.0	0%	12.0	50%	24.0	8385	375	15	153	25	5	3
15	Level 1	AHU with Electric Heater	WDCAHU3	1	4,500	12.0	375	0.0	0%	12.0	50%	24.0	8385	375	15	153	25	5	3
16	Level 1	AHU with Electric Heater	WDCAHU4	1	4,500	12.0	375	0.0	0%	12.0	50%	24.0	8385	375	15	153	25	5	3
17	Level 1	AHU with Electric Heater	WDCAHU5	1	4,500	12.0	375	0.0	0%	12.0	50%	24.0	8385	375	15	153	25	5	3
18	Level 2	AHU with Electric Heater	WDCAHU6	1	4,500	12.0	375	0.0	0%	12.0	50%	24.0	8385	375	15	153	25	5	3
19	Level 2	AHU with Electric Heater	WDCAHU7	1	4,500	12.0	375	0.0	0%	12.0	50%	24.0	8385	375	15	153	25	5	3
20	Level 2	AHU with Electric Heater	WDCAHU8	1	4,500	12.0	375	0.0	0%	12.0	50%	24.0	8385	375	15	153	25	5	3
21	Level 2	AHU with Electric Heater	WDCAHU9	1	4,500	12.0	375	0.0	0%	12.0	50%	24.0	8385	375	15	153	25	5	3
22	Level 1	Wall Mounted Electric Heater	WDC1FCH1	1	1,125	3.0	375	0.0	0%	3.0	100%	3.0	8385	375	15	153	25	5	3
23	Level 1	Wall Mounted Electric Heater	WDC1FCH2	1	1,125	3.0	375	0.0	0%	3.0	100%	3.0	8385	375	15	153	25	5	3
24	Level 1	Wall Mounted Electric Heater	WDC1FCH3	1	1,125	3.0	375	0.0	0%	3.0	100%	3.0	8385	375	15	153	25	5	3
25	Level 1	Wall Mounted Electric Heater	WDC1FCH4	1	1,125	3.0	375	0.0	0%	3.0	100%	3.0	8385	375	15	153	25	5	3
26	Level 1	Wall Mounted Electric Heater	WDC1FCH5	1	1,125	3.0	375	0.0	0%	3.0	100%	3.0	8385	375	15	153	25	5	3
27	Level 1	Wall Mounted Electric Heater	WDC1FCH6	1	1,125	3.0	375	0.0	0%	3.0	100%	3.0	8385	375	15	153	25	5	3
28	Level 1	Wall Mounted Electric Heater	WDC1FCH7	1	1,125	3.0	375	0.0	0%	3.0	100%	3.0	8385	375	15	153	25	5	3
29	Level 1	Wall Mounted Electric Heater	WDC1FCH8	1	1,125	3.0	375	0.0	0%	3.0	100%	3.0	8385	375	15	153	25	5	3
30	Level 1	Wall Mounted Electric Heater	WDC1FCH9	1	1,125	3.0	375	0.0	0%	3.0	100%	3.0	8385	375	15	153	25	5	3
31	Level 1	Wall Mounted Electric Heater	WDC1FCH10	1	1,125	3.0	375	0.0	0%	3.0	100%	3.0	8385	375	15	153	25	5	3
32	Level 1	Wall Mounted Electric Heater	WDC1FCH11	1	1,125	3.0	375	0.0	0%	3.0	100%	3.0	8385	375	15	153	25	5	3
33	Level 1	Wall Mounted Electric Heater	WDC1FCH12	1	1,125	3.0	375	0.0	0%	3.0	100%	3.0	8385	375	15	153	25	5	3
34	Level 1	Wall Mounted Electric Heater	WDC1FCH13	1	1,125	3.0	375	0.0	0%	3.0	100%	3.0	8385	375	15	153	25	5	3
35	Level 1	Wall Mounted Electric Heater	WDC1FCH14	1	6,750	6.0	1125	0.0	0%	6.0	100%	6.0	7635	1125	45	123	25	5	9
36	Level 1	Wall Mounted Electric Heater	WDC1FCH15	1	1,125	3.0	375	0.0	0%	3.0	100%	3.0	8385	375	15	153	25	5	3
37	Level 1	Wall Mounted Electric Heater	WDC1FCH16	1	1,125	3.0	375	0.0	0%	3.0	100%	3.0	8385	375	15	153	25	5	3
38	Level 1	Wall Mounted Electric Heater	WDC1FCH17	1	1,125	3.0	375	0.0	0%	3.0	100%	3.0	8385	375	15	153	25	5	3
39	Level 1	Wall Mounted Electric Heater	WDC1FCH18	1	1,125	3.0	375	0.0	0%	3.0	100%	3.0	8385	375	15	153	25	5	3
40	Level 1	Wall Mounted Electric Heater	WDC1FCH19	1	1,125	3.0	375	0.0	0%	3.0	100%	3.0	8385	375	15	153	25	5	3
41	Level 1	Wall Mounted Electric Heater	WDC1FCH20	1	1,125	3.0	375	0.0	0%	3.0	100%	3.0	8385	375	15	153	25	5	3
42	Level 1	Wall Mounted Electric Heater	WDC1FCH21	1	1,125	3.0	375	0.0	0%	3.0	100%	3.0	8385	375	15	153	25	5	3
43	Level 2	Wall Mounted Electric Heater	WDC1FCH22	1	1,125	3.0	375	0.0	0%	3.0	100%	3.0	8385	375	15	153	25	5	3
44	Level 2	Wall Mounted Electric Heater	WDC1FCH23	1	1,125	3.0	375	0.0	0%	3.0	100%	3.0	8385	375	15	153	25	5	3
45	Level 2	Wall Mounted Electric Heater	WDC1FCH24	1	1,125	3.0	375	0.0	0%	3.0	100%	3.0	8385	375	15	153	25	5	3
46	Level 2	Wall Mounted Electric Heater	WDC1FCH25	1	1,125	3.0	375	0.0	0%	3.0	100%	3.0	8385	375	15	153	25	5	3
47	Level 2	Wall Mounted Electric Heater	WDC1FCH26	1	1,125	3.0	375	0.0	0%	3.0	100%	3.0	8385	375	15	153	25	5	3
48	Level 2	Wall Mounted Electric Heater	WDC1FCH27	1	1,125	3.0	375	0.0	0%	3.0	100%	3.0	8385	375	15	153	25	5	3
49	Level 2	Wall Mounted Electric Heater	WDC1FCH28	1	1,125	3.0	375	0.0	0%	3.0	100%	3.0	8385	375	15	153	25	5	3
50	Level 2	Wall Mounted Electric Heater	WDC1FCH29	1	1,125	3.0	375	0.0	0%	3.0	100%	3.0	8385	375	15	153	25	5	3
51	Level 2	Wall Mounted Electric Heater	WDC1FCH30	1	1,125	3.0	375	0.0	0%	3.0	100%	3.0	8385	375	15	153	25	5	3
52	Level 2	Wall Mounted Electric Heater	WDC1FCH31	1	1,125	3.0	375	0.0	0%	3.0	100%	3.0	8385	375	15	153	25	5	3
53	Level 2	Wall Mounted Electric Heater	Cafeteria heaters	3	900	6.0	150	0.0	0%	6.0	100%	2.0	8610	150	10	158	15	5	2

53	Level 2	Wall Mounted Electric Heater	Cafeteria heaters	3	900	6.0	150	0.0	0%	6.0	100%	2.0	8610	150	10	158	15	5	2
54	Level 2	Heatpump	WDC1PACS1	1	236	0.1	2250	0.0	0%	0.1	70%	0.15	6510	2250	45	123	50	5	9
55	Level 2	Heatpump	WDC1PACS1-O	1	3,938	1.8	2250	0.0	0%	1.8	70%	2.5	6510	2250	45	123	50	5	9
56	Level 2	Heatpump	WDC1PACS2	1	236	0.1	2250	0.0	0%	0.1	70%	0.15	6510	2250	45	123	50	5	9
57	Level 2	Heatpump	WDC1PACS2-O	1	3,938	1.8	2250	0.0	0%	1.8	70%	2.5	6510	2250	45	123	50	5	9
58	Level 2	Heatpump	WDC1PACS3	1	3,938	1.8	2250	0.0	0%	1.8	70%	2.5	6510	2250	45	123	50	5	9
59	Level 2	Server Rm Cooling	WDC1PACS4	1	917	0.1	8736	0.0	0%	0.1	70%	0.15	24	8736	168	0	52	7	24
60	Level 2	Server Rm Cooling	WDC1PACS4-O	1	15,288	1.8	8736	0.0	0%	1.8	70%	2.5	24	8736	168	0	52	7	24
61	Level 1	Heatpump	WDC1PACS5	1	236	0.1	2250	0.0	0%	0.1	70%	0.15	6510	2250	45	123	50	5	9
62	Level 1	Heatpump	WDC1PACS5-O	1	3,938	1.8	2250	0.0	0%	1.8	70%	2.5	6510	2250	45	123	50	5	9
63	Level 2	Server Rm Cooling	WDC1PACS6	1	917	0.1	8736	0.0	0%	0.1	70%	0.15	24	8736	168	0	52	7	24
64	Level 2	Server Rm Cooling	WDC1PACS6-O	1	15,288	1.8	8736	0.0	0%	1.8	70%	2.5	24	8736	168	0	52	7	24
65	Level 1	Heatpump	WDC1PACS7	1	236	0.1	2250	0.0	0%	0.1	70%	0.15	6510	2250	45	123	50	5	9
66	Level 1	Heatpump	WDC1PACS7-O	1	3,938	1.8	2250	0.0	0%	1.8	70%	2.5	6510	2250	45	123	50	5	9
67	Level 1	Heatpump	WDC1PACS8	1	236	0.1	2250	0.0	0%	0.1	70%	0.15	6510	2250	45	123	50	5	9
68	Level 1	Heatpump	WDC1PACS8-O	1	3,938	1.8	2250	0.0	0%	1.8	70%	2.5	6510	2250	45	123	50	5	9
69	Level 1	Extraction Fan	WDC1VTL1	1	222	0.3	750	0.0	0%	0.3	80%	0.37	8010	750	15	153	50	5	3
70	Level 1	Extraction Fan	WDC1VTL2	1	480	0.6	750	0.0	0%	0.6	80%	0.80	8010	750	15	153	50	5	3
71	Level 2	Extraction Fan	WDC1VTL3	1	222	0.3	750	0.0	0%	0.3	80%	0.37	8010	750	15	153	50	5	3
72	Level 1	Extraction Fan	WDC1VTL2	1	480	0.6	750	0.0	0%	0.6	80%	0.80	8010	750	15	153	50	5	3
73	Level 2	Extraction Fan	WDC1VTL4	1	222	0.3	750	0.0	0%	0.3	80%	0.37	8010	750	15	153	50	5	3
74	Level 2	Extraction Fan	WDC1VTL5	1	222	0.3	750	0.0	0%	0.3	80%	0.37	8010	750	15	153	50	5	3
75	Level 2	Extraction Fan	WDC1VTL6	1	222	0.3	750	0.0	0%	0.3	80%	0.37	8010	750	15	153	50	5	3
76	Level 2	Extraction Fan	WDC1VTL7	1	518	0.3	1750	0.0	0%	0.3	80%	0.37	7010	1750	35	133	50	5	7
77	Level 2	Extraction Fan	WDC1VTL8	1	222	0.3	750	0.0	0%	0.3	80%	0.37	8010	750	15	153	50	5	3
78	Level 2	Extraction Fan	WDC1VTL9	1	518	0.3	1750	0.0	0%	0.3	80%	0.37	7010	1750	35	133	50	5	7
79	Level 2	Extraction Fan	WDC1VTL10	1	222	0.3	750	0.0	0%	0.3	80%	0.37	8010	750	15	153	50	5	3
80	Level 2	Extraction Fan	WDC1VTL11	1	222	0.3	750	0.0	0%	0.3	80%	0.37	8010	750	15	153	50	5	3
81	Level 2	Extraction Fan	WDC1VTL12	1	222	0.3	750	0.0	0%	0.3	80%	0.37	8010	750	15	153	50	5	3
82	Level 2	Extraction Fan	WDC1VTL13	1	222	0.3	750	0.0	0%	0.3	80%	0.37	8010	750	15	153	50	5	3
83	Level 2	Extraction Fan	WDC1VTL14	1	222	0.3	750	0.0	0%	0.3	80%	0.37	8010	750	15	153	50	5	3
84	Level 1	Lighting	Fluoro tubes	120	26,460	11.8	2250	0.0	0%	11.8	70%	0.14	6510	2250	45	123	50	5	9
85	Level 2	Lighting	Fluoro tubes	116	25,578	11.4	2250	0.0	0%	11.4	70%	0.14	6510	2250	45	123	50	5	9
86	Level 1	Lighting	Incandescent	30	1,620	0.7	2250	0.0	0%	0.7	40%	0.06	6510	2250	45	123	50	5	9
87	Level 2	Lighting	Incandescent	30	1,620	0.7	2250	0.0	0%	0.7	40%	0.06	6510	2250	45	123	50	5	9
88	Level 1	Lighting	Outside Lighting	20	7,812	0.9	8760	1.2	40%	0.0	0%	0.15	6510	2250	45	123	50	5	9
89	Level 1	Office Equipment	Computers	120	25,574	2.9	8760	1.4	20%	7.2	100%	0.06	6510	2250	45	123	50	5	9
90	Level 2	Office Equipment	Computers	140	29,837	3.4	8760	1.7	20%	8.4	100%	0.06	6510	2250	45	123	50	5	9
91	Level 2	Server Rm	Server Rm	1	87,600	10.0	8760	10.0	100%	10.0	100%	10.0	24	8736	168	0	52	7	24
92	Level 2	Hot water cylinder	3kW hot water Cylinder	2	19,818	2.3	8760	1.8	30%	3.6	60%	3.0	6510	2250	45	123	50	5	9
93	Level 2	Kitchen Equipment	Refrigerator	3	3,679	0.4	8760	0.4	70%	0.4	70%	0.2	24	8736	168	0	52	7	24
94	Level 2	Kitchen Equipment	Miscellaneous items	5	2,250	2.0	1125	0.0	0%	2.0	80%	0.5	7635	1125	45	123	25	5	9
95	Level 2	Office Equipment	Miscellaneous items	10	3,228	0.4	8760	0.3	10%	1.5	50%	0.3	8260	500	10	158	50	5	2
96	Level 1	Office Equipment	Miscellaneous items	10	3,228	0.4	8760	0.3	10%	1.5	50%	0.3	8260	500	10	158	50	5	2
97	Level 1	Portable fans and heaters	Heaters	15	2,700	18.0	150	0.0	0%	18.0	80%	1.5	8610	150	10	158	15	5	2
98	Level 2	Portable fans and heaters	Heaters	20	3,600	24.0	150	0.0	0%	24.0	80%	1.5	8610	150	10	158	15	5	2
99	Level 1	Portable fans and heaters	Desk Fans	15	360	2.4	150	0.0	0%	2.4	80%	0.2	8610	150	10	158	15	5	2
100	Level 2	Portable fans and heaters	Desk Fans	20	480	3.2	150	0.0	0%	3.2	80%	0.2	8610	150	10	158	15	5	2

10.5.2 Aquatic Centre

12	Department	Technology	Description	No. of items	kWh/yr	ave load kW	Hours/ year	After hrs (kW)	After hours % load	Process hrs (kW)	Process % load	kW rating per item	After hours/ year	Process hours/ year	Processing hours / week	Hrs/ wk outside process hrs	weeks per year	Days/wk	Hours/ day
13	Water heating	Heatpumps	Heatpump compressors	2	262,800	30.0	8760	30.0	50%	30.0	50%	30.000	4028	4732	91	77	52	7	13
14	Air handling	Fans	AHU4	8	323,808	37.0	8760	24.0	20%	48.0	40%	15.000	4028	4732	91	77	52	7	13
15	Air handling	Fans	AHU1 and AHU2 exhaust fans	2	19,030	2.2	8760	1.2	20%	3.0	50%	3.000	4028	4732	91	77	52	7	13
16	Air handling	Heatpumps	AHU3	1	39,420	4.5	8760	4.5	50%	4.5	50%	9.000	4028	4732	91	77	52	7	13
17	Toddlers Pool	Pumps	Recirc Pump (4)	1	64,474	7.4	8760	7.4	80%	7.4	80%	9.200	4028	4732	91	77	52	7	13
18	Toddlers Pool	Pumps	Lift pump	1	28,032	3.2	8760	3.2	80%	3.2	80%	4.000	4028	4732	91	77	52	7	13
19	Spa Pool	Pumps	Recirc pump	1	64,474	7.4	8760	7.4	80%	7.4	80%	9.200	4028	4732	91	77	52	7	13
20	Spa Pool	Pumps	Lift pump (5)	1	21,024	2.4	8760	2.4	80%	2.4	80%	3.000	4028	4732	91	77	52	7	13
21	Indoor Pool	Pumps	Recirc Pump (2)	1	105,120	12.0	8760	12.0	80%	12.0	80%	15.000	4028	4732	91	77	52	7	13
22	Indoor Pool	Pumps	Lift Pump	1	52,560	6.0	8760	6.0	80%	6.0	80%	7.500	4028	4732	91	77	52	7	13
23	Outdoor Pool	Pumps	S/F 1 Pump	1	22,176	4.4	5040	0.0	0%	4.4	80%	5.500	3720	5040	168	0	30	7	24
24	Outdoor Pool	Pumps	S/F 2 Pump	1	30,240	6.0	5040	0.0	0%	6.0	80%	7.500	3720	5040	168	0	30	7	24
25	Water heating	Pumps	Heatpump plantroom pump 1 (VSD)	1	6,833	0.8	8760	0.8	60%	0.8	60%	1.300	4028	4732	91	77	52	7	13
26	Water heating	Pumps	Heatpump plantroom pump 2 (DOL)	1	23,652	2.7	8760	2.7	90%	2.7	90%	3.000	4028	4732	91	77	52	7	13
27	Water heating	Pumps	Heatpump plantroom pump 3 (DOL)	1	23,652	2.7	8760	2.7	90%	2.7	90%	3.000	4028	4732	91	77	52	7	13
28	Lighting	Lighting	Type B	9	34,070	7.2	4732	0.0	0%	7.2	80%	1.000	4028	4732	91	77	52	7	13
29	Lighting	Lighting	Type Y	13	3,445	0.7	4732	0.0	0%	0.7	80%	0.070	4028	4732	91	77	52	7	13
30	Lighting	Lighting	Type D	13	1,772	0.4	4732	0.0	0%	0.4	80%	0.036	4028	4732	91	77	52	7	13
31	Lighting	Lighting	Type K	17	1,673	0.4	4732	0.0	0%	0.4	80%	0.026	4028	4732	91	77	52	7	13
32	Lighting	Lighting	Type T	4	757	0.2	4732	0.0	0%	0.2	80%	0.050	4028	4732	91	77	52	7	13
33	Lighting	Lighting	Type I	14	3,816	0.8	4732	0.0	0%	0.8	80%	0.072	4028	4732	91	77	52	7	13
34	Lighting	Lighting	Type U	15	1,476	0.3	4732	0.0	0%	0.3	80%	0.026	4028	4732	91	77	52	7	13
35	Lighting	Lighting	Type V	1	273	0.1	4732	0.0	0%	0.1	80%	0.072	4028	4732	91	77	52	7	13
36	Lighting	Lighting	Type C	10	1,363	0.3	4732	0.0	0%	0.3	80%	0.036	4028	4732	91	77	52	7	13
37	Lighting	Lighting	Type A	10	15,142	3.2	4732	0.0	0%	3.2	80%	0.400	4028	4732	91	77	52	7	13
38	Lighting	Lighting	Type L	10	2,650	0.6	4732	0.0	0%	0.6	80%	0.070	4028	4732	91	77	52	7	13
39	Lighting	Lighting	Type R	8	787	0.2	4732	0.0	0%	0.2	80%	0.026	4028	4732	91	77	52	7	13
40	Lighting	Lighting	Type AL	4	545	0.1	4732	0.0	0%	0.1	80%	0.036	4028	4732	91	77	52	7	13
41	Lighting	Lighting	Type S	3	295	0.1	4732	0.0	0%	0.1	80%	0.026	4028	4732	91	77	52	7	13
42	Lighting	Lighting	Type AM	8	1,090	0.2	4732	0.0	0%	0.2	80%	0.036	4028	4732	91	77	52	7	13
43	Lighting	Lighting	Type M	1	212	0.0	4732	0.0	0%	0.0	80%	0.056	4028	4732	91	77	52	7	13
44	Lighting	Lighting	Type N	6	454	0.1	4732	0.0	0%	0.1	80%	0.020	4028	4732	91	77	52	7	13
45	Lighting	Lighting	Tpe E1	6	3,784	0.4	8760	0.4	100%	0.4	100%	0.072	4028	4732	91	77	52	7	13
46	Lighting	Lighting	Type E2	7	4,415	0.5	8760	0.5	100%	0.5	100%	0.072	4028	4732	91	77	52	7	13

 All costs excl. GST

10.5.3 Te Kōputu Library

12	Department	Technology	Description	No. of items	kWh/yr	ave load kW	Hours/ year	After hrs (kW)	After hours % load	Process hrs (kW)	Process % load	kW rating per item	After hours/ year	Process hours/ year	Processing hours / week	Hrs/ wk outside process hrs	weeks per year	Days/wk	Hours/ day
13	Library	Lighting	D3	35	6,814	1.8	3744	0.0	0%	1.8	100%	0.052	5016	3744	72	96	52	6	12
14	Library	Lighting	R2	4	839	0.2	3744	0.0	0%	0.2	100%	0.056	5016	3744	72	96	52	6	12
15	Library	Lighting	R1	39	8,177	2.2	3744	0.0	0%	2.2	100%	0.056	5016	3744	72	96	52	6	12
16	Library	Lighting	D1	22	4,283	1.1	3744	0.0	0%	1.1	100%	0.052	5016	3744	72	96	52	6	12
17	Exhibition Centre	Lighting	S1	18	4,717	1.3	3744	0.0	0%	1.3	100%	0.070	5016	3744	72	96	52	6	12
18	Other Spaces	Lighting	S1	20	5,242	1.4	3744	0.0	0%	1.4	100%	0.070	5016	3744	72	96	52	6	12
19	Other Spaces	Lighting	S3	20	5,242	1.4	3744	0.0	0%	1.4	100%	0.070	5016	3744	72	96	52	6	12
20	Other Spaces	Lighting	D2	7	734	0.2	3744	0.0	0%	0.2	100%	0.028	5016	3744	72	96	52	6	12
21	Other Spaces	Lighting	UD2	11	2,883	0.8	3744	0.0	0%	0.8	100%	0.070	5016	3744	72	96	52	6	12
22	Other Spaces	Lighting	UD1	12	3,145	0.8	3744	0.0	0%	0.8	100%	0.070	5016	3744	72	96	52	6	12
23	External	Lighting	WU1	22	3,862	0.4	8760	0.8	100%	0.0	0%	0.035	5016	3744	72	96	52	6	12
24	External	Lighting	F1	10	1,304	0.1	8760	0.3	100%	0.0	0%	0.026	5016	3744	72	96	52	6	12
25	External	Lighting	GR1	2	351	0.0	8760	0.1	100%	0.0	0%	0.035	5016	3744	72	96	52	6	12
26	Other Spaces	Office Equipment	Computers	40	11,393	1.3	8760	0.5	20%	2.4	100%	0.060	5016	3744	72	96	52	6	12
27	Other Spaces	Office Equipment	Miscellaneous	10	7,502	0.9	8760	0.6	20%	1.2	40%	0.300	5016	3744	72	96	52	6	12
28	Services	Fans	Ventilation fans	10	14,252	1.6	8760	1.1	35%	2.4	80%	0.300	5016	3744	72	96	52	6	12
29	Services	Chillers	A/C Chiller	1	92,641	10.6	8760	6.8	35%	15.6	80%	19.500	5016	3744	72	96	52	6	12
30	Exhibition Centre	Lighting	Exhibition lights	30	629	0.2	3744	0.0	0%	0.2	80%	0.007	5016	3744	72	96	52	6	12

10.5.4 Whakatāne Water Treatment Plant

12	Department	Technology	Description	No. of items	kWh/yr	ave load kW	Hours/ year	After hrs (kW)	After hours % load	Process hrs (kW)	Process % load	kW rating per item	After hours/ year	Process hours/ year	Processing hours / week	Hrs/ wk outside process hrs	weeks per year	Days/wk	Hours/ day
13	Low Lift Pump	Low Lift Pumps	Low lift 3	1	105,120	12.0	8760	12.0	80%	12.0	80%	15.0	4392	4368	84	84	52	7	12
14	Low Lift Pump	Low Lift Pumps	Low lift 2	1	52,416	12.0	4368	0.0	0%	12.0	80%	15.0	4392	4368	84	84	52	7	12
15	Low Lift Pump	Low Lift Pumps	LL1 Sutherlands Lake P	1	105,120	12.0	8760	12.0	80%	12.0	80%	15.0	24	8736	168	0	52	7	24
16	High Lift Pump	High Lift Pumps	High lift 3	1	780,754	89.1	8760	99.0	75%	79.2	60%	132.0	4392	4368	84	84	52	7	12
17	High Lift Pump	High Lift Pumps	High lift 2	1	345,946	79.2	4368	0.0	0%	79.2	60%	132.0	4392	4368	84	84	52	7	12
18	High Lift Pump	High Lift Pumps	High lift 1	1	0	0.0	4368	0.0	0%	0.0	0%	132.0	4392	4368	84	84	52	7	12
19	Other	Air Compressors	Kaeser SM12	1	19,674	2.2	8760	0.8	10%	3.8	50%	7.5	4392	4368	84	84	52	7	12
20	Other	Miscellaneous	UV Treatment	3	13,759	3.2	4368	0.0	0%	3.2	30%	3.5	4392	4368	84	84	52	7	12
21	Office	Lighting	Office lights	30	9,173	2.1	4368	0.0	0%	2.1	100%	0.07	4392	4368	84	84	52	7	12
22	Office	Office Equipment	Computers etc	10	3,411	0.4	8760	0.2	30%	0.6	100%	0.1	4392	4368	84	84	52	7	12

10.5.5 Braemar Rd Pump Station

12	Department	Technology	Description	No. of items	kWh/yr	ave load kW	Hours/ year	After hrs (kW)	After hours % load	Process hrs (kW)	Process % load	kW rating per item	After hours/ year	Process hours/ year	Processing hours / week	Hrs/ wk outside process hrs	weeks per year	Days/wk	Hours/ day
13	Pumps	Pumps	Water Pump	2	758,259	200.3	3786	0.0	0%	200.3	90%	111.9	4974.4	3786	73	95	52	7	10

10.5.6 Paul Rd Pump Station

12	Department	Technology	Description	No. of items	kWh/yr	ave load kW	Hours/ year	After hrs (kW)	After hours % load	Process hrs (kW)	Process % load	kW rating per item	After hours/ year	Process hours/ year	Processing hours / week	Hrs/ wk outside process hrs	weeks per year	Days/wk	Hours/ day
13	Bore Pump	Pumps	Bore pump	1	181,272	41.5	4368	0.0	0%	41.5	100%	41.5	4392	4368	84	84	52	7	12
14	Supply Pumps	Pumps	Supply pump system	1	260,610	29.8	8760	29.8	35%	29.8	35%	85.0	4392	4368	84	84	52	7	12