Energy and utilities context paper for Waipapa Taumata Rau's Sustainability Strategy Development

Energy and utilities are a significant factor in any sustainability strategy and carbon inventory. The two most widely recognised ways to measure carbon and report progress are the ISO 14064-1 (ISO) and the Greenhouse Gas Protocol (GHG). These were established over two decades ago and initially focused on direct emissions (i.e., emissions resulting from the organisation's own activities or assets – e.g., burning fossil fuels, refrigerant use) and those from purchased energy (e.g., electricity from the grid).

Carbon associated with water in Auckland is predominantly that from wastewater treatment, including the methane released at treatment plants and the energy used in the treatment process.

Energy and utilities must be supplied and consumed appropriately in order to meet our carbon targets and commitments to the UN Sustainable Development Goals.

This paper summarises the University's status and approach to energy (electricity and gas) and utilities within the National context and future alignment to our emerging Sustainability Strategy.

1. Electricity

Whilst New Zealand is highly reliant on importation of energy for transport fuels, it is self-sufficient for the energy and utilities that are used in buildings, such as electricity, gas and water.

1.1National Context

Electricity is what keeps buildings occupiable. It powers work tools, provides light, pumps water, supplies ventilation, provides cooling and distributes heating. Regardless of how it is supplied, it is necessary. It should be treated as a precious resource and used as efficiently as possible.

In 2020 electricity generation in New Zealand was approximately 55% hydro-electric, 18% geothermal, 18% fossil fuel, 5% wind and 4% miscellaneous. Wind, solar and geothermal capacities are all increasing with several large wind and solar farms currently being designed. During dry years there is an increase in the amount of gas and coal fired generation to compensate for low lake levels.

There is a high degree of vertical integration between electricity generation and retail as the 5 main retail companies are also the main generating companies (referred to as Gentailers). The three largest Gentailers are 51% government owned.

Whilst the New Zealand electricity market is physically isolated from other countries, the Tiwai Point aluminium smelter, which uses approximately 15% of New Zealand's electricity, has a significant impact on the electricity market with tenders and contract prices being noticeably affected by announcements or expectations around the smelter's ongoing operations. A lower level impacting risk is the international price of low-grade thermal coal, which we import to burn at Huntly during dry years. The largest short-term volatility in electricity pricing in New Zealand is related to rainfall in the hydro-electric lakes' catchment areas.

The NZ Government has an 'aspirational goal' for NZ's bulk electricity generation to become 100% renewable during a normal rainfall year by 2035, although they do not have direct control over or ability to instruct generators how to generate. Protecting against dry year risk is a real problem that requires very large investment(s). As New Zealand moves towards a greater percentage of renewable electricity, the University's carbon footprint associated with electricity will decrease proportionally.

1.2 University Position

Electricity consumption represents 9.1% of the carbon footprint of the University and 53% of the energy related emissions.

In 2019 we used 71,000,000 kWh of electricity.

The University has 227 buildings that are supplied by mains electricity.

The increase in severe weather events that have been predicted in climate change models can both impact on the infrastructure supplying the electricity and increase the amount of electricity we need to use. E.g. the increase in the number of hot humid days will increase the amount of electricity used to keep our buildings comfortable.

Other impacts can include things like the recent Covid pandemic where, as a health response, we increased the outside air supply to our buildings which has resulted in additional electricity use to cool that warmer air.

The utilisation of space vs consumption of utilities is not always a tight relationship. When there are only a few occupants in a large building, such as during Covid with a lot of staff working from home, the small number of essential staff on site still have a significant heating and cooling load as the air conditioning in most buildings is either all on or all off.

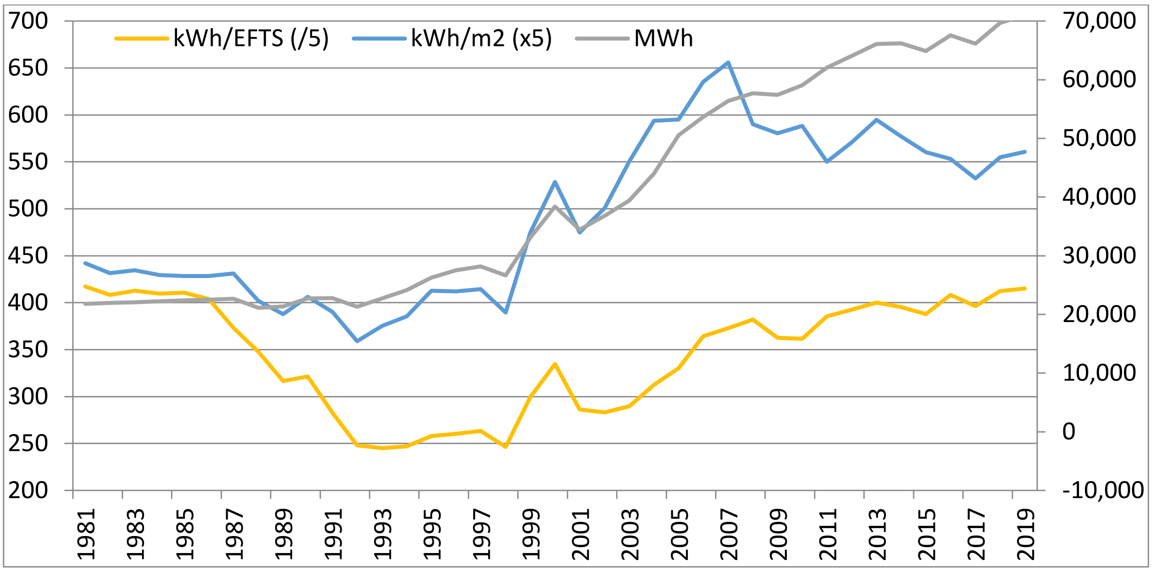
Other than some small installations for research, the University does not yet have any self-generation of electricity from photovoltaic (PV) panels, although the upgrade of B201 includes for a roof-mounted PV array which will generate up to 10% of that building's predicted needs.

Our most recent electricity procurement tender in October 2021 included the requirement for independent certification of the electricity supplied being from 100% renewable sources for a three-year contract term. This covers approximately 50% of our total electricity load which will show an approximate 50% reduction in carbon emissions associated with electricity from 1 October 2021. Our small electricity supply points, which represent only 1.5% of our electricity consumption, are also supplied by a retailer that has been certified by Toitu Envirocare as being 100% carbon neutral.

Our next large electricity tender is scheduled for Q3 2022 when we will look to procure from renewably generated and/or carbon neutral suppliers. The University has also started investigating options for a large scale PV generation scheme as part of its long term electricity supply.

Historic Consumption

This graph shows the total electricity used over the last 40 years, as well as the relationship between electricity consumption per FTE equivalent student numbers and m^2 floor areas.



* note: multipliers are used to bring things towards a common starting point, so that the relative changes between the indices are more easily interpretable.

There have been a large number of end-use efficiency projects over the years, improvements have seen buildings powered down after hours, more efficient operating plant, lighting and equipment; light and motion sensors minimising energy use in empty or naturally lit rooms; computers, screens and printing equipment upgraded to power down when not in use; targeted cooling systems in data centres; and energy efficiency incorporated in building design, fit-out and operation.

As a result of this sustained effort, our buildings are now more energy efficient than when monitoring first started. And despite increases in both student numbers and the physical size of the University, the total energy consumption has not increased by the same scale.

In 2019 we used the same amount of electricity per EFTS and 25% more electricity per m2 of building area than in 1981. Whilst we had some good efficiency improvements in the late 1980s and early 1990s, we have since had a significant increase in air conditioning across our portfolio and increasing amounts of office and technical research equipment.

Overall the absolute increase in electricity consumption since 1981 has been 225%, which compares to a 225% increase in student numbers and 155% increase in built area.

As we move away from using gas for space and water heating, the amount of electricity used can be expected to increase.

2. Gas

2.1 National Context

Gas is less essential to the University as the space and water heating it provides could alternatively be created from electricity. Gas though will not get 'greener' from changes in production, it does not have the option of supply chain certified off-sets and it is a significant element in our carbon footprint. Therefore, we must focus strongly on investing in plant and equipment upgrades to reduce our use of gas.

Most of New Zealand's gas infrastructure is below ground, therefore its supply is not as impacted by weather extremes, although, as with electricity, the amount of it we use will change in line with weather changes.

Gas in New Zealand is produced privately via on-shore and off-shore fields in Taranaki. It is transmitted by privately-owned high-pressure transmission pipelines to most regions in the North Island. Petrochemical companies, such as Methanex, are the largest consumers (51%), followed by electricity generators (26.5%). Gas demand for electricity generation fluctuates according to hydro water levels and the availability of other renewable forms of generation, such as wind. The industrial sector uses 14.8% of total gas supplied, with the commercial (which includes universities) and residential sectors using only 7.7% of total gas supplied.

With no gas infrastructure connections with other countries, the New Zealand gas market is relatively isolated from the rest of the world. However, the short-term price of gas is influenced by the world price of methanol which is Methanex's main export product.

In the last two years NZ gas supply has been constrained due to infrastructure issues on both off-shore drilling rigs and on-shore pipelines. This has impacted pricing and available volumes for supply to the commercial and residential sectors.

Whilst there has been a ban on issuing new consents for off-shore prospecting, there are no restrictions on new exploration in off-shore areas where prospecting consents have already been issued and no curtailment of the ability to consent onshore prospecting.

The NZ Government is currently considering bans on new residential connections to gas and has financial incentive programmes to encourage commercial and industrial users to switch from gas to electricity. The University has already benefited from a decarbonisation grant to change B250 heating from gas to electric heat pumps and we expect to be participating further with these grant schemes.

As the cost of carbon increases, so will the cost of gas.

2.2University Position

Gas consumption represents 7.1% of the carbon footprint of the University and 42% of the energy related emissions.

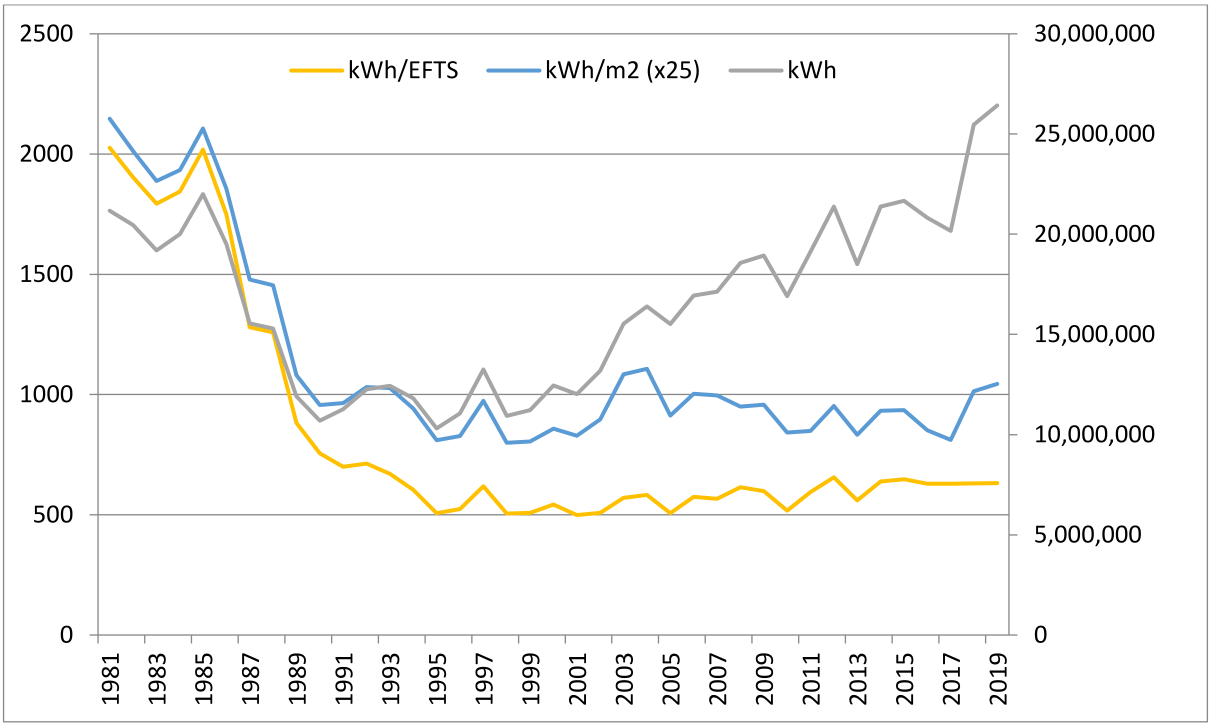
In 2019 the University used 26,500,000 kWh of gas.

Only 50 of the University's buildings are supplied by gas or by heating hot water from gas-fired boilers in adjacent buildings, but these are generally our largest 50 buildings.

Nearly all of the gas is used for space heating and domestic hot water, with a small amount directly used in laboratories or related academic direct use.

Historic Consumption

This graph shows the total gas used over the last 40 years, as well as the relationship between full time equivalent student numbers and m^2 floor areas.



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In 2019 we used half of the amount of gas per m2 of built area and less than one third of the gas per EFTS than in 1981. In absolute terms the total amount of gas used increased by 25%, despite a 225% increase in student numbers and 155% increase in built area.

The large decrease in gas use at the beginning of this graph relates to a major energy savings project to decommission a large central boiler plant that pumped high temperature hot water a long distance around our city campus buildings to having a large number of smaller localised boilers for heating. A lot of the boilers installed at that time have started to reach the end of their economic life, affording us the opportunity for the next generation of upgrades, i.e. some form of electrically driven equipment. In addition to the major heating system changes we also upgraded our control systems to the forerunner to today’s computerised building management systems. We continue to work on our control systems and related infrastructure to keep our heating systems efficient.

3. Water

3.1 National Context

Water is considered to be the lifeblood of our planet. Changes in climate can be severely impacting on access to sufficient water for healthy living in some areas.

Auckland has been impacted recently with two of the last three years having seen significantly lower than usual rainfall into its main drinking water catchment areas. Directly from this we have been notified of price increases for the next five years to part fund the creation of additional water catchment/extraction and treatment.

Carbon associated with water in Auckland is predominantly that from wastewater treatment, including the methane released at treatment plants and the energy used in the treatment process.

Water has been a local Council monopoly industry with a diversity of supply sources, prices and infrastructure quality controlled by each local Council. Under its Three Waters initiative the Government is planning on integrating the diverse approaches (and variable quality) under a common management umbrella. Auckland's supply water infrastructure assets are in better condition than most councils and a recent construction push has increased the available supply volume noticeably over the last 18 months, with further new supply capacities still being worked on.

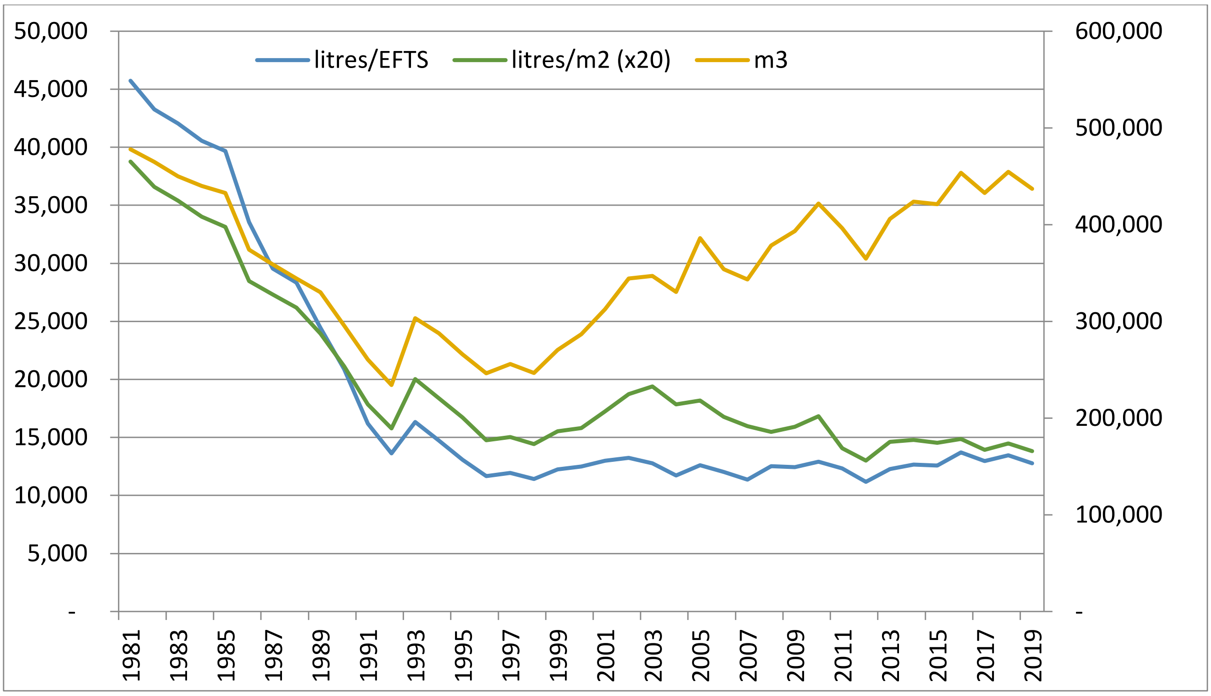
3.2University Position

Water and wastewater represent less than 1% of the carbon footprint of the University.

In 2019 the University purchased 435,000 m3 of water and also used a very small amount of rainwater.

Historic Consumption

This graph shows the total water used over the last 40 years, as well as the relationship between full time equivalent student numbers and m^2 floor areas.



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In 2019 we used 70% less water per EFTS and 65% less water per m^2 than in 1981. Despite a 225% increase in student numbers and 155% increase in built area the University achieved a decrease in water consumption of 10% in absolute terms.

We do have some small scale rainwater capture and reuse on the city campus as well as borehole water use at the Newmarket campus. There is the potential for rainwater capture and reuse to be included in all new buildings and possibly retrofitted to some existing buildings. Retrofitting a parallel pipework system into existing buildings to get rainwater to toilet cisterns, etc., is an expensive activity, but there is certainly potential for more rainwater capture and storage for irrigation, building washes and similar activities.

Our water saving story[1]

In 2019, the University used just under 437,000 cubic metres of water, which is equivalent to 0.69 cubic metres of water per square metre of gross floor area, or 13 cubic metres per full-time equivalent student.

The University has been monitoring, measuring and working to reduce water use for 40 years. We save water by including water-efficient operating plant, fittings and equipment in our buildings, and by encouraging staff and students to save water in kitchens, toilets and bathrooms, and labs. Water used for heating and cooling our buildings is re-recirculated. As a result of these initiatives, we still used slightly less water in total in 2019 than our peak in the early 1980's, despite tripling our student numbers and increasing our gross floor area by a factor of 2.5. Our buildings also use 64% less water per square metre of gross floor area than they did in 1981.

In 2016, the University won an Environment and Sustainability award for initiatives on our Newmarket Campus, that included sustainable water use. The award was conferred by New Zealand's Institute for Professional Engineers in recognition of the use of natural springs and borehole water for heat exchange in process cooling water systems, cooling tower make-up and irrigation, instead of potable mains water supplies. The initiatives included re-injection of water back into the aquifer system from which it came to protect the natural resource for sustainable use.

The University's Business School has a system for collecting water from its roof and using it for flushing toilets. This saves on average 1,250m3/year of fresh water.

Water crisis 2020[2]

Ngā Wharenoho – Accommodation has a long history of supporting sustainability in our residential halls. One initiative is the 'Green Your Room' challenge, in which students opt into actions to reduce their personal environmental footprint and promote sustainability awareness amongst residents.

In 2020 we had 2187 residents participate and take the Green Your Room challenge, 65% of Accommodation.

The Green Your Room challenge 2020 brought particular focus to pledges related to water consumption. The pledges were as follows:

- I turn the tap off while brushing my teeth or washing my face
- I never exceed a shower time of 4 minutes
- I turn off the water while applying soap or shampoo in the shower
- I use the half flush in the toilet
- I only wash full loads of laundry

[1] https://www.auckland.ac.nz/en/about-us/about-the-university/the-university/sustainability-and-environment/water-saver/water-saving-story.html
[2] https://www.auckland.ac.nz/en/about-us/about-the-university/the-university/sustainability-and-environment/water-saver/water-saving-initiatives.html

Water fountain inventory

Ensuring stakeholders at The University of Auckland have access to free and clean drinking water is critical to achieving Sustainable development goal 6: Clean water and sanitation. In 2020 two billion people around the world lack safely managed drinking water[3]. It is important we do our part to ensure availability and sustainable management of water and sanitation for all.

In 2019, a drinking water inventory was conducted as part of an initiative between Campus Life Health and Wellbeing and Sustainability Office within Property Services to better understand the distribution and accessibility of free drinking water for students at The University.

The inventory provided a snapshot of current access of students to free drinking water while on campus. A total of 76 water fountains have been identified to the room level, all of which can be freely accessed by all students and staff. A further 57 drinking water facilities were also identified inside kitchens. These are accessible mostly to postgraduate students and staff. In both cases, the facilities are connected to the University's main water supply.

The report concluded that in order to assess the suitability and sufficiency of drinking water facilities in the inventory, further work would be recommended. Firstly, setting criteria for number of drinking water facilities required, type, distribution, etc. Then, applying those criteria to analyse the data provided in the inventory to inform future decision making with regards to drinking water on campus. The University's Student Well-being and Sustainability teams are working with Property Services colleagues to address the gaps and minimise the need for bottled water on campus. It is anticipated that the availability and accessibility of free drinking water on campus will become part of the design standards to ensure consistency across the University.

4. Measures we are taking already or are incorporated into the project programme, the estate strategy or other plans.

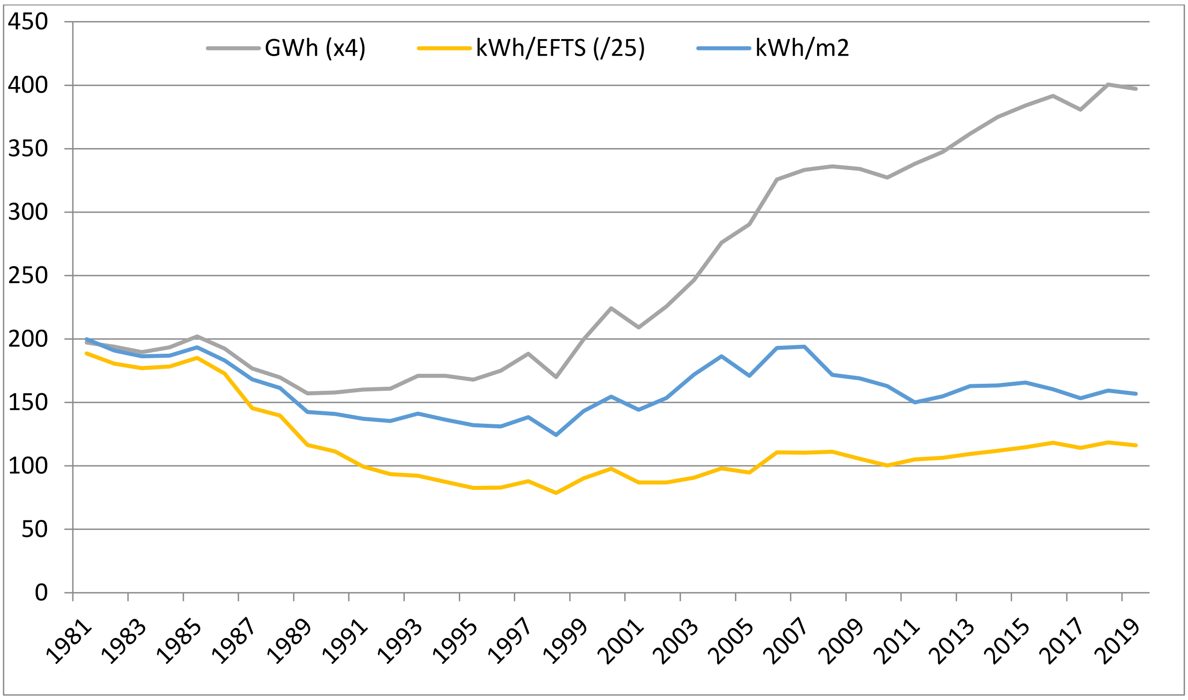
The University has been working on energy efficiency and water efficiency for close to forty years, and have demonstrated large improvements over the decades, including winning national awards for our energy management programme.

The following graph shows total energy (gas + electricity) over time and the relationship with student numbers and building floor area.

Whilst our total energy use has doubled, our energy per EFTS decreased by 40% between 1981 and 2019 our energy per m^2 of buildings decreased by 20%.

Most of these savings were made in the 1980s and 1990s.

[3] https://sdgs.un.org/goals/goal6



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Whilst the University has made a large number of efficiency improvements in the past, technologies continue to evolve and plant that was upgraded 20 years ago could now be cost effective to replace again. For example, our past lighting upgrades to the then latest technology are now superseded by LEDs. However most future projects will require higher capital investment with longer returns on investment or a reduction in service level, such as changes to heating and cooling set points.

Taumata Teitei and Te Rautaki Tūāpapa (Estate Strategy) will drive our programmes and environmental performance and sustainability will be a key criterion in the assessment of business cases going forward.

The energy used in the Estate and the University operations is significantly related to heating and cooling, domestic hot water, lighting, and office equipment. Some laboratories or research areas also have a measurable amount of academic equipment utility use.

As part of the asset management planning for the Estate we will undertake a full assessment of the carbon reduction benefits of upgrading existing assets in order to inform the capital programme and the rolling programme of refurbishment and asset replacement projects. This will assist in fully understanding the implementation challenges and programme for an overall net zero carbon programme for the Estate. Additionally, all new builds and major refurbishments will be assessed against GreenStar and other appropriate wellness standards with a key focus on investment leading to carbon reduction as well as improving other aspects of environmental sustainability. It will certainly be a case of increasing investment for lower return; this is why the approach we should take is to undertake marginal cost abatement curves to show the benefit of each investment and target the investments that will make the most difference first.

The most carbon intensive utilities use is the gas-based space heating and domestic hot water. The Estate Strategy identified a priority to remove the majority of gas hot water and space heating from the estate and a significant early part of our planning is to remove gas fired appliances from our buildings where practicable at the earliest opportunity. We have already received EECA funding to replace gas fired chillers in Building B250 and gas fired boilers that had been incorporated in the original design for the Recreation and Wellness Centre have now been removed and will be replaced with electric heat pumps.

Whilst technically feasible there are challenges associated with replacing gas fired boilers with electric heat pumps or alternative units. Due to the larger size and weight of the alternative equipment a number of these projects will require structural work for roof platforms, craneage and associated building works. Upgrades to the electrical infrastructure of the University including distribution networks and transformer capacity are likely to be required to facilitate the change from gas to electric water and space heating. With most of our consumption being during autumn, winter and spring, solar hot water is not likely to be as beneficial as domestic hot water heat pumps as we will still be needing supplementary heating during the cloudy winter months. In order to completely remove gas from the majority of our utility supply will require significant work and investment, that ordinarily would not appear to be financially viable.

Space heating is more technically challenging as the temperature of the heating hot water supplied from the boilers is hotter than the current technology of commercial heat pumps can achieve without using more complex staged systems that use additional machines to raise the temperature in stages. Equipment manufacturers are doing a lot of research work in this area and it is expected that over the next few years more cost effective systems will come to market. The majority of this equipment is manufactured overseas, therefore project programmes will need to accommodate any potential supply chain issues. Typically, buildings in Auckland are not highly insulated and do not contain high levels of thermal mass meaning that much heating is lost through the structure; or in the summer is gained requiring more cooling.

Whilst electricity is less carbon intensive; we use a lot of it. There is plenty of scope for the next generation of lighting upgrades and the recommissioning of air conditioning control systems can provide good returns on investment. One highly cost effective project would be to reduce the amount that we cool our buildings by, i.e. to cool to 24 degC in the heat of the summer instead of to 22 degC. An industry 'rough rule of thumb' is that for each 1 degC lift in the cooling set point, the electricity for cooling reduces by around 10%.

Budgetary pressures on maintenance can also end up having a negative impact on utilities consumption, so it will be important to maintain a strong preventative maintenance programme, but also to add analytics to identify issues more quickly. An example would be adding auto-diagnostics to the building management system to run daily reports on sensors not reporting or suspected as being out of calibration.

5. Measuring our Utilities Consumption

'You cannot manage what you don't measure' is as true for utilities consumption as it is for other areas of business management.

The University has some 200 utility retailer billing meters and approximately 1,700 check meters downstream of the billing meters. Close to 500 of the check meters are old ones that require monthly manual reading. The others are generally smart connected meters that can provide data down to 15 minute intervals which enables much better analysis of what is happening when.

The University is currently transitioning from a number of aged and disaggregated monitoring and reporting systems to a new single monitoring and reporting system that will bring together retailers' billing data (consumption and costs), internal check meter data and tenant billing onto a single platform. This web-based system will also export base data to the University's Snowflake data warehouse to enable wider access and reporting against other University data sets.

The new monitoring and reporting system will enable 15 minute interval data from smart check meters to be viewed on a 'day after' basis, instead of a single monthly data point with no differentiation between day/night or weekday/weekend. This will significantly increase our ability to identify wasted or poorly controlled utilities use.

Our measuring of end use utilities consumption is generally aligned with the age of our buildings. The older buildings have few check meters which limits our ability to analyse where within these buildings that our utilities are consumed. Our newest buildings have a lot of check meters enabling us to identify in-building end uses more accurately. We have also started a project for the progressive upgrading of our old manually read meters to connected smart meters that enable time of day profiling.

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