Energy and Water Strategy

2014 to 2017

Never Stand Still | Facilities Management

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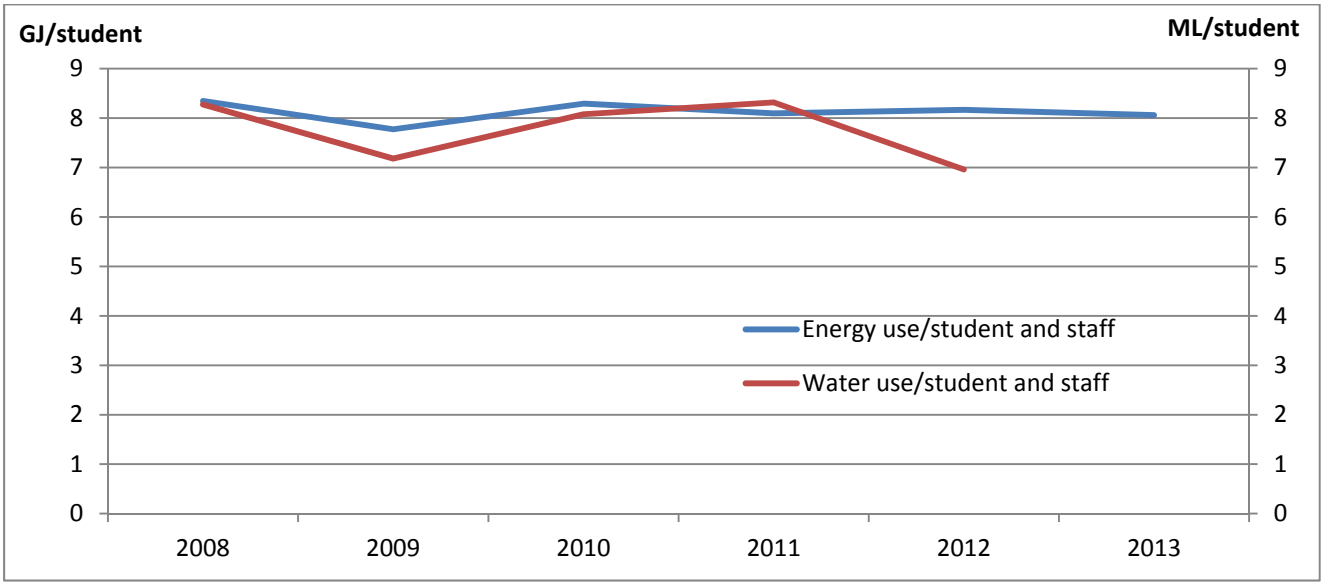
Executive Summary

UNSW Australia (The University of NSW) is a large user of energy and water with annual costs in the order of $11 million for energy and $1.25 million for water. The total energy use has been trending slightly upwards over the last three to four years despite a number of significant capital and operational projects being implemented. This is a result of constantly increasing building area as well as increasing research and air-conditioning equipment in some existing facilities.

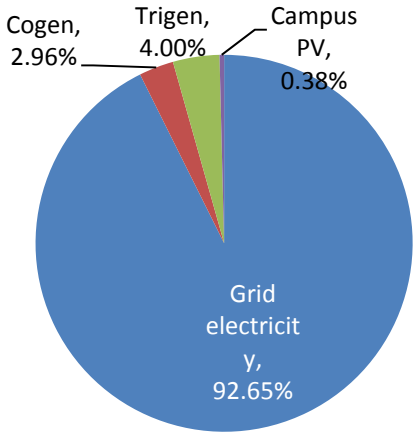
Because of this significant use coupled with increasing unit costs for both electricity and water, UNSW has been proactively undertaking energy and water management activities for many years. With the challenges of a growing campus, increasing energy needs for both new and existing buildings as well as increasing student numbers, a proactive approach to energy and water management continues to be essential for UNSW to keep use and cost under control.

Overall good progress has been made in recent years to improve the efficiency of energy and water use, to generate low and zero carbon energy onsite, and develop future plans. This Energy and Water Management Plan has been produced to provide a summary of recent and planned activities for a range of stakeholders.

The graph below shows the trend of energy and water usage per EFTSU student since 2008. Energy use stays remarkably consistent despite the number of new buildings increasing the floor area and more energy intensive services. This is a result of the saving and efficiency activities to date in reducing energy use across the campus. Water usage per student has been more erratic. The water use increase in 2011 was due to a large leak that was promptly identified and rectified. 2012 showed a significant reduction compared to 2011, however more in line with 2009, again reflecting the water reduction activities that have taken place over the last 4-5 years.



One of the major activities over the last 5 years has been the increasing transition to on site generation of electricity from low and zero carbon energy sources. In 2008, 99.9% of the campus energy needs was from grid energy. The 2013 energy mix is shown in the adjacent pie chart, with more than 7% of the site's electricity needs now generated on site. The trigeneration plant located in the Tyree Building provides 4% of on-site electricity needs, the cogeneration plant operated by a third party provider delivers 3% of electricity and a range of solar PV units generates 0.4% of the campus electricity needs. Given the substantial campus energy needs this on-site generation is a significant result.



As part of the development of the ongoing energy and water management program, UNSW has developed a range of energy and water monitoring tools. The backbone of the monitoring program is the large network of energy and water sub-meters installed across the campus. The data generated from these meters allows the regular measurement of energy and water use over a large proportion of the floor area of the campus and facilitates the proactive management of energy and water use. To effectively view, analyse and store the meter data, the Energy Management and Control System (EMACS) is used by facilities staff. Analysis of the data allows for easy identification of equipment failure or other areas of wastage and enables prompt rectification worksEMACS also enables load management activities. These aim to manage maximum hourly and daily demand for electricity and gas cost control purposes.

To enable the external representation of the energy and water use information for key buildings on campus, a third party system called LiveEnergy is used. By making LiveEnergy available through the UNSW Facilities Management webpage, it provides an effective external communication tool for any interested party to see the energy use of the whole Kensington Campus or a particular building.

Energy invoices are also tracked to control use, manage costs and enable the tracking of high level information.

The energy and water efficiency activities over the last few years have focused on:

- Implementation of a few large scale low or zero emission energy generation sources, such as the Cogent Energy cogeneration system, and the Tyree Building trigeneration system.
- Relatively small projects undertaken as part of maintenance.
- Campus wide energy and water audits.
- Upgrades to the energy and water monitoring and reporting system.

Updates to the EMACS Design Guide and installation drawings

These projects have managed to limit the energy and water use increase despite a number of significant new buildings on campus and increasing student numbers.

The future plan is focused on implementing projects identified in the recent campus wide energy and water audits. Various projects will be grouped together for implementation purposes and will be progressively implemented based on the ability to implement whilst the facilities are in constant use, as well as the availability of funding.

1. Purpose

The University of New South Wales (UNSW) has been proactively undertaking energy and water management activities for many years. With the challenges of a growing campus, increasing energy needs for existing buildings and increasing student numbers, a proactive approach to energy and water management continues to be essential for UNSW to keep energy and water use and costs under control.

In 2007, UNSW developed an Energy Savings Action Plan (ESAP) and a Water Savings Action Plan (WSAP) in response to mandatory programs for large energy and water users managed by the NSW Department of Energy, Utilities and Sustainability. This was a comprehensive document in response to the requirements of the program. This document has been used as a reference document by a range of internal and external parties. In 2011, the ESAP and WSAP mandatory requirement lapsed and has not been renewed by the government.

Recently, a number of other documents have been developed that either report specific activities or outline future projects and initiatives.

The purpose of this document is to:

1. Outline the activities that the UNSW have been undertaking with respect to energy and water management
2. Document the systems that are in place to proactively monitor, manage, and communicate, activities and performance
3. Summarise the energy and water management plans for the future covering new and existing facilities

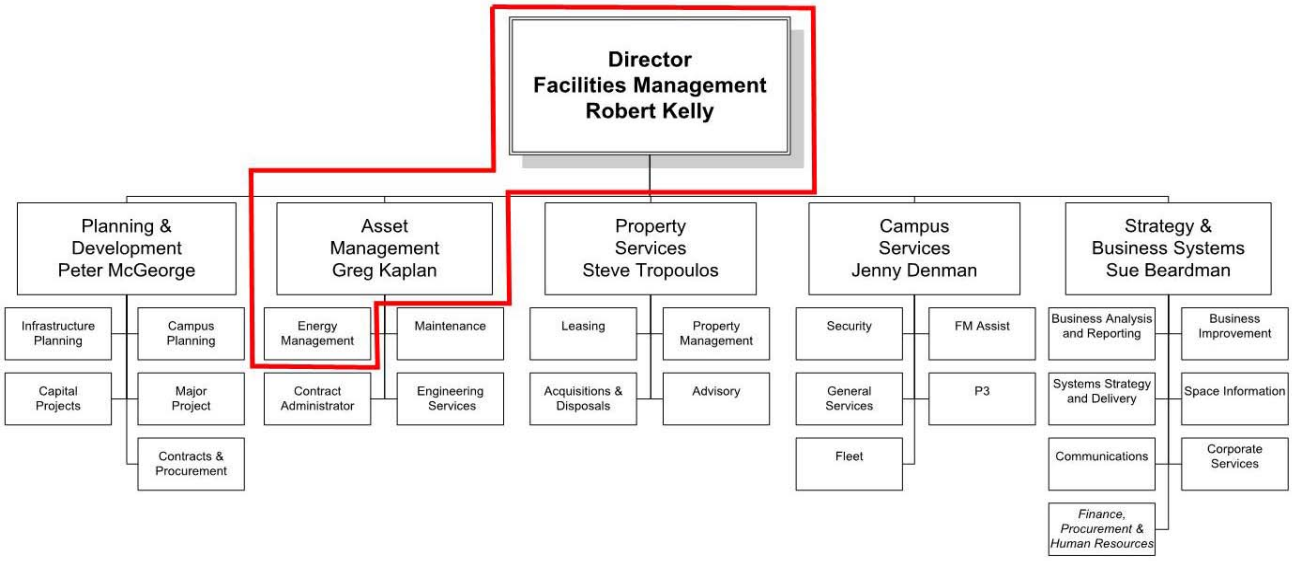
This document will replace the previous ESAP and WSAP documents

This strategy, and all the information and data included, is focused on the Kensington Campus, being the location responsible for 90% of the total energy and water use of UNSW.

2. Project Background

UNSW is classified as a large user of energy and water. In 2012, the total annual energy cost was in the order of $11 million and town water cost was $1.25 million. The total energy use has been trending slightly upwards over the last three to four years despite a number of significant capital and operational projects being implemented. This is a result of constantly increasing building area as well as increasing equipment in some existing facilities. A description of this trend is provided in Section 3.

Responsibility for energy management within UNSW rests within the Asset Management team. Currently there is a team of four with a focus on energy management led by the UNSW Energy Manager



Energy and water management is more than just cost reduction. Key reasons to implement energy and/or water management include:

- **Reduced greenhouse gas (GHG) emissions** - Currently the NSW grid supply has a GHG emission factor of 1.05 tonnes CO_2/MWh (Scope 2 + Scope 3). The use of coal and gas for electricity generation as well as the use of gas directly contributes greenhouse gases into the atmosphere. NSW grid electricity is made up of 80% coal generation, 6% from natural gas and 5% from a range of renewable sources. The remaining 9% is made up of imported electricity from other states. As a result, reducing the grid supplied electricity through either energy efficiency or on site generation (renewables or gas) results in lower GHG emissions for UNSW.
- **Part of the broader sustainability program** – Part of reducing our ecological footprint is reducing the reliance on fossil fuels. With coal and natural gas being fossil fuels, being more energy efficient will reduce the reliance on grid electricity and will contribute towards improving the sustainability metrics of UNSW.
- **Water is a critical resource** – While theoretically water is a renewable resource, waste water sent back into the stormwater or sewerage network needs to be stored and treated before it can be used again in the water supply. This requires the use of large storage resources, as well as energy and chemicals. There are also potential supply issues with long term forecasts of longer, more intense droughts.
- **Increasing utility cost** – the cost of all utilities is following a steadily increasing path, despite occasions where the price may marginally drop. Over the last four years, the cost of grid electricity has increased by more than 70%. Gas has historically increased by a smaller amount, however larger increases are forecast over the next 3-4 years. Water price increases have been less than electricity, however once again they have been increasing steadily at a rate greater than CPI with a step change price increase being forecast for 2014/5.
- **Good business practice** – In both the private and public sectors, it is seen as good business practice to ensure the costs that can be managed are managed efficiently. The presence and success of energy and water management programs are seen by some external parties as a reflection on the broader performance of an organisation.

By its nature, a university campus is a difficult environment to manage energy and water use. The key issues include:

- **Increasing floor area** – While the Kensington Campus has limited available space for new buildings, there has been a significant capital works program with old buildings being replaced by new buildings. The new building is often significantly larger than the original building and the project process results in a temporary reduction in energy use when the existing building is taken out of use, and then a larger increase as the new building begins operation.
- **More energy intensive services** – Standards of services to buildings have increased over the last 30 years, particularly with air conditioning which is the most energy intensive of building services. Despite new buildings being designed and built at or beyond energy and water efficiency standards, energy use per m^2 is significantly higher.
- **Increasing technology** – There is increasing need for technology across the education sector. The increasing use of student computers and IT requirements across the variety of rooms and teaching facilities is increasing every year.

Faculties' control over operation of buildings - The Facilities Management team have limited control on how faculties operate the buildings that they occupy, including the operating hours and the teaching and scientific equipment used by individual faculties. Some specialist research equipment can use a significant amount of electricity.

The University has been proactively managing energy and water use for more than 15 years when the Energy Manager role was created, the use of sub-metering to track performance of individual systems implemented and the use of external consultant expertise to identify and implement changes. UNSW actively participates in all the mandatory energy and water efficiency programs as well as a number of voluntary programs. An overview of these programs is given in Section 5 and an outline of the key initiatives undertaken is provided in Section 7.

3. Summary of Energy and Water Use

The UNSW Energy Management team keep track of all energy and water use data for the Kensington and other campuses. All sources of energy and water are reported on a monthly basis, including the energy generated on the campus from the cogen, trigen and PV installations. The Kensington Campus also has a significant number of sub-meters located at most buildings and to significant energy and water using systems such as large chiller plants and cooling towers.

3.1. Historical trend

Figure 1 below shows the trend of total energy use by month over the last 5 years.

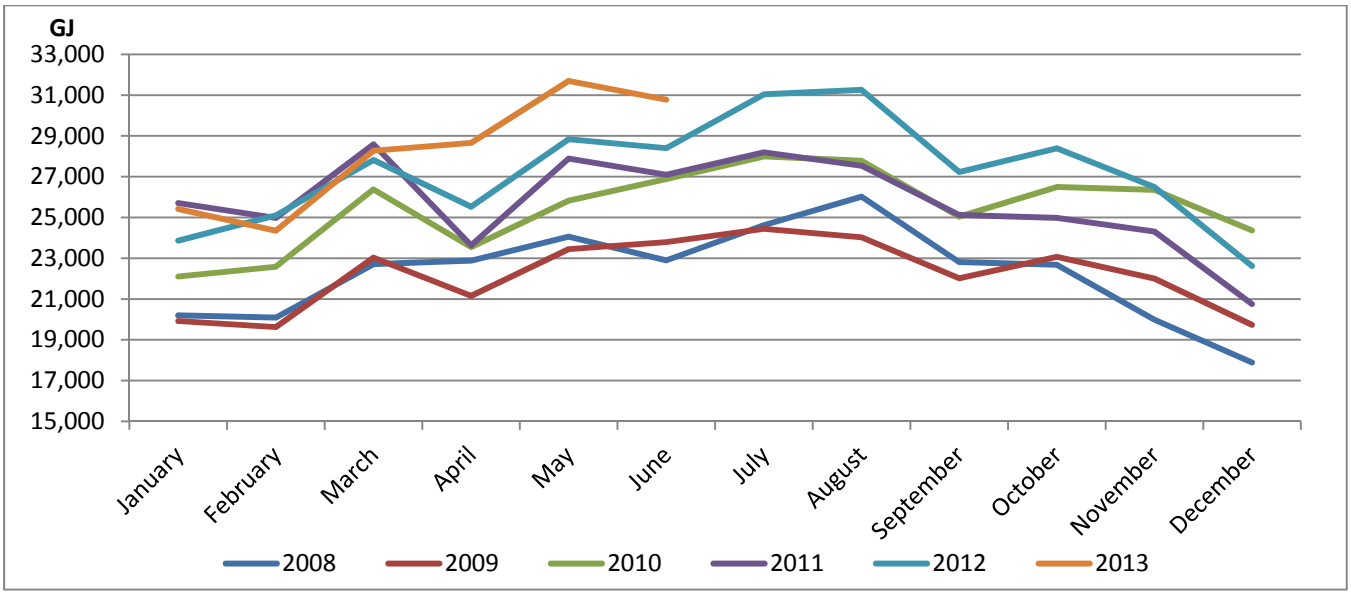


Figure 1: Monthly energy use 2008 to 2013

This shows a general trend of increasing energy use over the last 5 years. There is a consistent trend of low energy use in December, January and February reflecting low occupancy of the campus. March sees a spike in energy use, despite the often milder weather reducing the demand on air conditioning. This is a result of maximum use of the campus with the start of the university year. Energy use peaks in August given peak winter conditions (impacting on both electricity and gas use for heating) and the return of students for semester 2.

Figure 2 below shows the trend of monthly potable water use over the last 5 years.

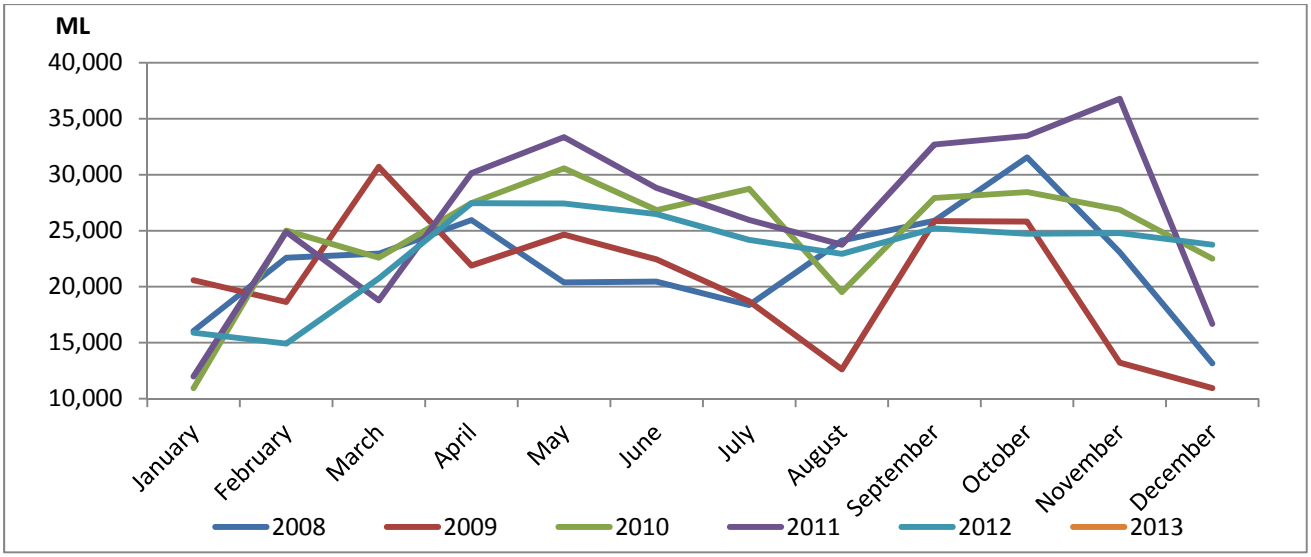


Figure 2: Monthly water use 2008 to 2013

Given that the cooling towers (for air conditioning) and irrigation of the grounds use bore water, the potable water use is driven by the on-campus accommodation, catering and bathroom use by students and staff. While there are some exceptions, the water use profile shows peaks during April/May and September/October. Note the higher use through 2011 was a result of a significant water leak. Once this was repaired in November 2011, the water use fell to a level more in line with other years.

3.2. Energy Sources

UNSW receives its energy from a range of sources. As shown in Figure 3 below, this has changed over the last 5 years with a reducing reliance on grid electricity and the introduction to low emission and renewable sources.

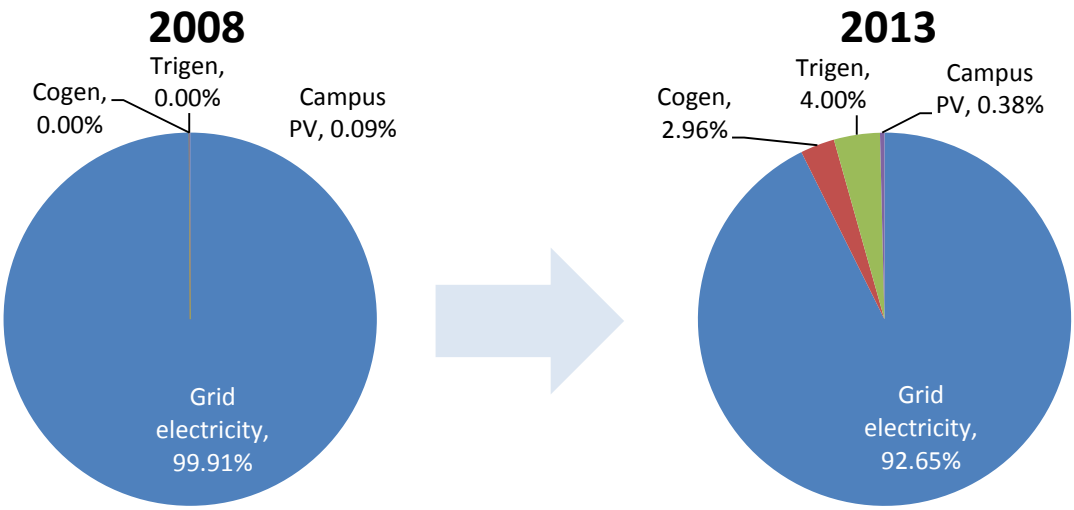


Figure 3: Energy source trend 2008 to 2013

This is a major change of the last five years given the significant energy use of the Kensington Campus. Key elements of the on-site generation include:

- The cogeneration system is located in the Lowy building and commenced operation in 2009. This installation is owned by Cogent who sell electricity, and hot water to UNSW.
- The trigeneration system is located in the Tyree building and is fully owned by UNSW. It commenced operation in late 2012.
- There are numerous solar PV installations across the campus, the main one being 150kWp on the Tyree building.

3.3. Energy End Uses

Figure 4 below shows a breakdown of the primary energy uses on campus.

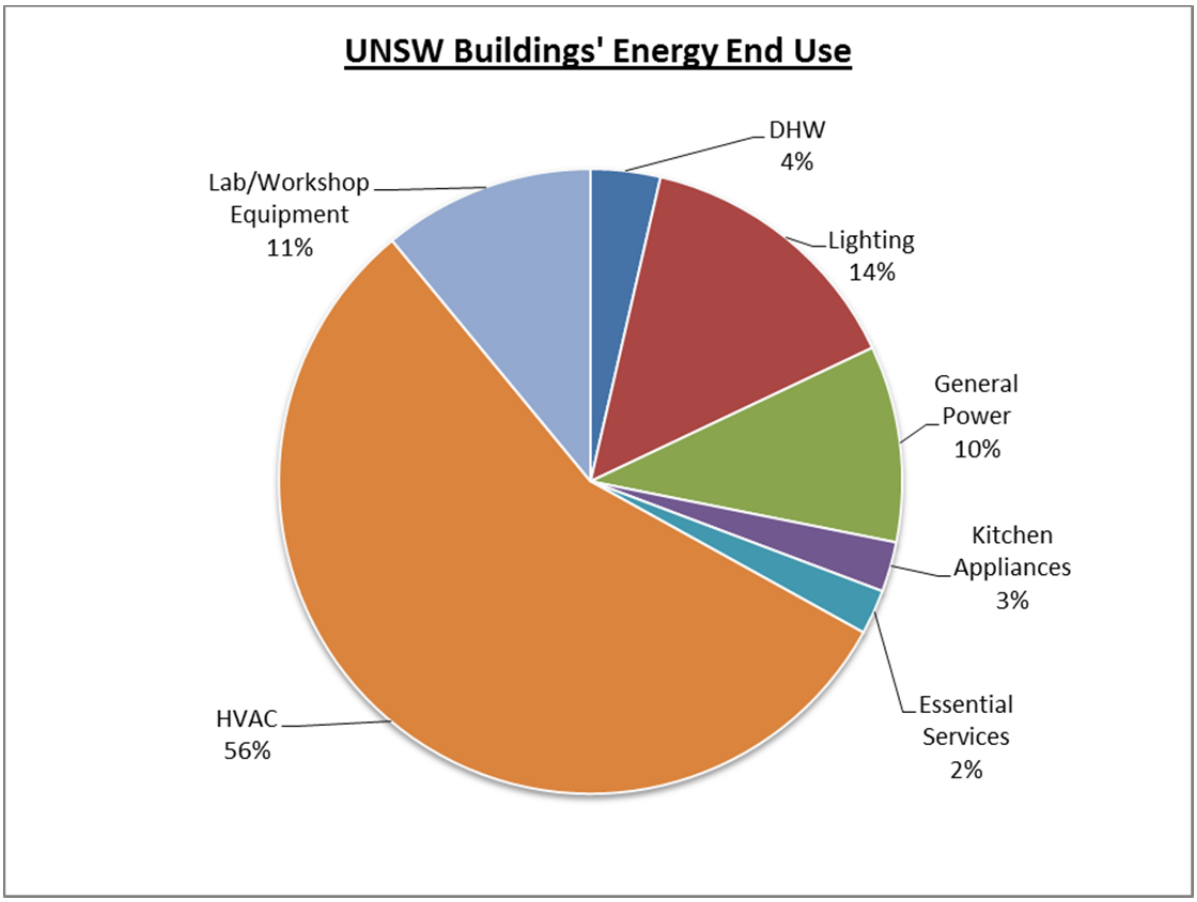


Figure 4: Estimated 2012 energy use breakdown

The end use breakdown was based on the findings of the in-depth energy audit program that was undertaken during 2012. This shows the most significant end use is Heating, Ventilation and Air Conditioning (HVAC), of which air conditioning is the major component. Almost all buildings on the campus are air conditioned and given the variable nature of occupancy, the air conditioning needs to run for a significant period of the day. Air conditioning plant for most of the large and medium sized buildings is provided by centralised systems, which are more efficient than the “split” or other distributed systems.

Lighting is the second largest user, in common with many commercial buildings.The other significant use is by the lab/workshop equipment. This is not unexpected in a large research intensive university such as UNSW, with both regular students as well as a large amount of post graduate research being undertaken. Also there is some equipment that operates 24/7, thus increasing the proportion of use.

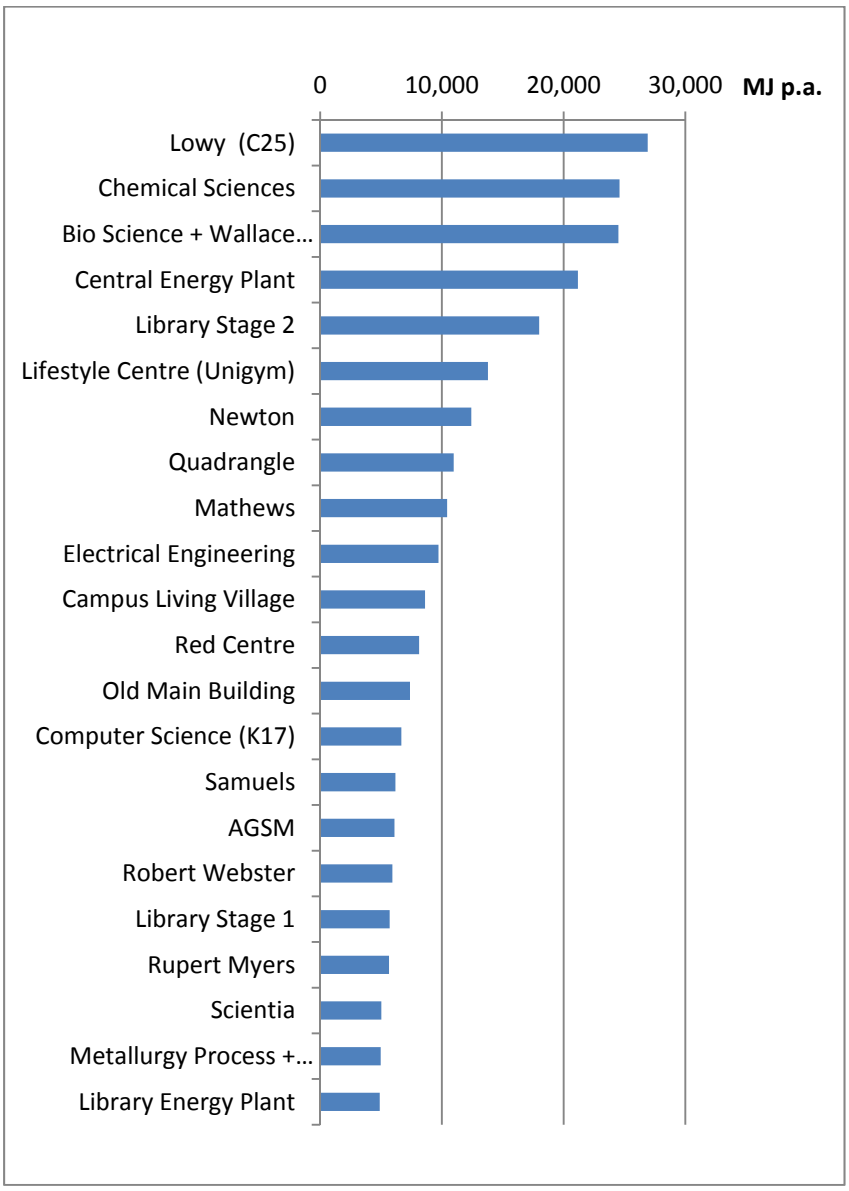
The remainder of energy using installations across the campus uses only 19% of the total energy.

Given the significant number of energy meters installed on the Kensington Campus, currently approximately 750, there is data available on more than 50 of the largest energy using buildings and areas. Figure 5 shows that the largest 22 buildings consume in the order of 75% of the entire campus energy use.

There are many factors that drive the variation in energy use, must notably:

- The age of the building
- The level of occupancy (i.e. for students during semester only or in use all year round)
- The key activities conducted in the building and their associated equipment

Figure 5: Largest energy using buildings



4. UNSW Benchmark

UNSW regularly tracks its energy and water use with respect to student numbers and floor space, as per TEFMA (Tertiary Education Facilities Management Association) reporting. Figures 6 and 7 below shows the historical trends of both these benchmarks.

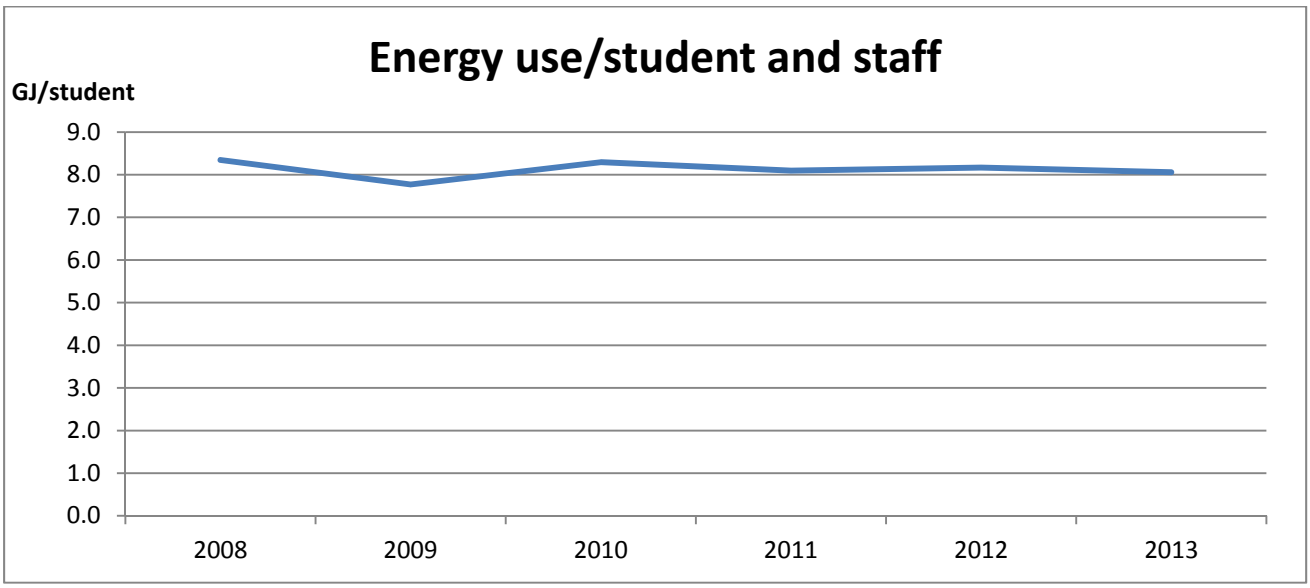


Figure 6: Energy use per student and staff member

Despite the increasing energy use indicated in previous tables, the total energy per student (EFTSU) and staff (FTE) member has stayed stable for the last five years.

Figure 7 below shows the historical trend of water use per student and staff member.

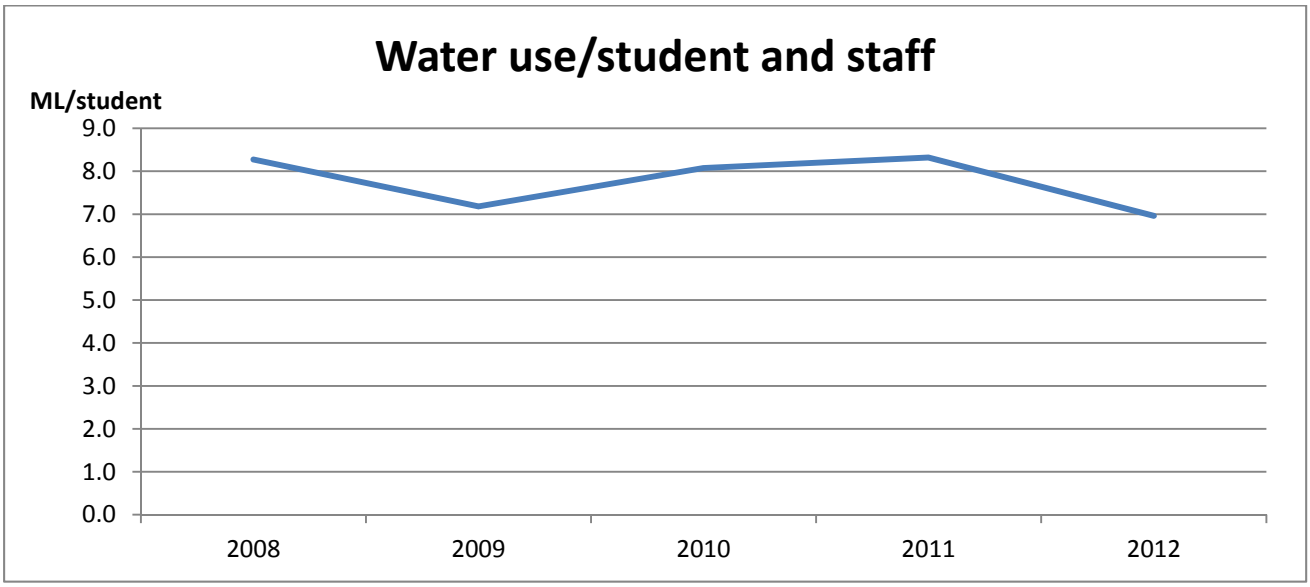


Figure 7: Water use per student and staff member

Similar to the energy use, the water use per student and staff member has remained stable over the last five years, reflecting the ongoing efforts at reducing water use across the campus. As previously mentioned, 2011 was an anomaly due to a significant water leak.

5. Relevant Legislation and Programs

There are a number of key energy related legislation and voluntary programs that impact on the University's energy and water management programs. Relevant programs are outlined below, however there is currently no NSW Government or water programs that impact on UNSW.

5.1. NGER

The National Greenhouse and Energy Reporting (NGER) Scheme was introduced in 2007 to provide data and accounting in relation to greenhouse gas emissions and energy consumption and production. Participating organisations must report on their energy use and carbon emissions on an annual basis. The current annual threshold for compulsory participation is emissions exceeding 50,000 tonnes of CO_2 or enegy consumption exceeding 200 terajoules (TJ). With total energy consumption in the order of 300TJ, UNSW participates in the NGER Scheme. The 2012-13 NGER Reportable Data is shown in Table 1 below.

Table 1: 2012/13 NGER data UNSW showing GHG emissions by source

UNSW 2012-3 Greenhouse source	TOTAL	Units	tCO2e Scopes 1 + 2	tCO2e Scope 3	tCO2e All Scopes
Electricity use (excluding tenants)	**71,829,093**	**kWh**	**62,491**	**13,648**	**76,139**
Electricity production (photovoltaic)	**293,383**	**kWh**	**0**	**0**	**0**
Electricity production (cogen, trigen)	**5,160,290**	**kWh**	**4,489**	**980**	**5,470**
Natural gas use (excluding tenants)	**111,731**	**GJ**	**5,735**	**1,430**	**7,165**

5.2. Energy Efficiency Opportunities Program

The Energy Efficiency Opportunities (EEO) Program is a Federal Government Program that encourages large energy users to identify opportunities to improve energy efficiency within their organisation. Over a five year cycle, participating organisations must undertake detailed energy assessments across a significant proportion of their energy using equipment. On an annual basis participating organisations are required to report on the progress of their assessments as well as the identification and progress of identified opportunities.

Corporations using more than 0.5 petajoules (PJ) of energy per annum must participate in the program. The University uses approximately 0.3 petajoules and therefore is not required to comply with this program.

5.3. National Construction Code

Given the significant number of new buildings being built on the campus, the regulations with respect to new facilities is also relevant. The National Construction Code (NCC), formerly known as the Building Code of Australia, is the only regulation that addresses energy and water efficiency in new buildings. All new and significantly upgraded buildings are required to comply with Section J of the NCC. Key aspects

include building fabric and glazing performance, specific lighting power densities, and minimum system efficiencies for a range of mechanical equipment.

The UNSW Facilities Management team are having increasing involvement during the planning of projects. There is now a process whereby ecologically sustainable (ESD) principles are included in the review of all new developments and relevant representation by Facilities Management at development review meetings.

5.4. NABERS

The National Built Environment Rating System (NABERS) is a national scheme that rates the performance of a building on a scale from zero to six stars. NABERS is currently available for commercial buildings, office tenancies, hotels, shopping centres, data centres and residential. Separate ratings are available for energy, water, waste and indoor environment quality. NABERS is an entirely voluntary program, although if the University had an office area greater than 2,000m2 to be leased to an external party, then they will come under the Commercial Building Disclosure Act and a NABERS Energy rating will be required.

The University only has only a small number of buildings that are eligible for a NABERS Rating under the NABERS rules. The Chancellery Building has recently had its first rating undertaken, achieving 5 stars (out of a possible 6 stars). The Law Building (F08) and the Australian School of Business building (E12) have also recently had NABERS ratings undertaken, achieving zero and 2 stars respectively. Further sub-metering work is required to gain a proper assessment of the efficiency of these buildings as there are items currently included that can be excluded under the rules. Given UNSW does not lease out any of these buildings, these ratings are being undertaken on a voluntary basis.

6. Energy and Water Monitoring

Over the last 10 years, UNSW has implemented a continuing program of installing energy and water meters across most of the buildings and major systems on the Kensington campus. The sub-metering data provides increased granularity in energy and water use analysis enabling the identification of opportunities, implementation of corrective actions, and measurement of savings. There are a number of key systems in place to track, monitor and analyse the data. These include:

- All utility invoices are entered into a spreadsheet to track the high level data and trends.
- All submeters are connected to EMACS. The system collects interval data and stores all historical records. This facilitates the on-going interrogation of data to determine trends and provides alarms and alerts when meter readings are outside the set boundaries.
- The Greensense LiveEnergy system is a visualization tool providing a user friendly interface to communicate EMACS data. This includes graphical representation (Figure 8) and flexible reporting. By making LiveEnergy available through the UNSW Facilities Management webpage, it provides an effective external communication tool for interested parties to see the energy use of the whole Kensington Campus or a particular building or area. See www.facilities.unsw.edu.au/campus-development/sustainability-campus/greensense-live-energy-project

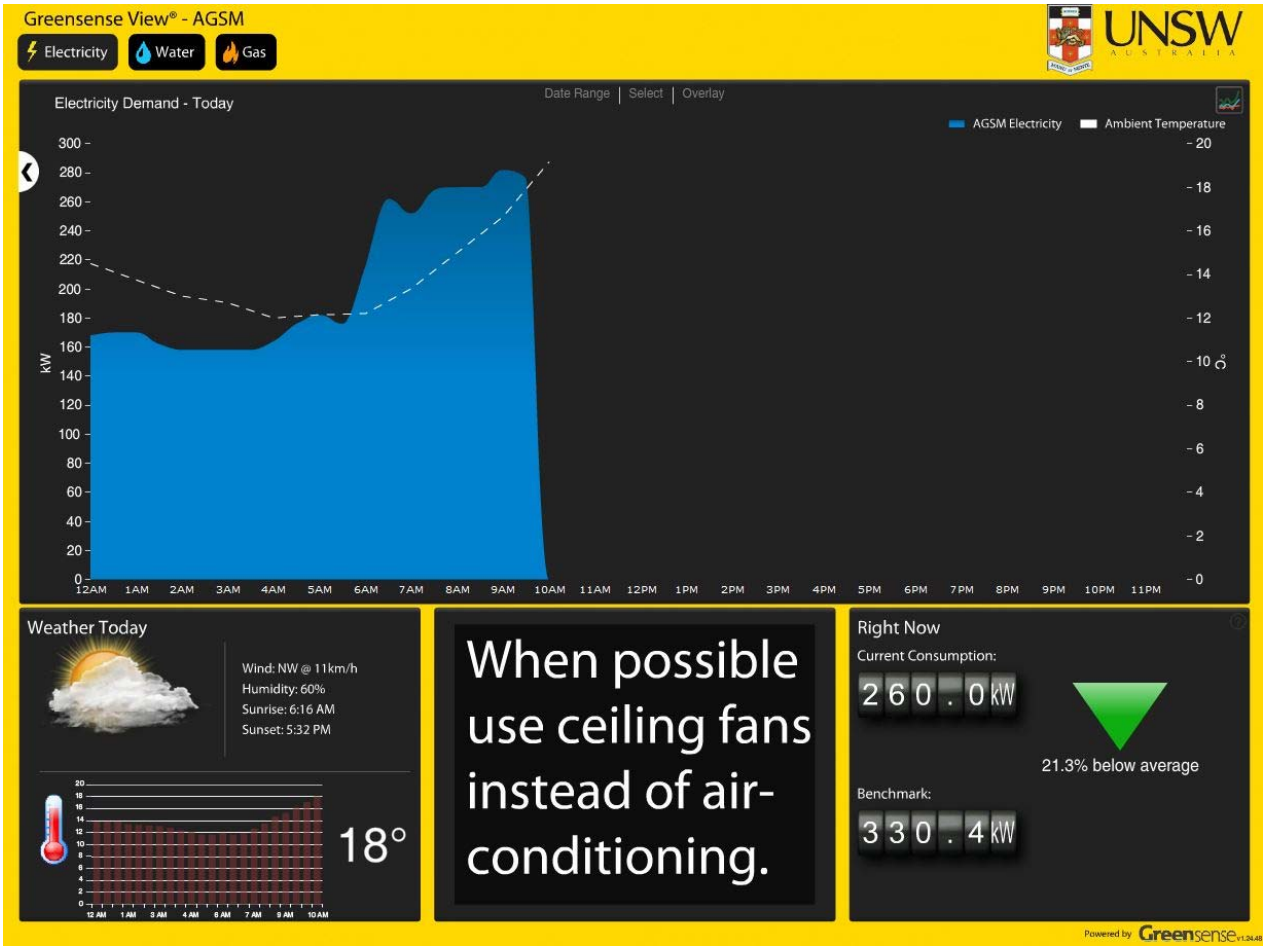


Figure 8: Screen shot of the Greensense LiveEnergy system

This combination of systems is an effective method for firstly checking that the invoices are correct, then being able to quickly identify major issues and where it might be occurring. On a more localised level, data on individual buildings is regularly analysed to compare similar periods to identify leaks, changes in equipment or schedules, and any other area of gradually occurring inefficiency.

The existing system is constantly being upgraded and all new buildings have significant metering installed to enable analysis of the total building use and specific systems.

7. Reporting

There are a range of regular and ad hoc reports using the collected energy and water data. Key regular reports are:

- Monthly report on use and cost submitted to the FM Executive Management team.
- Quarterly KPI report on use and cost submitted to the FM Executive Management team.
- Energy and water cost budgeting and forecasting.
- NGER (National Greenhouse and Energy Report) on an annual basis.
- TEFMA (Tertiary Education Facilities Management Association) – 2 reports on an annual basis.
- UNSW Sustainability Report on an annual basis.

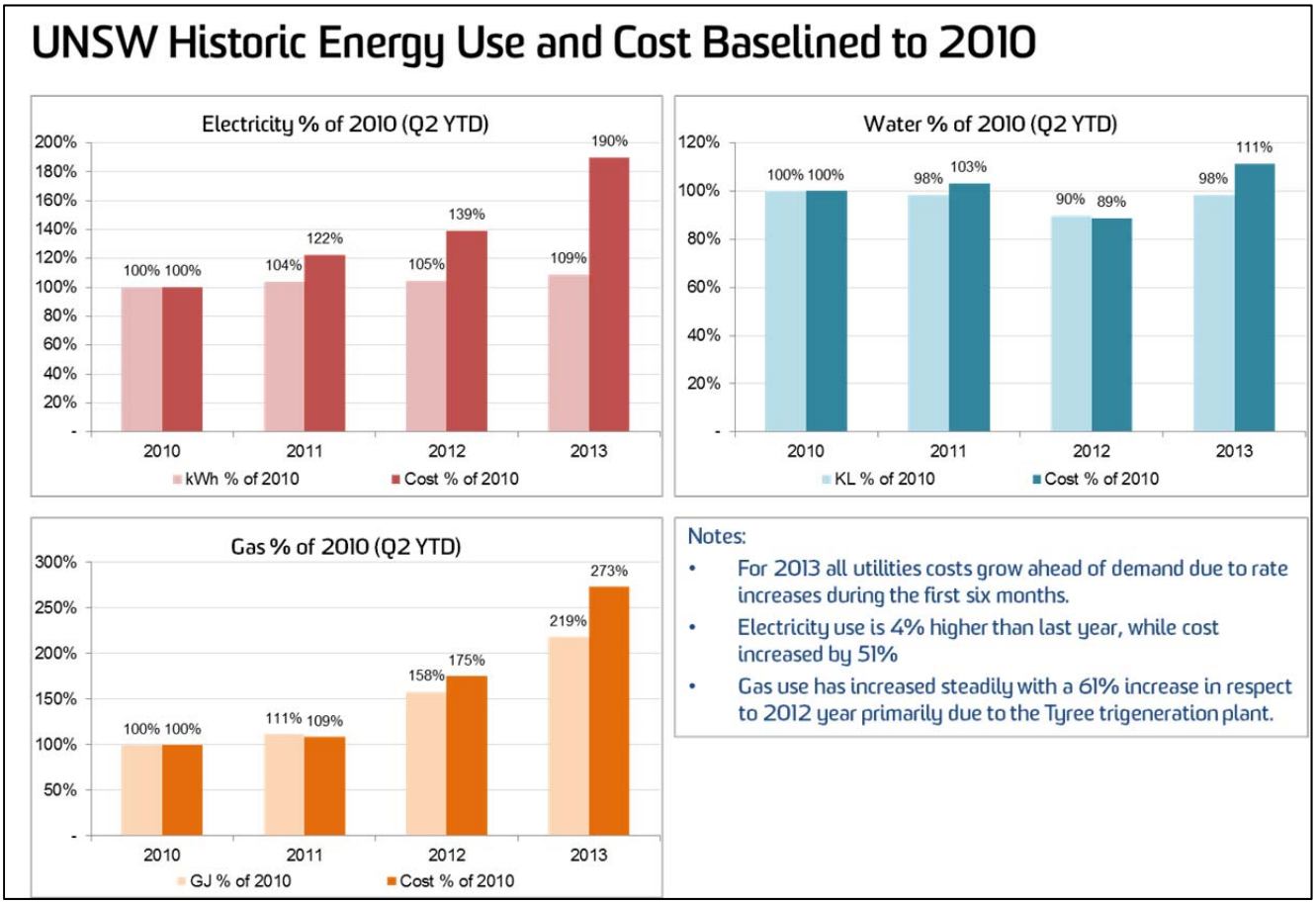


Figure 9: Sample internal energy and water report

On an adhoc basis, the UNSW FM team responds to a variety of requests for information from a wide range of stakeholders, including:

- Faculties
- Facilities engineering staff

- Students
- The Estates Group

The combination of the historical utility bills as well as EMACS and Greensense Live Energy systems enables prompt and reliable provision of accurate information for all these purposes.

8. Collaborative Approach

It is acknowledged by the Energy team that energy efficiency and energy saving activities are very much a “team sport” and that success often depends upon the support and co-operation from a broad cross-section of the campus community.

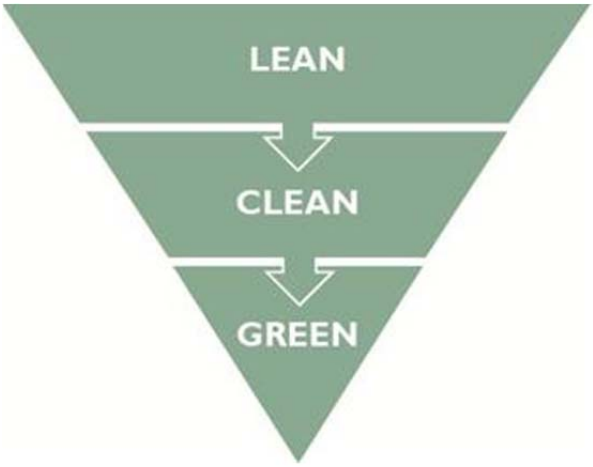
Naturally, there are many projects and savings opportunities which are implemented “back-of-house” by the Energy team and by the Energy team in collaboration with the FM Engineering teams that are not apparent to the general population. Equally there are other projects and opportunities that are carried out in full view involving internal and external resources which have a direct impact to certain sections of the population. In these cases collaboration with all stakeholders is an important component of the implementation process.

Groups that we collaborate directly with include

- FM Engineering and Maintenance
- FM Major Projects
- UNSW Sustainability
- Faculties
- External Consultants

9. Energy and Water Efficiency

The University has been undertaking a wide range of activities to reduce their energy and water use. To assist in understanding the depth and breadth of activities assessed, undertaken and planned the following structure has been used:



Lean: Being more efficient in use

Clean: Using lower emission energy sources and reusing waste water with no processing

Green: Using renewable energy (zero emission) and processing/cleaning recycled water
Using this framework, the following sections outline key activities that have been undertaken across each of these areas.

At any time there is a wide range of projects that could be undertaken, however with limited capital and human resources to ensure that projects are successfully implemented, it is important that the Energy team undertakes a process of deciding the most appropriate projects to implement at any one time.

The Energy team undertakes a fairly straightforward decision making process when looking at which projects to implement. The key issues considered when evaluating projects are:

1. What is the simple payback?
2. Is it technically feasible?
3. Does it align with the Campus Energy and Sustainability objectives?
4. Does it reduce infrastructure and/or systems risk?

Once these evaluations are made, then a range of additional factors are taken into account, including:

- The future of the building
- How does the cost fit into the capital or operations budget
- How easy is the project to implement
- Are there any risks of the savings not being achieved or impacting on other areas of the facility

After these factors are considered, the FM team implement a balanced program of measures that while individually have a range of paybacks, when combined have payback of approx. 7 years.

10. Current Activities

UNSW has had a long term energy management program, with periods of large capital expenditure (Clean, Green) followed by periods of focus on operational efficiency (Lean). While there were a number of large capital expenditure items in 2008 to 2010 period, over the last two to three years, the focus has been on:

1. Optimising the operation of existing equipment.
2. Bundling of smaller projects into larger projects with an average payback of 4-5 years.
3. Reducing wastage by ensuring equipment is turned off when not in use.
4. Specification of energy efficient equipment in new buildings.
5. Lower carbon fuel sources where appropriate.
6. Renewable energy sources where the budget allows.

Key projects that have been undertaken over the last 2 years are outlined on the following table.

10.1. Energy

Category	Activity	Savings
Lean	Energy Audits The largest program undertaken with respect to energy efficiency was the commissioning of Level 3 energy audits undertaken by an external consultancy throughout 2012. Level 3 energy audits involve detailed investigation of the energy using systems of the selected facility, determining where energy is used and identifying opportunities for reducing energy use and cost. Efficiency project costs are to be to an accuracy of +10% and savings to -10% In total, 368,811m^2 of the 500,182m^2 floor area of the campus was audited covering roughly 90% of the total campus energy use.	Given the nature of an energy audit is investigatory in nature, no direct savings were achieved, however the opportunities identified are summarised below: Total identified potential savings ■ 12,989MWh electricity ■ 10,962GJ natural gas ■ $1.9 million p.a. ■ Approx. 8% of total energy use
	Load shedding program UNSW keeps a constant monitor on electricity and natural gas use throughout the day, particularly during the more extreme temperature days in summer and winter. Depending on the fuel type and the supply arrangements, one component of the tariff structure is the maximum use on a daily or hourly period. By understanding the contractual arrangements, UNSW is able to turn off or reduce the operation of non-critical equipment for periods of 1 or 2 hours. While being undertaken for a cost management purpose, it also reduces total energy use.	■ Around $75,000 per MVA per year of electricity max demand ■ A premium of 37% over normal rates when gas daily maximum demand is exceeded.
	Evaluation of PC Power Management software Power Management systems are an information gathering and reporting system that track the use of PCs and printers on the network. These systems can improve energy use by 1) providing automatic shutdown of PC not being used and by 2) increasing the availability of information on computer use and energy consumption	Evaluation exercises estimated up to 1.07MWh, 1,144 tCO_2 and $150,000 p.a. could be saved by deployment of PC Power Management software
	Initiatives introduced into new buildings The Energy Management Unit has had increasing exposure to	Savings not quantified across all

	new buildings through the development process. An ESD framework has been developed that is used as a checklist for internal approval of new developments. This includes elements such as: ■ Insulation and building seals in excess of Section J of the BCA ■ Shading on external facades / glazing? ■ Optimisation of natural light into buildings ■ High efficiency lights and appropriate controls ■ Cogen/trigen where economically viable ■ Minimum chiller COP ■ High efficiency motors ■ Optimised technology for HVAC systems based on the spaces being served ■ Enhanced sub-metering ■ High efficiency gas boilers ■ Bore water used in appropriate places ■ Solar hot water and/or solar PV built into north facing façades	projects. The initiatives are expected to deliver energy efficiencies of 5-10% above a baseline building where none of these initiatives have been implemented
	<u>Ongoing awareness program</u> In 2012, the Energy Management Unit partnered with Greensense, an award-winning company that extracts the energy and water performance of a building and delivers it in real-time in an easy-to-understand format. Now, UNSW's staff and students can see how their personal day-to-day actions like leaving the lights on or opening windows in climate controlled rooms directly impacts on the energy demand of their building. Similarly, staff and students can see how their positive actions or habits such as turning off lights not in use, switching off their computer or taking the stairs can significantly reduce the amount of energy consumed by their building. The information is displayed on an interactive Greensense dashboard available online and in most buildings on campus. Staff and students will be able to see how much energy they've saved, generated or consumed, the emissions they've avoided by improving their daily habits, and how their building is performing in comparison to other buildings on campus	Savings not quantified

	Tenant energy efficiency The Energy team has also worked with tenants to identify waste and become more efficient in their energy use. A recent example was long-time UNSW food operator Gradueat who was becoming increasingly concerned with rising energy costs. Their initial thought was that there was a fault with the systems used to monitor their use but after speaking with FM's Property Services and Energy Management teams they could see that the problem was caused by the increase in the supply costs from the local utility (AusGrid). The Energy Management team recommended Gradueat perform a simple energy audit to identify areas where savings could be made. After close inspection, it was realised that many of Gradueat's cooking and heating appliances such as rotisseries, bain-maries, cooker heads and hoods were being left on longer than necessary. These simple changes had a dramatic impact on reducing their energy use with Gradueat reporting a 20% reduction in its energy costs - a remarkable achievement. Gradueat Manager, Katrina Mikhail, was delighted with the result and said "Once I started to look I soon found the opportunities for reducing our energy use and the savings appeared straight away on my next invoice. I am very happy to have achieved this outcome".	Total savings not quantified and are for the tenant as electricity is onsold
	Upgrade of the EMACS operating software To take advantage of the latest technology in metering, meter data acquisition and meter data analysis a program to update the operating software for the EMACS system commenced in 2013. Phase 1 of the program involved migrating the existing system from a stand-alone server located in the Red Centre onto a virtual server managed by UNSW IT. This provides a greater degree of system security and robustness and allowed the latest version of the proprietary operating software to be installed. The final step of the first phase was to create a graphical interface and connect the main intake meters. Phase 2 of the program, to be carried out in 2014 will be to migrate all of the sub-meters onto the new software platform and shut down the old system. The new platform will bring a number of benefits including – • Semi-automatic incorporation of new sub-meters • Automatic alarms for out of line occurrences • Enhanced analysis and reporting capabilities • An ability to communicate with other campus's systems such as the Building Management and Security Systems	

	Extending the metering installation In 2013 the UNSW metering system was extended to include sub-metering the new buildings on the Kensington campus. A major project was also completed to link in the Randwick and COFA locations allowing remote acquisition of their energy use data. This will now remove the need for the monthly manual reading. Altogether, we now have approximately 750 sub-meters connected to the EMAC system which allows us to have a comprehensive view of the university's energy and water use and carry out detailed analysis of performance. As the Kensington Campus is further developed with the addition of the new Materials Sciences building and refurbishment of the Mechanical Engineering facility additional sub-metering will be incorporated and added into the energy management system.	
	Electricity and Gas Supply Procurement To optimise supply costs and ensure the university has secured on-going supplies of electricity and gas. Regular re-procurement through competitive tendering is carried out by the Energy Management department.	Currently we tender for annual supplies of ninety million kWh of electricity and ninety five thousand GJ of gas together worth approximately $12.8 million.
Clean	Cogeneration A 750kW cogeneration plant was installed in the Lowy Building and has been operational since September 2010. Whilst located in the Lowy Building, the plant is owned and operated by Cogent Energy, a private sector business. The University purchases electricity and hot water off Cogent for an agreed price. Cogeneration uses natural gas to generate electricity and the water used to cool the system is at a temperature that is suitable for hot water use in the building. Due to the lower greenhouse emissions form natural gas generation than the grid as well as the ability to use the waste heat for hot water, this is an efficient method to meet the energy needs of a university.	Over the 2012 year, this cogeneration plant generated approx. 2.44MWh or 3.4% of the total campus electricity needs.
	Trigeneration System An 800kW trigeneration system is located in the Tyree Building. In addition to generating electricity and hot water, the energy is taken from the hot water to produce chilled water.	In the year to August 2013 the trigeneration system generated approx. 2.75MWh or 3.8% of total campus electricity needs.
	Removing domestic hot water systems Facilities Management is progressively removing domestic hot water systems from campus bathrooms (except for access bathrooms).	
	Natural gas air conditioning The Goodsell, Quad, Matthews, and Samuels buildings have had their conventional air conditioning units replaced with natural gas heat pump air conditioning units. This essentially uses a gas engine to drive the air conditioning process rather than an electric motor. While there is little or no energy use reduction, there is a significant reduction in greenhouse gases, and it solves a number of other issues related the electrical infrastructure.	

Green	Solar Hot Water The University has a number of solar hot water installations. Solar hot works by heating water in panels exposed to the sun and storing the hot water in storage cylinders. Key locations include: ■ Squash courts ■ Matthews building ■ AGSM ■ University Terraces These units have a natural gas or electricity booster to ensure that they system does not run out during the peak periods.	Approx. 20% of the University's domestic hot water needs are met by solar hot water.
	Solar PV The University has a number of significant solar photovoltaic (PV) installations. Solar PV works by generating electricity within photovoltaic cells and then converting to electricity for supply into the local electrical distribution grid to be used as it is generated. None of the University solar PV systems are equipped with storage. Key locations of the solar PV are: ■ Swimming pool ■ Tyree building ■ Substation 1 ■ Quadrangle The total installed capacity is 204kW compared to the University's average peak energy demand of 14MW.	Solar PV generated approx. 0.4%? of the University's electricity needs for the 2013 year.

10.2. Water

Category	Activity	Savings
Lean	Water Audits Similar to the energy audits, water audits were recently carried out by Sydney Water across the largest water using facilities of the campus. As these audits were only completed mid 2013, there has not been any implementation of projects yet, except for the use of bore water instead of potable water on the Food Arcade toilets in Mathews building. Forward project plans for implementing water saving projects are being developed. Leak Detection The is an ongoing leak detection program through analysis of data to ensure that leaks are identified and rectified as soon as possible.	Given the nature of an water audit is investigatory in nature, no direct savings were achieved, however the following opportunities were identified: ■ 25kl/day water savings ■ $240k p.a. cost saving ■ Approx. 20% of the total water use
Green	Bore water and aquifer recharge At UNSW, we want to dramatically reduce the amount of pure drinking water (potable) wasted each year on non-essential services such as flushing toilets and air conditioning. On many parts of the campus, potable water has been replaced with bore water from the aquifer and is estimated to supply 40% of the water requirements on campus. Bore water is primarily used for irrigation of the grounds, but we are increasingly using it to replace potable water applications. These include chemical labs, toilet blocks and construction activities. It supplies approximately 90% of irrigation requirements, 20% of toilets flushing and 5% of research requirements (e.g. reverse osmosis water) We have also installed a large scale Aquifer Recharger under the campus oval. This stormwater project has a chamber constructed under the Village Green, which acts as a stormwater retention tank and catches 70% of the storm water on campus (equivalent to 64 Olympic swimming pools). The collected stormwater is fed back into the Botany Sands aquifer and subsequently sourced for 40% of the total campus water demand.	

11. Current and Planned activities

The primary activities that are planned are focused on the outcomes of the campus wide energy audit. Key activities include:

- Install Variable Speed Drives on a range of pumps and fans
- Flue gas heat recovery from steam boilers
- Installation of UV sterilisation units to the Library air conditioning
- Chilled water bypass to allow “island” operation of the Tyree building absorption chiller
- Automation of Demand Management by incorporation into the Building Management System
- Investigation of compressed air leaks
- Upgrade and adjustment of BMS control systems across the campus
- Installation of dedicated air-conditioning units to cool the Scientia theatres’ control rooms allowing the main chiller plant to be turned off when the theatres are not in use
- A range of lighting projects, including:
  - De-lamping
  - Replacement of some down-lights with LEDs
  - Upgrade of T8 light fittings to T5 fittings using a conversion kit in seven buildings
  - Upgrade of T8 light fittings to new T5 fittings in seven buildings
  - Install occupancy and daylight sensors to fourteen buildings
- A range of smaller one off projects identified in the audit

In addition to these projects, the FM team will continue to review the design of new and retrofitted buildings to recommend potential energy and water reduction improvements.

12. Strategic Direction for the Kensington Campus

Over the years the Kensington Campus electricity distribution network has evolved into an installation resembling the infrastructure as may be seen in a small town. This includes major switchgear and voltage transformer installations in more than 25 electrical sub-stations owned and operated by the University.

Presently, there are five high voltage incomers serving four distribution “ring mains” across the campus. These ring mains connect the electricity supply to the buildings and also provide electricity to the numerous on-site retail outlets.

Embedded in and supplying electricity to this network are the trigen and cogen gas fired generating plant and the solar powered PV installations. Together they provide up to 1,700kW of energy into the ring mains and are an important contribution to lowering the campus’ CO_2 emissions and reducing reliance upon national grid sourced electricity.

With the ever increasing ability of our installed meters, EMACS, and the BMS systems to monitor, control and optimise energy use, our strategy is to create within the campus a “micro-grid” to fully integrate and leverage the “smart” abilities of these systems to automatically manage the micro grid.

In the future we plan to fully automate grid functions such as:

- Demand management
- Load balancing
- Supply source switching
- Use of standby generators

This is aided by energy efficiency activities. By reducing the total electricity demand of the campus and increasing the on-site generation, there is decreasing reliance on the external grid for electricity supply.