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CW&F Energy Efficiency Initiatives

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27th March 2014

Introduction

This report summarises recent and ongoing energy efficiency initiatives undertaken by Capital Works & Facilities. This is based upon a compilation of responses from across the following areas of CW&F: Minor Capital Works, particularly Campus Managers and Technical Specialists; Major Projects; Strategic Asset Planning, particularly design architects; Project Planning Services within Programming, Technical Systems and Services, particularly mechanical and electrical engineers; and Environment and Risk Management.

Responses have been compiled to reflect those initiatives which relate to:

- Energy supply contracts
- Renewable energy supply
- Campus centralised systems
- Peak demand management and load shedding
- BMS networks and smart meter monitoring
- Building design guidelines, and Green Star rated buildings
- Building initiatives
    - HVAC systems
    - Lighting controls and fixtures
    - Hot water systems
    - Solar film and insulation
- Strategy and reporting

This report only identifies the general initiatives undertaken and does not quantify the energy savings associated with each initiative.

Energy supply contracts

UWS campuses are the only campuses in Australia that are located in three different electrical network areas. As a result we have to work with different complex network requirements to deliver effective CW&F business outcomes.

Some business outcomes achieved recently include:

- Avoiding the $1million installation of a high voltage ring main at Werrington South campus for the Werrington Park Corporate centre; and
- Possibly avoiding installation of a $4 million high voltage feeder for the Science building at Parramatta South campus.

Key initiatives associated with energy supply and contracts include:

- UWS has established a 3 year contract with Origin Energy and the savings for these three years exceeds $750,000 compared with the NSW Government contract in 2011. We believe this is the first time UWS has considered market options and consider it reasonable to initiate a new contract with Origin Energy, instead of accepting NSW Government contract.
- We have negotiated workable volume variation, payment terms etc in the contract to minimise UWS future exposure.
- Proactively working to minimise UWS exposure on carbon tax and similar issues
- Our approach is “0 cents” errors in the utility (gas & electricity) from site consumption to the final invoice payment. This requires significant and constant effort from CW&F staff to ensure this outcome is achieved, especially when we manage approximately $9 million worth gas and electricity portfolio.
- In 2013 CW&F installed Smart Meters in all student accommodation. This has allowed, for the first time, UWS to charge the operators of student residencies (CLV) for the actual energy used, as opposed to the traditional charge based on gross floor area.

Renewable energy supply

Renewable energy initiatives include the installation of photovoltaic arrays on Kingswood campus, on Hawkesbury campus, and consideration for the Werrington Park Corporate Centre.

- In 2008, a 36kW roof mounted photovoltaic power generation system was installed on Building K, Penrith campus (Kingswood). The estimated power generation is 50,000 kWh of electricity per annum and the potential Carbon dioxide saving is equivalent to 52 000 kg per annum. You can also view display data online at http://10.4.83.30/SMVorschau.htm
- In 2011, a 98kW ground mounted solar power generation system on the Hawkesbury campus, as part of the infrastructure funding for the Hawkesbury Institute for Environment. Estimated annual power generation is 132MWh and the potential Carbon dioxide saving is equivalent to 137 000 kg per annum.
- Werrington Park Corporate Centre solar project- substantial capacity has been proposed for this project.
- UWS currently sources, through its provider, 2.5% of its total electricity from green energy sources paying an additional $70,000 per annum. Please note that

UWS may not continue with this option from 1 July 2014. Instead, the savings would be invested in more effective in-house energy management initiatives.

Campus centralised systems

Parramatta has integrated its central plant and the BMS (Building Management System) networks, providing a platform for both current and future initiatives. There are also smaller centralised systems, such as at Penrith campus (Kingswood) and at Hawkesbury campus. Key initiatives relating to these systems include:

Upgrade of centralised energy plant (EDa) and cooling towers at Parramatta South. These works included the installation of automated load shedding software (attachment 1. Extracted data from load shedding software) and heat exchangers in all the buildings utilising this plant: buildings EDa, ED, EE, EEa, EG, EH, EJa, EJc, EJd, EK, EKa, EM, EN, EO, EQ, ER, ES & EZ.

- Sharing HVAC infrastructure, such as chillers & boilers, across a number of buildings to reduce energy wasting, e.g. Kingswood (buildings O, L, K & N) and Hawkesbury campus (buildings G1, G6 & G7).

Peak demand management and load shedding

At a campus scale, coordinated efforts are necessary, including energy efficiency, peak energy demand, local energy generation, and efficient distribution of electricity heating and cooling. On all UWS campuses, energy supply infrastructure is limited but the campus continues to grow necessitating demand management to reduce peak demand. Initiatives addressing this issue include:

- Investigating the feasibility of options to build on the Parramatta central plant, including establishment of tri-generation capacity, or augmentation of chilled water storage, or electric chillers with gas fired generators to enable campus future expansion.
- Management of HVAC set points through BMS network at Parramatta campus to load shed when approaching peak demand.
- Installation of power factor correction equipment to improve supply demand across buildings and substations at Nirimba, Penrith, Campbelltown, Parramatta and Bankstown campuses.

Innovative HVAC initiatives such as thermal storage can also contribute to peak demand management, utilising off-peak power at night to cool a thermal mass which is then used the next day. Initiatives to date include:

- Installation of a Phase Change Media Tank at Campbelltown building 24. This technology had never been used in Australia prior to this installation. Utilising this tank as a storage unit, allowed the installation of a smaller chiller (by 70kW) without compromising the comfort of the building occupants.
- CW&F are currently investigating other appropriate locations to install more of this type of technology.

At a building scale, energy efficiency initiatives have shown significant reductions in maximum daily demand, as monitored by smart meters,

- Building L9, Hawkesbury Institute for Environment, has utilised BMS to ensure load shedding.

- Energy efficiency initiatives in Building AD Penrith campus (Werrington North) focusing on repairing control valves, BMS/time clock controls, fresh air strategy and after hours operations have shown a 30% reduction in maximum daily demand Nov. 2012 – Apr 2013).

BMS networks and smart meter monitoring

Building Management Systems (BMS) allow remote access to manage peak demand, time scheduling and temperature control of HVAC systems. BMSs have been installed in a number of buildings across all campuses:

- Bankstown: Buildings 2 & 3
- Campbelltown: Buildings 20 & 30
- Hawkesbury: Buildings G1, G6, G7, G10, H7, H8, K1, K3, K4, K12, K16, L2, L9, L11, M3, R2, R6, R8 & S39
- Nirimba: Buildings U3 & U4
- Parramatta South: Buildings EA, EB,ED, EDa, EE, EEa, EH, EI, EJa, EJc, EJd, EK, EKa, EM, EN, EO, EQ, ER, ES, ESa, ET, EV, EY, EZ & EZa
- Penrith (Kingswood): Buildings C, D, I, J, L, N, O, P, U,V, XB, XC & Y
- Penrith (Werrington South): Buildings BA, BB & BJ
- Penrith (Werrington North): Building AD

Energy monitoring through Smart meters has been installed and are being monitored at:

- Hawkesbury: Buildings G1, G6, G7, H4, H5, H7, H8, J4, J9, K12, K16, K29, L9, M3, M8, M10, P5, P13, P14, P15, P18, R1, R2, R4 & R8
- Penrith (Kingswood): Buildings O & Y (attachment 2 extracted data from the smart meter showing electricity consumption before and after modifications)
- Penrith (Werrington North): Building AD
- Smart Metering is being installed with all new builds and most major refurbishments.

Associated with the smart meter trial tests of a range of retrofitted interventions were implemented, including:

- Hawkesbury, Building K12 Teaching Laboratories and offices

Initiatives trialled included expansion of BMS controls, settings for HVAC for working days in laboratory to come onto shoulder level and motion sensor tripping full air conditioning, after hours button for operation outside of normal operating times.

- Hawkesbury, Building M16 office space

Retrofitting of fresh air intake and associated temperature sensors, to enable greater fresh air utilisation under suitable conditions.

- Penrith (Werrington North), Building AD

Improvements to HVAC valves, chillers and boiler operation, improved fresh air utilisation, and operating schedule with after hour's buttons.

Other activities undertaken with energy monitoring was:

- Consultation with building occupants at Hawkesbury to facilitate ownership of energy efficient behaviour.
- A poster campaign was undertaken at each campus to prompt individual behaviour change (example is shown in attachment 3).

Building design guidelines and Green Star ratings

Designing and installing energy saving initiatives has become 'business as usual' for CW&F. This is reflected in CW&F architectural, mechanical and lighting guidelines which outline the standards utilised in all building works.

CW&F have constructed or are undertaking construction of energy efficient Green Star rated buildings, including:

- Lithgow: 4 Star Design - Education v1.
- Bankstown, Building 17: 5 Star Design - Education v1.
- Nirimba, Building U10: 5 Star Design - Education v1.
- Penrith (Kingswood), Building W: 5 Star As Built - Education v1.
- Penrith (Werrington South), Werrington Park Corporate Centre: 5 Star - Office Design & Office As Built v3
- Parramatta, Science Building EHa: 5 Star As Built - Education v1.
- Campbelltown Hospital, Clinical School – potentially 4 Star - Education v1.

It should be noted that building L9 at Hawkesbury was refurbished to the criteria for a 5 Star building, however, it remains unregistered at this time.

Other Green Star tools are being investigated including the new Green Star Performance tool.

Examples of energy efficiency initiatives in these Green Star buildings include the following:

- Nirimba, UWSCollege Building U10 (5 Star Green Star)

Heating and cooling to teaching rooms and open areas by air-cooled variable refrigerant volume units. Outside air is delivered to dedicated Air Change AHU units for each teaching area, including the lecture theatre, with heat exchangers and economy cycle, and motorised dampers controlled by $C0_2$ monitoring. There is the capacity for automated natural operation by operable windows and BMS controls in teaching rooms and common areas. Operational control by BMS for both air conditioning and natural ventilation is by time schedule and movement sensors, and a night purge is enabled in summer.

- Bankstown, UWSCollege Building 17 (5 Star Green Star)

Efficient central Powerpax chillers serve the building, with teaching spaces and lecture rooms having individual FCUs with economy cycle and CO_2 monitoring. Common foyers and corridors are naturally ventilated through doors and operable windows. With supplementary FCUs in sitting areas for summer and winter. Operational control by BMS for both air conditioning or natural ventilation is by time schedule and movement sensors,

Building refurbishments

Energy efficiency initiatives are being applied across all campuses and are component of building refurbishments to: lecture theatres, common teaching spaces, laboratories, learning common spaces, collaborative learning spaces, wash room facilities and external areas of the campus.

The following section outlines initiatives relating to:

- HVAC systems
- Lighting controls and energy efficient fixtures
- External lighting upgrades
- Hot water systems
- Passive solar film on windows

HVAC systems

Heating, ventilation and air conditioning (HVAC) is a critical area for improved technology associated with energy efficiency and performance. In some major buildings such as Building BJ at Penrith campus (Werrington South) extensive redesign incorporating energy modelling, has led to a mix of technology, passive and fresh air strategies. Major redesigns of building HVAC systems include those implemented for:

- Penrith (Werrington South): Building BJ.

  Refurbishment incorporates centralised water-cooled Powerpax chillers, with variable speed drives to all AHU fans, cooling tower fans and pumps, and full BMS control and energy metering. Each teaching or office area serviced by a: dedicated fan coil unit (FCU); preconditioned outside air with heat recovery coils; room controls and after hours capability; and 'mixed mode' operation for openable windows. Production Studios incorporate separate air handling units (AHUs) with economy cycle, with additional heat recovery and $C0_2$ monitoring in lecture theatres. The atrium has natural ventilation when the outside air temperature is between 18.5 – 25.5 degrees, <60% humidity, and favourable wind conditions. Operable louvers enable this natural ventilation, as well as supporting a pre-cooling strategy at night to purge heat accumulated during the day.

- Hawkesbury: G precinct Buildings G1,G7,G10.

  A central chilled/hot water plant has been installed, with a common BMS across all buildings. The G1 lecture theatre was upgraded with Air Change AHUs, incorporating heat exchangers, economy cycle and $C0_2$ monitoring. The library area has been optimised for Co_2 monitoring and humidity controls in critical areas. The G1 learning commons has heat exchangers to reduce load, building G7 has economy cycle and $C0_2$ monitoring, and G10 incorporates a manual mixed-mode operation for manually opening windows.

A broad range of improved technologies have been implemented across all campuses, including modern air handling units (AHUs), efficient chillers / boilers, replacement of electrical units with gas fired units, replacement with newer units and modification to improve performance.

Installation of Airchange Air Handling Units (AHUs) which incorporate energy saving features such as: air-to-air counterflow heat exchanger; CO_2 monitoring; variable speed drives; and economy cycle, at:

- Bankstown: Building 20
- Campbelltown: Building 20
- Parramatta: Building EE
- Hawkesbury: Building L2 hall

Installation of more efficient chillers and/or boilers, with variable speed drives to allow for changes in air flow with temperature fluctuations:

- Bankstown campus: Buildings 2 & 3
- Nirimba: Building U4
- Campbelltown: Building 24
- Penrith (Kingswood): Buildings L, O
- Penrith (Werrington South): Building BJ

Replacement of electrical air conditioning to gas powered units at:

- Hawkesbury: Buildings K4 (partial) & R4
- Penrith (Kingswood): Building XA

Upgrade of inefficient stand alone air conditioning units with newer more efficient models at:

- Penrith (Kingswood): Building C
- Nirimba: Building U3
- Parramatta: Buildings ET, EV & EY

Modification of existing air conditioning systems to ensure they work as efficiently as possible, including renewal of valves and actuators; installation of HVAC control systems, including occupancy sensors, outside air economy cycle, offset temperatures and after hours start buttons at:

- Bankstown: Building 3
- Hawkesbury: Buildings K12, K16 & M16
- Parramatta: Buildings EA & EB
- Penrith (Kingswood): Buildings XB, Y, O
- Penrith (Werrington South): Building BA
- Penrith (Werrington North): Building AD

Lighting controls and energy efficient fixtures

Internal lighting control systems, including installation of occupancy & daylight sensors; use of dimmers in classrooms; use of T5, compact fluoros and LED fittings:

- Bankstown: Buildings 3, 17, 18, 19, 20, 24 & 28 & student residencies
- Campbelltown: Buildings 4, 6, 17, 18, 20, 21, 24, 30 & student residencies
- Hawkesbury: Buildings G1, G6, G7, H4, H5, H7, H8, J4, J9, K12, K16, K29, L9, M3, M8, M10, P5, P13, P14, P15, P18, R1, R2, R4, R8 & student residencies
- Nirimba: Buildings U1, U2, U3, U4, U10 & U49
- Parramatta: Buildings EB, EZ, EE, EEa & EQ
- Penrith (Kingswood): Buildings D, I, P, V, XA, XB, XC & student residencies
- Penrith (Werrington South): Buildings BB & BJ
- Penrith (Werrington North): Buildings AD, AE & AG

External lighting upgrade to LED fittings at:

- Parramatta
- Hawkesbury
- Kingswood commencing June 2014

Hot water systems

Replacement of electric hot water systems with instantaneous gas systems at UWSConnect eateries in Building 1 at Bankstown and Building 2 at Campbelltown.

Replacement of electric water re- pressurisation pumps with hydraulic operating backflow prevention devices in Buildings 17 & 21 at Campbelltown.

Solar film and insulation

Solar film installed on westerly facing windows on buildings:

- Hawkesbury: Buildings G1, K27, R1 and G10.
- Penrith (Kingswood): Buildings U, P.
- Campbelltown, Building 10.

Insulation initiatives have taken place during roof restoration works and have included the use of thermo shield paint, which reduces heat intake by 45%. These works have been undertaken at:

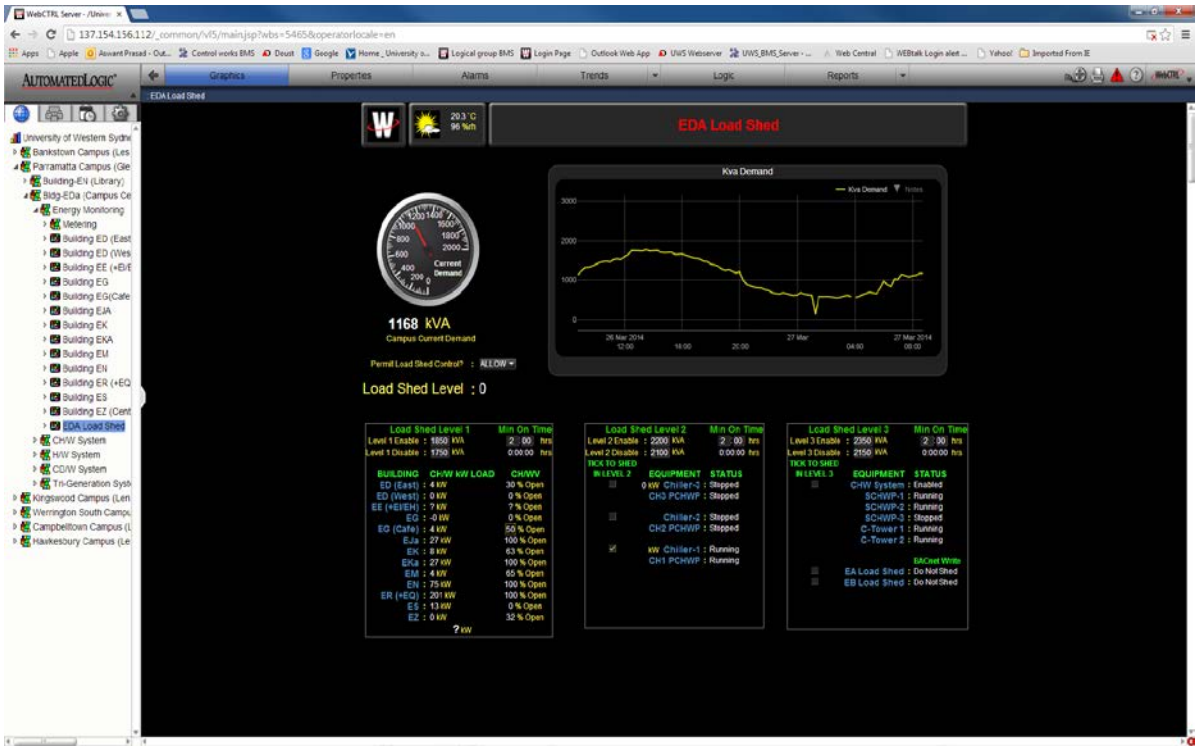
- Hawkesbury: Buildings D12, G1 (partial), H4, H5, K16, J4, K16, K27, P5, P12, P13, P14, P15, P22, R8 and X2.
- Bankstown: Building 2 teaching areas
- Penrith (Werrington South): Building BH

Strategy and reporting

Energy efficiency continues to be a key aspect of environmental sustainability for UWS as reflected in:

- The current UWS Environmental Management Plan and Greening UWS Action Plan (available on policy DDS system)
- Current draft update of the UWS Environmental Management Plan (Attachment 3 extract of the Energy Conservation and Management Program), which is being revised along with other documentation of the UWS Environmental Management System.
- UWS Bringing Sustainability to Life website

Attachment 1. Extracted data from load shedding software at Parramatta South



Load Shedding Options

Max Demand (25/02/2013) **2315 KVA**

Additional Max Demand after all buildings commissioned in 2013- **2500 KVA**

Extra KVA required 2500-2315 = **185 KVA**

Existing Major HVAC Plant on Parramatta South

Power Pax Chiller- EDA	186 KW
York Reciprocating Chiller- EDA **–NOT OPERATIONAL** (967KW)	
Trane Centrifugal Chiller -EDA	301 KW
Trane Centrifugal Chiller –EA 2X 100 KW	200 KW
Carrier Air cooled Chiller – EB 2X 257 KW	514 KW
TOTAL	**1201 KW or 1334 KVA**

All buildings (existing)	47,250 m^2
Existing power demand	2315 KVA
All Buildings (2013)	48,950 m^2
Anticipated power demand	2500KVA
All Buildings (2016)	53,050 m^2
Anticipated power demand	2900 KVA

1850 KVA – Green

2100KVA - Amber Alert all 12 plant room serving off the CEP to have 50% cooling call only

2200 KVA- Red Alert – One chiller in CEP (York Reciprocating) drops out- (**207 KVA comes off the total load**)

If KVA continues to raise an additional chiller in EA or EB drops out or both one in EA and in EB, in conjunction with York Reciprocating in CEP

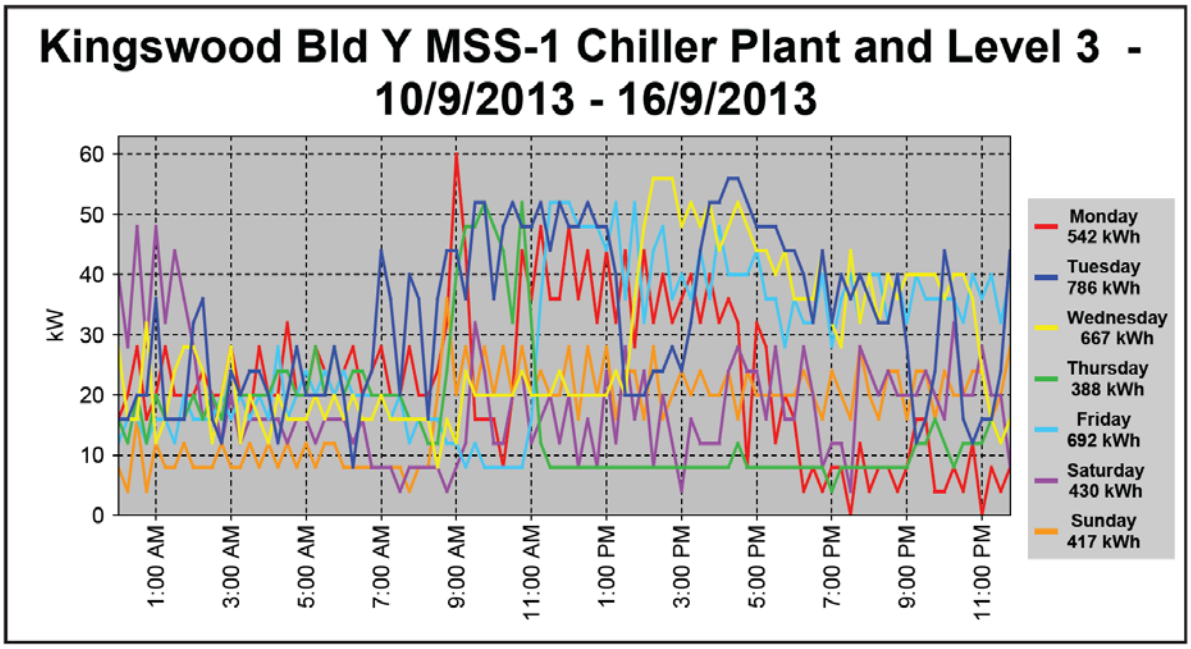
(**186 +257+100= 543/0.9 = 603 KVA**)

All temp set point will be globally adjusted to 24-25^0 C

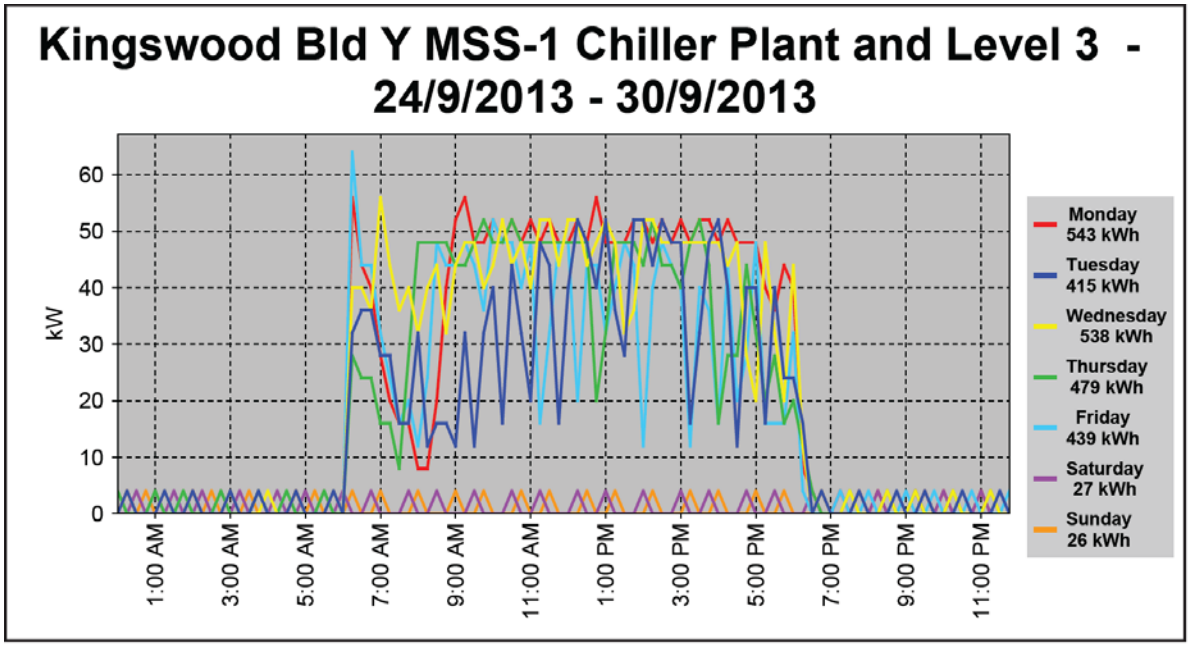
1334/2315 =58% (major HVAC Plant energy consumption on site)

Attachment 2. Extracted data from Energy Monitoring of Bld Y Chiller highlighting energy use before and after modifications.

Before:



After:



Attachment 3. Energy behavioural change prompting poster.

Attachment 4. Extract from draft UWS Environmental Management Plan

1. ENERGY CONSERVATION AND MANAGEMENT PROGRAM

1.1 Compliance requirements and guidelines

Relevant legislative, regulatory and best practice guidelines for the Energy Conservation and Management Program, include those relating specifically to:

- National Greenhouse and Energy Reporting Act 2007, which provides a common framework for reporting on businesses greenhouse gas emissions, energy production and energy consumption
- TEFMA benchmarking for energy consumption by the tertiary education sector, given continuing program of refurbishment for increasing intensity of building use, and new building floorspaces
- Importance of demonstrating best practice energy efficiency in new buildings and monitoring building performance post occupancy

1.2 Objectives and action plans

Based upon the compliance requirements outlined above, the following objectives have associated action plans:

1. Support the preparation and reporting associated with NGERS requirements
2. Implement strategies for increasing efficiency in overall energy consumption in comparison to sector benchmarks
3. Develop and implement strategies for increasing energy efficiency in design, and assessing building ongoing performance

1.3 Action Plan 1.1 NGERS reporting

1.3.1 Objective

Support the preparation and reporting associated with NGERS (National Greenhouse and Energy Reporting Scheme) requirements

1.3.2 Action plan

1. Responsibility for reporting established with contribution from CW&F and submission of reporting via Office of Sustainability
2. Structure of reporting and data interpretation established
3. Yearly reporting undertaken each year for reporting deadline of 31st October
4. Initiative to streamline data capture negotiated with CW&F and IT, to be trialled in 2014
5. Continue to streamline reporting process, and communicate trends and results

1.3.3 Key performance indicators

- Submission of yearly report prior to deadline of 31st October
- Capture and reporting of performance of greenhouse emissions, energy production and energy consumption
- Track annual carbon emissions against the Australian national higher education average, as reported by Tertiary Education Facilities Management Association (TEFMA), through:
    - Carbon emissions per meter square Gross Floor Area (Fig 1)
    - Carbon emissions per EFSTL (Fig 2)

1.3.4 Timeframe

- Yearly, with submission of reporting due prior to 31st October

1.3.5 Responsibilities

- Manager, Sustainability – submission of NGERS report
- Environmental Supervisor – support in compiling necessary data

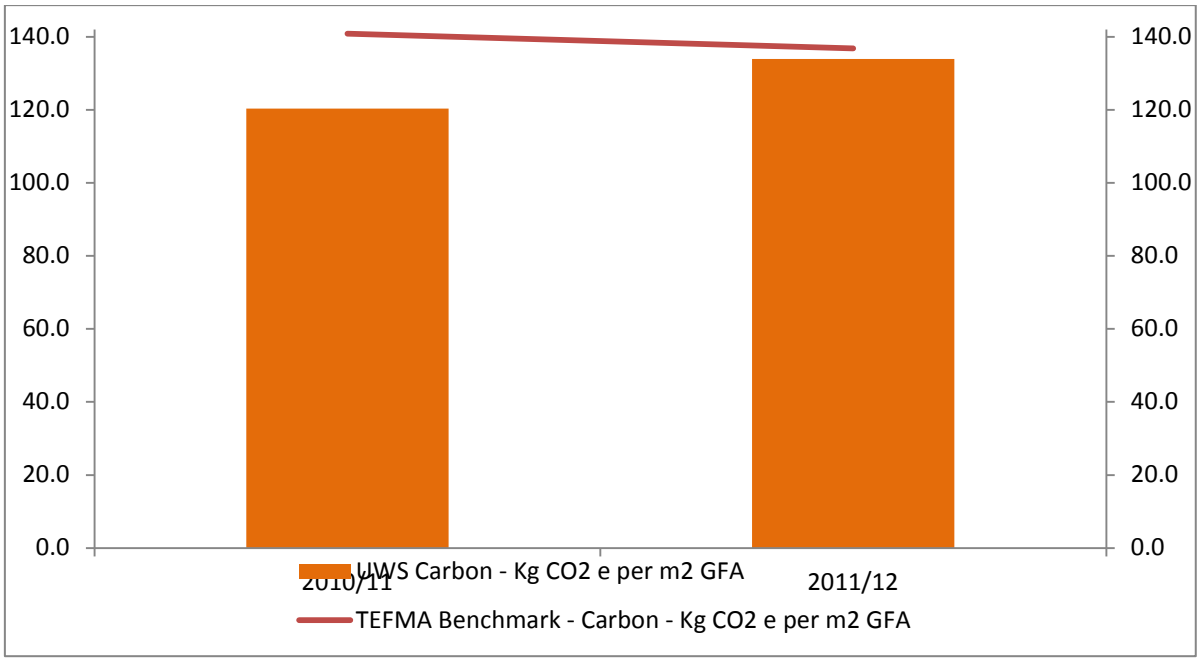


Figure 1. Tracks UWS Carbon emissions (per kg of CO_2) per M^2 of Gross Floor Area against the Australian national higher education average, as reported by TEFMA. N.B. data for TEFMA 2013 will not be available until after June 2014.

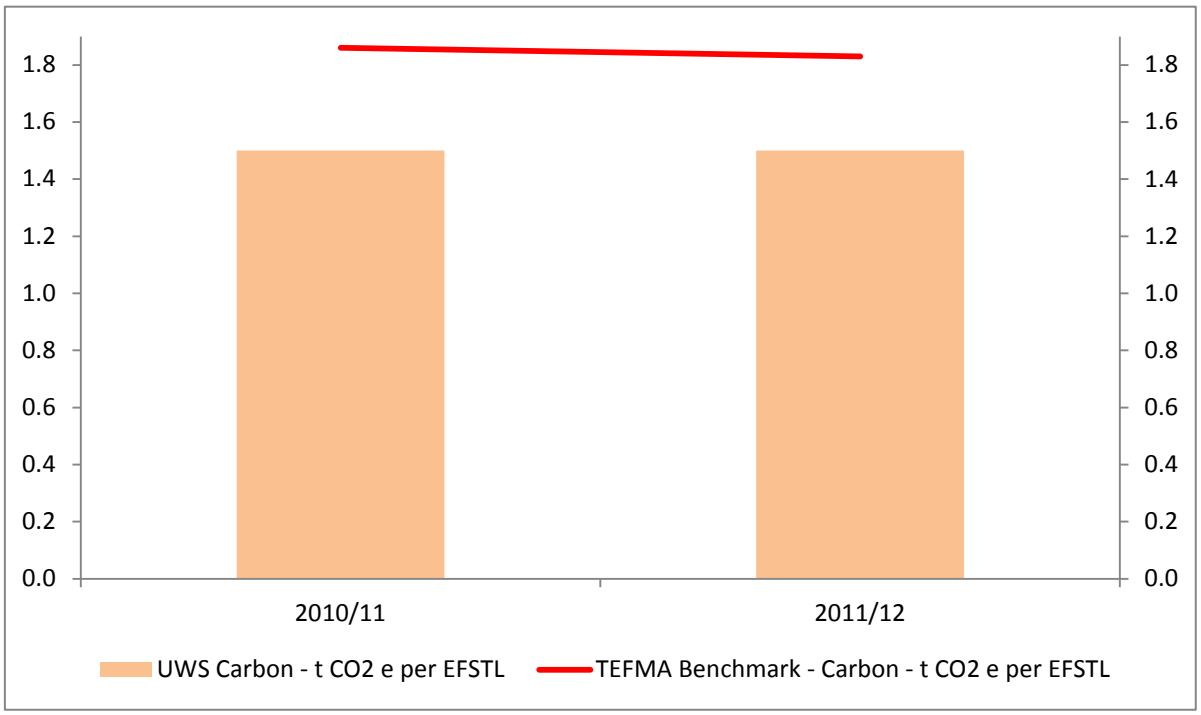


Figure 4. Tracks UWS Carbon emissions (per t of CO_2) per EFSTL against the Australian national higher education average, as reported by TEFMA. N.B. data for TEFMA 2013 will not be available until after June 2014.

1.4 Action Plan 1.2 Energy efficiency and sector benchmarks

1.4.1 Objective

Implement strategies for increasing efficiency in overall energy consumption in comparison to sector benchmarks

1.4.2 Action plan

1. Maintain architectural guidelines for HVAC, lighting, BMS and associated building technologies which reflect reliable and cost-effective means to achieve energy efficiencies without compromising functionality
2. Implement strategies for both new buildings and renovations consistent with these guidelines and strategies
3. Establish strategies for managing campus energy demand (peak and baseload) in a manner consistent with available energy sources and contracts, planned campus development and future energy needs, reliable cost-effective technologies, and energy use behavior.
4. Promotion of energy efficient behavior by building occupants, and smarter controls of individual and aggregate buildings
5. Establish strategies to aid comparability of particular building uses and aggregate energy usage against sector benchmarks such as TEFMA.

1.4.3 Key performance indicators

- Establishment, use and revision of CW&F architectural guidelines for HVAC, lighting and BMS which incorporate consideration of energy efficiency
- Implementation of energy efficient technologies and strategies in new buildings and building renovations
- Planned and rationally analysed strategies for developing campus energy needs
- Energy efficient behaviour of building occupants and smarter building controls
- Track annual energy consumption against the Australian national higher education average, as reported by TEFMA, through:
    - Energy consumption per meter square Gross Floor Area (Fig 3)
    - Energy consumption per EFSTL (Fig 4)

1.4.4 Timeframe

- Ongoing, 2014 - 2016

1.4.5 Responsibilities

- All CW&F Managers, designers and project managers

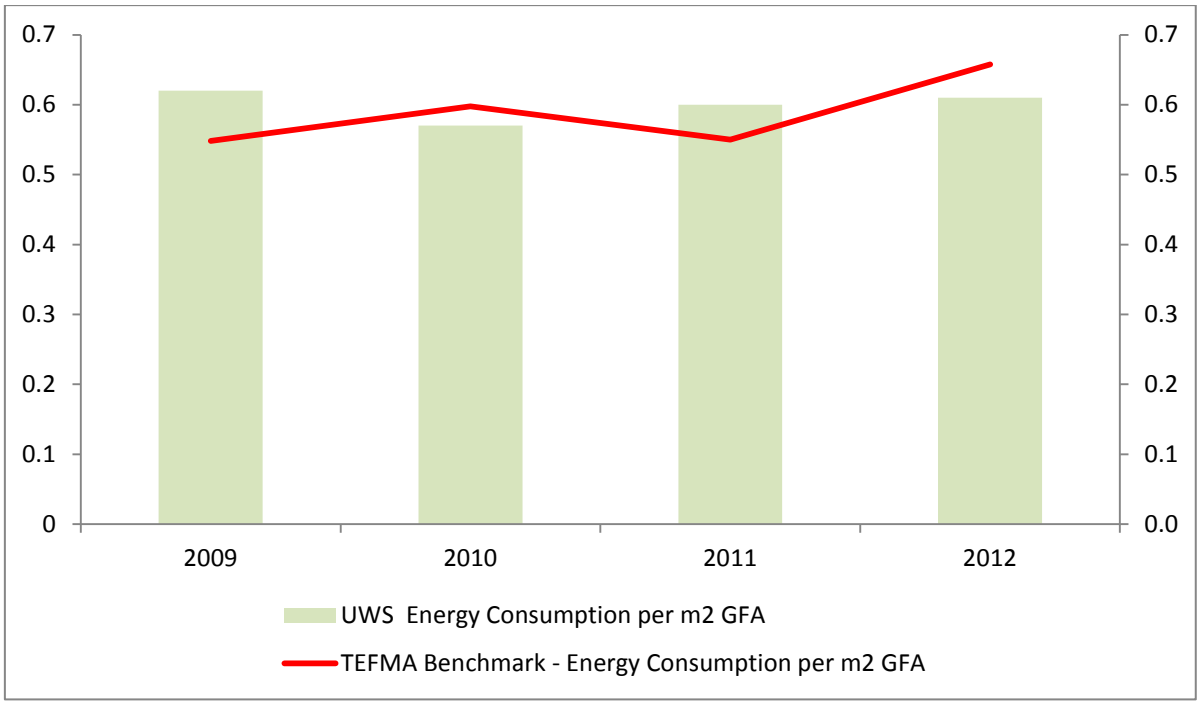


Figure 3. Tracks UWS energy consumption per M^2 of Gross Floor Area against the Australian national higher education average, as reported by TEFMA. N.B. data for TEFMA 2013 will not be available until after June 2014.

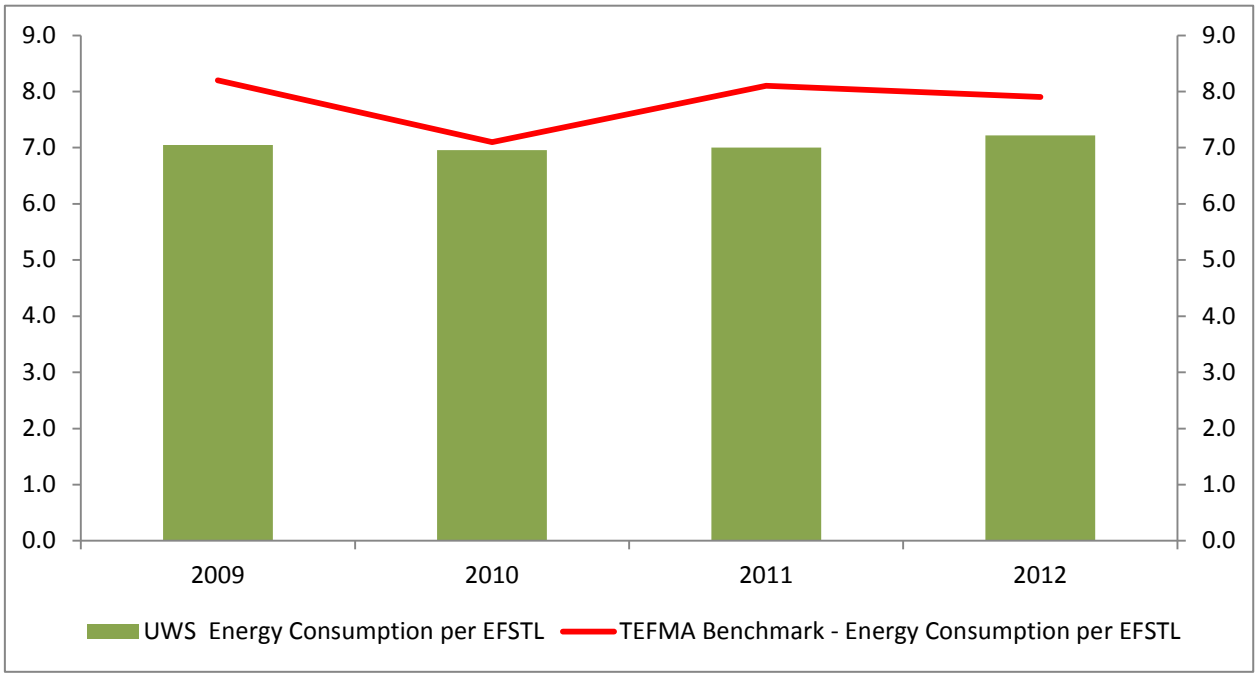


Figure 4. Tracks UWS energy consumption per EFSTL against the Australian national higher education average, as reported by TEFMA. N.B. data for TEFMA 2013 will not be available until after June 2014.

1.5 Action Plan 1.3 Building design and performance

1.5.1 Objective

Implement strategies for increasing energy efficiency through building design and performance.

1.5.2 Action plan

1. Maintain architectural guidelines which incorporate relevant building design and performance, including utilization of green star design and rating tools, passive solar design in combination with HVAC design, etc
2. Implement building design and performance utilizing green star design and rating tools
3. Implement building design and performance incorporating passive solar design elements in coordination with HVAC design
4. Implement BMS, lighting control and energy monitoring strategies to manage building energy performance
5. Develop methods to characterize and benchmark building performance in a manner which reflects the type and use of buildings (eg common teaching, administration, teaching laboratories, research laboratories)
6. Engage building occupants and enabling energy efficient behaviour

1.5.3 Key performance indicators

- Maintenance of relevant architectural guidelines
- Implementation of green star design and rated buildings
- Implementation of passive solar design
- Implementation of BMS, lighting control, and energy monitoring strategies
- Develop characterization and benchmarking of building use and energy performance
- Engagement of building occupants and energy efficient behaviour

1.5.4 Timeframe

- Ongoing, 2014-2016

1.5.5 Responsibilities

- All CW&F Managers, designers and project managers