ENERGY AUDIT AT THE UNIVERSITY OF MELBOURNE

The University of Melbourne has commissioned an energy audit of the Parkville Campus to review its energy consumption, cost and associated greenhouse gas emissions.

The energy audit summarised the baseline and breakup of energy usage, a management systems review of how energy is being managed energy by the University, energy savings opportunities for the total audited University and a description of the energy supply infrastructure, energy supply agreements and options in the procurement of greenhouse offsets (i.e. Green Power).

SUMMARY

The total energy consumption of the University audited is approximately 77,588 MWh of electricity, 207,870 GJ of natural gas and 5,126 Tonnes of steam respectively. The annual cost is approximately $6.7 million and the associated total greenhouse emissions associated for this energy usage are 127,837 tonnes of CO_2-e per annum.

Electricity Cons (MWh pa)	Elect Cost $ pa	Natural Gas Cons (GJ pa)	Gas Cost $ pa	Steam Cons (T)	Steam Cost $ pa	Perf Index (MJ/m2 pa)	Total Energy Cost $/m^2	Perf Index (GJ/EFTSU pa)	Tonnes CO_2-e pa
77,588	**$5,647,858**	**207,870**	**$958,113**	**5,126**	**$113,944**	**954**	**12.78**	**14.70**	**127,837**

- All Costs exclude GST
- EFTSU is 34,008

Table 1 – Summary of Energy Usage for the Audited University

The University also purchases 5% Green Power of its electricity usage at $43.79 per MWh, which amounts to an offset of 3,783 MWh and 5,550 Tonnes of CO_2-e greenhouse emissions per annum (4.3% of total audited energy emissions).

Electricity is the largest energy use source and greenhouse emitter accounting for 84% of the total energy costs and 89% of the greenhouse emissions.

ENERGY BREAKUP BY FACULTY

Table 2 and figure 1 show the breakup of energy usage and cost by faculty. The individual faculty reports provide more detailed description.

Faculty	Total GJ	Total $ pa	Total T CO_2 pa
Affiliated Organisation	46,809	$ 611,236	11,657
Architecture, Building & Planning	11,110	$ 121,921	2,259
Arts	34,457	$ 456,323	8,721
Economics & Commerce	13,465	$ 174,294	3,320
Education	14,818	$ 205,850	3,961
Engineering	38,795	$ 425,938	8,243
Land & Food Resources	6,546	$ 85,722	1,636
Law	28,634	$ 391,506	7,520
Medicine, Dentistry & Health Science	95,419	$ 1,259,103	23,125
Music	796	$ 16,148	325
Science	97,466	$ 1,392,161	26,894
University General	104,607	$ 1,453,777	27,978
Veterinary Science	6,804	$ 125,937	2,200
Total	**499,726**	**$ 6,719,916**	**127,837**

Table 2 – Breakup of Energy Usage and Cost by Faculty

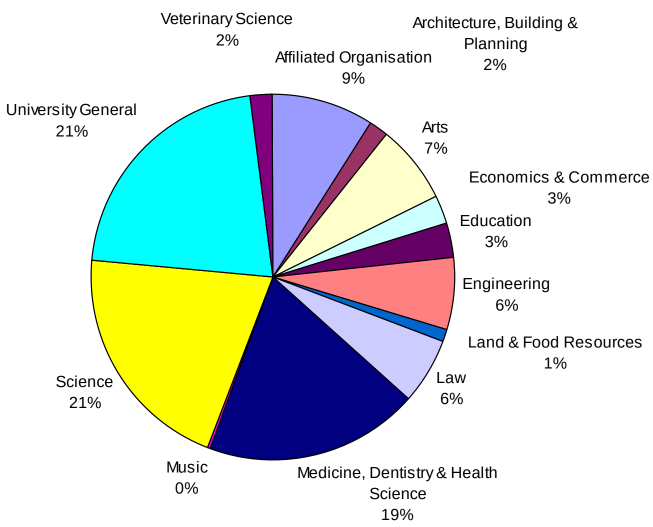

Fig 1 – Breakup of Energy Usage by Faculty

The University General, Science and Medicine, Dentistry and Health Faculties are the largest energy users accounting for over 60% of the total audited energy usage.

ENERGY BREAKUP BY ENERGY END USE SYSTEM

Table 3 and figure 2 show the breakup of energy cost by energy end use systems. The individual faculty reports provide more detailed description.

End Use System	**Energy Cost $ pa**
HVAC	$ 3,479,974
Lighting	$ 1,280,599
Dometsic Hot Water	$ 159,172
Kitchen & Lab	$ 173,260
Office Equipment	$ 488,938
Lab/Workshop Equipment	$ 518,699
Lifts	$ 169,680
Computer Systems	$ 165,124
Other	$ 284,470
Total	**$ 6,719,916**

Table 3 – Breakup of Energy Cost by End Use System

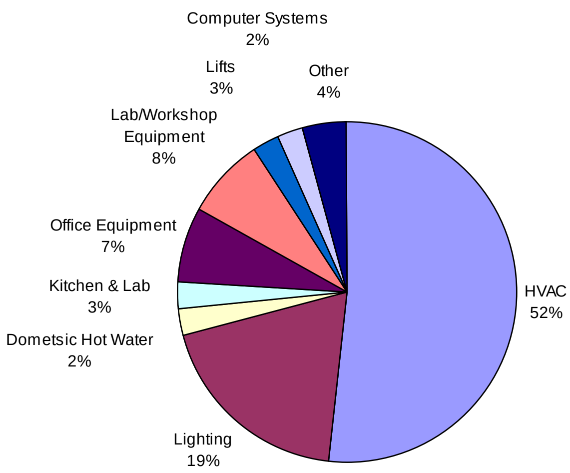

Fig 2 – Breakup of Energy Cost by End Use System

HVAC (Heating, Ventilation and Air Conditioning) and lighting are the largest energy users accounting for a total of 71% of the total audited energy usage. These are therefore the main focus areas for energy saving opportunities.

RECOMMENDATIONS

Table 4 summarises the key energy efficiency recommendations made by the Consultant, together with estimated implementation costs for each initiative. These recommendations will be assessed and selected for appropriate implementations.

Recommendations	Savings (pa) [1]	Cost [2]	Payback Years[3]	Savings TCO_2-e [4]
Green Power – Procure at competitive market rates				4,218
Heating Ventilation & Air Conditioning Systems - Optimisations and Controls	$494,000	$703,300	1.4	10,225
Lighting - Substitutions and Controls	$455,000	$2,631,000	5.8	9,213
Boiling Water Units & Water Cooler - Timer Control	$7,070	$9,760	1.4	251
Staff Awareness	$288,000	$0	-	5,919
Solar Pool Heating – Beaurepaire Building	$9,200	$96,000	10.4	127
Total (Approximately)	**$1,253,270**	**$3,440,060**	**2.7**	**29,953**

Table 4 – Summary Key Energy Efficiency Recommendations

The energy audit has identified potential energy usage savings worth in excess of $1,336,270 per annum, which represents 20% of the total cost. The capital cost of implementation is estimated at $3,440,060 which equates to a simple payback of 2.6 years.

The energy cost savings identified equates to a reduction in CO_2 emissions of 29,953 tonnes per annum, which represents 23% of the total emission.

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[1] “Savings” is defined as Australian dollar savings per annum; they are not cumulative as those incurred by any one item could affect impact of other initiatives.
[2] “Cost” is defined as implementation cost in Australian dollar. It excludes any contingency for project management.
[3] “Payback years” is calculated using the simple payback method.
[4] The “tonnes of CO_2 savings” is calculated based on the emission factor of 1.467 kg of CO_2 per kWh.

SCOPE OF THE ENERGY AUDIT

This audit covers 13 faculties containing 70 buildings within the Parkville Campus as identified in Table 5 below.

The buildings have a variety of roles and occupancies, including sports facilities, offices, function centres, computer laboratories and server rooms, lecture theatres, libraries, galleries, meeting rooms and a child care centre.

Building No	Building Name	Faculty
102	David Penington	Affiliated Organisation
104	Alan Gilbert	Affiliated Organisation
113	Baldwin Spencer	Architecture, Building & Planning
132	Old Commerce	Architecture, Building & Planning
133	Architecture	Architecture, Building & Planning
149	Old Arts	Arts
150	Old Quadrangle	Arts
158	Sidney Myer Asia Centre	Arts
191	John Medley	Arts
199	Arts Centre	Arts
263	234 Queensberry Street	Arts
139	Babel	Economics & Commerce
148	Economic & Commerce	Economics & Commerce
162	Alice Hoy	Education
168	Doug McDonell	Education
189	Frank Tate	Education
163	Walter Boas	Engineering
164	Old Radiation Laboratory	Engineering
165	Chemical Engineering 1	Engineering
166	Old Metallurgy	Engineering
167	Chemical Engineering 2	Engineering
169	Engineering Workshop	Engineering
170	Mechanical Engineering	Engineering
173	Old Engineering School	Engineering

Building No	Building Name	Faculty
174	Engineering Block C	Engineering
175	Engineering Block B	Engineering
176	Engineering Block D	Engineering
193	Electrical & Electronic Engineering	Engineering
142	Land and Food Resources	Land & Food Resources
106	Law	Law
115	Redmond Barry	Medicine, Dentistry & Health Science
181	Medical Centre	Medicine, Dentistry & Health Science
184	Microbiology & Immunology	Medicine, Dentistry & Health Science
185	Biochemistry	Medicine, Dentistry & Health Science
260	200 Berkeley Street	Medicine, Dentistry & Health Science
379	207-221 Bouverie Street	Medicine, Dentistry & Health Science
141	Conservatorium of Music	Music
105	Information & Communication Technology	Science
122	Botany	Science
123	Botany North Extension	Science
143	Natural Philosophy	Science
147	Zoology	Science
153	Chemistry	Science
154	Chemistry East Wing	Science
160	Richard Berry	Science
192	Physics	Science
194	Genetics	Science
200	Earth Sciences	Science
101	Beaurepaire Centre	University General
103	Sport Centre	University General
112	University House	University General
128	Old Physics	University General
134	Elisabeth Murdoch	University General
136	Ian Potter Museum	University General
140	Grainger Museum	University General
151	Wilson Hall	University General

Building No	Building Name	Faculty
152	Raymond Priestley	University General
155	Old Geology	University General
156	Old Geology South	University General
161	Centre for theStudy of Higher Education	University General
171	Education Resource Centre	University General
172	Plaza Conference Centre	University General
177	Baillieu Library	University General
182	Brownless Library	University General
197	John Smyth	University General
198	1888	University General
201	Thomas Cherry	University General
262	228 Queensberry Street	University General
266	258 Queensberry Street	University General
400	Veterinary Science	Veterinary Science
TOTAL		

Table 5 - Audited Buildings for the Total University Campus

RENEWABLE ENERGY REVIEW

The University of Melbourne purchases 5% Green Power through their electricity contract with AGL. Excluding losses and GST, the rate for Green Power that AGL is charging is $43.6/MWh. This translates to approximately 3.8 GWh pa, $166K and 5,575 Tonnes of CO_2-e per annum.

The following Table provides a brief summary of several green energy and carbon offset products that are available for purchase in Australia.

Mechanism	Green Power	RECs	Green Energy	Greenhouse Friendly Electricity	NGACs
Product Type	**New** Renewable Energy	**New** Renewable Energy	Renewable energy (normally from old sources)	Zero emission electricity	Carbon Offset
Scheme	National Green Power Accreditation Program	Mandatory Renewable Energy Target	Various (either old green power or individual company scheme)	Greenhouse Challenge Plus	NSW Greenhouse Gas Benchmark Scheme
Certificate units	1 MWh of renewable energy	1 MWh of renewable energy	1 MWh of renewable energy	Each MWh of electricity is bundled with a carbon offset	1 tonne CO_2-e
Duration	n/a	April 2001 to December 2020	n/a	n/a	2003 – 2012 (possibly 2020)
Suitability	Well recognised retail product for purchasing new renewable energy	Alternative option for purchasing new renewable energy. Product does not have all the benefits of Green Power	Often described as existing green energy (eg old hydro sources). Investment in this product has a low environmental benefit	Only available from selected retailers	Available for customer to offset emissions from electricity and any other emission
Current Market Price (Nov 06)	$20-35/MWh	$15-$25/MWh	$2-$8/MWh	$7-$10/MWh	$10-15/tonne
Market Availability	Large market surplus	Large market surplus	Large market surplus	Unknown at this time, several eligible projects not yet accredited.	Limited availability due to market shortfall

Table 6: Australian Green Energy and Carbon Offset Schemes & Products

The difference between green energy and carbon neutral schemes are that green energy is electricity generated by renewable sources, while carbon neutral products are generated by projects that reduce greenhouse emissions to the atmosphere.
Green Power is the premium retail renewable energy product that customers use for ensuring that their renewable energy is government accredited and from new sources.

An alternate product the REC (Renewable Energy Certificate) has both of these features however it is does not enable the customer to use the Green Power Logo for promotion.

Green Power is also better understood by students and the wider community.

Each MWh of Green Power has the equivalent of 1 REC attached to it and 1 Green Power Right (Please note there are some minor special exemptions from this general rule). There is a small premium for the Green Power right ($1-2/MWh).

While the retail prices for Green Power do vary, it is possible for customers like the University of Melbourne to negotiate for a Green Power price that is within the cost of the two separate green products of $20 to $30/MWh. It should be noted that the lowest price recently received was $26/MWh and should be open for negotiation at any time. The University of Melbourne has just entered discussions with AGL to review the purchase of Green Energy.

Most contracts allow the customer to reset or adjust their commitment to Green Power. A customer should also be able to source this product from an alternative supply if the price is not competitive and still maintain their Green Power commitment for the year.

In understanding the differences between a REC and Green Power, it is important to note that MRET (Mandatory Renewable Energy Target) is a mandatory program specifically designed to create a liability on retailers to purchase more renewable energy. The Green Power program is specifically designed to focus on the retail/end user market to facilitate installation of new renewable energy generators across Australia beyond mandatory renewable requirements. The Green Power program is a government funded initiative and many universities/TAFEs are required or have a specific policy to purchase Green Power. A REC on its own would not be sufficient for compliance.

RENEWABLE ENERGY GENERATION

Alternative energy sources can offer benefits of reduced greenhouse gas (GHG) emissions compared to those associated with the University's current energy sources. The technical compatibility, commercial feasibility and level of environmental benefits of a range of alternative energy technologies were assessed for appropriateness for the Parkville campus site. These alternative energy sources included alternative electricity generation options as well as alternative sources for air conditioning.

In Australia, alternative energy sources are generally more expensive than the University of Melbourne's existing electricity and gas contracts. This means that alternative energy options are likely to be commercially unfeasible at present. However, the University is interested in which alternative energy sources offer the highest potential in the future.

Wind

Wind power can be harnessed by wind turbines. Generally wind turbines are mounted upon large towers and located in regions with attractive wind conditions. Turbines are also mostly located away from populated areas due to noise and visual impacts. Therefore, wind turbines are, in general, not appropriate for commercial use in built up areas. However, renewable energy generators produce some energy from wind and feed it to the national grid, allowing commercial entities to purchase wind power through green electricity.

Further, the application of very small-scale wind turbines to individual buildings is being piloted in a number of areas in throughout Melbourne (for example CH2). However, these turbines have not yet been commercially proven for use at present. Sizes range from a 200W domestic turbine to larger machines for commercial buildings, which typically have an output of about 2kW. Such sizes would only supply a fraction of the electricity used at the Parkville campus.

The rate of wind electricity production relies upon the weather conditions. This means that backup electricity source or energy storage would be required to ensure a reliable electricity supply.

Solar Photovoltaic

Photovoltaic (PV) solar cells are made of semi-conducting materials and directly convert sunlight into electricity. The scale of PV cells required supplying the required electricity for each building or building system is not likely to be compatible with the available area.

The University has installed PV cells in the Alan Gilbert building on Grattan Street. The maximum total connected load is around 48kWe.

The rate of PV electricity production relies upon the weather conditions. This means that backup electricity source or energy storage would be required to ensure a reliable electricity supply.

The occurrence of solar PV installations in the commercial sector is very low. Under current market conditions, PV technology tends to be used by organisations wishing to make a strong environmental statement, rather than in response to any economic drivers. The additional cost of PV is ranked as high compared to the University’s current energy costs.

There is some debate over the level of environmental benefits derived from the use of PV cells due to the high level of energy required to produce PV cells. In addition, PV is only likely to supply a fraction of the electricity demand. Therefore, for the purposes of this review, the environmental benefits are ranked as Low.

Biomass

Biomass refers to organic matter which can be used as a fuel, such as wood, agricultural wastes, biodiesel and bioethanol. Since biomass is the output of a short carbon cycle, it is often considered to be a ‘carbon neutral’ source of energy. That is, the amount of carbon released as carbon dioxide during combustion is absorbed during growth of the plant matter. However some biomass sources which require significant energy during fuel processing, such as biodiesel, need to be further investigated to determine their level of carbon neutrality.

Biomass can be combusted to produce electricity together with cogeneration, as discussed elsewhere in this report, or without cogeneration as a dedicated combustion process. Regardless of whether cogeneration is used or not, the appropriate technology type for the small scales required by the University is internal combustion engines. Steam or gas turbines would not be economically feasible at these scales. Internal combustion systems require liquid or gaseous fuels, which limits the possible biomass sources to biodiesel or bioethanol.

Electricity generation from diesel is significantly more expensive than purchasing electricity from the national grid, meaning that this type of electricity generation is not currently commercially viable. The cost of biodiesel and bioethanol depends upon the biomass source used for the production, but is likely to cost significantly more than fossil fuel derived diesel. In addition, capital expenditure is required for a generator, and generator must be maintained. However, relative to the other technologies considered in this review, electricity generated using biomass is considered be higher than the University’s existing electricity and gas costs.

Determining the environmental benefits of obtaining electricity from the grid and comparing with generating electricity from a diesel generator is not straight forward. Firstly, it is important to ensure that the biomass comes from a sustainable source. Secondly, all types of air emissions from biomass combustion must be considered. Although there will be a reduction in carbon dioxide emissions, it is likely that a small diesel generator will not have the same level of emission abatement equipment as a large scale electricity generator. This means that the release of other air emissions, such as oxides of nitrogen and particulates, may be higher from diesel generation than from large scale electricity generation. Therefore the environmental benefits of biomass derived electricity are ranked as low.

Cogeneration

Cogeneration is the sequential generation of electricity and useful heat from the same primary fuel. Cogeneration makes use of heat that would otherwise be wasted. Cogeneration therefore significantly improves the efficiency of energy use with the consequent potential for improved economic efficiency and the additional benefit of reducing GHG emissions. Typically cogeneration will increase overall efficiency of energy use from that of coal-fired electricity of around 35% to somewhere in the range of 70-75%.

The heat produced from cogeneration could be used by the University. This heat could replace gas heating in winter, and possibly replace electric air conditioning in summer through an absorption chiller (‘trigeneration’).

Hydro, Tidal, Wave and Geothermal

Renewable energy sources such as hydro, tidal, wave and geothermal can only be harnessed when the energy demand is conveniently located close to the energy source. Electricity generated from some of these sources is harnessed by renewable energy generators and fed into the national electricity grid. This electricity is labelled as ‘green electricity’, and can be purchased from the grid and used by any electricity user. Although the option of green electricity is discussed further, the technical compatibility of Melbourne University directly harnessing hydro, tidal, wave and geothermal energy is low.