University of Waterloo - Energy Conservation and Demand Management Plan 2014-2019

June 2019 - Final Review

Introduction

The University of Waterloo is a large and growing research intensive post-secondary institution. With facilities for approximately 40,000 faculty, students and staff, encompassing multiple campuses, the annual cost of energy is a major concern.

Under Reg 397/11 "The Green Energy Act", the Ontario Government has required all institutions to create an energy conservation and demand management plan. The Act has two main focuses. The first is to have organizations formalize their energy plans; the second is to encourage organizations to install renewable energy generation.

Energy Consumption

For the operating year May 2013 to April 2014, the University of Waterloo used a total of 1,114,824 GJ of energy; 62.7% was natural gas, the balance was electricity. With a total building area of 647,485 m^2, the energy intensity was 1.72 GJ/m^2.

Appendix A includes historical energy data. In general, the intensity has been holding steady, however, a new large high energy use building was completed in 2012 and that has caused a step jump in the index.

Goals and Objectives

1) Minimize energy consumption and environmental impact while ensuring the needs of the university community are met.
2) Support a culture of efficiency and sustainability by converting theory into practical, cost-effective actions.
3) Ensure that everyone on campus is aware of the need and does their part to conserve energy.

Organizational Energy Measures

1) LEED silver. New buildings will continue to be designed to meet LEED silver compliance. Certification will not necessarily be obtained. Where major renovations are occurring, the same standard will be implemented.
   Cost: 2% above base project cost. Annual Savings: 20% annual operating costs. Lifespan: indefinite.

2) Develop a lighting control plan. The University operates virtually 24 hours a day. There are no formal policies or methodologies relating to operation of interior lights. This measure will encompass a detailed campus audit to develop a plan to address this situation. The resulting plan should include both a technical measure (lighting automation) as well as a behavioural measure.
   Cost: Internal. Annual Savings: None directly. Lifespan: indefinite.

3) Exterior lighting conversion. This is an ongoing measure. Currently, about 40% of the exterior lights have been upgraded to a modern energy efficient style. As opportunities and capital are available, work will

continue. Note that as new bulb and fixture technologies become available, the design and implementation will change.
Cost: Varies. Annual Savings: Variable. Lifespan: 15 years.

4) Building lighting conversion. This is an ongoing measure. There are still large areas of building spaces containing fluorescent T12 bulbs and incandescent bulbs. As opportunities and capital become available, work will continue. Conversion to T8 and/or LED bulbs are completed as deemed appropriate.
Cost: Varies. Annual Savings: Variable. Lifespan: 10 years.

5) Develop a policy for stringent mechanical and electrical designs with respect to new building/renovations. It is common for lab spaces to be over engineered with regards to estimated heat loads, electrical loads, and cooling loads. Oversizing HVAC equipment leads to short cycling and poor overall equipment performance as well as high electrical demand spikes. Ensuring the optimum sizing of equipment and infrastructure leads to a better overall performance of the space as well as more satisfied occupants. This organizational measure requires enhanced communication between the space occupant, designer and operator.
Cost: Internal. Annual Savings: unknown. Lifespan: indefinite.

6) Fume hood design. The industry standard for fume hood design is 100 fpm face velocity. Makeup air for fume hood needs is a large energy use for buildings with labs. This organizational measure is to develop a set of design criteria for all new fume hoods. Recent research into containment velocities will be used as well as evaluating the cost benefit of monitored demand based fumes hoods.
Cost: Completed in-house. Annual Savings: TBD. Lifespan: 20 years.

7) Improved marketing of energy conservation at student residences and on campus with attention to plug loads. This will be a broad based behavioural measure. Occupants have a good basic understanding of energy conservation. A detailed plan will be developed to leverage the existing knowledge with more detailed UW specific information. The plan will include methods to develop concrete actions with the campus community.
Cost: Internal. Annual Savings: unknown. Lifespan: 5 years.

Technical Energy Measures

8) HVAC filter selection. High quality filters can perform the same function at lower pressure drop compared to lower quality filters. When coupled with variable frequency drives, this can produce measurable hydro savings beyond the added cost of the filters. Labour cost for reduced filter changes can also enhance the cost benefit comparison.
Cost: Varies. Annual Savings: Varies. Lifespan: 1 year (max).

9) Automation of chiller plant selection. UW has many chiller plants located around the main campus. Choosing which chillers to operate is currently done manually through the building automation system. This technical measure will automate the selection process to ensure optimum efficiency under all operating conditions.
Cost: $8000. Annual Savings: $4,000. Lifespan: 5 years. Updates will be required as the campus chilling system changes.

10) Chilled water booster pumps. The main campus has a large multi-loop chilled water distribution system. During low load times, chillers must operate to meet flow needs rather than cooling load. By installing strategically located booster pumps, the chillers themselves could be left off.
Cost: $50,000. Annual Savings: $25,000. Lifespan: 20 years.

11) Thermal cool storage. Conduct a feasibility study into installing a thermal cool storage system to reduce daytime loads from the chiller plants.
Cost: $15,000. Annual Savings: NA. Lifespan: NA.

12) VAV systems replacing constant volume. Many of the older buildings have constant volume air handling systems with terminal reheat. This kind of system is inefficient and requires summer heat. Refurbishing the systems for variable air volume will reduce energy demands.
Cost: Varies. Annual Savings: Varies. Lifespan: 20 years.

13) New windows. Older buildings have inefficient windows. Replace and upgrade for better overall insulation value and building integrity. Wall and roof construction may need to be evaluated and improved at the same time.
Cost: Varies. Annual Savings: Varies. Lifespan: 30 years.

14) Heating system upgrades. As conventional boilers are replaced, condensing boilers are being installed in their place. Further, system changes allow the heating systems to drop into the condensing temperature range, thus improving the overall system efficiency.
Cost: 10% above base project. Annual Savings: 10% fuel costs. Lifespan: 15 years.

15) Re-commission building mechanical systems. Develop and implement a systematic, documented process for optimizing existing system performance. Systems will be compared to the original design intent and improved where cost effective changes can be made.
Cost: Internal. Savings: 2-3% of operating cost of building. Lifespan: 7 years. 2-3% savings are likely if a building is re-commissioned every 7 years.

16) Conversion of AHU1 in R.J. Coutts Hall from 100% outdoor air to modulating recirculation.
Cost: $25,000. Annual Savings: $5,000. Lifespan: 20 years.

Renewable Energy Sources

60 kW solar collector EV3 – Refurbished in 2019.

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Summary

Growth of the University continues to drive the absolute energy consumption of the organization. The University's official plan has set us on a course of real growth for many years to come. With improved technology and construction methods, the energy intensity can be reduced, but making absolute reductions in energy consumption will be a challenge.

2017 update. The increased focus on greenhouse gas emissions is changing how energy management is being viewed. New opportunities and challenges are emerging as the cap and trade financial impacts are developing.

2019 update. Energy intensity has basically stayed flat. Since the campus has grown, the total energy use has gone up proportionately. UW has committed to being carbon neutral by 2050. In the next 5 years, a focused effort will have to be made to reduce the energy intensity of the campus in preparation for later fuel switching.

Task	Done	Ongoing	Not Done
1) LEED silver	X		
2) Develop lighting control plan			X
3) Exterior lighting conversion		X	
4) Building lighting conversion (half way through a $875k LED program)		X	
5) Policy for stringent building design (mech & elec)			X
6) Fume hood design			X
7) Improved marketing of energy conservation at residences			X
8) HVAC filter selection	X		
9) Automation of chiller plant selection			X
10) Chilled water booster pumps			X
11) Thermal cool storage			X
12) VAV system replacing constant flow systems			X
13) New windows		X	
14) Heating system upgrades		X	
15) Recommissioning of buildings			X
16) Conversion of AHU1 in Coutts Hall to recirculating	X		
TOTALS	3	4	9

Appendix A – Energy calculations

All information is based on fiscal year (May-April). Future versions may switch to calendar year to align with other government submissions. 2013/2014 is the base year for reference. 0.0036 GJ/kWh; 0.0389 GJ/m^3.

Year	Gross Area (m^2)	Hydro ('000 kWh)	Gas ('000 m^3)	Total Energy (GJ)	Energy Intensity (GJ/m^2)
2002/2003					1.44
2003/2004					1.32
2004/2005					1.27
2005/2006					1.39
2006/2007					1.45
2007/2008					1.43
2008/2009					1.41
2009/2010					1.36
2010/2011					1.49
2011/2012					1.34
2012/2013					1.64
2013/2014	647,485	115,465	17,973	1,114,824	1.72
2014/2015	661,371	116,077	18,940	1,154,643	1.75
2015/2016	681,754	121,360	16,325	1,071,939	1.57
2016/2017	694,555	130,149	17,366	1,144,074	1.65
2017/2018	712,478	132,421	19,113	1,220,211	1.71
2018/2019	773,557	137,025	18,496	1,212,795	1.57

Appendix B – Jan 2019 update of completed projects

		Savings			
Year	Bldg	Energy kWh	Demand kW	Cost	Description
2014	HS			NA	Conversion from electric to hot water reheat coils
	CSB	205300	46.6	$ 82,000	VFD retrofit to the main boiler water pumps
	Various			NA	Upgrading lighting - ongoing
	RCH	83000	NA	$ 12,500	Conversion of S1 from constant volume to recirculating
	Various			NA	BAS system upgrade
2015	L Lot				Upgrading lighting
	Commons				Upgrading lighting
	PHY	197800	8.4	$ 42,000	Floating head control for Sharcnet cooling system
	EC4	61500	23.7	$ 27,400	Upgrading lighting
	FED			NA	energy efficient design of major renovation
	PHA	23600	2.7	$ 2,000	Upgrading lighting
	DWE	390800	44.6	$ 500,000	Upgrading lighting
	PAS			NA	Conversion to VAV system - ground floor
	Various			NA	Upgrading lighting - ongoing
	Various			NA	BAS system upgrade
2016	CIF			NA	Chiller barrel replacement (ice plant)
	H Lot				Upgrading lighting
	EC1-5			$ 19,700	BAS system upgrade
	EC1				Upgrading lighting
	EC5				Upgrading lighting
	QNC	27130	7.7	$ 5,000	Upgrading lighting
	PHA	21100	8	$ 5,500	Upgrading lighting
	Various			NA	Upgrading lighting - ongoing
	UWP				Boiler replacement
	Various			NA	BAS system upgrade
2017	HH				Upgrading lighting
	MC	74048	16.2	$ 41,300	Upgrading lighting
	PAC	326978	46.5	$ 219,900	Upgrading Lighting
2018	DC	120684	26.3	$ 24,562	Upgrading Lighting
	E2	77639	16.9	$ 84,007	Upgrading Lighting