

## Appendix A1

ECO Recommendations Summary - Macalester College										
ECO #	Description	Annual Cost Avoidance (Cost Savings)				Cost to Implement - Labor, Mat'ls., & Eng'g.	Simple Payback - Years	Utility Rebates - Recomm'g & Prescriptive	Net Initial Cost to Implement	Payback with Rebates - Years
		Electric	Thermal	Other	Total					
1	Modify discharge and mixed air reset control on all air-handling units by changing from reset by outside air to reset based on building demand	\$0	\$8,711	\$0	\$8,711	\$20,000	2.30	\$5,761	\$14,239	1.63
2	Readjust start and end times of air-handler operation to match building occupancy as closely as possible	\$650	-\$269	\$0	\$382	\$1,000	2.62	\$552	\$448	1.18
3	Provide reset of VAV air-handler discharge static pressure for all AHU's when there is limited cooling demand from the space being served	\$5,402	\$0	\$0	\$5,402	\$6,200	1.15	\$2,148	\$4,052	0.75
4	Modify control strategy for heating pump operation to allow individual building heating pumps to be energized based on building demand instead of outside air temperature	\$2,343	\$0	\$0	\$2,343	\$3,000	1.28	\$1,243	\$1,757	0.75
5	Separate operating schedules of exhaust fans serving rest rooms from air-handlers so that they can be scheduled independently	\$434	\$8,516		\$8,950	\$7,000	0.78	\$287	\$6,713	0.75
6	Modify enthalpy/economizer control program to utilize outside vs. return air dry bulb comparison when chilled water for cooling is not available	\$5,618	\$0	\$0	\$5,618	\$5,200	0.93	\$676	\$4,524	0.81

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7	Modify control sequence on AHU start-up to keep the OA dampers closed until occupancy, unless the AHU's are in economizer mode and the space is calling for cooling	\$2,658	\$0	\$0	\$2,658	\$4,800	1.81	\$2,807	\$1,993	0.75
8	Modify operation on all air-handler heating valves to allow them to remain under control when the unit is turned off		\$2,221		\$2,221	\$4,200	1.89	\$1,470	\$2,730	1.23
9	Modify cooling control algorithm to ensure that the outside air dampers on all air-handlers are 90% open before the cooling valve opens	\$628	\$2,634	\$0	\$3,261	\$4,000	1.23	\$1,538	\$2,462	0.75
10	Connect (14) recirculating domestic hot water pumps to the EMS and program to operate on building occupancy	\$5,077	\$2,540		\$7,617	\$17,200	2.26	tbd		
11	Restore night setback/setup control function to all heated/cooled spaces in the academic buildings	-\$2,756	\$10,807	\$0	\$8,051	\$10,000	1.24	\$3,945	\$6,055	0.75
12	Install occupancy sensors in select areas to control operation of the electronic VAV terminal units and lighting in Campus Center, Kagin and Dayton Halls to allow for reduced operation when the space is vacant	\$23	\$1,741	\$500	\$2,264	\$12,000	5.30	\$3,308	\$8,692	3.84
13	Install occupancy sensors in select areas to control operation of the pneumatic VAV terminal units and lighting in Carnegie, Library, Old Main and 30 Mac to allow for reduced operation when the space is vacant	\$23	\$1,741	\$500	\$2,264	\$20,000	8.83	\$3,308	\$16,692	7.37

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14	Modify chilled water supply software algorithm to allow chilled water pumps in the buildings to energize on building demand rather than when the chiller plant energizes	\$3,010	\$0	\$0	\$3,010	\$4,000	1.33	\$326	\$3,674	1.22
15	Provide feedback from select academic buildings to allow the chiller plant to be energized based on schedule, demand and outdoor air enthalpy	\$8,475	\$0	\$0	\$8,475	\$3,000	0.35	\$0	\$3,000	0.35
16	Reset chilled water temperature at the main chiller plant in response to overall campus building space demand	\$12,784	\$0	\$0	\$12,784	\$5,000	0.39	\$0	\$5,000	0.39
17	Install a separate DX cooling unit to provide cooling for the laboratory animals and allow the chilled water plant to be energized independently	\$5,618	\$0	\$1,000	\$6,618	\$65,000	9.82	tbd		
18	Remove inlet vanes and install variable frequency drives (VFD) on supply air-handlers in the Library, Carnegie, & 30 Mac (3 total)	\$1,837	\$0	\$0	\$1,837	\$8,600	4.68	\$2,100	\$6,500	3.54
19	Install variable frequency drives (VFD) and remove inlet vanes on return air fans in Carnegie and Weyerhauser Halls, and Library AHU-3 return fan (5 total)	\$1,333	\$0	\$0	\$1,333	\$7,800	5.85	\$2,350	\$5,450	4.09
20	Install hand-set interval timers for the grill, kitchen and bakery exhaust fans in the Campus Center so that the units operate only as needed	\$1,640	\$12,222	\$0	\$13,862	\$5,500	0.40	\$0	\$5,500	0.40

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21	Install a CO <sub>2</sub> sensor in the return air of Campus Center AHU-1 for monitoring and adjusting minimum outside air delivered during occupied periods	\$276	\$471	\$0	\$746	\$2,000	2.68	\$1,200	\$800	1.07
22	Install an occupancy sensor in the Game Room of the Campus Center so that the air handler operates only when the space is occupied	\$204	\$589	\$0	\$793	\$1,800	2.27	\$559	\$1,241	1.56
23	Install humidity sensor and controls in the lower level of the Campus Center to allow AHU-1 to cycle on during unoccupied periods only when conditions require humidity control	\$2,024	\$3,802	\$0	\$5,826	\$4,000	0.69	\$0	\$4,000	0.69
24	Install variable frequency drives (VFD) on air-handlers serving the Campus Center dining room to operate at reduced speed when the space is marginally occupied	\$5,227	\$3,485	\$0	\$8,711	\$9,000	1.03	\$2,467	\$6,533	0.75
25	Reduce heat loads in the Campus Center Bookstore through lighting improvements and add additional cooling capacity to the Bookstore and Print Shop to allow the discharge air temperature of AHU-2 to be raised from a continuous discharge of 59°	\$0	\$1,395	\$0	\$1,395	\$4,000	2.87	\$923	\$3,077	2.21
26	Install controls and a damper in the outdoor air intake of Campus Center make-up air unit MUA-2 to allow use of penthouse relief air for make-up prior to using untempered outside air	-\$1	\$4,797	\$0	\$4,796	\$22,000	4.59	\$3,173	\$18,827	3.93

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27	Install a unit heater in Kagin Hall Room 203 to allow air-handler AT-2 to cycle on unoccupied temperature in the main space rather than the small storage room	\$2,039	\$2,768	\$0	\$4,807	\$4,600	0.96	\$995	\$3,605	0.75
28	Modify controls to Chapel air-handler S-1 to allow unit to operate only when the space is occupied or on a call for heating/cooling	\$2,664	\$2,440	\$0	\$5,103	\$2,200	0.43	\$0	\$2,200	0.43
29	Provide a hot water reset control for the 77 Mac building	\$0	\$108	\$0	\$108	\$1,600	14.78	\$72	\$1,528	14.12
30	Install variable frequency drives (VFD) on exhaust fans serving rest rooms and other spaces in the residence halls to operate at reduced airflow during periods of limited occupancy	\$1,602	\$5,901		\$7,502	\$30,000	4.00	\$850	\$29,150	3.89
31	Reset heating water temperature for the residence halls by using feedback from the occupied spaces	\$0	\$3,604	\$0	\$3,604	\$10,000	2.78	\$3,903	\$6,097	1.69
32	Restore night setback control function to residence halls by applying heating water temperature depression during late night to early morning hours	\$0	\$2,121	\$0	\$2,121	\$5,000	2.36	\$1,404	\$3,596	1.70
33	Provide separate schedules for each of the exhaust/make-up fans in Doty, Dupre and Bigelow Halls so that they can be scheduled independently	\$0	\$8,219	\$0	\$8,219	\$12,000	1.46	\$5,836	\$6,164	0.75
34	Modify controls to allow cycling of AHU-1 serving Dayton Hall VAV's during periods of low activity or marginal occupancy	\$0	\$162	\$0	\$162	\$1,200	7.41	\$403	\$797	4.92

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35	Replace existing (32 or 28) watt fluorescent lamps with 25 watt lamps	\$219	\$0	\$0	\$219	\$300	1.37	\$100	\$200	0.91
36	Install occupancy sensors in the hallways of residence halls that currently operate continuously	\$598	\$0	\$0	\$598	\$5,000	8.37	\$500	\$4,500	7.53
37	Provide daylighting sensors to reduce lighting levels in south and west-facing rooms in the Library and Campus Center	\$620	\$0	\$0	\$620	\$4,800	7.74	\$50	\$4,750	7.66
38	Install occupancy sensors to control lighting in rest rooms of Carnegie, Old Main, 77 Mac, Weyerhauser and Doty Halls	\$447	\$0	\$0	\$447	\$4,000	8.95	\$500	\$3,500	7.83
39	Install photocells in the Chapel ambulatory area to turn off lights when the ambient level exceeds a certain level	\$111	\$0	\$0	\$111	\$500	4.50	\$25	\$475	4.28
40	Convert 3-way heating water valves on AHU's to 2-way, install VFD on heating pumps, and provide for pressure control (5 VFD's, 6 controls total)	\$6,624	\$0	\$0	\$6,624	\$17,900	2.70	\$6,960	\$10,940	1.65
41	Insulate remaining bare sections of steam/condensate piping in the attic of Bigelow Hall	\$0	\$1,342	\$0	\$1,342	\$2,100	1.56	tbd		
42	Insulate exterior walls of boilers 1 & 2 in the heating plant, and various steam accessories including valve bonnets	\$0	\$12,758	\$0	\$12,758	\$14,000	1.10	tbd		
	Totals	\$77,447	\$104,826	\$2,000	\$184,274	\$371,500	2.02	\$61,736	\$309,764	1.68
	Savings per Month	\$6,454	\$8,736	\$167	\$15,356					