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Environmental State of the College Report
ES Senior Seminar
Spring 2004

Electricity

Introduction

Like at any other educational institution, electricity runs our campus. We use computers, printers, and lighting in every building at Macalester. Electricity runs the fans and ventilators that keep us cool and circulate air through the buildings. Olin-Rice has laboratories with fume hoods. We watch movies and slides in our classes, and we play stereos and set alarm clocks in our dorms. This campus would not run without electricity, and last year (2002-2003), the school spent $637,914 on this needed energy resource.

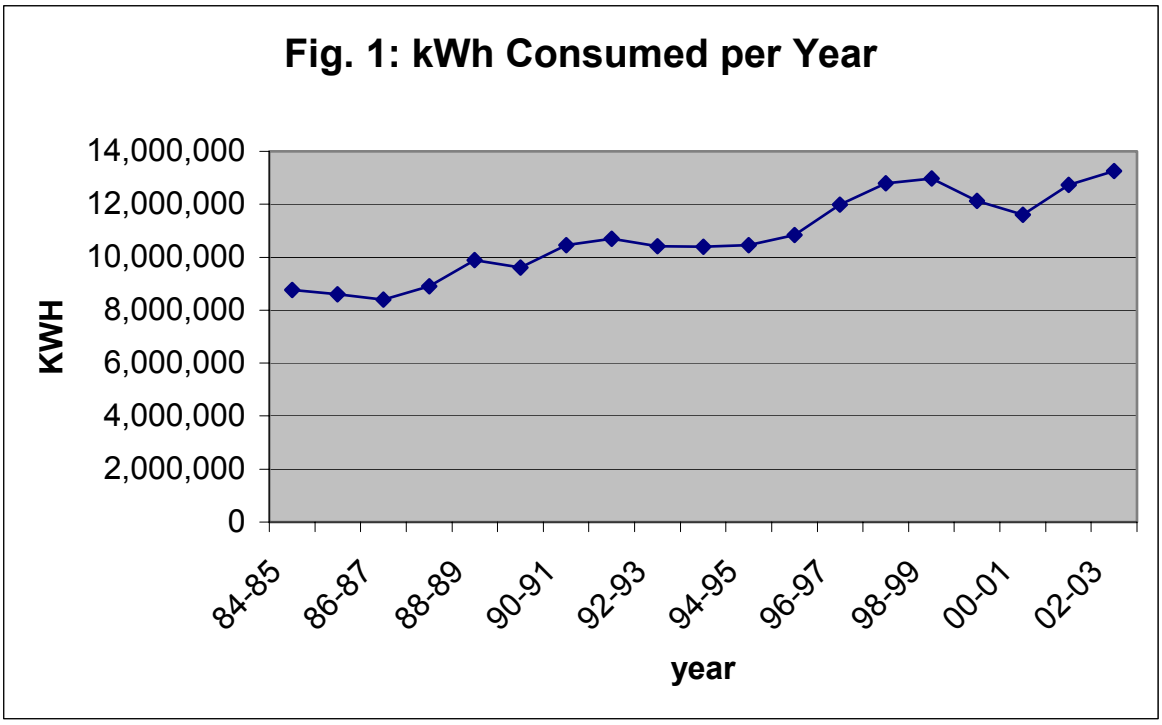
Unfortunately, the generation of electricity causes many environmental problems. Many of the fuel sources used by Xcel Energy to generate Macalester's electricity release carbon dioxide, sulfur dioxide and other greenhouse gases, along with mercury and other health problem causing toxins into the atmosphere. A rough calculation shows that just Macalester's electricity use contributed 16,097,245 pounds Of CO_2 in 2002-2003 (See APPENDIX A-pg. 12). Human-produced greenhouse gases are increasing the earth's temperature and endangering the planet through global warming.

The purpose of this study is to look at campus electricity consumption over time and try to understand where we can make changes to reduce consumption and improve efficiency.

Electricity Consumption at Macalester (Data)

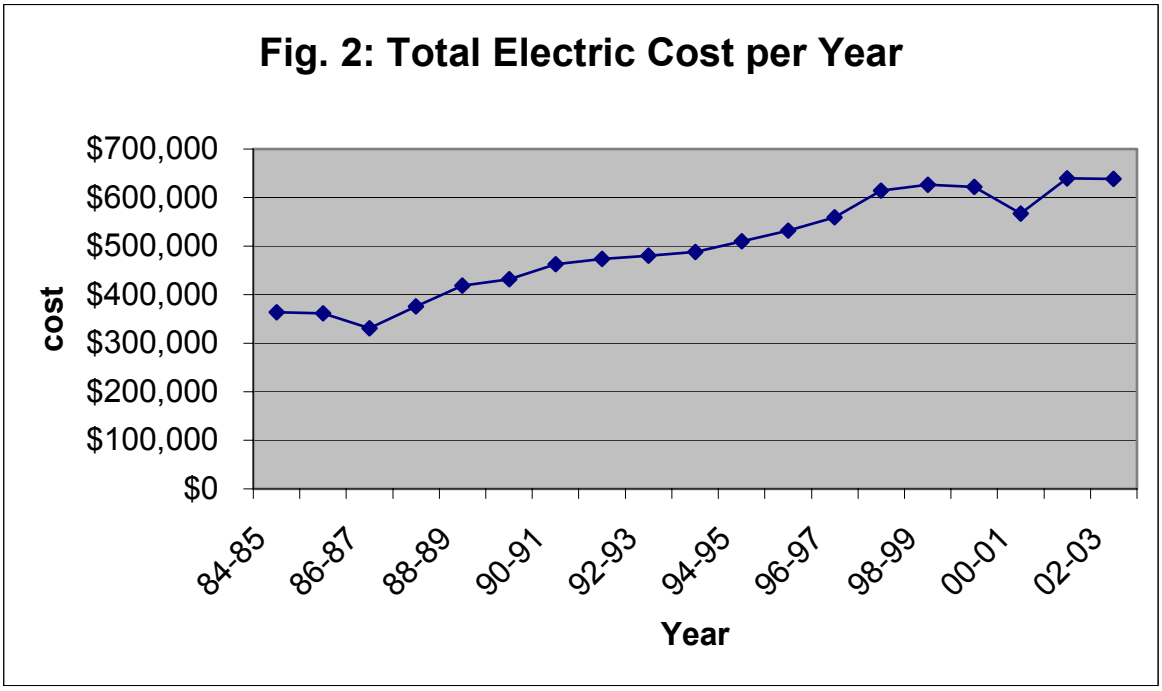
The following graphs and the information about them are derived from energy data from Facilities Management. The first graph (Fig. 1) shows the general increase in Kilowatt-hours

consumed each year in electricity at Macalester. During 1984-85 we consumed 8,767,200 kWh, and last year we consumed 13,257,600 kWh.[1]

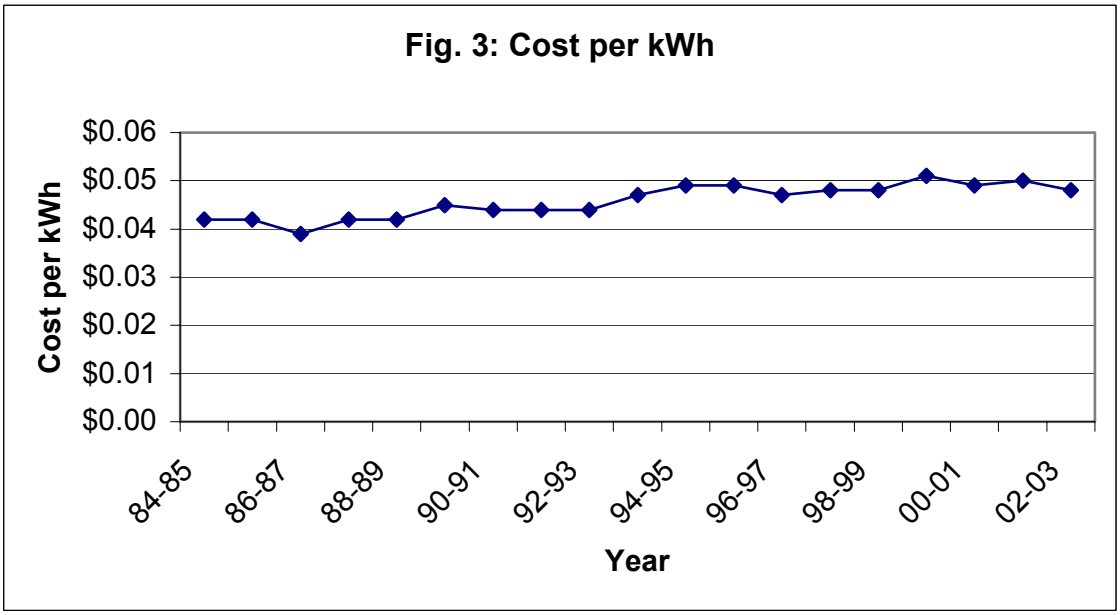


Electricity made up about 60% of Macalester's energy expenditures in 2002-2003. The graph below (Fig. 2) shows the total expenditures per year on electricity at Macalester from 1984 through 2003—an increase of $273,876 over the last 18 years.

[1] One kWh = 1000 Watts over a period of one hour. That is the equivalent of burning ten 100-watt light bulbs for an hour.

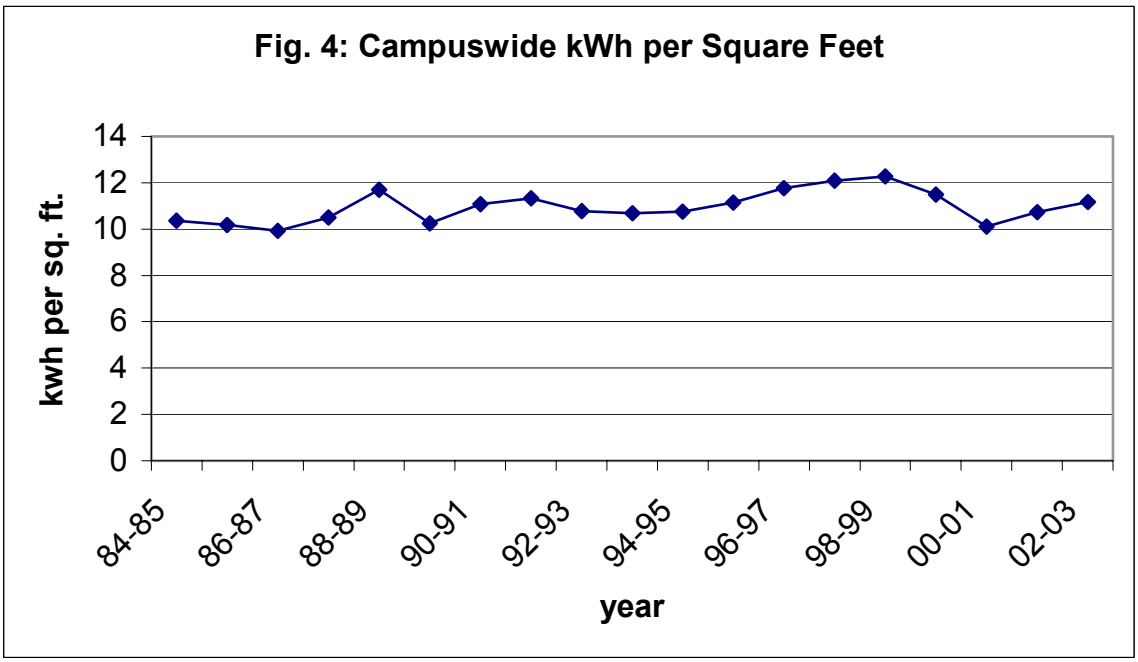


It is also important to look at electricity rates over the years to figure out whether our increase in expenditures on electricity is based solely on an increase in use, or based on an increase in electricity rates or on increased use AND increased utility rates.



The graph above (Fig. 3) shows very little increase in electricity rates. The price has fluctuated between 4.2 and 5.1 cents per kWh in the last 18 years. Mark Dickinson says that Xcel's rates are consistently below national averages and rate increases have not "spiked" recently at all (from interview 3/9/04).

One important factor to keep in mind is how much Macalester has expanded. Since 1985 the school has added 341,352 square feet of building space. This means more lighting, computers, and other equipment running off electricity. The following graph shows our electricity consumption per square foot of building space (Fig. 4).

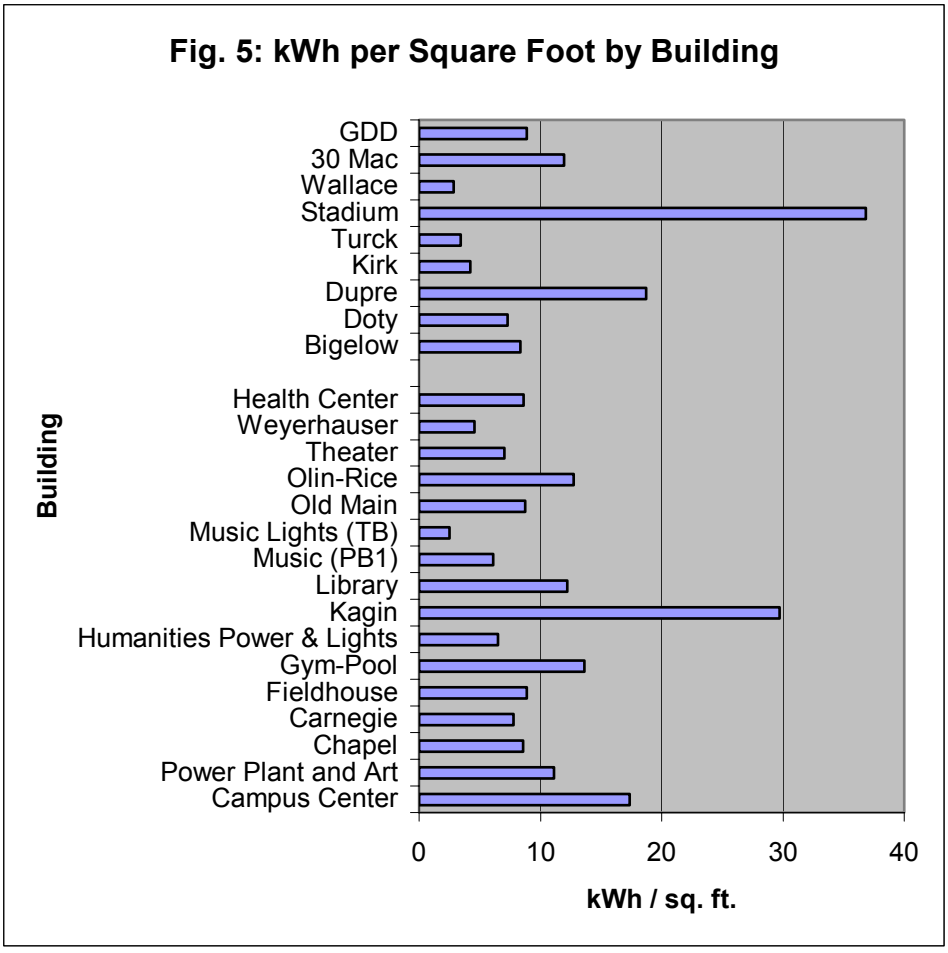


Significant dips and peaks in the graph can be correlated to buildings being taken off or put back online, before and after renovations.

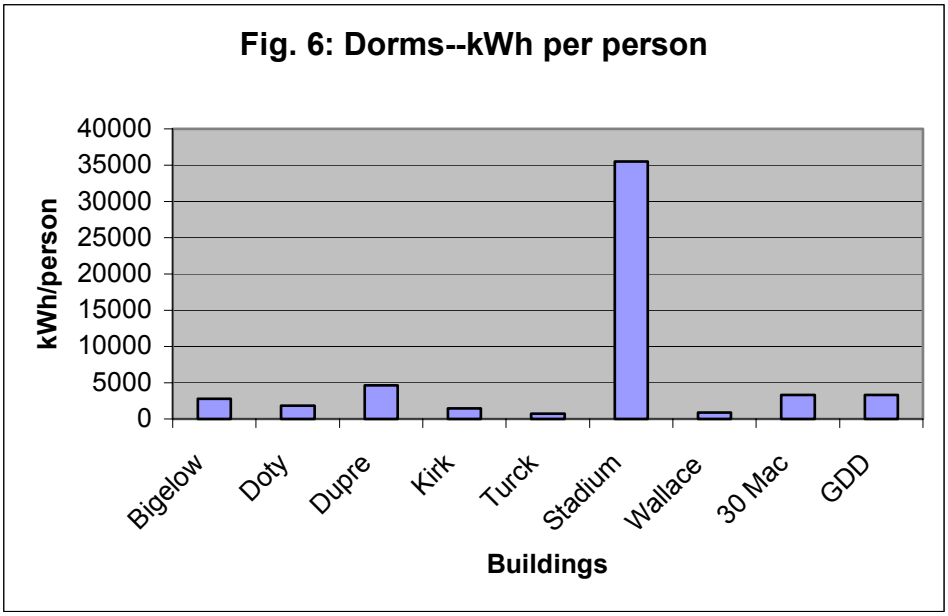
We can also look at electricity consumption in each building. Olin-Rice has the highest consumption by a large margin. There are many reasons for such high consumption and many reasons why it is not possible to reduce that consumption, such as safety regulations for labs and

fume hoods. But students and professors can reduce electricity use by keeping the hoods closed as much as possible.

Olin-Rice consumes the most electricity overall, but when we look at electricity consumption per square foot of each building, we get a different picture. The graph below shows that the Stadium, Dupre, Kagin, and the Campus Center have the highest consumption per square foot. Square footage is not a perfect divisor for electricity. It may be more appropriate for heating and cooling. But it does give a sense of what buildings we may want to target for lighting retrofits or a detailed energy audit. Kagin is of particular interest, because after renovations, energy efficient equipment in the building was supposed to reduce that building's electricity consumption by 230,000 kWh.



We can also look at per capita energy consumption in each dorm. To do this, the kWh of electricity consumed in each dorm is divided by the number of students who live there. What is most striking in the following graph (Fig. 6) is the Stadium, which has more than seven times the per capita consumption of most other dorms. However, only 19 people live there, and the stadium serves as more than just a dorm.



Successes

Facilities Management has implemented some energy efficiency strategies to try to reduce electricity consumption. They have been switching to efficient fluorescent lighting in several buildings. In the fall and winter of 1997-98 new lighting was installed throughout the library, which decreased electric consumption by about 50,000 kWh or $2,400. Some buildings also have motion sensors. A major lighting retrofit project was completed in February 2001 in Weyerhauser, Carnegie, and Humanities –expected to save 40,000 kilowatt hours/year. Building renovations for Wallace were expected to save $7,000 yearly. Physical Plant received $553,207 worth of energy efficiency rebates from Xcel energy (from July 1994 through December 2001). Of these rebates, $99,015 came from lighting upgrades alone (See APPENDIX B-pg. 13).

Reducing air flow through Olin-Rice during off-peak hours has reduced electricity consumption, along with better operational procedures of the central chilled water plant, where pumping levels were reduced.

Solar Energy

The 2000 campus audit had a section on solar power that essentially said retrofitting a building with solar panels would not work. "Currently Macalester looks for a 7-10 year return on investments. Retrofitting buildings is very expensive and given current energy costs ($.048 kWh), solar energy would not meet this criteria. It is likely that a typical return on solar investment would take a minimum of 25-30 years." Their calculations for Winton Health Services estimated that solar electricity would cost the school 20 cents per kWh, when the current electricity costs were 5 cents/kWh. Current electricity costs from Xcel are still at about 4.8 cents/kWh, but it is possible that we could receive free or reduced price photovoltaic panels from the Green Institute or British Petroleum (the company that gave the Green Institute the panels they are currently installing). With such a reduction in capital costs, solar power on campus could be closer to reality. Also, Facilities Management has promised Richard Graves of the student group Macalester Conservation and Renewable Energy Society some money to help install solar panels on Olin-Rice. The project is not happening at the moment. The proposed project would also be mostly for educational and awareness purposes.

The University of Vermont installed 5 kW of solar panels on their central heating plant when it came time to replace the roof. Macalester should consider the possibility of a similar project when it remodels the Fieldhouse. Solar panels can also be used to heat swimming pools, which would be a perfect incorporation into the new athletic facility design.

Wind Energy

There are a couple of ways the school can go about getting wind power. The first is from our own wind turbine, which is supposed to provide 18,000 kWh of energy, saving the school about $1,000 annually. A problem with our wind turbine is that we do not know how much it is

actually generating. So even as an educational tool, the wind turbine is not entirely fulfilling its job. Soon, however, an informational/monitoring kiosk will be hooked up so that we can monitor how much electricity is produced by the turbine.

The other way to get wind energy on campus is to sign up for Windsource® from Xcel Energy. This program allows utility customers to purchase wind energy that is then added to the grid. There has also been a goal to get 10% of our power from renewable sources (started by MPIRG), but since it would currently add $32,000 to our energy expenditures, this is not happening right now. Green power costs more to buy from Xcel. One possible idea is to let students vote on whether they would like to pay $10-20 extra per year to buy this wind power. This method was used at Lewis & Clark as the final step to their complying with the Kyoto Protocol (http://www.rso.cornell.edu/kyotonow/national/updates/lewisandclark.html).

Benchmarks

Macalester clearly tracks electricity consumption on campus. At this time we do not have any goals for reducing electricity consumption. A simple reduction in kWh from year to year is a start, but we need to define more specific benchmarks to measure progress. I think we could look at the criteria for energy categories in the NWF's State of the Campus Environment, such as "Leading Schools for Energy Efficiency and Conservation" and "Leading Schools for Which More Than 50% of Energy Comes from Renewable Sources." Would it be possible for Macalester to make it into either of these groups? Lewis & Clark just became the first college to comply with the Kyoto Protocol. Could that be a goal for Macalester? Calculating the CO_2 emissions from 1990 is tricky because the calculations require that we know the fuel mix used by Xcel. It is important to note that Macalester does not keep track of estimated CO_2 emissions from our energy use. The environment is important to the college to a certain extent. The way

we will be able to make significant changes, however, is to show the cost benefits of reducing energy use further.

Recommendations

Record Keeping

One recommendation I have is to work with Facilities Management to develop a system that records improvements in energy efficiency every year. This would probably done in conjunction with heating and cooling. If one person in Facilities Management knows to keep track of new devices, studies, programs, etc. and can keep it in one place, it will be easy for us to do these audits each year and to find out if we are meeting any goals we set. The methods we use for gathering audit data can then be recorded and passed on to each year's senior seminar. Currently, there is a binder in the FM office with energy data and information. Bev Johnson will gladly let students look through it.

Infrastructural/Administrative Changes

These are the kinds of improvements made by Facilities Management to improve efficiency and reduce electricity consumption using larger systems (e.g. motors, fans, lighting retrofits). Facilities Management should continue to seek out rebates from Xcel energy. Mark Dickinson will be meeting with Rick Hermans, an energy consultant from the Center for Energy and Environment to discuss the possibility of an energy audit or recommissioning (getting the systems of a building working the way they do when a building is new). This process should continue and future decisions can be made based on this meeting and others. The school should also devise long- and short-term goals for future reductions in electricity use.

Macalester should take advantage of a program by the Weidt Group called Energy Design Assistance. Through funding from Xcel Energy, Macalester will be able to consult with

the design professionals at the Weidt Group in order to ensure sustainable design in all future building projects. This is especially important as plans for renovations of the field house and fine arts center begin.

Campaigns/Student Involvement

There are many ways for students to get involved. MacCARES (Macalester Conservation and Renewable Energy Society) sponsored a KYOTO NOW! forum on March 25. KYOTO NOW! is a "grassroots global climate change (a.k.a. global warming) campaign, promoting national action though the power of the university" (www.rso.cornell.edu/kyotonow). Meeting the Kyoto Protocol will take a lot of work: data collection and analysis, awareness campaigns, and cooperation and action from Facilities Management.

Another idea is to have a "Green Cup" in which dorms compete with each other to reduce electricity consumption. We may also want to set up a team of volunteers who monitor energy use and turn off unused lights and equipment around campus.

Approaches From Other Campuses

- The University of Rochester hired an energy manager on his assurance that they would save several times the amount of his salary in energy costs. (Morris A. Pierce has reached and surpassed this goal. He was actually a grad student at the university when he accepted the part-time position).
- SUNY Buffalo had a 5-year energy management business plan.
- SUNY Buffalo changed fan systems, expected to reduce their electric bill by $500,000/year.
- SUNY Buffalo uses a team of volunteers who monitor energy use and turn off unused lights and equipment.

- Northwestern and Harvard hold Green Cups with competitions among dorms.
- Lewis & Clark is the first college to become Kyoto compliant. They have reached their goal by reducing emissions on campus, mostly by encouraging alternative forms of transportation and upgrading gas boilers, but also through the use of Energy Star appliances. The college also used offsets, including giving students the option to pay for green energy in their dorms.
- Carleton College in Northfield is spending $1.7 million in endowment funds to put a 1.65 MW wind turbine near campus to show its commitment to environmentally sustainable practices

Resources

Keniry, Julian. *Ecodemia: Campus Environmental Stewardship at the Turn of the 21st Century*. Washington D.C.: National Wildlife Federation, 1995.

Pierce, Morris A. "Campus Energy Management Programs" in *The Campus and Environmental Responsibility*, David Egan and David Orr, Eds. San Francisco: Jossey-Bass Publishers, 1992.

Smith, April A. *Campus Ecology*. Los Angeles, CA: Living Planet Press, 1993

Kyoto Now! www.rso.cornell.edu/kyotonow/

National Wildlife Federation, State of the Campus Environment Report, www.nwf.org/campusEcology/HTML/stateofthecampusreport.cfm

Senior Seminar Environmental Audits, 2000-2003, www.macalester.edu/environmentalstudies/Audits/enviraudits.htm

Xcel Energy fuel mix data, www.xcelenergy.com/docs/corpcomm/YourElectricityYourChoice03-08-009_4.pdf

Mark Dickinson, Director of Macalester Facilities Management, Interview 3/9/2004

Macalester Facilities Management electricity data

Appendix A

Using Xcel Energy's Fuel Mix Data, the number of kWh consumed in a year, and some simple math, we can estimate how much Macalester's electricity consumption contributes to certain air emissions. The first table below is data from Xcel Energy about their fuel mix and emissions by fuel source.

FUEL MIX (What Xcel uses)		Emissions by Fuel Source per 1000kWh (in pounds)				
		CO2	SO2	NOx	Particulate Matter	Mercury
Coal	37.40%	2400	5.9	5.3	0.34	0.00005
Nuclear	33.10%					
Hydro	12.60%					
Natural Gas	2.30%	1191	0.04	1.9	0.07	0.000004
Wind	2.20%					
Refuse Derived Fuel	1.50%	5605	1.2	9.2	0.15	0.00004
Wood	0.10%					
Oil	0.20%	2523	5.4	8.7	0.43	0.00003
Biomass	0.30%	3553	1.6	6.4	0.77	0.00008
Purchases	10.30%	1839	5.5	4	0.33	0.00004

Using 13,257,600 kWh, which is what Macalester consumed in 2002-03, we calculate:

Macalester's Contribution to the Following Emissions (in pounds):

Fuel Source	CO2	SO2	NOx	Particulate Matter	Mercury
Coal	11,900,022	29,254	26,279	1,686	0.24792
Nuclear					
Hydro					
Natural Gas	363,165	12	579	21	0.00122
Wind					
Refuse Derived Fuel	1,114,633	239	1,830	30	0.00795
Wood					
Oil	66,898	143	231	11	0.00080
Biomass	141,313	64	255	31	0.00318
Purchases	2,511,215	7,510	5,462	451	0.05462
TOTALS:	**16,097,245**	**37,222**	**34,635**	**2,230**	**0.31569**

Appendix B

REBATES FROM XCEL ENERGY:

Date	Rebate Type	Kw Saved	Rebate Amount
July-94	Steam Traps		$ 15,345.00
July-95	Boiler		$ 574.53
July-95	ASD (ventilation motor)	23.61	$ 8,750.00
October-96	VAV Air Handler	225.75	$ 60,200.00
December-96	Cold H2O Storage	1000.00	$ 190,000.00
December-96	Chiller	67.50	$ 16,875.00
December-96	ASD (ventilation motor)	63.00	$ 16,800.00
December-96	Motors	21.18	$ 4,235.00
December-96	Lighting	151.64	$ 30,116.40
January-97	Gas		$ 74,995.00
March-97	Engineering study		$ 10,000.00
May-97	Boiler		$ 44,190.00
December-97	Motors	0.39	$ 55.00
April-98	Motors	0.64	$ 120.00
April-98	Motors	1.60	$ 300.00
April-98	ASD (ventilation motor)	1.60	$ 300.00
May-98	Lighting	8.98	$ 2,694.00
December-98	Lighting	47.07	$ 15,087.00
March-00	Motors	2.20	$ 440.00
March-00	Lighting	0.59	$ 135.00
June-00	Boiler		$ 48.35
December-00	Boiler		$ 500.00
August-01	Lighting	49.64	$ 9,235.00
August-01	ASD (ventilation motor)	45.80	$ 645.00
September-01	Motors	18.80	$ 3,877.00
December-01	Lighting		$ 31,171.50
November-02	Lighting	69.27	$ 10,713.00
		TOTAL	$ 553,207.03