5 ENERGY MANAGEMENT

ENERGY MANAGEMENT INDICATORS

Table 5. Energy Management Indicators for Carnegie Mellon, FY 2004

Report Section	Indicator	Reason	FY2004	Units
5.1.1	Electricity Used Annually	Tracks electricity use over time	98,593,752	kWh/yr
5.1.1	Unit Cost of Electricity	Can be used to analyze a response in demand to price	0.051	$/kWh
5.1.1	Steam Used Annually	Tracks steam use over time	345,619	Mlbs/yr
5.1.1	Unit Cost of Steam	Can be used to analyze a response in demand to price	8.920	$/Mlbs
5.1.1	Natural Gas Used Annually	Tracks natural gas use over time	48,433	Mcf/yr
5.1.1	Unit Cost of Natural Gas	Can be used to analyze a response in demand to price	8.380	$/Mcf
5.1.2	Total Energy Used Annually	A total energy use normalized to Btus	730,552	MMBtu/yr
5.1.2	Energy use per square foot	Normalizes energy use to total building space	174,755	Btu/gsf/yr
5.1.2	Energy use per sq ft weather-normalized	Normalizes energy use to building size and weather extremes	172,968	Btu/gsf/yr
5.1.2	Energy use per capita	Normalizes energy use per person	54	Btu/yr
5.2.1	Total % of Renewable Energy Purchased by total energy used	Indicates a commitment to purchasing energy from renewable sources	3%	% of total energy used
5.2.1	Total % of Renewable Energy Purchased by total electricity		6%	% of total electricity used
5.2.1	Source of Renewable Energy		Wind	
5.2.1	Unit Cost of renewable energy	Can be used to analyze a response in demand to price	1.4	cents/kWh premium
5.2.2	*% Reduction in Energy Use due to conservation*	*Shows the percent of energy conserved and compared to the total energy used*	*FWD*	*% of total energy used*
5.2.2	Number of buildings with accessible metering data	Indicates accessibility of energy use information	0	#
5.2.2	*Number of times the metering data webpage is accessed*	*Indicates how often the information is being sought out*	*FWD*	*#/yr*
5.2.2	*Amount of money used from the energy revolving fund*		*FWD*	*$/yr*
5.2.2	Amount of external funding for energy related projects	Indicates money received for energy related projects	$88,000	$/yr
5.2.2	Amount of University funding for energy (budget line item)	Indicates fiscal commitment to energy conservation	0	$/yr

5.3	CO_2 emissions produced at the source	Indicates change in emissions due to changes in energy mix purchased or energy purchased.	396,698	tons CO_2/yr
5.3	SO_2 emissions produced at the source	Indicates change in emissions due to changes in energy mix purchased or energy purchased.	682	tons SO_2/yr
5.3	NO_x emissions produced at the source	Indicates change in emissions due to changes in energy mix purchased or energy purchased.	914	tons NO_x /yr

ENERGY MANAGEMENT INDICATORS RATIONALE

Carnegie Mellon University is committed to manage the use and costs of utilities efficiently through the FMS Energy Management Program[31]. The goals of the energy management program are to

- "Reduce end-use campus energy consumption;
- Lower energy supply purchase rates;
- Distribute energy supply more efficiently on campus; and
- Be willing to be environmentally responsible even when it's not profitable. For example – wind power electricity supply."

5.1 Energy Consumption

5.1.1 Types of Energy Consumed

Carnegie Mellon University uses energy from three major sources: electricity, steam, and natural gas. The amount of each type of energy consumed by Carnegie Mellon and the unit cost of the energy consumed are indicators of energy consumption, which can be related to conservation efforts or to increases in demand. The quantities of energy used and the cost of this energy are shown in Figure 5-1 and Figure 5-2.

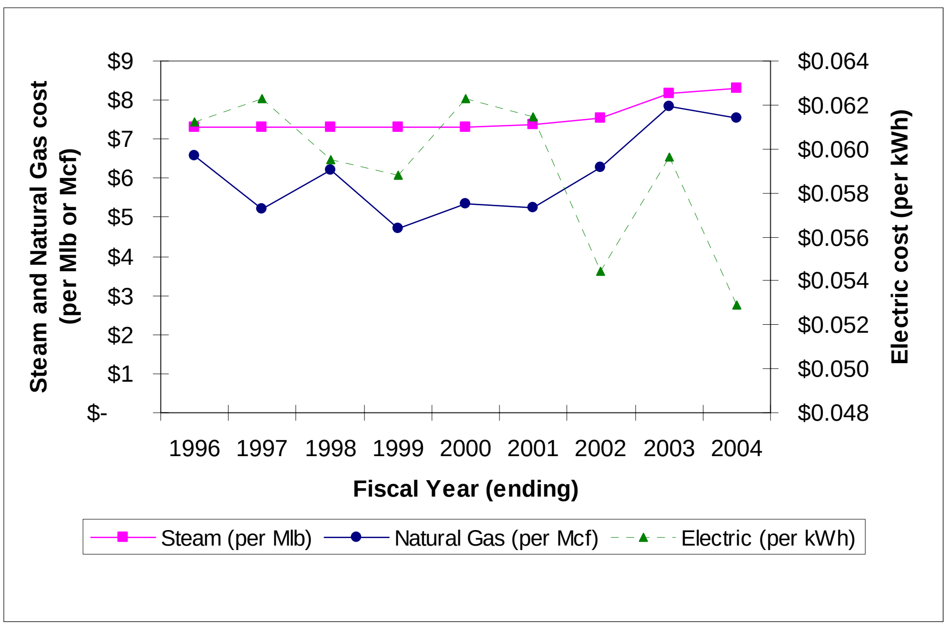

Figure 5-1. Unit Cost of Energy purchased by Carnegie Mellon

[31] Carnegie Mellon Facility Management Services. http://www.cmu.edu/fms/workman.html. Accessed 10 October 2004.

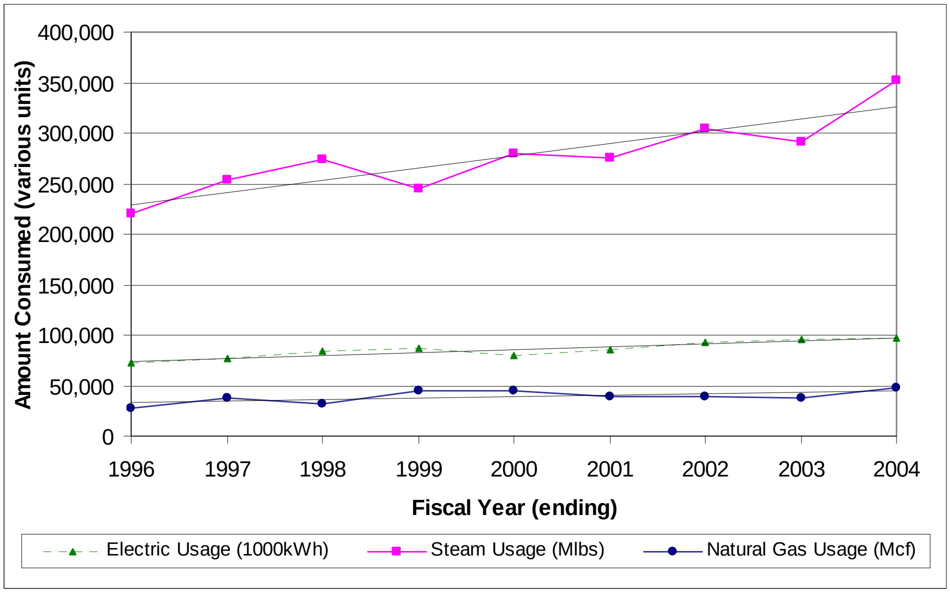

Figure 5-2. Energy Consumed Annually by Carnegie Mellon

5.1.2 Total Energy Consumption

The total energy used is calculated by normalizing the three energy types to BTUs (based on the energy density of the different types) and to square foot of the campus buildings. The energy use can also be calculated using two other systems of normalization: energy use by square foot that is also weather-normalized, and energy use per capita. In order to weather-normalize energy use, first the number of heating or cooling days are obtained from National Oceanic and Atmospheric Administration (NOAA) and used to perform a regression in order to remove the effects of extremely hot or cold days on energy use. This weather normalization allows one to compare energy use longitudinally over time to observe true energy use, and not energy use due to unusual heating or cooling demands. Per capita energy use is calculated for the total on-campus population, including students, staff, and faculty.

5.2 Renewable Energy and Conservation

5.2.1 Renewable Energy Purchases

In 2002 Carnegie Mellon made a commitment to purchase renewable energy from wind generation.[32] The amount of renewable energy purchased (percent of total) by Carnegie Mellon indicates how well this program is executed. Also, the source (in the future other renewable

[32] Carnegie Mellon University, Green Practices Webpage. "Background of Wind Energy at Carnegie Mellon." http://www.cmu.edu/greenpractices/green_initiatives/we_background.html. Accessed 21 December 2004.

sources may be used) and the unit cost of the renewable energy are tracked in order to compare how changes in price may influence the types of energy purchased.

5.2.2 Energy Conservation

The primary goal of the energy management program at Carnegie Mellon is to reduce energy consumption.[33] This is best achieved through conservation measures. A measure of conservation success is the calculated percent reduction in energy use due to conservation. This indicator is calculated by comparing the energy used before and after a conservation improvement (for example, replacement of an old and inefficient chiller) in order to calculate the reduction of energy use. The percent reduction of energy due to conservation is a forward-leaning indicator because the type of data necessary to calculate the reduction is not collected currently.

As you can not conserve what you do not measure[34], it is important to meter energy use at Carnegie Mellon. Currently there are a large number of energy meters on campus, however, many of these do not present accurate or useful information (meter may be out of calibration, only one portion of a building is metered, or meter is not accessible or useful to the community etc.). Metering information is not available for many of the Carnegie Mellon buildings and use is calculated generally on a campus per square foot basis, which averages the low energy use buildings with the high energy use buildings. The number of buildings with accessible metering data indicates how well metering data are collected with the potential to influence conservation. Ideally this metering information would be accessible in real-time to the campus community so the immediate effects of conservation or excessive use can be seen. The number of times the data are accessed (e.g., number of hits to a webpage) indicates the community use of the data. This is a forward-leaning indicator as the data is not currently accessible.

In order to undertake necessary conservation projects, funding is required. One proposed mechanism is an energy revolving fund that would operate in the following manner: after a conservation effort is undertaken (with seed funds), the annual calculated energy would be deposited in the revolving fund for the calculated payback period of the new conservation measure. The revolving funds could be withdrawn to perform more conservation projects, and the calculated energy savings from these would be added to the revolving fund. Carnegie Mellon

[33] Carnegie Mellon Facility Management Services. http://www.cmu.edu/fms/workman.html. Accessed 10 October 2004.
[34] Pers. Comm. Bradley Hochberg, Energy Manager.

would have a dedicated source of money with which to undertake energy projects. The amount of money in this fund is a forward-leaning indicator, because this type of fund has not been implemented at Carnegie Mellon. Another source of funding for energy projects is grants from external organizations. The number of grants received for energy conservation (which includes installation of renewable energy sources and construction of green roofs, which are more insulative and conserve heating and cooling energy) indicates the success of Carnegie Mellon to propose energy projects. The university may budget a set amount for energy improvements or conservation. A budget line item indicates the University's willingness to fund conservation efforts or to invest in technologies which may be more expensive initially, but which will reduce energy demand over time.

5.3 Energy Generation Emissions

Emissions from energy generation can be calculated at the source. The emissions produced at the source indicate Carnegie Mellon's effect on the environment from energy use. The emissions tracked are CO2, SO2, and NOx. These emissions will change if the energy demand of Carnegie Mellon changes (increases or decreases) dramatically, if the generation methods become more efficient, or if the energy source shifts towards (or from) renewable energy sources. In order to calculate the emissions produced at the source, emissions factors for the types of generation plants are obtained (from eGRID[35]) and applied with an efficiency factor (designed to account for energy losses during generation) to calculate the emissions at the source. The equation for this calculation is:

$$\text{Emission (Type)} = \sum(\text{amount of energy type purchased} * \text{energy specific emission factor} * \text{generation type efficiency factor})$$

[35] USEPA. Emissions & Generation Resource Integrated Database. (eGRID). http://www.epa.gov/cleanenergy/egrid/index.htm. Accessed 5 December 2004.