

Becca Lehr
Faculty Mentor Cameron Wake
University of New Hampshire

Developing a Climate Action Plan for UNH: Analysis, Collaboration and Implementation

This report contributes to the University of New Hampshire's (UNH) President's Climate Commitment and to the university's role in climate change through its reduction of greenhouse gases. I performed my research as an individual study on the climate action plan for UNH (WildCAP) and was mentored by Dr. Cameron Wake. I continued the research of emissions reductions that was initiated in Dr. Wake's course Global Environmental Change. I worked mainly with Dr. Wake and Brett Pasinella of the University Office of Sustainability, and also collaborated with the UNH Energy Task Force.

This report represents an analysis which serves as an initial contribution to the development of the WildCAP. Here I identify and quantify strategies to reduce the university's greenhouse gas emissions. The second part of the process will entail collaboration and getting feedback from the greater university community. The third part will be the implementation of UNH's WildCAP.

As part of the first step in the process of the WildCAP, I have evaluated and reevaluated some strategies and quantified their effectiveness for reducing UNH's greenhouse gas emissions. These strategies cut costs and may even make money for the university. Each of the summaries attached provides a brief description of the strategy, how it relates to or fits in at UNH, the assumptions used in the analysis, the reduction in the metric tons of carbon dioxide equivalent (MTCDE) emitted per year, the overall cost of the project, and money saved per year. These strategies include:

Campus Energy Monitoring System,

Computer Cluster Sleep Mode,

Geothermal Energy for the Gables,

Converting of Four Buses to compressed natural gas (CNG)

1. Campus Energy Monitoring System

A Campus Energy Monitoring System is a real-time energy monitoring system that is implemented into dormitories on campus. The purpose of this system is to let students know how much energy they use at any given time with feedback that allows them to better understand how their actions serve to reduce energy consumption. Incentives such as gift certificates for textbooks could be used to implement the system and improve participation. The information that the system will provide students is priceless. It will motivate and empower students to reduce their own energy use. One system is installed per dorm or building; initially 10 systems would be installed on campus and after the two year payoff period, 10 more will be purchased.

This system has already been installed and implemented at Oberlin College as can be seen at <http://www.oberlin.edu/dormenergy/>. At Oberlin, a study took place to test the Campus Energy Monitoring System through a Dorm Energy Competition in 2005. This competition demonstrated that resource-use feedback systems provide information to motivate students in reducing their use of energy in dormitories by showing their energy use as environmental and economic costs. During this two week competition, dorms on average reduced their electricity use by 32% during the competition. The students, through their participation, conserved 68,000 kWh, saved \$5,100 and reduced emissions by 150,000 pounds of CO₂. Another way to show the participation this system inspired was the website showing the dorms' energy use received 4,000 hits during the competition. The study concluded that dormitory residents developed resource saving strategies that they could use at college and beyond (<http://www.oberlin.edu/dormenergy/news.htm>).

Assumptions based on UNH Office of Sustainability: Frequently Asked Questions on hall energy use<<http://www.sustainableunh.unh.edu/faq.html#hallenergyuse>>

Electrical use/student per month	1500 kWh
Student participation	45%
Students/dorm	400
Number of students/dorm participating	180
Changed behavior resulting in reduction of:	50%
cost of electricity per kilowatt hour	\$0.06
Kg of CO ₂ per kWh	0.2850

So 135,000 kWh can be saved per dorm with a 50% reduction of each student's 1500 kWh use by each of the 180 students/dorm result. At \$0.06 per kWh, \$8,100 can be saved per dorm each month. And at 0.2850 kg/CO₂ kWh, each month one dorm would save 38.475 MTCDE. This

results in 342 MTCDE saved as well as \$72,900 for one dorm over 9 months (an average school year).

The use of this monitoring system for 10 dorms results in the reduction of 3,420 MTCDE and \$729,000. When the initial cost for these 10 systems is deducted, \$580,000 is saved per year from electrical use. After the payoff period of two years and when 10 more dorms have this system installed, the numbers are doubled, resulting in 6,840 MTCDE saved per year.

MTCDE/yr	6840
save/year	\$580,000
payoff in year	2
Marginal Capitol Cost Per Unit	\$1,490
Initial Cost	\$29,800

2. Computer Cluster Sleep Mode

Computer Cluster Sleep Mode is a strategy that would add software on all computers at UNH to put them into sleep mode when not in use. Because there are so many cluster computers on campus, and there is no need to keep them on when not in use, this software would reduce the university's use of energy. The university could buy the software for the entire university and install it on EVERY computer. In addition, the software could be made available on the UNH website for all UNH students to download for their personal computers just as McAfee is available on the UNH website. The initial cost would be negligible because the university would buy it once as a package deal.

If 10,000 computers for the 13,000 students on campus had activated power management over the course of a year, this would translate into a reduction of electricity costs by \$150,000 (<http://www.unh.edu/news>). This would also prevent approximately 701 MTCDE from being emitted into the atmosphere. This application will be bundled in with virus protection software that UNH already distributes freely to its students.

MTCDE/yr	700
save/year	\$150,000
payoff in year	<1
Marginal Capital Cost Per Unit	Negligible

3. Geothermal energy

Geothermal energy is heat or stored solar energy within the earth's crust. A geothermal heat pump taps into that energy through polyethylene pipes put into the ground filled with a refrigerant. The refrigerant is used as a heat transfer medium, taking in the geothermal heat and circulating it through the heat pump. This process of heat exchange can be reversed to a cooling process. Also, according to the geothermal pump company ECONAR (www.econar.com), one of their Geothermal Heat Pumps may qualify the buyer for a Federal Energy Tax Credit of up to \$300.

Installation of a geothermal system is more costly and labor intensive than classic heating; however, implementing such a heating system will save the University approximately half the cost of heating the Gables right now. The Gables is an on-campus apartment complex made up of five buildings. Geothermal heating would be ideal for this site because of its distance from the cogeneration plant on campus. With the current system, it costs \$115,870 per year to heat all five Gables buildings. The geothermal system would reduce this to \$32,815 per year. The university would save \$83,055 per year. According to installation rates from ECONAR, the system would cost \$1,016,135 to install to heat all five buildings. It would pay for itself in 12.2 years.

MTCDE/yr	676
save/year	\$83,055
payoff in year	12.2
Marginal Capitol Cost Per Unit	\$1 million

A geothermal system would also nearly eliminate the Gables' carbon emissions from heating. The Gables currently emits about 682 MTCDE per year, according to the average carbon emissions per square foot of buildings using number two fuel and the estimated square footage of the Gables (<http://www.ggeothermal.com/GEO/ymca.htm>). If a geothermal system were installed, the Gables would emit an estimated 5.93 MTCDE per year, (based on the average per square foot emissions of buildings heated/cooled with geothermal heat pumps). So the university would save 676 MTCDE per year from being emitted into the atmosphere.

4. Converting Four Buses to Compressed Natural Gas

Converting Four Buses to Compressed Natural Gas (CNG) is a strategy that can be implemented at UNH. This would consist of converting 4 vehicles running on gasoline into engines that are CNG compatible. Vehicles running on CNG produce 90% less carbon dioxide than vehicles running on gasoline (http://www.cleanpower.org/section_03/alternativefuels.html). Assume that the gasoline-run engines are easily converted to be CNG compatible. Also assume that for one gallon of gasoline there are 8.2 kg of CO₂ emitted. If there were 850,000 trips per year /12 buses (which is the number on a run at a time)

x 1.6 miles/trip x 1 gal (fuel burned)/6 miles (which is the bus route)

x 4 buses x 8.2 KG CO₂/gal

x 0.9 (efficiency of CNG)

x 1 MTCDE/1000 kg CO₂ which equals out to a reduction per year of 557.6 MTCDE.

Also using the assumptions of prices in today's market, CNG costs only \$1.99/gal as opposed to \$3.00 for gas.

Gasoline: 850,000 trips per year/12 buses x 1.6 miles/trip x 1 gal/6 miles
x 4 buses x \$3/gal= \$226,666.6/year

CNG: 850,000 trips per year/12 buses x 1.6 miles/trip x 1 gal/6 miles x
4 buses x \$1.99/gal= \$150,355.5/year

Savings: \$226,666.6-\$150,355.5= **\$76,311.1/year.**

MTCDE/yr	557
save/year	\$76,000
payoff in year	<1
Marginal Capitol Cost Per Unit	\$8,000

UNH has already begun to advance toward more efficient fuels and this strategy would continue the university's reduction of emissions. CNG is 90% more efficient than gasoline and \$1.01 less expensive per gallon. This strategy would reduce emissions and make money each year for the university. This money saved from smart consuming could be used in the budget for the climate action plan or elsewhere at the university.

While it is important to consider what is financially feasible, the goal of the WildCAP is to reduce emissions at UNH, a climate protection campus. These one-page summaries of the strategies making up the goal of reducing emissions will become a part of UNH's climate action plan. During the implementation of the WildCAP, these strategies will be handed over to working groups who will implement them into the UNH community.