SII – Sustainability Innovation Inventory

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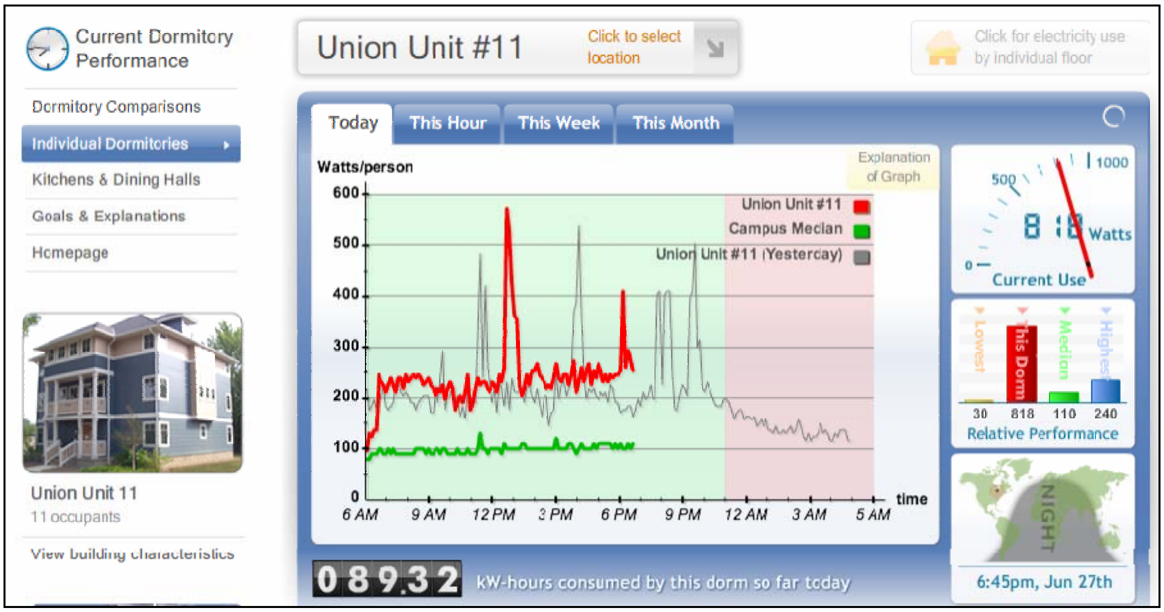
Campus Resource Monitoring System (Oberlin College)



Executive Summary

In 2005, Oberlin College retrofitted its on-campus dormitories with a monitoring system that tracks energy and water use and gives residents real-time data on their resource consumption habits via the Internet. Depending on the dormitory, the monitors track resource consumption for the building as a whole or for individual wings, floors, or kitchens. The monitoring system software not only displays consumption trends, it also connects specific buildings' consumption levels to environmental and financial impacts. Additionally, individual building/section monitors send information collected to a central server, which displays building comparisons online for residents to track their energy and water use compared to other groups of students.

Oberlin found that this system encouraged significant reductions in energy use. For example, dorms involved in a two-week energy-savings competition reduced their energy usage an average of 32%, saving the College 68,300 KWh of electricity, 20,500 gallons of water, and $5,368 over the two-week period. More importantly, Oberlin found that the educational impact of the monitoring system continued to encourage energy and water conservation after the competition ended.

The Oberlin College Campus Resource Monitoring System (CRMS) is supported by the U.S. Environmental Protection Agency, Department of Energy, and Green Building Council; the Ohio Foundation of Independent Colleges; and the LucidDesignGroup,

How does a Building Monitoring System contribute to Sustainability?

Residential and commercial buildings account for a significant portion of overall human-caused carbon emissions and water consumption. According to the CRMS project, buildings in the United States consume two-thirds of the total electricity and 12% of the total fresh water used nationwide, resulting in 36% of greenhouse gases emitted (9% worldwide). Moreover, at least 50% of energy used in residential buildings can be attributed to “lifestyle choices” (Petersen et al, 2005).

Like many large buildings, in which part or all of utilities are included in basic use fees, college dorms provide very little feedback to residents about their resource use. Without even basic utility bill information, college students living in these dorms have no tangible way to connect their daily actions to resource consumption.

The CRMS project aims to help conservation-minded students reduce their energy and water use and overall emissions by giving individual dorm residents the tools to manage their own resource consumption. Competitions and publications about energy and water use in different buildings aid the project by promoting awareness and turning resource conservation into a community-building activity. The CRMS project defines this kind of monitoring as a “socio-technical feedback system” through which residents “teach themselves how to conserve resources by trial and error” (Petersen et al, 2005).

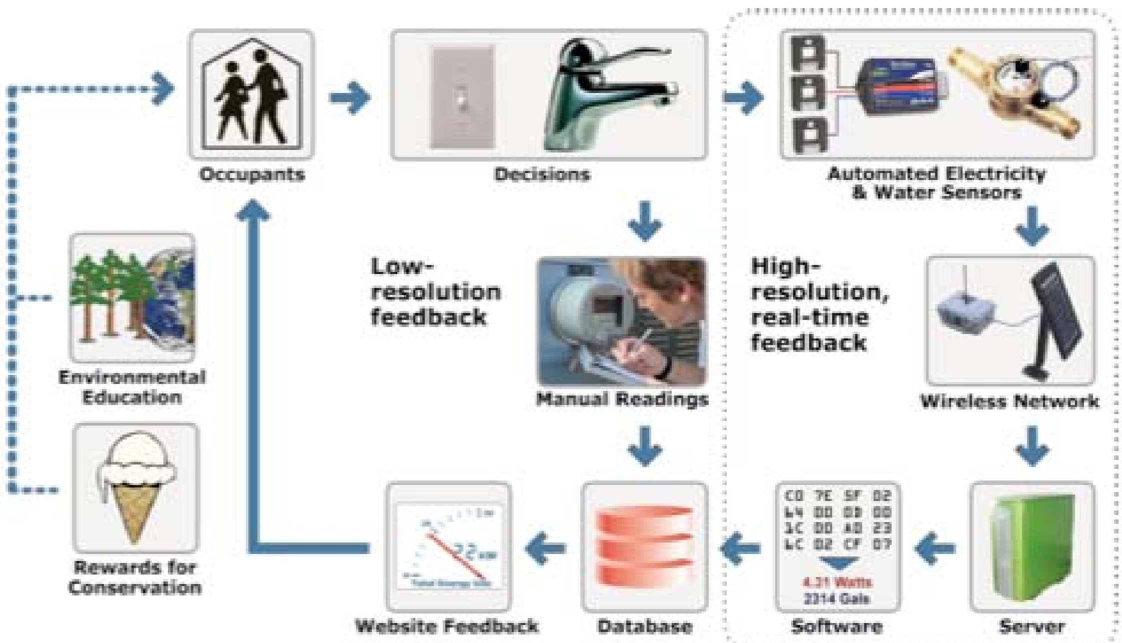


Figure 1: A Socio-technical Feedback System

Financial Incentives for Institutions

The CRMS project predicts that a typical building installation of energy monitoring equipment and analysis software will pay for itself in energy savings in less than eight years on average.
Their cost-benefit analysis uses conservative estimations of $10,000 per building and a sustained utility savings of 5% from changes in building user behavior. By comparison, it cost Oberlin $10,000 to retrofit two buildings, and they have been achieving an energy savings of 20% from behavior changes alone, indicating that a combination of energy monitoring displays and building user education can achieve significantly more cost-savings and a quicker payback on investments.

Current Technology

The CRMS project uses off-the-shelf water and electricity flow sensors, which take readings every 20 seconds and transmit the updates via wireless datalogging and networking hardware to a central server. Software developed in-house then aggregates the data for analysis, comparison, and display online. Dorm residents can access this real-time information on their personal computers and on dedicated kiosks in the dorm lobbies and the College's Science Center.

For better comparison, energy used for heating purposes is excluded from the energy monitoring, and analyses of the CRMS project's effectiveness control for variations in outdoor temperature and light intensity during the course of the year.

While the technology is currently a custom-made system for Oberlin College, the CRMS project is working to make their hardware and software more adaptable and user-friendly in order to extend its benefits to other organizations.

The Human Link: Education and Motivation

A key factor in the success of the CRMS project is its social component. While disseminating information is an important part of increasing consumer awareness, information alone does not make a more educated community. CRMS consequently relies on public outreach in several different ways:

- The "Dorm Energy Competition"
- Connection of resource consumption to social/environmental costs
- Distribution of Educational Materials

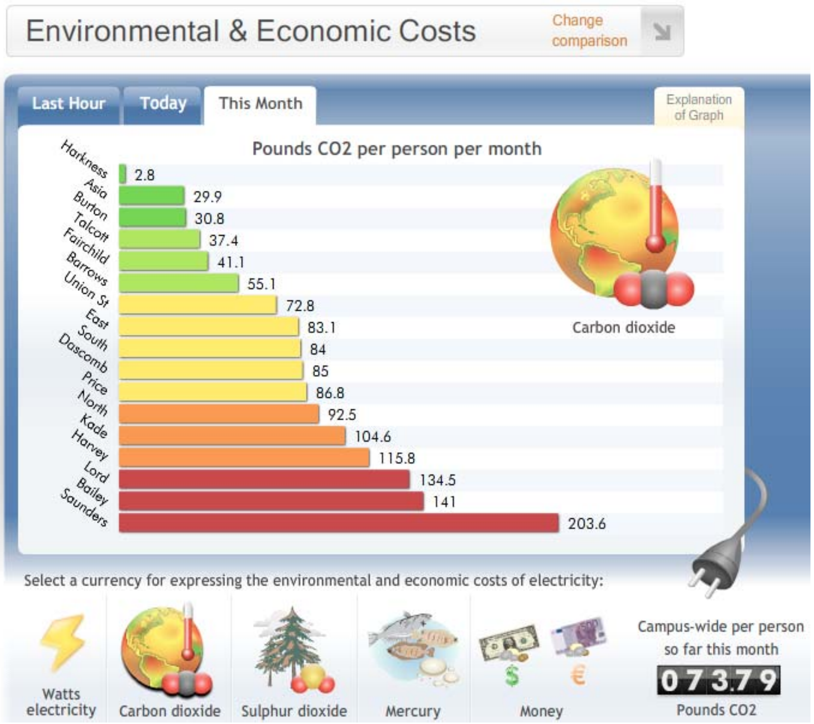
The Dorm Energy Competition

Every year since the CRMS was installed at Oberlin, the College has held a two-week competition to see which dormitory can reduce its energy and water usage the most. These competitions have been effective means of disseminating information about the CRMS and resource-saving techniques. They have also encouraged students to experiment with different resource conservation methods and identify which actions are sustainable and which are cumbersome to practice on a daily basis. Oberlin has found that, after the competition, many students are inspired to continue the more sustainable conservation measures. Meanwhile, unsustainable activities that were attempted but abandoned after the competition identify concrete areas for future work, whether that means research on more adaptable technology or reevaluation of taken-for-granted cultural practices (e.g. vending machines should run all night, or toilets should be fully flushed after every use).

The Competition rewards winning dorms (in several different conservation categories) with an ice-cream party. However, the CRMS project has observed an interesting trend: although many students actively participate in the competition, the celebratory ice-cream parties have proportionately low attendance, indicating that material incentives play only a small role in motivating students to participate.

Putting Resource Consumption in Practical Terms

In addition to making consumption practices more visible, the CRMS project allows students and observers to easily translate consumption into tangible social and environmental costs. The CRMS website allows users to view energy consumption in a variety of units, including watts, lightbulbs (CFL or incandescent), fuels (coal or gasoline), miles driven (in a hybrid or SUV), and burgers eaten (beef or veggie). In addition, the website details the environmental costs of such energy expenditure in the viewer's choice of pounds of carbon dioxide, grams of sulfur dioxide, milligrams of mercury, or monetary cost ($ or €). Using a mix of cultural and scientific units helps to drive home the message that everyone contributes to global problems and everyone can make small contributions to global conservation.



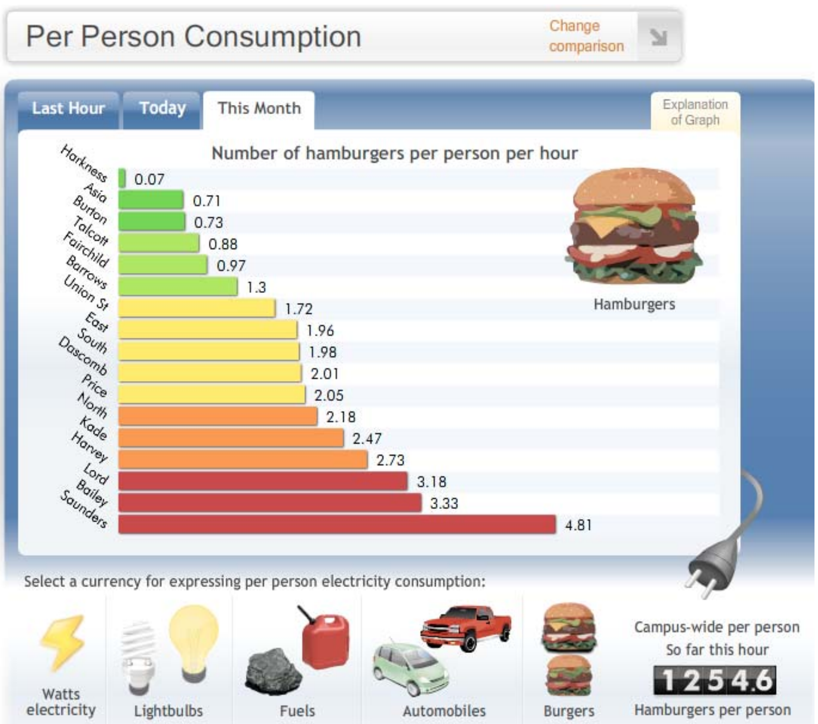


Figure 2: Online Comparison Tools for Evaluating Dormitory Energy Consumption. *Oberlin's CRMS puts resource consumption in terms everyone can understand – whether that means Watts or Gallons, Dollars or Euros, Hamburgers or Veggie Burgers, lbs* CO_2 *or SUV miles driven.*

Educational Materials

The CRMS project has also been successful at disseminating information. Students from a campus environmental group and an introductory environmental studies class have advertised the competition and resource-saving techniques through a combination of posters, fliers, and fact sheets posted all over campus, including in every bathroom stall in the participating dormitories. Additionally, computer kiosks displaying the real-time resource consumption data and dorm comparison tools in dormitory lobbies allow students to check up on their dorms' performances quickly and frequently, making resource awareness part of their daily routine.

Technology and Experience Roadmap

"Smart Building" Energy Control Technology

Building automation systems designed for energy conservation could be coordinated with user energy monitoring programs to great effect, particularly if both are designed to be adaptable to lessons learned from the other. The CRMS project positions itself as an alternative to "smart building" energy control systems, because, as they say, such systems produce "environmentally dumber people" (Petersen et al, 2005). However, automation and user feedback have the capacity to play different roles in energy conservation. For example, after a monitoring system is in place, automated systems could be designed to address resource-saving measures that building users identify as overly cumbersome for daily practice. Similarly, monitoring can identify times, locations, or activities for which automated systems are not particularly effective and user education programs can help fill in the gaps by encouraging different practices.

Competition and Community Building

Other programs that use competition – such as the Nissan "Eco-Drive and You" program – demonstrate that tying individual behavior to larger social phenomena, especially through measures that compare individuals against average behavior, is an effective way to encourage change. The results of such studies have broad implications for sustainability initiatives – whether they target home energy use, travel habits, consumption or disposal choices, work solutions, or any number of other individual behaviors that currently deliver little to no user feedback but have major resource consumption implications in aggregate.

Moreover, such programs create community by connecting people with a common goal. Analyses of student reaction to the Dorm Energy Competition report that many dormitories held planning sessions or engaged in extended email discussions to develop strategies for reducing resource consumption (Petersen et al, 2005).

Knowing Where Your Electricity Comes From (and How to Use it Wisely)

The electricity grid that serves Oberlin College gets much of its energy from coal-fired power plants. The electricity reductions on Oberlin's campus therefore have a significant environmental effect – the initial two-week competition in 2005, for example, encouraged a reduction of 148,000 lbs of CO_2, 1360 lbs of SO_2, and 520 lbs of NO_x.

However, it is important to keep in mind that reduction is a means to an end – using natural resources more sustainably – and not an end in itself. Where possible, energy-intensive campuses and buildings may choose to investigate potential local energy sources (e.g. solar, wind, or thermal) to meet some of their electricity needs using onsite emissions-free technology rather than working on marginal reductions. Additionally, smoothing out daily fluctuations in energy demand may do more to increase the sustainability of a campus than a simple overall reduction in energy use. Resource Monitoring Systems like the one developed at Oberlin can help large buildings and campuses meet these goals as well.

Works Cited and Sources for Additional Information:

Campus Resource Monitoring System Website:
http://www.oberlin.edu/dormenergy/

Petersen, John E., Vladislav Shunturov, Kathryn Janda, Gavin Platt, and Kate Weinberger. "Does Providing Dormitory Residents with Feedback on Energy and Water Use Lead to Reduced Consumption?" Greening the Campus VI, Ball State University, Muncie, Indiana, 15-17 Sept. 2005.

The SII – Sustainability Innovation Inventory is part of a research project on Connected Urban Development between MIT Mobile Experience Lab, Massachusetts Institute of Technology and Cisco Systems, Inc.

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