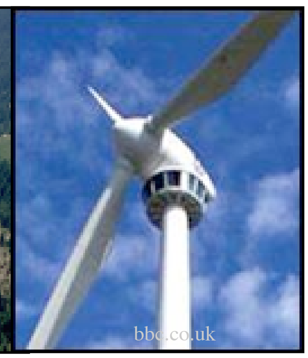
University of Oregon Energy Project:
Research, Education and
Alternative Energy



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Research, Education and Alternative Energy

Prepared by the Environmental Studies Service Learning Program Campus Energy Team

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Appendix K **110**

Education Campaign Number

Executive Summary

This project set out to **raise awareness** amongst 25% of the University of Oregon (UO) community about energy issues on campus. We aimed to connect students and staff to the issues facing the environment and our pocketbooks as a result of our energy consumption, as well as revitalize conservation efforts across campus. To meet our objectives, the Campus Energy Team created an **education campaign** and initiated the proposal for an increase in purchases of **alternative energy** on campus.

After compiling an **energy profile** of the UO, we presented our findings to over 4,000 members of the University community. Our presentation focused on the UO's current energy use, the economic and environmental impacts of that use, conservation efforts, and alternative energy sources. Of those reached by the education campaign, we performed 412 student **surveys** in order to assess the effectiveness of the presentation. In analyzing this data, we found that our education campaign increased knowledge significantly, had a marginally significant effect on attitudes, yet showed little correlation with changes in behavior surrounding energy use (for further analysis see pg. 23).

In researching the University of Oregon energy profile for 2003, we found that the University's electric consumption was the third highest of Eugene Water and Electric Board (EWEB)'s customers, with only Weyerhaeuser and Hynix purchasing greater amounts. That electrical use accounted for only 22.5% of the University's total energy consumption. The remaining 77.5% of the energy used in 2003 consisted of natural gas used for heating and the generation of electrical power (see pg. 6). The majority (48%) of electricity used on campus is purchased from EWEB in the form of hydroelectric power. In 2003, the University consumed over **45 million kilowatt-hours** (kWh) of electricity.

To moderate the high amounts of energy used on campus, we recommend continued and increased conservation efforts across campus. As our survey shows, one brief presentation is not sufficient to change attitudes and behaviors. Yet we feel that an **ongoing education campaign** – focused on general energy issues – is essential for a growth in campus energy awareness.

While conserving energy is the most important factor in reducing environmental impacts from energy use, investment in alternative energies can also lessen our impact. Based on analysis of our survey, University of Oregon students are willing to address the high levels of campus energy consumption through the investment in and use of wind power on campus (see pg. 27). The Energy Team recommends purchasing wind energy from EWEB to power the Erb Memorial Union. This high-profile building represents 5% of the total campus energy use and is used primarily by students. For our goal to become a reality, two phases must occur. First, the EMU board must agree to include wind power in their budget and then the Associated Students of the University of Oregon (ASUO) must accept the budget and increase student fees to support the extra cost. The

Campus Energy Team has initiated this process through a presentation to the ASUO senate on May 26, 2004. We will continue to work for this conversion by the 2005/2006 academic year.

Introduction

Background

Yearly, the University of Oregon consumes as much energy as 3,600 average Eugene residences use in a year (EWEB, 2004). While the United States relies on coal for the majority of its power, in the Pacific Northwest and at the University of Oregon, we depend primarily on hydroelectricity. Although this source is largely considered a renewable and cleaner source of energy than coal, it has many associated impacts for the region. To counter our vast use, many conservation efforts have taken place on campus both in physical applications and towards educating the community.

Issues

On the University of Oregon campus, there exists a **disconnect** between some students, faculty, and staff, and the issues surrounding our energy needs. Many students come to the University immediately from high school, with little applicable knowledge of energy costs and sources. By providing a framework that places the University community in context with the issues surrounding our energy use, we hope to raise awareness of the **monetary and environmental costs** that result from our energy consumption.

Project Funding

The Campus Energy project was funded by a $7,500 grant from the local utility company, Eugene Water and Electric Board (EWEB) as well as matching funds from the University of Oregon. EWEB and the University invested in this project to promote awareness of energy issues and, ideally, a decrease in consumption.

Project Methodology

In order to achieve our goals, we engaged in various stages of **research and education**. By focusing our initial data collection on the United States, the Pacific Northwest, and the University's energy trends, we were able to compare local and national energy sources and available alternatives. We developed an energy profile detailing specifics of the University's energy use, sources, conservation practices, and alternatives. Next, we created multiple outlets to educate the campus community, including: a website, PowerPoint presentations (in classrooms and online), and an energy tour (both online and on Earth Day). In drawing attention to the connection between our use and the sources of our energy, we hoped to promote conservation practices among individuals and encourage the purchase of alternative energies on a campus wide level. We then designed a survey to evaluate the success of this campaign. We also set the process of purchasing 100% wind power for the Erb Memorial Union in motion. Lastly, we created a poster displaying significant project information and a final presentation about the accomplishments of our project.

Campus Energy Profile

Introduction

To build an energy profile for the University of Oregon, we gathered information on the amount of energy the University uses, campus conservation efforts, current electricity sources and possible alternatives for use on campus. While analyzing consumption and conservation provided us with an understanding of trends, considering the sources of this energy revealed subsequent environmental impacts. By investigating alternative energies and conservation practices, we were then able to suggest methods for improvement. Ultimately, each section provides important information that together forms a comprehensive energy profile as well as exposes areas for reducing the impact of the University's use.

Methodology

Data collected for this profile came primarily from web-based searches, library research, and **interviews** with campus faculty and Eugene Water and Electric Board (EWEB) experts. At a preliminary meeting at EWEB on January 15, 2004, Jim Maloney, Brian Hawley, and John Femal introduced a broad range of information and ideas applicable to the Campus Energy Project. Throughout the months of January and February, we conducted further interviews and carried out e-mail correspondences with various experts in the field. Josh Ruddick, Utilities Analyst at the University of Oregon power plant, provided raw data and insight into campus energy use and conservation. Other interviews included individual meetings with John Mitchell in Media Relations at EWEB; Jim Maloney, EWEB's Energy Resource Project Manager; and Jeff Kline, research associate with Energy Studies in Buildings Laboratory (ESBL).

Online databases from the Bonneville Power Administration (BPA) and EWEB provided a wealth of information about local energy, while the Energy Information Administration (EIA) database supplied information about national energy use. Online documents with details on general operations for ESBL and Facilities Services as well as the Environmental Issues Committee's (EIC) annual reports, news, and archival records provided further insight into the University's energy use.

Data

Data is presented in four sections: University of Oregon Energy Use, Energy Conservation, Electric Providers, and Wind Power.

University of Oregon Energy Use

The University Oregon spent over **4.4 million dollars** on energy in 2003, averaging over $12,000 a day (Ruddick, 2004). At over 45 million kWh of electricity a year, this is equal to the amount of electricity required to power over 3,600 average Eugene residences for an entire year (EWEB, 2004). This electrical use makes the University Eugene Water and Electric Board's third largest customer.

Energy Measurements

The basic unit used to measure electricity is the watt (W). For example, a 100-watt light bulb consumes 100 watts of electricity at any given time. A kilowatt is equal to 1,000 watts. When measured over time, kilowatt-hours (kWh) are used. For example, ten 100-watt light bulbs powered for one hour consume one-kilowatt hour of electricity. For the purposes of this report, non-electrical forms of energy are converted to watts to allow for comparison.

In addition to electricity, the other primary form of energy used by the University of Oregon is natural gas. Each form of energy requires **different measurement tools** – the existence and monitoring of which regulate the data available for each form of energy.

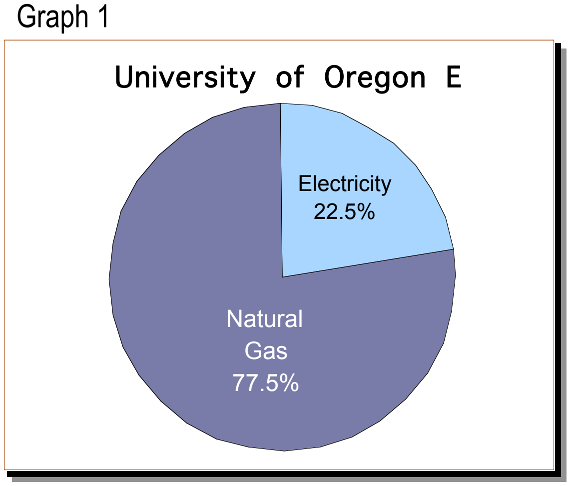
Energy Form	Measurement Standard	Meter Availability
Electricity	Kilowatt hour (kWh)	Individual Buildings
Natural Gas	British Thermal Unit (BTU)	10-12 total

Energy Breakdown

Of all the energy used by the University of Oregon in 2003, natural gas made up 77.5% of the pool while electricity made up the remaining 22.5% (Ruddick, 2004). Graph 1 displays this divide. Analyzing the use of each form explains the **uneven** distribution.

The University purchases natural gas from Northwest Natural and PG&E, which the campus power plant uses to create steam. The steam is first pumped through electrical generators, and then distributed to all campus buildings for **heating**. A portion is used to generate electricity at the University power plant.

Graph 1



The University uses electricity for general electric needs such as lighting and computers as well as for cooling water for air conditioning. Three meters funnel electrical energy to campus. In 2003, the University purchased 87% of its electricity directly from EWEB. The other 13% came from the steam-powered generators at the University power plant (Ruddick, 2004). Each year, the percent of electricity generated on campus **fluctuates** in order to minimize costs. For example, when natural gas prices are low and electricity prices are high, the University saves money by generating its own electricity.

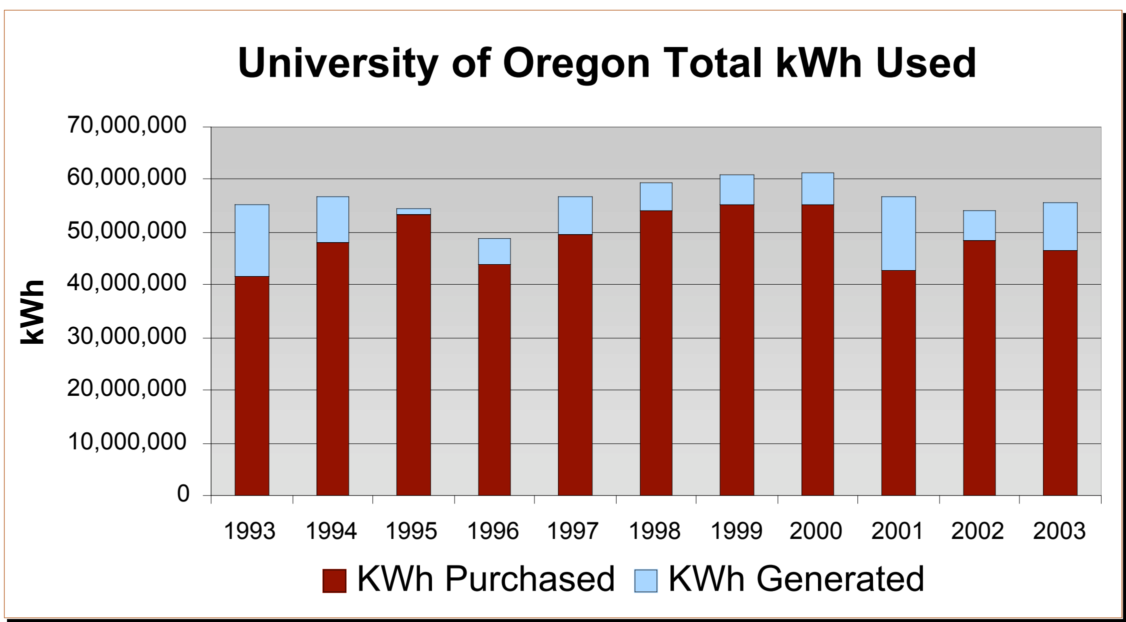
> **Did you know?**
> **The U of O uses over three times as much gas as electricity, yet in 2003 the costs of each were almost identical.**

In 2003, natural gas cost the University 2.3 million dollars, while electricity cost 2.1 million (Ruddick, 2004). The cost ratio of electricity to natural gas fluctuates yearly depending not only on how much the University uses, but also on the **purchasing cost** of each form of energy.

Electricity

More information exists for the use of electricity than for natural gas, primarily because of electrical meters on nearly every campus building. Due to this availability of information and the even distribution of cost between natural gas and electricity, we focused our efforts on the electrical portion of the University's energy use. For these reasons, as well as the cooperation and support that EWEB provides, the University of Oregon also concentrates on conserving electricity rather than natural gas.

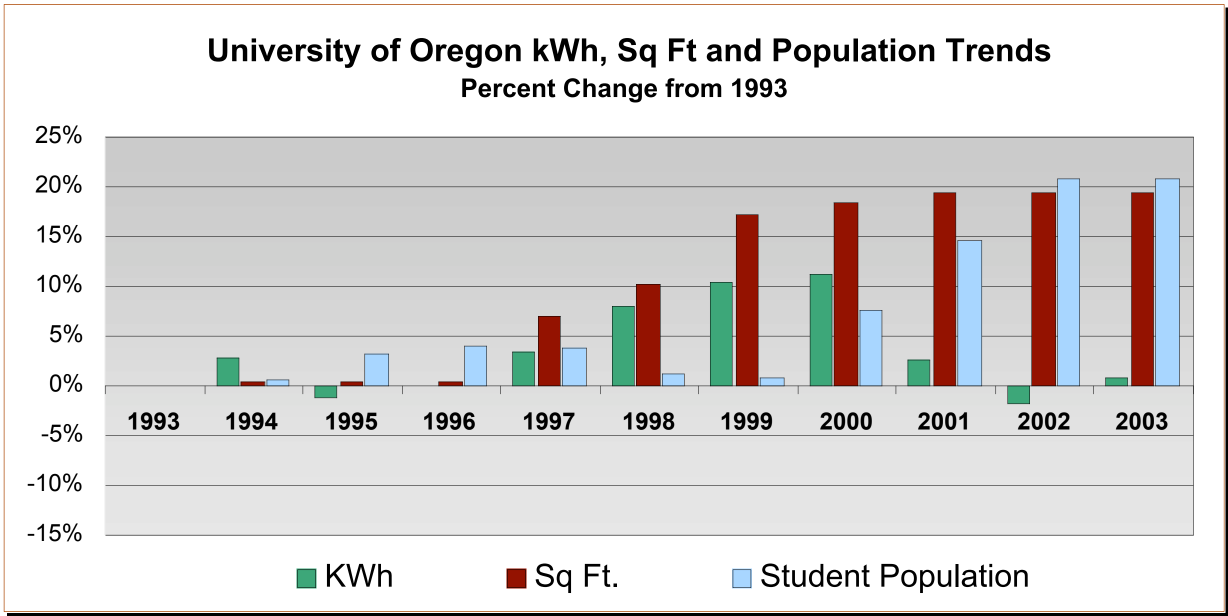
Graph 2



Graph 2 displays the total electric use, as well as the breakdown between the electricity the University purchased directly from EWEB and the electricity generated on campus. In 1993, the University used 55.1 million kWh of electricity. Of this total, 41.7 million kWh were purchased directly and 13.4 million kWh were generated at the University power plant. In contrast, in 2003, the University used 55.6 million kWh. Of this total, 46.5 million kWh were purchased directly and only 9.1 million kWh were generated on campus. Over the last decade, the University generated an annual average of 13% of its electricity, with natural gas and electricity prices dictating differences in source (Ruddick, 2004).

Obviously, yearly electricity use has **fluctuated**. This fluctuation is a result of many factors including campus additions, student enrollment, and weather. Graph 3 displays the trends for kWh use, as well as total square feet and student population over the last decade.

Graph 3



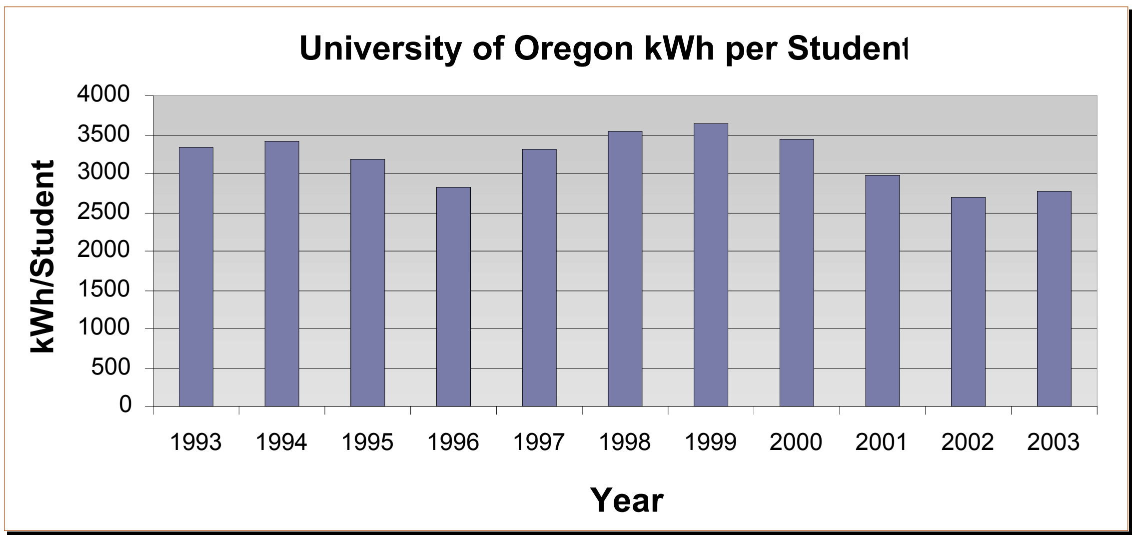
Over the last decade, many **new buildings** and expansions were added to the University's facilities. For example, the additions of the Student Recreation Center and the Knight Law Center account for the increase between 1998 and 1999. In 1993, the University had a total of almost 4.4 million square feet, and by 2003, the total square footage was nearly 5.2. The percent increase over this decade is almost 20% (UO, 2004).

Student enrollment at the University also increased over the last decade. Between 1993 and 1999, the student population oscillated, but increased minimally overall. Starting in 2000, the student population increased dramatically each year until it leveled off in 2003. In 1993, there were 16,593 students at the University and by 2003 there were 20,033 students enrolled (UO, 2004). These additions amount to a 20% increase in student enrollment over the last decade.

The kilowatt-hours used by the University each year varied even more dramatically. In 1993, the University used 55.1 million kWh, but used only 55.6 million kWh in 2003. Although in 2000 there were over 10% more kWh used than in 1993, by 2003 the percentage increase from 1993 dropped to less than 1% (Ruddick, 2004). This minimal increase in kWh usage occurred regardless of the 20% increase in both square feet and student population. The decrease between 2000 and 2003 is particularly noteworthy because during this time **student enrollment increased**.

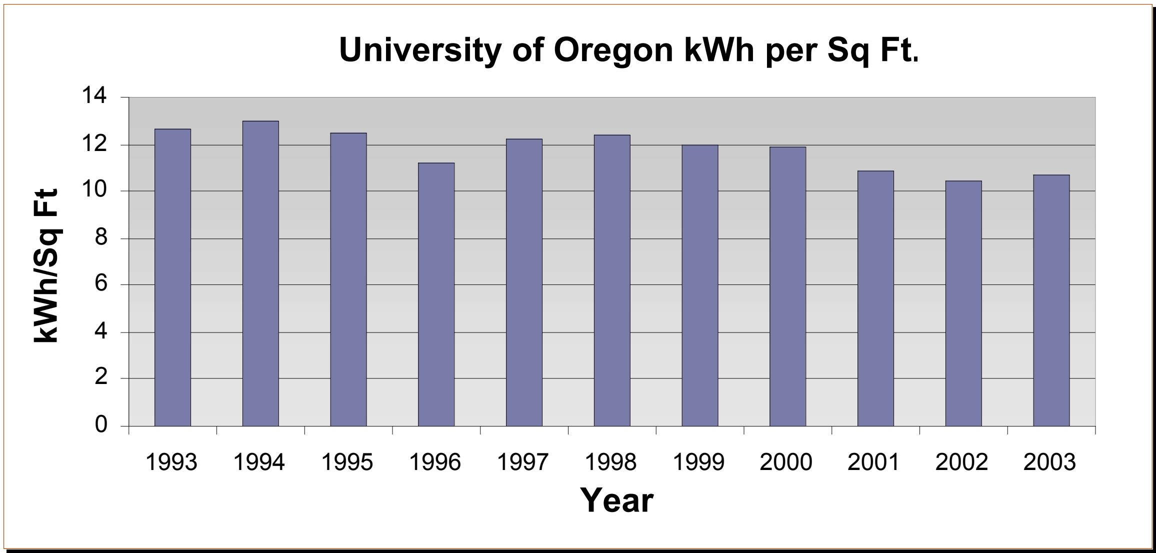
The total kWh used by the University does not directly correlate with square footage or student population; other factors explain the trend. For example, even though the total square footage increased, newer buildings were designed with higher energy efficiency standards. In addition, the University worked to improve efficiency in older buildings. In regards to individuals' impact, campaigns for students to reduce energy use counteracted a growth in that population.

As graph 4 illustrates, the total kWh use per student has decreased over the last decade. In 1993, per capita usage was approximately 3,321 kWh while in 2003 it was only 2,774 kWh. Although per capita usage fluctuated during this time, it decreased by 16% over the decade as a whole.
Graph 4



Similarly, kWh use per square foot at the University experienced a downward trend as well. The University used 12.7 kWh per square foot in 1993 and only 10.7 kWh per square foot in 2003, representing a 15% reduction over the last decade.

Graph 5



Discussion

The combination of these figures demonstrates that the University can **reduce its energy use** even as it continues to expand. As the data shows, the **minimal increase** in kWh consumption occurred regardless of increases in student population and total campus square footage. The University's various conservation investments have helped make this possible.

Energy Conservation

Conservation projects are essential to **reducing** campus energy consumption. Recent projects include upgrading lighting and fan timers, installing awnings and watt-stoppers, utilizing alternative energies, and improving building design standards. In addition, educational campaigns have proved effective in initiating conservation practices among students and faculty.

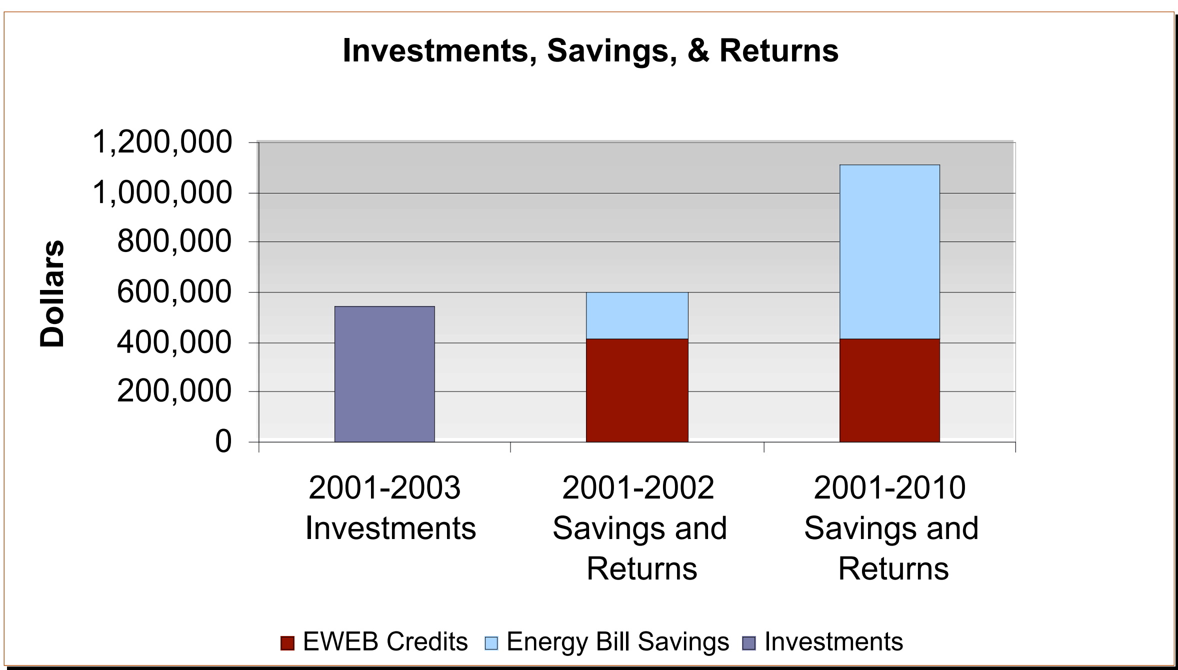
Lighting and Fan Timer Upgrades

From 2001 to 2003, Facilities Services invested $539,688 to install fan timers across campus and upgrade existing t-12 magnetic fluorescent lights with electronic t-8 fluorescent bulbs. The following table gives the annual breakdown of investments and energy savings (monetary as well as electrical). The graph shown below combines each year's **conservation investments** by Facilities Services with both present and predicted future energy savings and returns.

	2001	2002	2003
Facilities Invested	$451,688	$8,000 – 10,000	$80,000
ECM* Return	$341,627	$7,000	$62,000**
Energy Saved	1.7 Million kWh or $57,000	58,000 kWh or $2,000	390,000 kWh or $14,000

* Energy Conservation Measure (ECM) refers to EWEB's monetary credit to the University for completing conservation projects.
** Expected return to the UO. At the time of writing, EWEB was processing this information.
[Ruddick, 2004]

Graph 6



Awnings

The installation of awnings on certain buildings reduces heating and cooling needs by blocking out high angled summer light yet still allowing in low angled winter light. Facilities Services invested a total of $31,877 to install awnings on the Volcanology Building, Johnson Hall, Hendricks Hall, and the Music Building. Calculated energy savings for these projects are unavailable due to the inability to track heating and cooling savings in natural gas for individual buildings on campus.

Watt-Stoppers

Of the 500 energy saving watt-stoppers, only 88 have been installed.

The University of Oregon purchased 500 watt-stoppers at $50 apiece. Watt-stoppers are infrared motion detectors connected to a power strip. The infrared sensor focuses on a point in an office or classroom where occupants might be. When the occupant exits the room, the sensor **powers down** each appliance connected to the power strip. EWEB has agreed to reimburse the University $20 to $25 per watt-stopper installed on campus. So far, only 88 of 500 have been installed, due in part to a lack of promotion and of receptivity. The watt-stoppers are not safe for powering down computers, and as most people use only a computer and possibly a desk lamp in their office, many people feel little need to use the device (Kline, 2004).

Solar Energy

Solar panels are located on the Erb Memorial Union (pictured to the right), Gerlinger Annex, and the Lillis Business Complex (pictured below). **Campus solar power** is used for two distinct purposes. The photovoltaic panels on the EMU and Lillis reduce reliance on grid power. Consequently, the University saves money while reducing environmental impacts from traditional energy sources. The Gerlinger Annex solar water heating panels, on the other hand, connect to the building's water heating system, reducing the need to pump steam from the campus power plant to heat water for the building. An additional benefit of the solar water heater comes from decreased summer cooling needs due to the lack of steam in the building. Both of these energy savings substantially reduce costs. Similar projects are planned for Condon and Chapman halls in the summer of 2004.

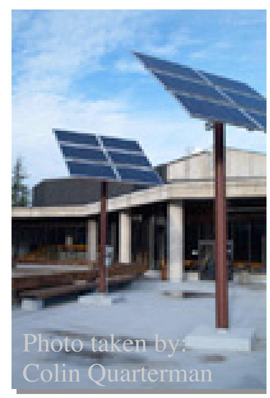
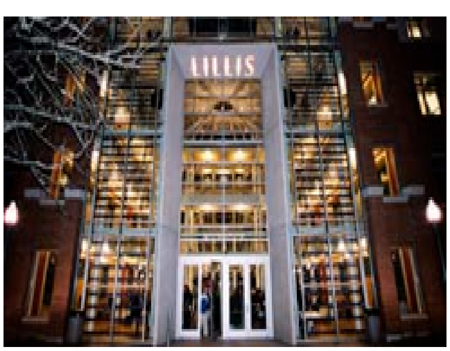


Photo taken by: Colin Quarterman

Building Design Standards

The University's 2000 Sustainable Development Plan recognized the need to conserve energy in designing new buildings. Consequently, the newest campus building additions and renovations incorporate numerous sophisticated **sustainability measures**. At a cost of $41 million, the Lillis Business Complex uses only 50% of the state required energy consumption for a building its size. Light sensors throughout this latest addition to campus



restrict the use of electric lighting when natural light is available. Solar panels embedded in the south atrium windows and on the roof produce 5% of the building's total energy use (Lundquist College of Business, 2004).

Educational Campaigns

In addition to physical applications and design standards, the University engages in educational campaigns to boost **awareness** and support for energy conservation on campus. In the 2001/2002 academic year, Facilities Services contracted Energy Studies in Buildings Laboratory (ESBL) to research and monitor a conservation competition between dormitories.

ESBL hired three students to educate dorm residents on ways to conserve energy in their buildings. The selected students distributed flyers and light switch reminders and held meetings with Resident Assistants. **Incentives** were offered to the dorm that conserved the most electricity. This awareness campaign not only saved electricity, but also initiated conservation practices in newer students at the University. Although the exact electrical savings have yet to be calculated, Jeff Kline with ESBL states that a sizable reduction occurred (Kline, 2004).

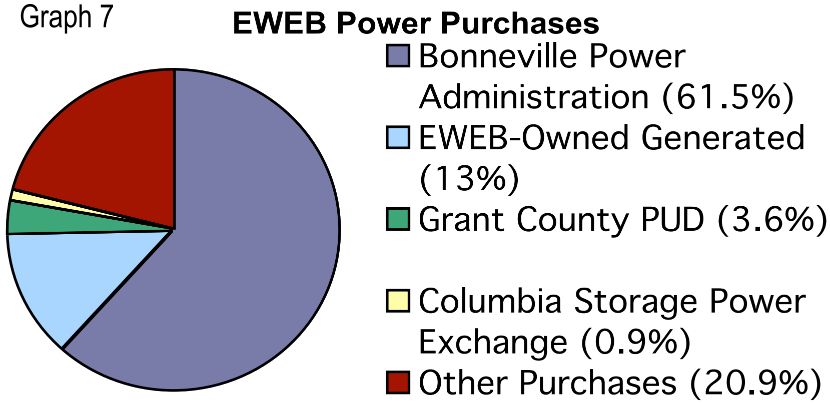
Discussion

By no means do the previous examples represent all conservation efforts made by the University. Numerous campus groups are involved with conservation projects, and in its history, multitudes of building renovations, new constructions, facilities upgrades, awareness campaigns, and energy research has occurred on campus. These illustrations simply emphasize specific accomplishments and provide examples of previous successful conservation measures.

Electric Providers

In the United States, power generated from coal accounts for about 52% of the electricity profile, while hydroelectric power makes up 6% (EIA, 2004). Most of this hydroelectric generation occurs in the Pacific Northwest, from powerhouses such as Grand Coulee, Chief Joseph, or Bonneville dams. Hydroelectric generation **dominates** the Northwest power pool. The Bonneville Power Administration (BPA) owns and distributes much of this power among various residences, businesses, facilities and other utilities such as the Eugene Water and Electric Board (EWEB).

Graph 7



Breakdown of EWEB's power purchases, which make up 87% of the UO electric profile. Data for graph provided by Eugene Water and Electric Board.

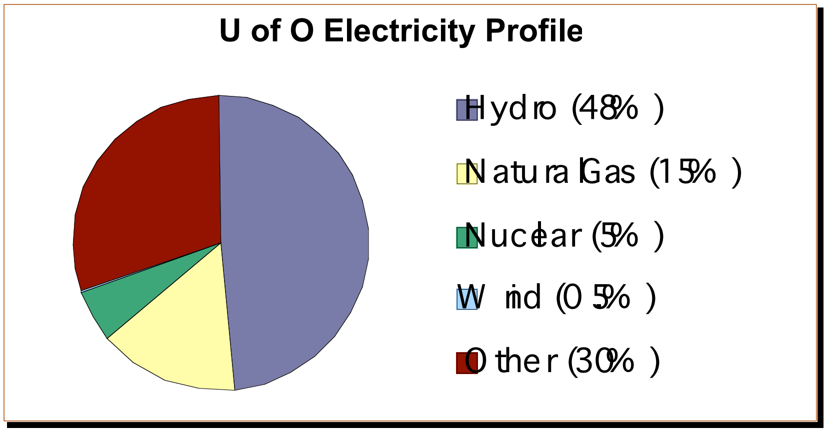
Power purchased from the BPA makes up 61.5% of EWEB's electric profile (EWEB, 2004). EWEB also purchases power from Grant County Public Utilities Distributor, which supplies additional hydropower from its two dams: Wanapum and Priest Rapids. Because of the Columbia River Treaty (1964), EWEB also receives a small portion of power from the Mica dam in British Columbia. This treaty detailed an agreement between the United States and Canada in which the U.S. would purchase a certain amount of Canadian power if Canada would build three dams — two large storage dams and one dam for power generation (the Mica dam).

EWEB owns and operates several dams, and partially owns a cogeneration plant and wind power plant. The rest of the power purchased by EWEB is **purchased daily** and can vary depending upon price and availability. The University of Oregon purchases most of its electricity from EWEB, making it EWEB's third largest customer. As mentioned earlier, the University supplies an average of 13% of its own electricity, which Facilities Services generates as a by-product of its natural gas-powered steam plant (Ruddick, 2004).

EWEB-Owned Generated Power		BPA-Owned Generated Power	
Hydroelectric Generation	76%	Hydroelectric Generation	67%
Natural Gas/Cogeneration	20.5%	Nuclear Generation	10%
Wind Generation	3.5%	Firm Contracts and Other	23%

University of Oregon Electricity Profile

Graph 8



In 2003, hydroelectric power provided the majority of the University's energy. Natural gas supplied about 15%, nuclear 5%, and wind made up less than 0.5% (BPA, EWEB, & Ruddick, 2004). The additional 30% of the energy used by the University is undefined, because it is purchased from day to day, depending upon the cost and availability of electricity. This portion consists of numerous forms of energy, including coal. Each source of energy has both benefits and drawbacks, explained briefly below.

Natural Gas

The Pacific Northwest receives almost all of its gas from Canada, transported by pipelines owned by Northwest and PG & E from the Western Canadian Sedimentary Basin located in Alberta. Natural gas **burns cleaner** than any other hydrocarbon fuel. Unlike coal, it produces very little sulfur dioxide or other air contaminants and produces very little solid waste. Like coal, however, it is **cost competitive**. However, natural gas has its drawbacks. The flammability of the gas makes it **susceptible to hazards** in extraction or production, and it is a **finite** natural resource. In addition, gas consumption continues to rise. According to the Energy Information Administration, natural gas consumption rose by 21% from 1990 to 2002. Production peaked in the 1970's and by the mid-1980s, consumption rose above production, causing an increase in imports to meet demand. The transportation of natural gas has limitations, however, because the gas remains in vapor form. It cannot be transported far as such, and turning it into a liquid can prove quite expensive. Because of these transportation restrictions, the U.S. imports very little natural gas, limiting supply.

Natural Gas has already reached its peak production.

Hydroelectricity

Hydroelectricity dominates the University of Oregon's electricity pool. Often considered a **"renewable"** energy, hydroelectric generation emits **no air pollution** and has an **unlimited** power source (water), which does not deplete during generation. In addition, hydroelectric plants have a long generation life – generally over 50 years.

Power generation represents only one motive for building dams: flood control is another. This results in faster flowing water downstream, which carves deep into the riverbed while blocking sediment upstream. These factors cause disruptions in nutrient availability and increased sediment loads (turbidity) of the waterway. Lower levels of nutrients **decrease food sources** while higher levels of nutrients increase susceptibility of **algae bloom**. The latter affects spawning practices by decreasing the diversity of the river channel. Fish, particularly salmon, need areas of both slower moving and faster moving water. Dams stabilize the flow rate in waterways. The changes in the river channel cause fluctuations in water temperatures, which affect oxygen absorption and increase stress on salmon populations. Flood control also detrimentally affects flood dependent ecosystems: decreased flooding prohibits nutrient and sediment replenishment of the floodplain, **decreasing biodiversity** of riparian vegetation.

Hydroelectricity makes up about 66% of the Pacific Northwest electricity profile.

Dams additionally **block passage** along the waterway, making it difficult for salmon to return upstream for spawning. This has greatly decreased salmon populations. Fish ladders can help salmon passage, although few dams have them.

Salmon not only have an impact on the economy of the Pacific Northwest, they also are a key component of the local ecosystem. Over the past 100 years, the reduction in salmon populations has diverted huge amounts of nutrients away from rivers. Most salmon populations are anadromous, meaning they spawn in small freshwater streams and eventually work their way to the ocean, where they spend the majority of their lives. Over the years, the fish grow from feeding in the **nutrient-rich ocean** and in the last leg of their lives, return to their native stream to spawn again. After spawning, the fish die, depositing the nutrients carried from the ocean. According to the Washington Department of Fish and Wildlife, only 3% of the nutrients once transported by anadromous fish currently reach these rivers.

Nuclear

Nuclear power makes up about 5% of the University of Oregon electric profile. This comes from the Columbia Generating System, a nuclear plant located in southeast Washington. Often considered a clean form of energy, nuclear power **does not emit hazardous gases** into the atmosphere and unlike wind, solar, or hydropower, it does not rely upon weather conditions for generation.

Did you know?
According to the Institute for Energy and Environmental Research, if uranium dioxide leaks into the ground water supply, it will react by creating a very toxic hydrofluoric acid that can cause serious risks to health.

Uranium acts as the primary fuel source for the Columbia Generating System. Power generation produces a **radioactive** by-product of uranium dioxide, which has the capacity to cause **kidney toxicity** or even **death** when inhaled or ingested. Immediate contact with the substance can cause **cancer.** This waste is temporarily stored until it can be moved to the national repository at Yucca Mountain (about 100 miles northwest of Las Vegas, Nevada). Yucca Mountain may only provide a short-term answer to a long-term problem. Removing waste from nuclear power plants creates room for more production, rather than providing incentives for more efficient production. Also, the transportation of the uranium dioxide may be subject to truck, train, or barge accidents which would pose an immediate danger to the health of surrounding populations.

Coal

About 30% of the University's electricity profile is undefined, because EWEB and the BPA purchase a portion of their energy day to day from a variety of utilities and wholesale energy brokers. The supplemental energy purchased depends on the amount or cost of what is available. In the Pacific Northwest, 20% of electricity comes from coal, meaning that the University could receive a portion of its electricity from this source. Coal power is **economical,** but when burned, is the highest producer of **toxic air pollution** in the world, causing **acid rain** and significantly influencing global climate change.

Discussion

While all these forms of energy generation have both beneficial and detrimental attributes, ultimately cost competitiveness and locality define the energy market. Most of these energy sources, such as hydroelectricity or natural gas, are routinely touted as "clean" or even "renewable." However, these labels may encourage false and idealized perceptions. Instead, we feel that focus should lie in a search for cleaner and more efficient alternative sources of energy, such as wind or solar power, and in improving the competitiveness of these sources in the energy market

Wind Power

Wind power is truly a clean, renewable energy, and its use on campus can significantly reduce the ecological footprint caused by the University's energy use. To understand the implications of promoting this energy on campus, a basic understanding of this resource is essential.

Background

The concept of harnessing wind to generate power can be traced back to the 7th century AD, while the first documented Dutch windmill dates back to 1180. By 1850, wind supplied 90% of the power used in Dutch industry, and in the U.S., over 6 million wind mills were visible on the American landscapes by the early 20th century – pumping water and powering farms. However, when other technologies became readily available, cheaper and more convenient sources such as coal and oil displaced the use of wind from America's energy equation. By the late 1970s, 6 million windmills became a mere 150,000 (Gipe, 1995).

The 1973 oil embargo and the Three Mile Island incident in 1979 prompted a revival of wind power research. Once reestablished as a **viable alternative**, wind power progressed faster than any other energy technology. By the late 1980s, over 70 large wind farms in six states were producing commercial quantities of power – less than a decade after intensive research began. The majority of these farms are in California, where 16,000 operating wind turbines produced 3.5 billion Kilowatt-hours of electricity in 1994 (Gipe, 1995).

1180	First known wind mill
1900-1950	Early wind power in the United States
1960-1970	Coal and oil become mainstream sources of energy
1973	OPEC oil embargo raises prices of this inexpensive source
1979	Three Mile Island incident prompts fear of nuclear power
1979	Federal funding for wind power research and development
1980s	Technological advances in turbine design and efficiency
1994	Cost of wind down to $0.05 per Kilowatt Hour

An Energy Information Administration study shows that enough wind blows through the United States to produce up to **two times** more electricity than current U.S. generating capacity (EIA, 2004). While the likelihood of harnessing all of that unrealized power is impractical, the estimate displays the boundless potential of wind power.

Modern wind turbines can generate electricity at up to a 30% efficiency rate – rivaling conventional sources of energy (Gipe, 1995). In addition, technological advancements and design modernization have reduced capital and operating costs of wind energy production, resulting in the decreased price of wind power. Since 1994, wind power has averaged $0.05 per Kilowatt-hour in California – **competitive** even in today's energy market (EIA, 2004).

The Science

Wind is a form of solar energy that results from the uneven heating of the atmosphere, surface irregularity, and the rotation of the earth. Wind hits the blades of a turbine, resulting in spinning. This spinning converts the solar energy that is stored in wind into kinetic energy, which turns an axle, which powers a pump, runs a mill, or performs some other type of function. The amount of power that is converted in this way depends on the length of the blades and wind speed. Thus, both design and geographic patterns must be considered when turbines are constructed.

Updated design and experience in both operation and positioning have greatly improved the science of wind power production. **Technological innovations** such as improved blades, variable-speed generation, simplified mechanisms, and modern controls have improved the scope and possibility of this renewable resource (Gipe, 1995). Despite economic and technological prosperity, wind power still makes up only a minor percentage of the country's energy budget.

Costs

The utilization of wind as a resource has stagnated because many elements are needed for successful wind power generation. Barriers hindering integration of wind into the electric utility system include the low cost of electricity from natural-gas-fired power plants, the intermittent nature of wind, the lack of data on viable wind resource areas, the distance of wind resources from demand centers, and the high financing cost of wind energy projects. Environmental impacts of wind power generation include degradation of plant and animal life due to disturbed habitat (a result of the extensive land needed to implement enough turbines to produce abundant power) as well as what the industry has dubbed "the bird problem".

Location	An average wind speed of 15 miles per hour is needed to sustain a wind farm. The average wind speed in Eugene is 2.5 miles per hour.
Compatibility	Issues of migrating birds and scenic beauty often suspend the building of wind turbines.
Storage	Wind varies, and so do energy needs. Effective ways to deal with surplus and shortage are insufficient at best

The Bird Controversy

One of the most controversial aspects of wind power is the impact on birds. In the late 1980s, the California Energy Commission reported the deaths of 160 birds due to collisions with wind turbines, including the cherished golden eagle. Since the emergence of the immense wind project in Altamont Pass, California, estimated tens of thousands of birds have died. Now, many environmentalists who supported wind power are condemning it.

However, a study completed in 2001 by the National Wind Coordinating Committee argues for the insignificance of the problem. The study, which scientifically observed numerous human-made structures, found that wind turbines in the U.S. are responsible for 10,000 to 40,000 bird deaths per year. However, vehicles, buildings, and power lines are responsible for 60 to 80 million, 98 to 980 million, and up to 174 million, respectively. In addition, the National Audubon Society estimates that upwards of 100 million bird fatalities are the result of house cats every year in the United States (NWCC, 2001).

In addition, advancements in wind technology have also lowered the bird fatality rate per turbine, so that the original numbers at Altamont Pass will not be repeated. For example, the Foote Creek Rim project in Wyoming, which is partially owned by EWEB, placed turbines in a particular location and direction to avoid interference with flight patterns. In addition, new designs disallow birds to perch or nest on turbines, which has also lowered bird fatality rates (EWEB, 2004).

Benefits

Wind power yields **zero-emissions**, offsetting air pollution that is otherwise generated by conventional power plants. In addition, while migrating birds may not mix well with spinning turbines, most other animals do.

Clean	Wind power offers a non-polluting alternative to fossil fuels: a service to the air and sky.
Efficient	Advanced technology allows for efficiency comparable, if not superior, to conventional sources.
Affordable	The cost of wind is now competitive with popular polluters such as oil and natural gas.

Discussion

The University of Oregon Campus Environmental Policy states “the University will explore the application of developing technologies for energy systems and use of resources, as well as the potential for use of renewable energy resources.” Considering the application of wind power on campus may be a viable means for the University of Oregon to fulfill this assertion.

Conclusion

Despite recent growth in square footage and student population, the University of Oregon has shown its ability to reduce overall energy consumption. Nonetheless, **future environmental consequences of this consumption** may be considerable. Conservation investments reduce the University's ecological footprint and **save money**. In addition to reducing its energy use, the University has implemented the use of some alternative energy sources, thus reducing our reliance on conventional resources. Taking the size of campus into account, investments in conservation and alternative energy make a substantial impact. However, many **opportunities for future improvements** exist in all areas of energy use: namely, the utilization of clean, renewable energy sources such as wind or solar power.

Education and Outreach Campaign

Goals

The purpose of the education and outreach campaign was to **raise awareness** of energy issues and promote conservation practices on campus. The project was established with a goal of reaching 25% of the campus community, which as of winter term 2004 included 19,450 students. We therefore aimed to reach about **5,000 people**. As of the writing of this report, we reached 4,131 people, coming close to our initial goal.

Methodology

We used multiple methods to contact the sizable number of people that our goal dictated. The majority were educated through in-class or faculty and staff **presentations**, while a campus energy **tour** and project **website** reached the remainder. The presentations, although fulfilling the majority of the goal, represented a condensed version of the energy profile data. Those reached through the energy tour and website had access to a greater wealth of information.

Implementation

Presentation

After compiling data, we arranged notable information into a ten minute PowerPoint presentation. The goal of the presentation was to share a University energy profile with audiences. The presentation includes information on use, sources, conservation efforts, and investments in alternative energy. Finally, it briefly discusses ways individuals can help to conserve energy both on and off campus. The Project Manager scheduled presentations by sending letters to faculty members and using the website and Oregon Daily Emerald article for publicity.

Photo taken by: Steve Mital

With a goal of reaching about 5,000 people, **five additional students** were recruited to help give the presentation throughout spring term of 2004. The role of the Energy Team in this public speaking class included supplying the presentation slides, script, a quiz, and a list of frequently asked questions and answers, as well as acting as mentors. As a team of nine presenters, we were able to reach 3,724 people using this method. For a presentation spreadsheet and public speaking class information, see appendices D and E.

Campus Energy Tour

A tour of energy-saving projects on campus emphasized conservation and alternative energy efforts made by the University. Highlighted on the tour were seven stops: awnings on the

Volcanology building, upgraded lighting systems in Pacific hall, Energy Studies in Buildings Laboratory (ESBL), the Lillis Business Complex, a solar water heater on Gerlinger Annex, the Student Recreation Center, and solar panels on the Erb Memorial Union. Sites were chosen based upon exhibition of noteworthy conservation or alternative energy projects.

Two tours visited these sites on Earth Day, April 22, 2004. Three people attended the morning tour, and three attended the afternoon tour. Publicity consisted of a front-page article in the Oregon Daily Emerald on April 20, initiated by a press release sent to the editors about the Campus Energy Project. Flyers posted around the EMU the day before the tour and Environmental Studies and Geography undergraduate email list-serves assisted in promoting the tour.


Photo taken by: Steve Mital

In addition to the physical tours, a self-guiding pamphlet and a virtual tour are available. Supplementing the pamphlet is a script for the tour; available so others can lead a similar tour in the future. For press release, newspaper article, self-guiding pamphlet and script, see appendices H and I.

Website

The purpose of the website is to supply information about the goals of the Campus Energy Project, provide data from our research, and furnish links to useful information. During winter term, the site consisted of campus energy profile data, a glossary of energy terms and an energy IQ quiz. Throughout spring term, a continuously updated current events page described project activities, and in April, we added the virtual energy tour. As the wind campaign began, a "How to Help" page and letter writing campaign promoted community involvement. Added with the help of UO media services, a virtual “Virage” presentation allows individuals to view the educational presentation from their computers. With help from energy tour promotion (including Oregon Daily Emerald article and mass e-mails), a link from the Service Learning Program home page, and promotion during PowerPoint presentations, the website received **379 hits** as of May 31, 2004.

Conclusion

Judging purely by the numbers reached, the education and outreach campaign appear **successful**. However, numbers alone do not indicate true project success. The presentation itself stimulated different responses from each class, often depending both on the subject of the course and the motivation or interest of the professor. Often, when the professor expressed interest in the project and encouraged questions, the class appeared more attentive. Time constraints also limited the availability of a question and answer period, detracting from the presentation. In addition, it is difficult to gauge the success of the website and energy tour. Consequently, a determination of the effectiveness of the campaign requires **further analysis**.

Survey Results

Goals

A phone survey not only measured the effectiveness of our education and outreach campaign, but also provided general information about students. By conducting surveys both before and after participants had seen the education presentation, we determined changes in energy knowledge, conservation attitudes, and behaviors. By asking demographic questions we analyzed other trends among the student population. Gathering a **statistically significant** number required us to survey 354 people both before and after viewing the presentation.

Methodology

We created twenty-four survey questions which were then approved by the University's Human Subjects Review. The first question addressed how many times the participant had seen the presentation, while subsequent questions dealt with individual knowledge, values, and behaviors regarding energy issues. The remaining questions functioned to provide basic demographic information about the individual surveyed. For survey questions and script, see appendix G.

After acquiring phone lists for scheduled classes, calls were made both before and after the scheduled presentation. We used the same lists to call students both before and after the presentation, so some respondents were surveyed twice. Complications included missing or wrong numbers and unavailability. Given these unexpected obstacles and our limited personnel, we reduced our goal from 354 surveys to 200 surveys both before and after the presentation. Although we reduced number of surveys performed, 200 surveys still provided us with a **93% confidence interval**. All data was entered into File Maker Pro, which allows for easy data analysis.

Results and Discussion

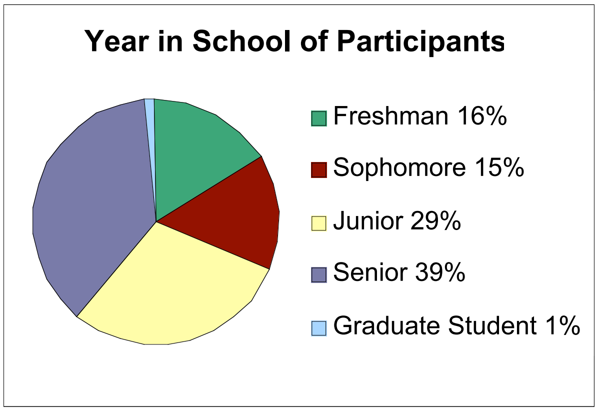
After completing the survey, we recorded and analyzed responses. We completed a total of 412 surveys – 217 before the presentation and 195 after the presentation – both figures close to our revised goal of 200. The survey analysis focused on four categories: demographics, knowledge, behaviors, and attitudes. Using the demographic information gathered, we analyzed other trends in order to better understand the campus community and develop recommendations for the future.

412 surveys were completed; 217 before and 195 after the presentation.

Demographics

We gathered Demographic information such as gender, age, housing, and financial responsibilities. Of the total surveyed, 56.3% were female and 43.7% were male. This is slightly different than the University average of 53% female and 47% male. The median age of participants was 21, whereas the average age at the University is 22. Along with age, we also considered year in school.

Graph 9



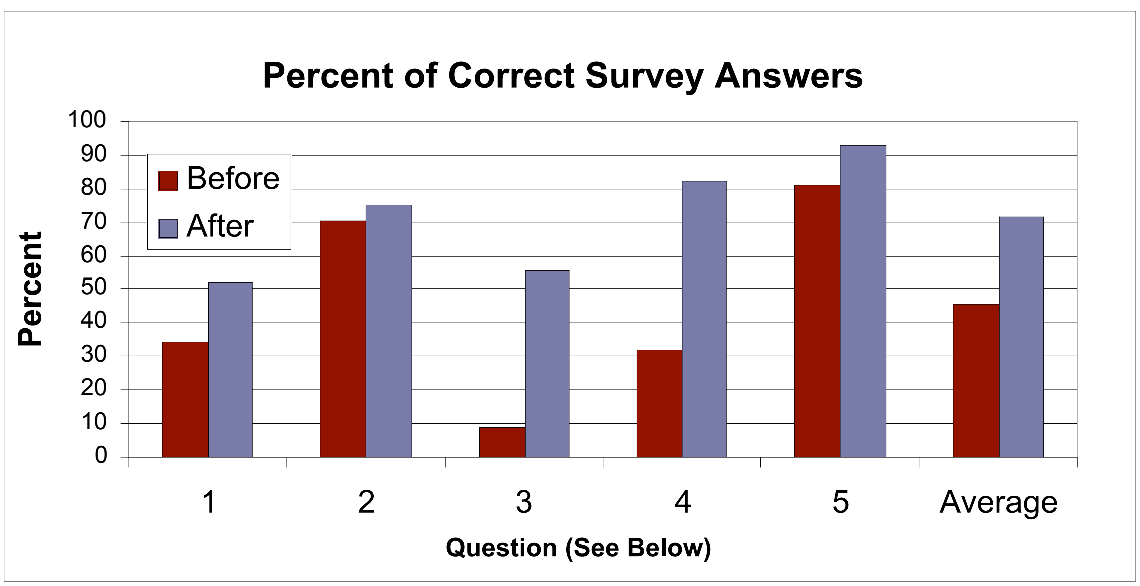
Graph 9 displays the year in school of all survey participants. The majority were upper-class, undergraduate students. The demographics of those we surveyed are related to the makeup of classes that allowed us to give the presentation.

The remainder of the survey demographic results are available in appendix G.

Knowledge

The first section of the survey consisted of questions regarding knowledge of energy use. Each of these questions addressed information presented in the **education presentation**. Comparing the responses of participants both before and after seeing the presentation provides a measurement of the change in knowledge.

Graph 10



Questions:

1. Does the majority of US electricity come from nuclear, coal, hydroelectric sources? (Correct Answer: Coal)

2. Does the majority of the University of Oregon's electricity come from nuclear, coal, or hydroelectric sources? (Correct Answer: Hydroelectric)
3. Has the University of Oregon's per capita electricity use increased, decreased, or stayed the same over the last decade? (Correct Answer: Decreased)
4. What forms of alternative energy has the U of O invested in: none, wind, solar, or both wind and solar power? (Correct Answer: Both)
5. Does it damage a computer to turn it off and on for the purpose of saving energy? (Correct Answer: No)

Graph 10 displays the results of those answering correctly both before and after the presentation for five of the knowledge questions. For all of the questions, more participants knew the correct answer after seeing the education presentation. The average correct responses increased by 25.8% - from 45.7% before to 71.5 % after. This was the **largest percentage increase** of any of the survey categories.

Questions 1 and 5 displayed only slight improvements. These questions related to general energy information participants could have obtained from numerous sources. Thus, our presentation would be influenced by what participants already knew. The questions with the most **significant improvements** – three and four – related specifically to information about the University of Oregon. It is likely that our presentation had been the only source of this information, allowing for a greater increase in correct responses.

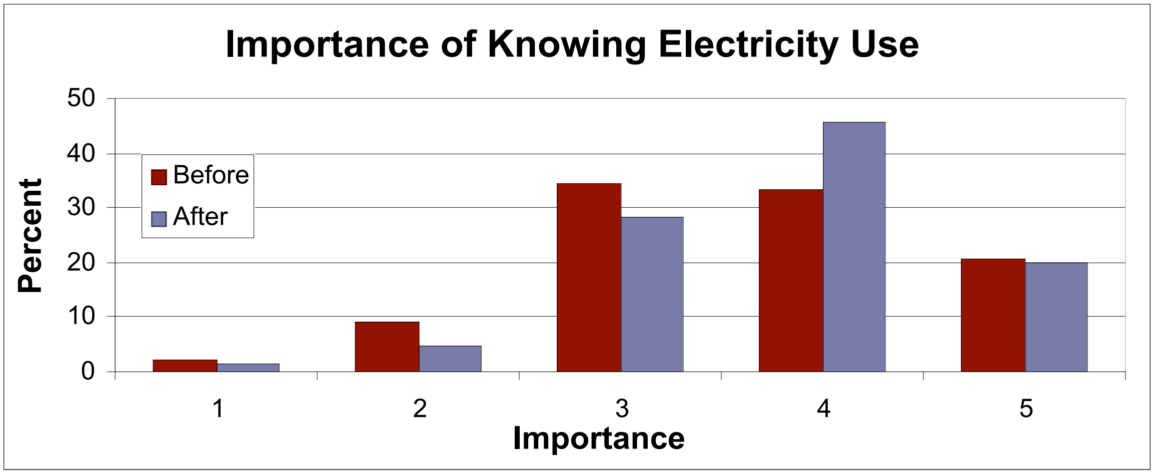
Attitudes

The next series of questions related to the participants' attitude regarding energy consumption. One attitude question asked where the participant was more energy conscious: at home, at the university, or about the same. As predicted, most people were **more energy conscious at home** rather than at the University both before and after the survey, 72.8% versus 70.8%, respectively. Surprisingly, fewer participants were more energy conscious at the University rather than at home after the presentation, 9.7% before as compared to 2.6% after. However, there was an increase in those who were equally energy conscious. Before the presentation, only 17.5% answered they had the same consciousness at home and at the University, whereas after, 26.7% said they had the same level of energy consciousness in both places. These figures suggest that the presentation increased awareness at home for those who previously were most conscious at the University.

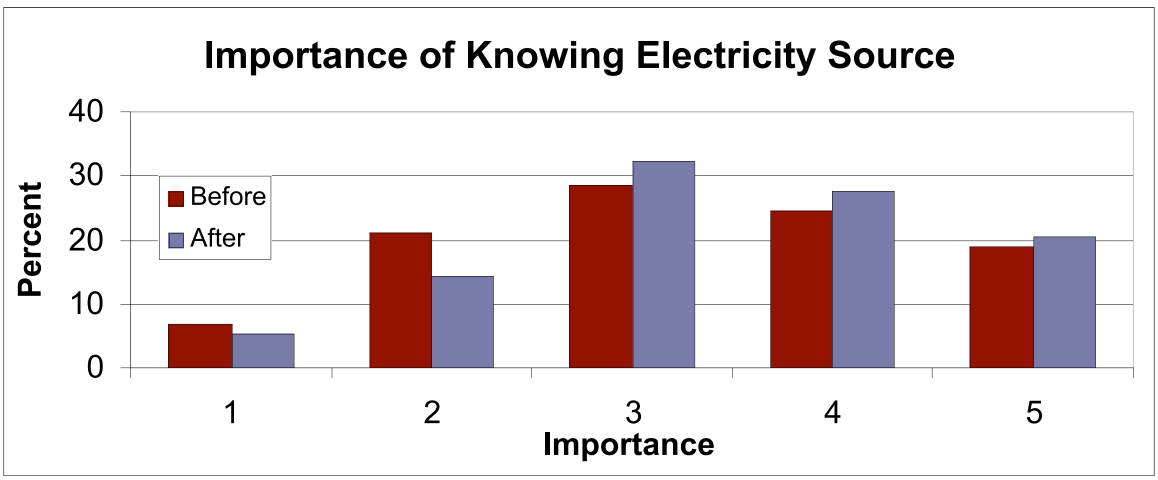
Two other questions that relate to attitudes about energy are displayed in graphs 11 and 12. These graphs address the **personal value** placed on knowing one's level of electricity use and source of that electricity.

Each question displayed similar results: the overall importance of knowing the amount and source of electricity increased slightly. In graph three, the average response increased from 3.61 to 3.78. This change has a 94.3% confidence interval and is marginally significant. The average response also increased in graph four, from 3.27 to 3.44. Given the distribution of responses, this change only has an 88.8% confidence interval and therefore is not a significant difference. In general, the participants felt it was more important to know how much electricity they used, rather than the source of that electricity.

Graph 11



Graph 12



Behaviors

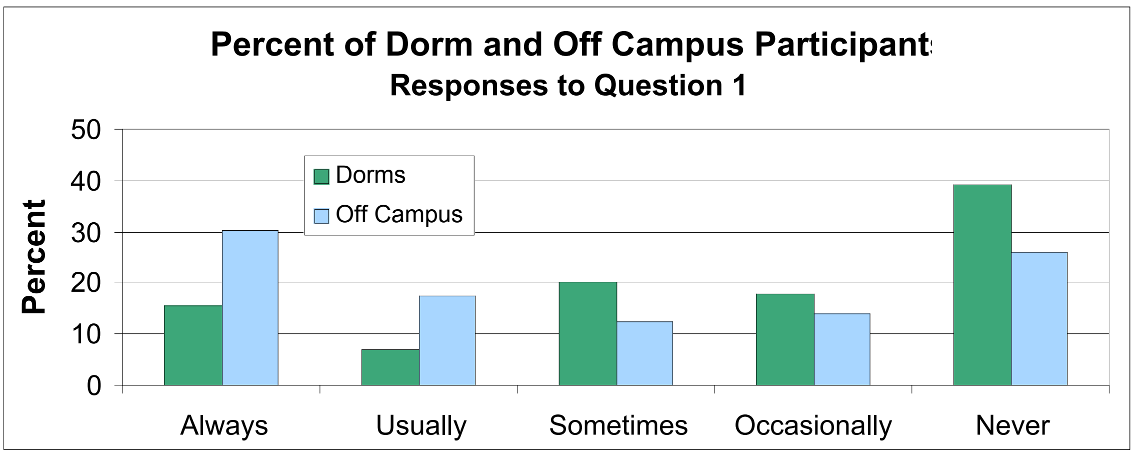
The next series of questions related to participants' behaviors. In general, these changed very little. For example, one question asked participants if they were more likely to turn up the heat or put on warmer clothing if they were cold. The majority of those surveyed before the presentation answered clothing (80.2%). This number only increased to 82.5% after. The presentation seems to have had minimal immediate effect on that behavior. However, the survey took place in May, beyond the point when most people are either turning up their heat or putting on warmer clothing, so it could be that respondents were referencing past behavior.

Three questions considered the frequency of behaviors, specifically how often participants turn off lights, turn the heat down, and turn off a computer. The majority of participants answered on the extremes; always or never. Overall, the behaviors changed very little between before and after results. In some cases, such as turning lights off when leaving a room, we were surprised to find that less people did so after: 40.1% compared to 51.6% before. The question that displayed the most positive results related to turning off a computer more often. The responses for "always" increased from 24.9% to 29.7%. The minimal behavioral changes could be the result of the difficulty of measuring and influencing such changes. Compared to knowledge or attitudes, behaviors proved the hardest category to affect with just a 10-minute presentation.

Trends

Analyzing basic demographic information, other **trends emerged**. We are interested in continuing presentations in the future. Therefore, we analyzed which groups showed the most potential for benefiting from the presentation. We compared results for those living off campus versus those living in dorms. Graph 13 compares these two categories for the behavioral question that demonstrated our intended outcome: turning off a computer.

Graph 13



Question:

1. Do you turn off a computer (not including sleep mode) when you won't be using it for more than 30 minutes?

This graph clearly displays that those who live in dorms are more likely to leave computers on continuously. A possible reason for this may be that they are **not directly responsible** for paying a utility bill. These results suggest that students living in dorms could benefit more from the presentation than those off campus who are already more likely to conserve energy, at least in this specific manner. Although frequency of turning off a computer is correlated with where the participant lives, other influential factors could include age, knowledge, or financial responsibilities.

Conclusion

Overall, the survey demonstrated that aspects of the education presentation were **successful**. Some areas, including knowledge and attitudes, displayed notable changes. Self reported behaviors, however, revealed minimal changes. One reason for this is that knowledge and attitudes may be more easily altered than behaviors, which are habitual and difficult to change despite new knowledge. In addition, the presentation focused primarily on sharing knowledge, while suggestions for energy saving behavioral changes featured a less prominent role. Given there was less new information provided for behaviors, it would be expected that fewer behavioral changes would result.

Comparing off-campus to dormitory residents strengthens our recommendation for a continuation of the education campaign. According to the on-campus responses, it is precisely these new students that could benefit the most from the presentation. This is also a prime target group because their time at the University of Oregon is just beginning, allowing for years of future conservation.

Wind Power Campaign

Goals

The central goal of the wind power campaign is to displace environmentally detrimental energy sources used by the University by **purchasing renewable wind energy** for campus. Although conservation is a priority, purchasing wind power not only offsets the impact of current sources, but also provides an example for the rest of the community.

If the entire campus purchased 10% wind energy, the extra charge would be $6,300 a month – costing each student approximately $4 a year. Although this cost is minimal, we propose starting by converting the **Erb Memorial Union**, which consumed 2.3 million kWh in 2003, to 100% wind power. This purchase would cost an extra $3,200 a month, or $38,400 a year. At current enrollment, that would be an additional $1.98 per student for the entire year. The EMU is a good candidate for alternative energy because it is a huge consumer, representing about 5% of the total University of Oregon electric use. In addition, it is a prominent building in the center of campus and is the most widely used student building at the University.

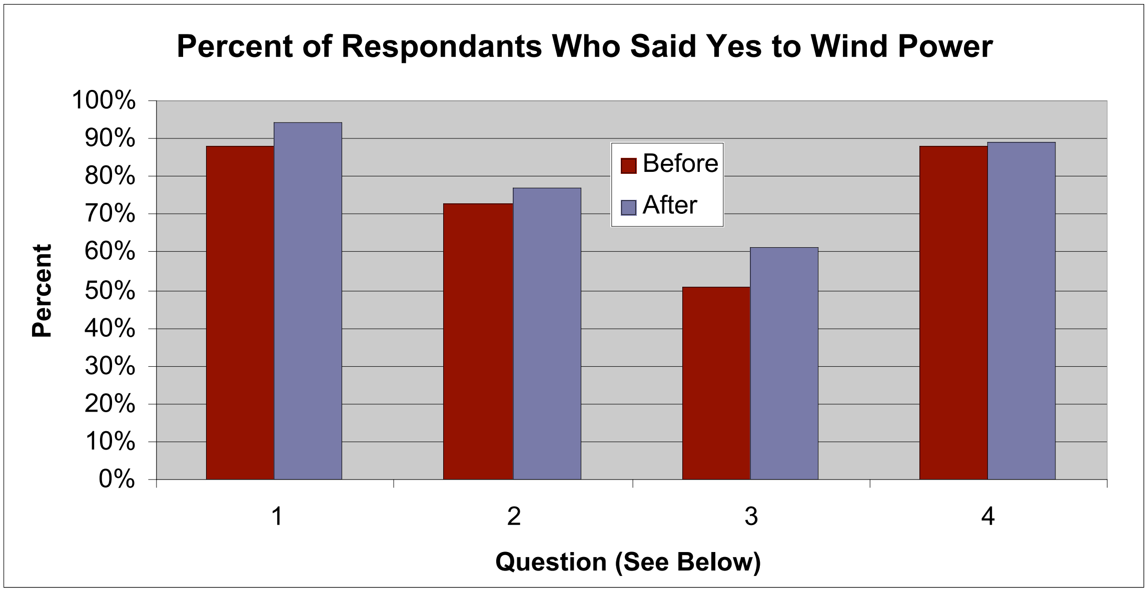
Methodology

To accomplish this objective, the EMU board must first choose to include wind power as part of the EMU budget and then ask the Associated Students of the University of Oregon (ASUO) Senate to pass this budget with an increase in student fees to support the extra cost. On May 26, 2004, we presented our proposal to the ASUO Senate. We will give additional presentations to the EMU board and the ASUO Senate a second time, during the 2004/2005 academic year when the 2005/2006 budget is up for consideration.

Discussion

Survey results, displayed in graph 14, demonstrate that wind power is highly supported on campus. 88% of those questioned before the presentation supported the idea of wind power on campus, while 94% supported it after the presentation. Of those who took the survey before seeing the presentation, 73% supported this idea even if it would cost more, while 51% supported raising student fees to cover that cost. Of those who took the survey after seeing the presentation, 77.4% supported the idea at an extra cost, while 61% agreed to raise student fees. Of those who disagreed with an increase in student fees, 88% before and 89% after supported the idea if the increase were less than $5 a year.

Graph 14



Questions:

1. Should the University invest in wind energy?
2. Even if it cost more?
3. Even if student fees were raised to support the cost?
4. (If disagreed with raising student fees) If student fees were increased less than 5 dollars a year?

Conclusion

The University community strongly **supports** wind power on campus, and many are willing to pay for it through their student fees. The EMU is a good option for this purchase because of its high use and prominent position on campus. The Campus Energy Team suggests that the EMU purchase **100% renewable wind energy** from EWEB by the 2005/2006 school year. Members of the energy team and others will work next year to get this passed.

Discussion

Recommendations

After reviewing the successes and limitations of the Campus Energy Project, we give four recommendations for **future improvements**: continuation of research and education; the implementation of wind power on campus; and persistent conservation measure investments.

Research

Continuing to research alternative energy sources available to our community such as wind, solar, and geothermal should be a priority. Energy production is a dynamic process and it is imperative to **stay current** on available technologies in the Pacific Northwest. This is essential for keeping the educational presentation up to date, as well as encouraging the University to invest wisely.

Continuing Education

Continuing an educational awareness campaign that focuses on campus energy issues is a fundamental step in reducing the University's ecological footprint. Educating **incoming students** is of particular importance, as our survey results show that dorm students' attitudes and behaviors towards energy use were less conscientious than their off-campus peers. We specifically recommend giving a similar PowerPoint presentation at incoming student and introductory dorm meetings – informing new students of the issues early on. The Virage presentation could also be included on the Duckware software to reach new members of the campus community. This presentation could suggest ways for students to conserve energy, including: turning off computers, turning off lights in common areas when not in use, and turning down heat rather than opening windows. While our survey results displayed a minimal impact on conservation behaviors, we feel that persistence in continuing education will help in this area.

Wind Power

We advocate the **purchase of 100% wind power** for the Erb Memorial Union. The majority of students surveyed supported purchasing wind power by increasing student fees. For this reason, as well as those outlined in the wind campaign section of this report (see page 28), we recommend a 100% wind energy purchase for this building by the 2005/2006 academic year by raising student fees. We further recommend that the University consider matching the student purchase by investing in more wind power in the future. We hope that the purchase of wind power for the EMU will just be the beginning.

Conservation

Although we recognize the importance of alternative energy sources, continuing to promote basic **conservation practices** both through physical applications and human effort is the most important suggestion we propose. Reducing energy use decreases environmental degradation and reduces energy costs, an important issue considering the size of the University.

Continuing an educational campaign will help to promote conservation practices.

Conclusion

Over the course of this academic year, the Campus Energy Team worked to compile an **informational overview** of campus energy issues. After assembling relevant data into an educational campaign, we worked at informing the University community about these topics. Although our goal of reaching 25% of the campus population was not met, we feel that by reaching over 4,000 people we have succeeded in educating a substantial portion of the community. Survey results support this claim. While answers to the survey questions show that behaviors did not change significantly, attitudes and knowledge about energy issues did. Thus, a **general awareness** of campus energy use has been created in those reached by this campaign; which may lead to more mindful behaviors in the future.

In addition, we feel that this year's project successfully paves the way for **future improvements** in campus energy conservation and alternative energies. Although wind power will not be on campus in the next academic year, significant steps have been taken for our recommendation to be implemented in the 2005/2006 academic year. In addition, the data that we compiled provides a wealth of information for **future projects** on campus, including a possible continuation of similar educational campaigns.

The information presented in this report is essential knowledge that should be continuously updated in an effort to reconnect students and staff with issues facing our environment as a result of the University's energy consumption. Our ecological footprint is a function of our attitudes and knowledge on how to use wisely and conserve whenever possible.

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