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Moving Towards a Sustainable Energy Future at Portland State University



Recommendations for a Campus Sustainable Energy Policy and Management Plan

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Recommendations for a Campus Sustainable Energy Policy & Management Plan

I. Introduction

The campus environmental stewardship movement has grown considerably over the last decade, establishing roots in both operational and academic aspects of university life. Indeed, universities and colleges around the world are recognizing the inherent responsibility of higher education in increasing awareness, knowledge, and technologies that support an environmentally sustainable future. Though approaches to “greening” higher education vary, most prescribe academic and curriculum changes to incorporate sustainability and improvements in campus operations and facilities.

The time is ripe for Portland State University (PSU) to embrace sustainability and rethink all aspects of its planning and operations. This proposal concentrates on energy practices on campus, and offers recommendations for a sustainable energy policy and management plan.

While it is energy-specific, the broader intention is to lay a foundation for sustainability policies and plans in other aspects of campus operations, such as water, landscaping, and purchasing, and to stimulate integrated, long-range, sustainable campus planning.

"Colleges and universities are vested by society to ... impart moral vision and technical knowledge needed to ensure a high quality of life for future generations."

-- Richard M. Clugston, Executive Director, University Leaders for a Sustainable Future

In its shift towards sustainability, energy is a sensible place for the University to begin for a few basic reasons. First, University expenditures on energy utility bills are considerable – over \$3 million in fiscal year (FY) 2002-03, or nearly 30% of the Facilities & Planning budget¹. Second, energy production and consumption impose serious environmental consequences, including air pollution and global climate change. Third, there are numerous opportunities for the University to implement easy energy savings measures to reduce energy use and quickly benefit from cost savings. And, lastly, the uncertainty over the future energy market – energy supply and prices – makes the University extremely vulnerable to market irregularities.

In all, it is through a sustainable energy strategy that the University can better protect itself from unpredictable market fluctuations, while also demonstrating its recognition of the importance to increase energy security, reduce environmental threats, protect public health, and enhance educational opportunities.

In many cases, an "energy strategy" means identifying and implementing sensible energy conservation measures. Here, however, the definition broadens to the development of a comprehensive energy policy that integrates supply, demand, facility operations, campus outreach, implementation, and financing opportunities. While ambitious, this proposal is not unprecedented. A growing number of universities around the United States are developing

¹ Facilities & Planning FY 2003-03 budget totaled \$11,375,608.

such policies in effort to control energy consumption and commit to cleaner, alternative energy practices.

It is through a sustainable energy strategy PSU can better protect itself from unpredictable market fluctuations, while also demonstrating its recognition of the importance to increase energy security, reduce environmental threats, protect public health, and enhance educational opportunities.

II. Context

A. Sustainability Defined

In the 1980s, increasing concern about the effects of economic development on health, natural resources and the environment led the United Nations to publish "Our Common Future," a.k.a. The Brundtland Report. It was in this report that the term 'sustainability' was first popularized and defined as "meeting the needs of the present without compromising the ability of future generations to meet their needs" (UN, 1987). The report highlighted three fundamental pillars, or the "three E's," of sustainability: environmental protection, economic growth, and social equity.

Today, there are numerous definitions and interpretations of sustainability, but these two principles – intergenerational equity and the three E's – are still widely acknowledged. In the context of planning and the role of educational institutions, we can consider "what (we) can do differently and better to ensure intergenerational success and well-being" (Kirk, 2003).

Sustainability is ... "using, developing and protecting resources at a rate and in a manner that enables people to meet their current needs and also provides that future generations can meet their own needs ... It requires simultaneously meeting environmental, economic and community needs."
--Governor Kitzhaber, Executive Order EO-00-07, May 2000

What then does this mean for energy management on campuses? An energy strategy lies at the core of sustainability, as changing how we satisfy our energy needs can help increase resource efficiency, minimize unnecessary waste, and greatly reduce the adverse environmental impacts of energy production (Beatley, 2000). In this proposal, a "sustainable energy campus" is one that adheres to the following five principles:

1. Reduction of energy consumption
2. Reduction of sources of energy waste
3. Reduction of pollution from energy production
4. Minimization of life-cycle costs
5. Creation of healthy campus environments (BuildingGreen, 2001)

B. Sustainable Energy Planning

Urban areas require tremendous amounts of energy to support their populations and, as a consequence, are confronted with many of the associated impacts, including rising demand for energy, energy price volatility, an overextended distribution system, and consequent air pollution from burning fossil fuels. Sound energy planning can prevent or mitigate these outcomes and, as an urban university, PSU faces exceptional opportunities – and challenges

– in demonstrating how the energy system can be improved to facilitate urban sustainability.

Campuses are complex systems, requiring vast amounts of resources, generating significant quantities of waste, managing building renovations, new building construction, and a complex utility infrastructure, and bearing large financial risks and investments. It is for this reason that, in terms of operational needs, campuses are often likened to cities (Kirk, 2003). Indeed, land use, transportation, landscape design, storm water runoff, energy use, waste reduction, and facilities maintenance are all aspects of campus life and infrastructure – and aspects that can be made more sustainable, efficient, and cost-effective through better planning (Rappaport, 2003).

Today in the city of Portland several factors are converging which may affect the nature of energy planning in the future. Among these factors are:

1. Electric Utility Restructuring in Oregon
2. Future Ownership of Portland General Electric
3. Changes in the Energy Industry
4. Increasing Energy Demand

*"By considering energy in urban planning, city planners can improve the quality of life in their cities while providing significant dollar savings to city governments, citizens, and the business community."
-- Portland Energy Policy, 1990*

Each of these factors is briefly discussed below.

Electric Utility Restructuring in Oregon

Passage of Oregon's 1999 Electricity Restructuring Law (Senate Bill 1149) was the culmination of years of negotiation and compromise among policymakers, utilities, industrial and commercial interests, and consumer, environmental and public health organizations. Still relatively new, the legislation is being closely watched by the industry and is still considered somewhat experimental. Principally, the legislation: (1) began phasing in open competition for industrial and commercial customers, (2) required disclosure of fuel sources, emissions and prices, and (3) created a "public purpose fund," with dollars specifically set aside for energy conservation and renewable energy development (OPUC, 2003).

To many, the "public purpose fund" was one of the most important, innovative components of the bill, as it now provides tens of millions of dollars for energy conservation and renewable energy projects to governments, businesses, residents, schools districts, and universities. The fund is supported by a 3% public purpose charge that is added to the electric utility rates of the state's two largest utilities, Portland General Electric and PacifiCorp, and is administered by The Energy Trust of Oregon.

Through electric utility bills, PSU contributes nearly \$80,000 per year to the State's public purpose fund. This money in turn is available to the University for energy efficiency and renewable energy projects.

Through its monthly electric utility bills, PSU contributes to this fund (approximately \$80,000 in FY 2002-03) and can – and should – take full advantage of the dollars available for campus energy efficiency and renewable energy projects.

Future Ownership of Portland General Electric

Portland General Electric (PGE), PSU's electric utility, is the largest remaining asset of the Enron Corporation. In its bankrupt state, Enron is auctioning off its assets in hopes to

return – at least some – money to its creditors. Still today, it is uncertain who will buy PGE and when, or how such a sale will affect current customers, the utility, or the region.

At the heart of this conundrum is the public versus private power debate. Because of the Enron debacle – and the vulnerability of PGE customers – many in the region are strongly advocating for a locally owned utility. City of Portland officials agree and are in negotiation to purchase the utility. Of course, it will be the highest bidder, from anywhere or with whatever interests, who will gain control of utility and so far Enron has rejected bids submitted by the City (City of Portland, 2003).

To further complicate the situation, a recent court decision in California allows utilities to be broken up for sale in order to generate more revenue. The sale of PGE in pieces could pose problems for regional ratepayers (City of Portland, 2003). Of course, the uncertainty of the situation does have implications for the University, as utility agreements and rates will likely change (could increase or decrease) with a change of ownership.

Changes in the Energy Industry

Today, electricity generation in the United States is largely characterized by central, thermal power plants and an extensive transmission grid that carries electricity great distances – within and across regions. Arguably, this system has served energy producers and consumers very well; today, electricity generates more than \$220 billion of U.S. sales per year, access to the grid is nearly universal, and consumers enjoy relatively low-priced, reliable power (EIA, 2003).

There are deep concerns, however, about how the existing power system – and the associated dependence on fossil fuels – will be able to meet future energy needs. The U.S. Energy Information Administration estimates that national power demand will increase by 43% in the next 20 years (EIA, 2003). This rapidly growing demand, coupled with an already strained power system, brings rise to a burgeoning paradigm of decentralized power production and new small-scale, on-site energy technologies, or “distributed generation.”

As a broad definition, distributed generation applies small generating units at or near consumer sites to meet specific customer needs, to supplement the existing power grid, or both (FETC, 1999). Current technologies that are utilized in such ways include: small-scale combustion engines, microturbines, fuel cells, reciprocating engines, stirling engines, and photovoltaics. To many, these distributed energy technologies represent the “next generation” of power resources, as they can be applied in many different manners, including stand alone electricity generation, standby power, and combined heat and power (CHP) (FETC, 1999). These technologies and applications are discussed further in Section V, page 29.

“Profound changes in the U.S. production of heat and power are underway ... the 80-year paradigm of centrally generating most electric power is yielding to a hybrid system that locate new electric generations plants near users.”
--World Alliance for Distributed Energy, 2001

To illustrate the wide range of benefits inherent to distributed generation, Table 1 lists some commonly cited problems with our current, centralized power system, as well as the general benefits of a more decentralized, distributed system.

Centralized Power System (problems)	Distributed Power System (benefits)
<ul style="list-style-type: none"> • transmission failure and losses • failure to recycle heat • over-dependence on fossil fuels • low power reliability and quality • vulnerability • pollution 	<ul style="list-style-type: none"> • lower capital costs • greater efficiency • fuel flexibility • greater reliability and quality • less vulnerability • less pollution

Source: California Energy Commission, 2002

Indeed, there is a great deal of evidence pointing towards the superiority of a distributed power system over the centralized system we operate today and, in many ways, the benefits of distributed generation pertain to all three pillars of sustainability. To illustrate this, a specific example is given below for each element:

- *Environmental:* A distributed power system utilizes technologies that are considerably more efficient and therefore use less fuel to generate the same output. Also, nonpolluting, renewable technologies – such as solar photovoltaics and small-scale wind – are considered distributed generation resources.
- *Economic:* Volatile fuel prices represent a financial risk and many distributed generation technologies use fuels more efficiently, are adept at using a variety of fuels, or don't use fuels at all (Lovins, 2003).
- *Social:* Small-scale, local power generation provides community benefits, as energy reliability, quality, and security are improved. Further, local "control" over energy resources enhances energy awareness and understanding of where power comes from and supports community-based planning and development.

Today, applications of distributed generation technologies are typically found at large energy consuming sites, such as industrial and commercial complexes, hospitals, colleges and universities. Undoubtedly, these entities will continue to play an important role in the development of distributed generation technologies and, for this reason, it is an imperative consideration for long-range urban and campus planning.

Increasing Energy Demand

Our society is becoming increasingly energy intensive and, as previously noted, energy demand is on the rise. This is a critical reality for urban areas and, especially for the University, as the campus footprint grows, enrollment increases, and requirements for computers and energy-driven teaching equipment (i.e., distance learning classrooms) increase.

Looking out to the near future, substantial additions to the PSU campus will be made via new construction projects, renovations of current buildings, and property or management acquisitions.

Upcoming additions include:

- Expansion of the Helen Gordon Child Development Center (August 2003)
- Stephen Epler Student Residence (August 2003)
- Native American Student and Community Center (September 2003)
- Building management responsibilities for West Hall and Ondine student housing complexes (September 2003)
- Broadway Housing (September 2004)
- College of Engineering and Computer Science (September 2005)

These additions alone will amount to nearly 750,000 square feet of additional occupied building space for Facilities & Planning to manage, an increase of about 15%.

C. Benefits of Sustainable Energy Measures

As a large energy consumer, the University plays an important role in the region's energy market and will inevitably influence future decision-making. It is for this reason that the University must understand, support, and effectively articulate the benefits of sustainable energy measures. Below, four broad benefits are briefly described. These include: long-term cost savings; risk management; clean, efficient energy generation; and educational and research value.

Long-term cost savings

There are two principal trends that must be regarded when considering long-term utility expenditures: (1) increasing energy costs and (2) decreasing costs for new, clean energy technologies. By investing in energy conservation measures throughout campus, the

The Oregon Office of Energy predicts that energy prices will increase over time at a rate of one to one-and-a-half percent above the rate of inflation. --OOE, www.energy.state.or.us

University can better safeguard itself from changes in energy prices. This is of particular concern as energy forecasters currently warn of great fluctuations in natural gas supply and pricing in the years to come (EIA, 2003). Also important to consider is the decline in the cost of alternative

energy resources. For example, the cost of solar photovoltaic technology has dropped 1,700% over the past 40 years, 50% over the past 10 years, and is predicted to continue downward into the near future (OOE, 2003).

Risk management

The last few years have been one of the most disruptive and unpredictable periods for energy supply and prices in recent memory. In many ways, the 2000-01 energy "crisis" underscored our vulnerability to market irregularities and the need to diversify our energy resources. As a result of the crisis, utility customers across the region were subjected to record increases in electricity rates; in FY 2001-02, PSU paid 34.4% more for electricity than it did the previous year, or an increase of approximately \$680,000.

These recent market instabilities, coupled with budgetary constraints in the state, provide strong reasoning for the University – and the region as a whole – to evaluate its energy operations and develop a long-term energy policy and management plan.

As a result of the 2000-01 energy "crisis" in the West, PSU faced an increase in electricity rates of 34.4%. This equaled an increase of approximately \$680,000 in utility costs between FY 2000-01 and 2001-02.

Clean, efficient energy generation

Burning fossil fuels is one of the most ecologically damaging human activities and, according to the Union of Concerned Scientists, electricity generation from fossil fuels is a primary cause of such environmental calamities as global climate change, acid rain, water and soil pollution, and smog (see Table 2). Measures to reduce energy consumption and support clean, renewable energy production can, of course, help to mitigate these impacts.

Table 2: Primary environmental impacts from burning fossil fuels for electricity generation	
<u>Emissions:</u>	<u>Primary impact:</u>
40% of Carbon dioxide	Global climate change
67% of Sulfur dioxide	Acid rain
33% of Mercury	Water and soil pollution
25% of Nitrous oxide	Smog
Source: Union of Concerned Scientists, www.ucsusa.org	

Educational and research value

Aside from the financial and environmental benefits, the University faces an extraordinary opportunity to claim leadership in campus sustainability and put PSU on the map as a clean energy leader. In addition, demonstrating new energy savings techniques and generation technologies can present new educational opportunities for faculty and students, and provide cutting-edge research material.

Also, as mentioned at the onset, universities and colleges carry a responsibility to champion sustainability values that support a high quality of life for future generations, and express them not just in lecture halls and laboratories, but also in its mission, policies, architecture, facilities and campus operations (Filho, 2000).

*"Campus operations must be an exemplary model of environmental practices in order to ensure that every student graduates with a stronger awareness of environmental issues."
--M. Calkins, "Eco-Friendly Campuses," 2002*

III. Sustainable Energy Policy

Central to PSU's pursuit of sustainability is a policy that translates the core sustainability concepts – intergenerational equity and the "three E's" – into practice. This task is no less daunting at the micro level (i.e., university) than it is at the macro level (i.e., country or state) (Filho, 2000). One approach is to develop a campus-wide sustainability policy articulating the University's purpose in and commitment to incorporating sustainability in academics and operations. Then, to supplement this "umbrella" sustainability policy, sub-policies and plans to make improvements in specific areas of sustainability can be developed (see box).

Potential areas for campus sustainability policies and management plans:

- Energy
- Waste
- Water
- Landscaping
- Transportation
- Purchasing
- Food Service

Thus, this proposal – directed towards energy practices – is meant to be the basis for one of many sustainability sub-policies with accompanying management plans, all integrated and connected to the overall sustainability policy.

The primary barrier to implementing sustainability at all levels – micro and macro – is that sustainability is often viewed as a peripheral concept, dispensable when leadership turns over or funding cuts occur. In actuality, however, sustainability must be treated as a core concept, requiring cultural and institutional changes.

These changes present challenges, as sustainability defies traditional short-term thinking and requires a long-term vision. To be effective then, a sustainability policy must consider this status quo and intentionally facilitate integrated, longer-term planning. Essential elements to consider include: top-level leadership; authority and accountability; clear, integrated goals; and involvement of the campus community. Each of these is briefly described below, specific to a campus sustainable energy policy.

The primary barrier to implementing sustainability at all levels – micro and macro – is that sustainability is often viewed as a peripheral concept, dispensable when leadership turns over or funding cuts occur. In actuality, however, sustainability must be treated as a core concept, requiring cultural and institutional changes.

Top-level leadership

To reach full potential, a campus energy program needs a clear commitment from campus leaders.

*"The jump from individual initiative to campus-wide policy ultimately involves an ethical commitment of senior administrators who formulate, or at least approve, policy."
--Ecodemia, 1995*

The University president, provosts, department directors, and financial officers can inspire the campus community by articulating support for sustainability and formally adopting policies and plans that support sustainability measures (Simpson, 2003).

Authority & accountability

Institutionalizing sustainable energy goals will help to heighten campus energy awareness and motivate facilities staff and managers to seek out – and act upon – energy savings opportunities. It is imperative to establish at the onset who manages day-to-day implementation of an energy management policy and plan and who is responsible for meeting the adopted goals.

*"Campuses with progressive energy programs usually have progressive managers skilled at encouraging creative employees."
-- Ecodemia, 1995*

Also, facilities staff who are in a position to spot energy waste or implement energy conservation should be empowered to identify energy savings opportunities – and rewarded for it. This expectation can be included in energy manager job descriptions and job performance evaluations (Simpson, 2003).

Clear, integrated goals

To be effective, a sustainable energy policy should identify clear, measurable energy goals. Also important is to make connections between these goals and the University mission statement or other goals that have already been articulated by the University.

Perhaps more important, and essential to the treatment of sustainability as a “core” concept, are the vast connections among the vital areas conveyed in a campus sustainability policy. For example, because of PSU’s distinctiveness as a

Essential to the treatment of sustainability as a “core” concept are the vast connections among the vital areas conveyed in a campus sustainability policy.

commuter university, explicit connections exist between campus energy use and transportation. Operating longer hours to accommodate a diverse university population, building operations and scheduling, energy consumption, and commuting behaviors are all affected. Traditionally treated separately, “core sustainability” would entail integration and coordination of each.

Involvement of the campus community

As mentioned, there are multiple purposes of pursuing sustainable energy measures; among them are cost savings, risk management, cleaner, more efficient energy use, and educational opportunities. For the University, the educational component is, of course, particularly important, and therefore the engagement of the campus community in a campus sustainable energy program is essential.

Simple energy conservation behaviors – such as turning off lights and computers when not in use – can go a long way, and a primary reason that the campus community must be informed of the University’s intentions and energy goals. Also, considering the role of PSU as a higher education institution, one can argue that kilowatt-hours saved lose meaning if the educational component is lost.

These policy elements are relatively intuitive, but how do they translate into sustainable energy practices? The remainder of this proposal sets out to try to answer this critical question. In addressing this, two important steps were undertaken: (1) gaining an understanding of the PSU campus and energy behaviors (Section IV) and (2) strategizing the implementation of a Sustainable Energy Policy (Section V).

IV. Portland State University Campus Assessment

In shaping a campus energy policy, it is imperative to understand the current energy infrastructure and practices. This section describes PSU and addresses such questions as: Where does PSU’s energy come from? How much energy does the University consume? How is energy being used? Where are the energy “hotspots” on campus? What are the ecological impacts of PSU’s energy consumption?

A. Campus Profile²

Portland State University was first known as the Vanport Extension Center, established along the Columbia River in 1946. In the 1950’s, the Center moved to downtown Portland and became Portland State College. The institution was granted university status in 1969, and today, PSU covers approximately 35 city blocks and encompasses nearly 46 acres of the University District in downtown Portland. A campus map can be found in Appendix A.

*"PSU's vision is to enhance recognition of the value of higher education by continually strengthening the metropolitan environment and utilizing that strength for its own growth toward standards of excellence ... It is the vision of a university that will set the standard for institutions located in an urban setting."
--PSU's Mission Statement, 1999*

² Source: PSU Facilities & Planning, 2003

PSU is a mixed-use campus, containing educational facilities, office space, parking, retail, food service, housing, and childcare. The campus contains 47 buildings ranging in age from the 108-year old historic Marston House to the Urban Center Building completed in 2000. The average age of all PSU campus buildings is 54 years, with the bulk of the buildings built during the expansion years of the 1960's. Building space on campus totals more than four million square feet, and buildings range in size from single-story wooden structures to the 15-story, concrete Ondine residence hall. For a complete listing of campus buildings, see Appendix B.

In fall term 2002, 19,698 regular students and 1,969 extended studies students attended classes at PSU, served by 2,400 faculty and staff. PSU is the largest university in Oregon, and represents over a quarter (27%) of the total enrollment in the Oregon University System (OUS, 2002). Over the past five years, student enrollment has increased an average of 4% annually, with a 9% increase in both the current year and year previous. This trend is anticipated to continue into the foreseeable future and PSU projects that student enrollment will reach 35,000 students by 2010.

Housing on the PSU campus accounts for 498,000 square feet of the building space on campus and is currently managed by College Housing Northwest, a nonprofit housing organization. There are currently 10 student housing buildings on campus, with an average age of 65 years. The 10 buildings currently contain 915 units, primarily apartment type, and house approximately 1,226 residents. Nearly half of these buildings, containing 17% of the residential units, are slated for demolition and replacement as funding becomes available. The Stephen Epler housing development will open in August 2003 provide an additional 130 units and house an estimated 161 residents and the Broadway housing complex, currently under construction will add 384 units in September 2004.

The campus currently contains 3,727 parking spaces dispersed among nine parking structures and seven surface lots. Ninety-three percent of the parking is currently structured, and comprises approximately 1 million square feet of campus buildings. The average PSU parking structure is 31 years old. This parking inventory includes the recent addition of 348 spaces through the expansion of Parking Structure 3 and 110 spaces added through recent building acquisitions.

PSU is distinct from typical universities in that it is primarily characterized as a commuter campus, accommodating a very diverse student population. This presents unique challenges for campus planning, especially in terms of transportation and parking, building scheduling, and energy use. Also, as mentioned, the campus' population and demand for facilities is rapidly increasing. The addition of computers, distance learning classrooms and offices, research requirements, continuous classroom loads, and hours of operation is taxing the already-taxed building systems, and, of course, will have a great impact on energy use and utility bills. Further, PSU, like many universities, is facing the challenge of meeting these growing needs and upgrading its stock of aging, inefficient buildings under very tight budgetary constraints.

PSU, like many universities, is facing the challenge of upgrading its stock of aging, inefficient buildings under very tight budgetary constraints.

B. Energy Infrastructure

A majority of the University facilities were built 30 to 35 years ago and many have not had major upgrades to the mechanical and electrical systems. The infrastructure of the University's power system includes: power plants, a distribution system (steam and chilled water tunnels, electrical, and plumbing), and independent building mechanical systems. The campus heating and cooling plants and the buildings they serve are below.

West Heating Plant:	Millar Library, Stott Center
East Heating Plant:	Cramer Hall, Extended Studies Building, Lincoln Hall, Neuberger Hall, School of Business & Education, Science 1, Science 2, Shattuck Hall, Smith Memorial Center, University Services Building
West Cooling Plant:	Science 1, Science 2
East Cooling Plant:	School of Business & Education, Cramer Hall, Lincoln Hall, Neuberger Hall, Smith Memorial Center, University Services Building



The "Tunnel" – PSU's underground energy distribution system



The West Heating Plant's Kawancee Boiler, installed 1972

C. Energy Supply & Demand

The utilities for the University are the responsibility of the Facilities & Planning office. The energy utilities include: electricity, natural gas, and fuel oil.

Electricity: Electricity is purchased from Portland General Electric (PGE). In FY 2001-02 and 2002-03, electricity consumption in kilowatt-hours (kWh) was nearly identical, 41,678,194 and 41,683,132 respectively. To put these figures into perspective, 41.7 million kWh of electricity is roughly enough to power 3,500 average homes in the Northwest³. PSU's current electrical rate is approximately \$0.067/kWh, meaning annual electric bills of about \$2.7 million.

³ An average home in the Northwest consumes 1,000-1,500 kWh per month (Oregon Office of Energy).

Natural gas: For heating purposes, the University generates its own steam from the combustion of natural gas at the following sites: East Heating Plant, West Heating Plant, Helen Gordon Child Development Center, East Hall, University Center Building, and the Urban Center. Natural gas is purchased from NW Natural at an approximate rate of \$0.67/therm. In 2002-03, PSU spent \$585,484 on natural gas and consumed 920,459 therms. This is enough to heat about 1,250 average Northwest homes⁴. Natural gas usage came down slightly from FY 2001-02 (-5.9%).

Fuel oil: Fuel oil is supplied as a back-up energy source for emergency generators in two buildings on campus: Cramer Hall and the University Honors Building. Fuel oil is used very infrequently at PSU; in FY 2002-03, only 935 gallons of fuel oil were purchased.

Table 3 below provides a summary of utility purchases for the last three fiscal years.

Table 3: Summary of utility purchases, 2000-03			
	Utility	Quantity Purchased	Total Costs
FY 2000-01			
Electricity	Portland General Electric	43.9 million kWh	\$1,974,043
Natural Gas	NW Natural	949,694	\$758,685
Fuel Oil	McCall Oil	9,497gallons ⁵	\$11,216
Total			\$2,743,944
FY 2001-02			
Electricity	Portland General Electric	41.7 million kWh	\$2,653,770
Natural Gas	NW Natural	977,823 therms	\$653,155
Fuel Oil	McCall Oil	1,636 gallons	\$1,708
Total			\$3,308,633
FY 2002-03			
Electricity	Portland General Electric	41.7 million kWh	\$2,797,654
Natural Gas	NW Natural	920,459 therms	\$585,484
Fuel Oil	McCall Oil	935 gallons	\$1,161
Total			\$3,384,299

Source: PSU Facilities & Planning, 2003

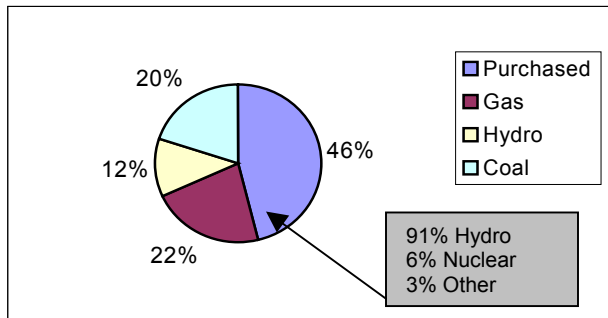
PSU consumes nearly 42 million kilowatt-hours in a single year. This is enough electricity to power 3,500 average homes in the Northwest. Annual natural gas consumption is just under one million therms, or enough to heat 1,250 homes.

⁴ According to NW Natural's 2001 Operating Statistics, the average residential customer used 738 therms (www.nwnatural.com).

⁵ During the 2000-01 energy "crisis," natural gas prices spiked and PSU switched over to fuel oil to run the boilers in Cramer Hall for a short period of time. It is for this reason that the fuel oil consumption is considerably higher in this fiscal year.

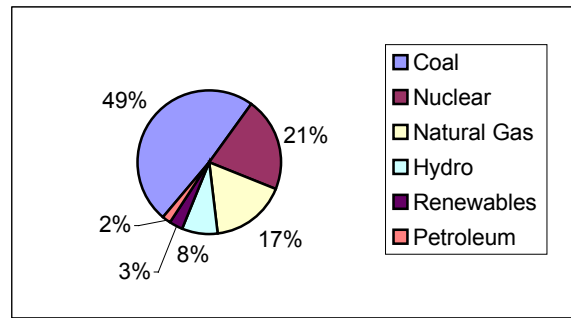
Figures 1 and 2 show the 2002 energy supply mix of PGE and the United States as a whole. In many ways, the Northwest is fortunate to have such a large supply of clean hydroelectric power generation – more than 50% of PGE’s mix is from hydropower, while only 20% is from high-polluting coal. In contrast, the national energy supply is dominated by coal (49%). In both cases, however, only a nominal percentage is generated by clean, renewable energy sources.

Figure 1:
Portland General Electric’s Energy Mix, 2002



Source: Portland General Electric, 2002

Figure 2:
Sources for Electricity Generation in the U.S.

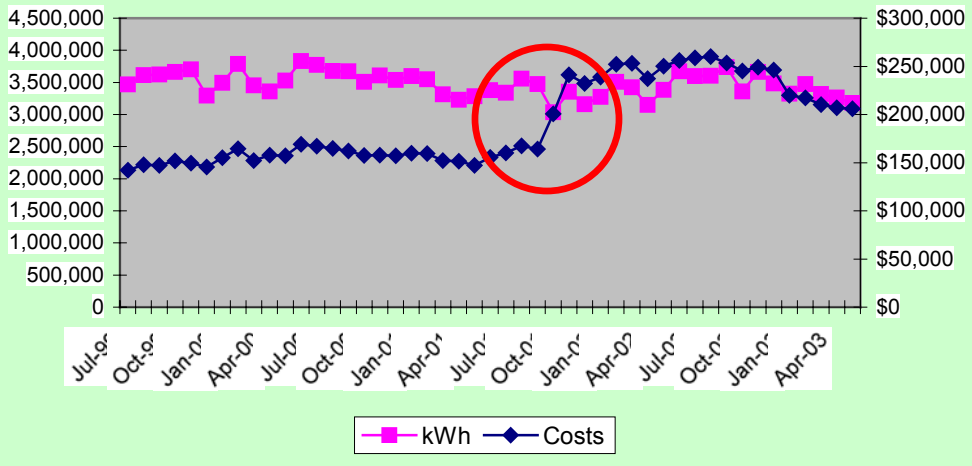


Source: D.O. E. Energy Information Administration, 2002

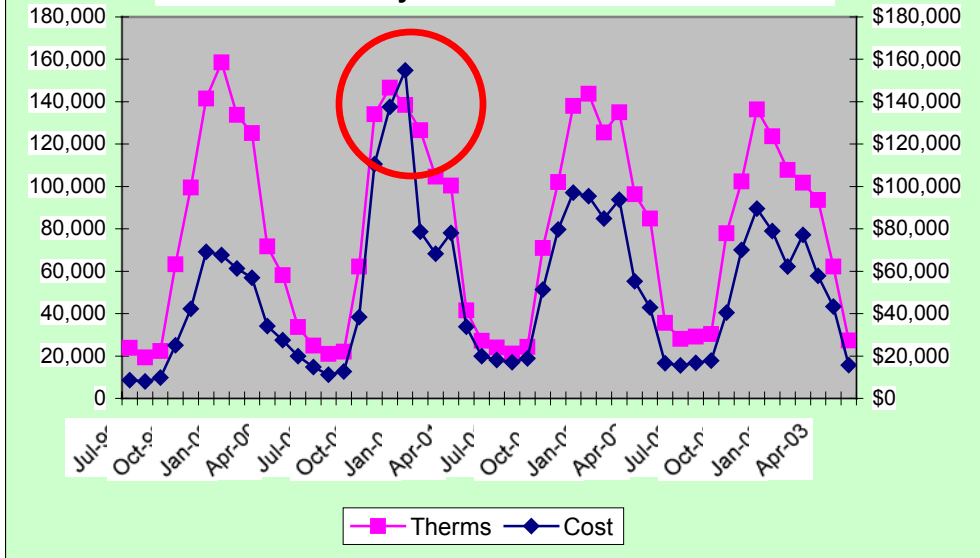
Figures 3 and 4 illustrate energy usage and costs since July 1999, first for electricity, then natural gas. Both figures highlight two important points. First, increasingly apparent are the implications of rate increases and the vulnerability of the University to such increases. In both graphs, sharp price spikes (circled in red) are starkly illustrated – in October 2001 for electricity and January 2001 for natural gas. These unpredictable increases pose a tremendous threat to the University. Secondly, the figures reveal that consumption of both electricity and natural gas have been relatively stable over the last few years, and, in recent months, has shown a slight downward trend.

Additional consumption and cost graphs can be found in Appendix C.

**Figure 3: Portland State University Electricity Usage and Costs
July 1999 - June 2003**



**Figure 4: Portland State University Natural Gas Usage
July 1999 - June 2003**



D. End-uses

End-uses, or how energy is used at its final stage, are important to understand when deciding where to direct energy savings measures. Surprisingly, however, current data on energy end-uses at PSU are limited. The most comprehensive data comes from the U.S. Energy Information Administration (EIA) "Commercial Buildings Energy Consumption Survey" (CBECS) database, which includes information on typical education facilities.

National data on energy use in education facilities indicate that the top three end-uses are space heating, water heating, and lighting, and together represent the vast majority (over 80%) of the energy consumed.

The CBECS database lists approximately 8.7 billion square feet of buildings in the U.S. with a principal activity of education, which includes elementary school, middle school, high school, college, university and vocation school academic space, but not recreational or dormitory space). In 1999, total energy consumed in educational buildings was estimated at 649 trillion BTU/year, or an average of 79.3 million BTU per square foot (mBTU/sqft). Of this energy, 40% was provided by electricity, 35% from natural gas, 7% from fuel oil, and 18% from district heating. In those educational facilities the sum of major fuel consumption is broken down by the following end-uses:

End-Use	Percent Share
Space Heating	41.4 %
Water Heating	21.8
Lighting	19.9
Cooling	6.0
Other	3.9
Ventilation	2.1
Cooking	1.8
Office Equipment	1.8
Refrigeration	1.3

Source: U.S. Energy Information Administration

These percentages are nationwide averages and are not available for education facilities by region; percentages, of course, will vary according to local climate. Still, however, it provides some insight into energy usage and where energy measures ought to be directed. From the CBECS data, we learn that the top three end-uses in education facilities are space heating, water heating, and lighting and represent the vast majority (over 80%) of the energy consumed.

E. Building BTU Analysis

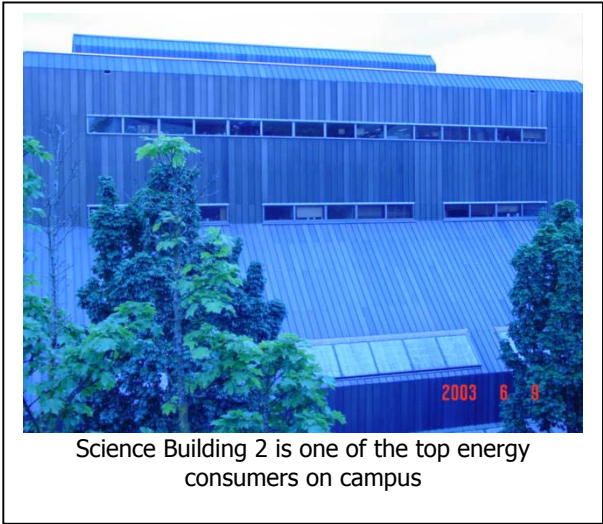
Critical to developing a campus-wide energy strategy is examining energy use by building and identifying the primary energy consumers on campus. For the purposes of this proposal, an initial analysis examined PSU buildings larger than 25,000 square feet and their individual electricity and natural gas consumption levels.

For a constant unit, kilowatt-hours and therms were converted to British Thermal Units (BTU)⁶ per square foot. In all, the analysis included 18 buildings, representing nearly 2.5 million square feet of space and found that, in 2001-02, the average mBTU per square foot was 91.3, or about 15% above the national average. Table 5 details these results.

The three buildings with the highest energy consumption per square foot (mBTU/sqft) are: Fourth Avenue Building (173.72), Science 2 (167.26), and Science 1 (147.64). These numbers, of course, are well above the national average, while the other 15 buildings' usage ranges from a low 52.01 mBTU/sqft to 95.41 mBTU/sqft. This analysis indicates that directing energy savings measures to the top three users could result in quick and fast payback.

*"Achieving success with the worst cases will yield the largest savings."
--Walter Simpson, 2003*

The three buildings on campus with the highest energy consumption per square foot are Fourth Avenue Building, Science Building 2, and Science Building 1.



⁶ BTU is a unit of energy consumed by or delivered to a building, and is defined as the amount of energy required to increase the temperature of 1 pound of water by 1 degree Fahrenheit (EIA, 2003). Building energy consumption is expressed in BTU to allow for consumption comparisons among fuels that are measured in different units (EIA, 2003).

Table 5: BTU Analysis: Energy consumption in campus buildings (>25,000 square feet), 2001-02

	Sq. Ft.	Electricity (KWH)	Gas (therms)	Annual mBTU	mBTU/ Sq Ft	% Share Total mBTU
Fourth Avenue Bldg	217,282	11,060,034	N/A	37,747,896.04	173.73	16.94%
Science Two	214,015	4,028,619	220,455.5	35,795,229.81	167.26	16.06%
Science One	91,608	2,057,060	65,046.2	13,525,369.21	147.64	6.07%
Library East	53,302	587,374	30,809.3	5,085,636.00	95.41	2.28%
Neuberger Hall	233,671	3,408,554	87,707.9	20,404,187.31	87.32	9.15%
Shattuck Hall & Computer Center	93,659	1,035,800	41,720.8	7,707,266.04	82.29	3.46%
University Center	87,771	1,691,444	13,000.9	7,072,988.37	80.58	3.17%
Peter W. Stott Center	223,335	1,585,123	120,780.2	17,488,040.94	78.30	7.85%
Smith Memorial Student Union	178,448	1,953,360	67,499.1	13,416,727.68	75.19	6.02%
Urban Center	147,306	1,665,400	50,408.9	10,724,900.20	72.81	4.81%
Extended Studies Bldg	30,000	234,928	13,274.7	2,129,283.43	70.98	0.96%
University Services Bldg	74,593	817,943	22,785.1	5,070,154.05	67.97	2.27%
School of Business & Education	101,099	1,238,400	25,601.3	6,786,787.95	67.13	3.04%
SEAS Annex/Materials Lab/5th Ave Cinema	64,767	333,800	30,000.0	4,139,259.40	63.91	1.86%
Millar Library	194,783	2,656,325	32,712.8	12,337,312.86	63.34	5.54%
Lincoln Hall	145,139	790,396	52,102.0	7,907,817.14	54.48	3.55%
Cramer Hall	241,573	950,398	95,208.3	12,764,542.75	52.84	5.73%
PCAT	53,465	814,680	N/A	2,780,502.84	52.01	1.25%
Totals	2,445,816	36,909,638	969,113.1	222,883,902.03	91.13	100.00%

F. Ecological Impact

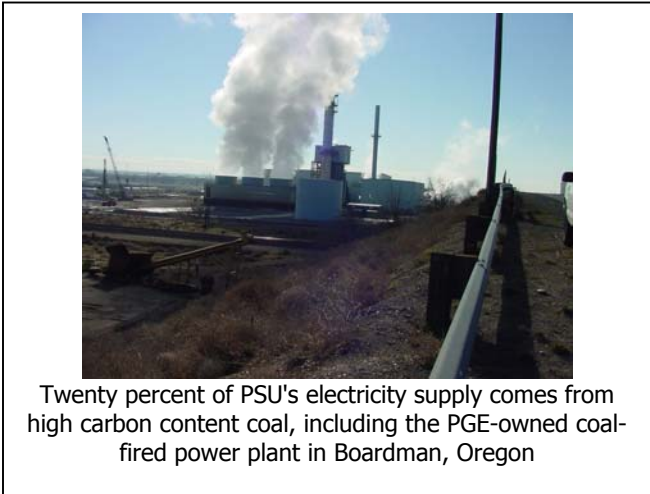
As mentioned earlier, burning fossil fuels – coal and natural gas – for electricity production results in the emission of carbon dioxide into the atmosphere, a primary cause of global climate change. There are differing perspectives on the effects of climate change, but there is a growing consensus around the world that we should act cautiously and curtail activities that exacerbate the problem. A 1999 study on the consequences of climate change in the Pacific Northwest warned of serious impacts on water resources and marine ecosystems, and consequently on human health (www.climatesolutions.org).

In FY 2002-03, PSU energy consumption resulted in the emission of nearly 70 million pounds of carbon dioxide into the atmosphere.

Therefore, it is appropriate for PSU to consider its carbon dioxide emissions from energy consumption as a primary indicator of its ecological impact. Table 6 shows that the carbon dioxide equivalent for the University’s electricity and natural gas consumption in 2002-03 was nearly 70 million pounds; or about 3,000 pounds per person on campus (students, faculty and staff). To further put these figures into perspective, 70 million pounds is the equivalent emissions of driving a car 138,266 miles⁷ - or nearly six times around the earth!⁸. Also, to offset these emissions, 2,765,325 new trees would need to be planted⁹.

Table 6: PSU CO₂ emissions from energy use, 2002-03	
41,683,132 kilowatt-hours ¹⁰	58,356,385 pounds
920,459 therms ¹¹	10,776,734 pounds
Total:	69,133,119 pounds of CO₂

A central goal of a campus sustainable energy policy is to minimize ecological impact by reducing reliance on fossil fuels for energy production and the consequent carbon dioxide emissions.



Twenty percent of PSU's electricity supply comes from high carbon content coal, including the PGE-owned coal-fired power plant in Boardman, Oregon

⁷ 1 gallon of gasoline = 20 pounds of CO₂, assumes a fuel efficiency of 25 miles per gallon (EPA)

⁸ The circumference of the Earth is ~24,000 miles (www.sciencenet.org)

⁹ Planting 1 young tree offsets 25 pounds of CO₂ per year (EPA)

¹⁰ 1 kilowatt-hour = 1.4 pounds of CO₂ (Northwest Power Planning Council)

¹¹ 1 therm = 11.708 pounds of CO₂ (DOE Energy Information Administration)

V. Policy Development and Implementation

To develop a sustainable energy policy for the campus, it will be necessary to *fully* understand PSU's campus infrastructure, energy practices, and impacts. Section IV provides an initial analysis, but the University will need to conduct thorough audits and assessments to effectively identify energy problems and solutions.

As mentioned in an earlier section, the primary objective of developing a sustainable energy policy is to articulate the University's commitment to sustainable energy goals and practices, and to provide the framework – or policy components – that will help facilitate the process. In crafting a campus energy policy, a few basic guiding questions ought to be considered, such as:

- 1) What purpose can a sustainable energy policy serve?
- 2) What can a policy achieve, which may not be achieved through present processes or structures?
- 3) Who should coordinate the policy and who should participate in the preparation process?
- 4) How will the policy be implemented? (Filho, 2000)

Effectively articulating the purpose at the onset is critical, as it will be the message delivered to campus energy managers and to the broader campus community. As an example, the overarching goal presented in Illinois State University's energy management policy is shown below:

"To improve energy practices in order to ensure maximum energy conservation, efficiency and reliability" (ISU, 2002).

PSU will need to develop its own central goal – or purpose – for campus policy, and then policy components that will help the University achieve that goal. This proposal suggests four sustainable energy policy components for PSU to consider, shown in the box below and detailed in the following subsections.

Suggested Sustainable Energy Policy Components:
A. Energy Aware Team
B. Sustainable Energy Management Plan
C. Green Standards
D. Sustainable Economics

A. Energy Aware Team

It is imperative that responsibility is taken for developing and implementing the energy policy and advocating sustainable energy operations. The vehicle for this could be a facilities energy committee, or an 'Energy Aware Team' (Simpson, 2003). Typically, such campus committees are comprised of facilities supervisors, temperature control/heating and cooling staff, electrical staff, maintenance staff, and mechanical staff, as well as faculty and student representatives (Simpson, 2003). Table 7 shows a sample ten-person PSU 'Energy Aware Team,' and the potential roles and responsibilities for each member.

Name	Title	Roles / Responsibilities
M. Irish	Director, Facilities & Planning	Energy Champion / Input
M. Crim	PSU Sustainability Coordinator	Sustainability Champion / Input
TBD		Team Leader / Management and coordination
TBD		Mechanical systems expert / Data collection and verification
TBD		Mechanical systems expert / Data collection and verification
TBD		Maintenance expert / Information and verification
TBD		Electrical systems expert / Data collection and verification
TBD		Faculty representative / Input and energy awareness campaign
TBD		Student representative / Input and energy awareness campaign
TBD		Student representative / Input and energy awareness campaign

Among the potential responsibilities for the Energy Aware Team is carrying out the remaining three suggested policy components (Sections B, C, and D below): (1) developing, monitoring, and updating a campus energy management plan; (2) setting energy and green building standards; and (3) proposing policy and economic analysis changes that facilitate, rather than hinder, sustainability-oriented decisions. These areas are introduced in the following three sub-sections.

B. Sustainable Energy Management Plan

While a policy can present a broad framework and set of principles to follow, an energy management plan can describe specific strategies and procedures to result in sustainable energy practices through energy efficiency, conservation, and incorporation of clean, renewable energy.

This proposal lays out four primary goal areas, with individual objectives and action items. These are recommendations for areas to be included in an energy management plan, but the final plan should not be limited to these. The proposed goal areas are:

- (1) Reduce energy consumption
- (2) Incorporate renewable energy
- (3) Demonstrate new energy technologies and applications
- (4) Effective measurement and communication

These goals and their action items are summarized on the following page and then discussed in some detail.

Summary of Goals and Action Items

Goal 1: Reduce energy consumption

Through energy savings measures, reduce the campus energy consumption per square foot by 10% by 2008 and 20% by 2013.

- 1.1 Identify and pursue energy efficiency opportunities
 - 1.1.1 Heating, Venting, and Cooling
 - 1.1.2 Lighting
 - 1.1.3 Building Envelope
 - 1.1.4 Water Heating
- 1.2 Ongoing maintenance
- 1.3 Conduct routine audits and assessments

Goal 2: Incorporate renewable energy

Procure 5% of campus electricity from renewable energy resources by 2008, and 10% by 2013.

- 2.1 Purchase "green power"
 - 2.1.1 Portland General Electric – Green Power
 - 2.1.2 Bonneville Environmental Foundation – Green Tags
- 2.2 Support solar photovoltaic installations on campus

Goal 3: Demonstrate new energy technologies and applications

Support the development of emerging energy technologies.

- 3.1 Employ Distributed Generation Technologies
 - 3.1.1 Combustion Turbine
 - 3.1.2 Reciprocating Engine
 - 3.1.3 Microturbines
 - 3.1.4 Stirling Engines
 - 3.1.5 Fuel Cells
 - 3.1.6 Photovoltaics

Goal 4: Effective measurement and communication

More effectively track and report energy data. Educate the campus community on energy use and conservation measures.

- 4.1 Improve energy data reporting
- 4.2 Track progress with energy indicators
- 4.3 Improve internal communication
 - 4.3.1 Facilities & Planning newsletter
 - 4.3.2 "Employee Awareness" educational efforts
- 4.4 Increase campus energy awareness
 - 4.4.1 Communicate with the campus community
 - 4.4.2 Energy Awareness Month
 - 4.4.3 Clean Energy Fair
 - 4.4.4 Develop a suggestion program for campus input

Goal 1: Reduce energy consumption

Through energy savings measures, reduce the campus energy consumption per square foot by 10% by 2008 and 20% by 2013.

As revealed in the BTU analysis of 18 primary buildings on campus (Table 4), average BTU usage in FY 2001-02 was 91.3 mBTU/square foot. In future energy analyses, this figure can be used as a baseline indicator to measure progress of energy savings measures – as long as the analysis only considers those buildings greater than 25,000 square feet.

Using the mBTU/square foot figure, the goal to reduce energy consumption by 10% by 2008 will bring the University close to the national average (82.17 mBTU/sqft/yr), while the more aggressive 20% goal will bring the University well below the national average (73.04 mBTU/sqft/yr). The energy consumption reduction goals are summarized in Table 8 below, and, in addition to mBTU, show kilowatt-hour and therm usage per square foot.

These reduction goals may seem aggressive; however, energy management plans for other universities set similar targets, and some with even greater goals. For instance, the State

	2001-02 (baseline)	2007-08 (10%)	2012-13 (20%)
mBTU/sq foot	91.3	82.17	73.04
kilowatt-hours/sq foot	15.09	13.59	12.08
therms/sq foot	.40	.36	.32

University of New York at Buffalo energy goal is to reduce campus consumption by 20% by 2010 and the University of British Columbia Energy Action Plan calls for reduction in energy

consumption of 30% by 2010. Still, meeting these targets will require serious commitment from the University, the Facilities & Planning office, and university administrators.

An important question to consider is how these goals translate into utility cost savings for the University. The question can be addressed by using the kilowatt-hour/square foot and therm/square foot goals shown in Table 8 and deriving kilowatt-hour and therm usage for target years 2007-08 and 2012-13. The results are shown in Table 9.

It is important to note that, the calculation of cost savings used the square footage of the 18 primary campus buildings (2,445,816) and current utility rates (\$0.067/kWh). These are both variables that are very likely to change, as the campus footprint expands and utility costs rise over the next decade. Nevertheless, the calculation reveals that the potential savings from reducing energy consumption on campus to these levels could be significant; if the goals are met, \$305,332 in FY 2007-08 and \$312,991 in FY 2012-13.

Table 9: Calculation of cost savings due to energy consumption reduction goals			
	2001-02	2007-08 (10%)	2012-13 (20%)
Kilowatt-hours			
Usage/square foot	15.09	13.59	12.08
Estimated total usage	36,909,638	33,238,639	29,545,457
Cost	\$2,472,945	\$2,226,989	\$1,979,546
Energy savings	-	3,670,999	3,693,182
Cost savings	-	\$245,957	\$247,443
Therms			
Usage/square foot	.40	.36	.32
Estimated total usage	969,113	880,494	782,661
Cost	\$649,306	\$589,931	\$524,383
Energy savings	-	88,619	97,833
Cost savings	-	\$59,375	\$65,548
Estimated cost savings	-	\$305,332	\$312,991

The following action items meet Goal 1 primarily by addressing energy efficiency, or the ratio of power output to input (DOE, 2003). On the efficiency side, much of the energy that is used by the University can be conserved by installing efficient systems in newly constructed buildings and by repairing or replacing inefficient equipment and mechanical systems in existing buildings. Typical technological “fixes” to improve energy efficiency include:

- High efficiency motors
- Variable speed drives
- Computerized facility management systems
- Variable air volume systems for HVAC
- Combustion systems improvements
- Cogeneration
- Thermal insulation
- Waste stream utilization (ISE, 2003)

Action Items:

1.1 Identify and pursue energy efficiency opportunities

As stated, at the onset of a university-wide sustainable energy program, it will be necessary to conduct a *thorough* audit of all university facilities to identify energy management and efficiency opportunities. The following areas – HVAC, lighting, building envelope, and water heating – are logical places to start, as efficiency improvement opportunities and payback are usually considerable (ISU, 2002).

1.1.1 Heating, Venting and Cooling (HVAC)

Most of the existing HVAC systems at PSU are at the end of their functional lifespan (30 years), are single-stage, and are very inefficient in comparison to modern two-stage systems. While the costs of new HVAC systems are high, the payback is relatively short. HVAC systems account for the largest variable electric load in a

facility and therefore offer the highest potential for energy savings (BuildingGreen, 2001).

The greatest potential for energy savings comes from improvement of building controls and equipment scheduling. Most PSU facilities are in use at all hours, but many buildings and classrooms sit idle for long stretches. Perhaps the simplest measure – and first to be considered – should be to retrofit HVAC system controls to include a “setback,” or downtime, mode during unoccupied periods (BuildingGreen, 2001).

Other potential HVAC upgrades with fast payback in energy conservation include:

- Room occupancy sensors
- Variable frequency drives in all fan systems
- Elimination of heating and cooling in unoccupied space, such as storage rooms
- Preventive maintenance to extend life of systems

1.1.2 Lighting

On a typical campus, lighting accounts for 20% of the total electrical load (CBEBS, 1999). Experience on many campuses has shown that lighting is often the easiest, quickest, and least expensive way to conserve energy and realize costs savings (Keniry, 1995). New energy-efficient lighting systems offer the potential of reducing lighting energy requirements by 35 to 50%, with additional savings being realized in reduced air conditioning costs as lighting systems with lower energy use translate into reduced cooling loads (BuildingGreen, 2001).

In 2003, PSU retrofitted lighting in eight main campus buildings to improve efficiency. The annual savings are estimated to be 580,763 kWh, or \$38,911.

Potential electrical upgrades with fast payback in energy conservation include:

- Reduction in current number of lighting fixtures (delamping)
- Upgrade to T-8 or T-5 fluorescent lamps
- Upgrade from magnetic to electronic ballasts
- Efficient fixture designs
- Automatic lighting controls and occupancy sensors
- Highly-efficient LEDs in all exit lights

In 2003, PSU underwent a significant round of lighting retrofits on campus. Eight buildings – University Services Building, School of Business and Education, Extended Studies Building, Cramer Hall, Stott Center, Art Building, and Lincoln Hall – were retrofitted and the annual savings are estimated to be 580,763 kWh, or \$38,911.

1.1.3 Building Envelope

The “building envelope” is everything that separates the interior of a building from the outdoor environment, including: windows, walls, foundation, basement slab, ceiling, roof, and insulation (DOE, 2003).

Potential building upgrades with fast payback in energy conservation include the following:

- Insulation. An insulation program can save energy costs immediately. One example is to insulate energy transfers, i.e., pipes that carry steam and water for use in HVAC systems. In many systems around campus, insulation has been stripped off pipes during repair and not replaced due to costs of material and labor. This, of course, results in considerable heat loss. Most estimates predict that the payback of revamping a facility's insulation is 3 to 12 months (ISU, 2002).
- Windows. An average facility may lose up to 30% of its heat or air conditioning through its windows (BuildingGreen, 2001). Therefore, performing window upgrades throughout the campus could result in significant energy savings. It is estimated that the payback period of window replacements ranges from 2-10 years (BuildingGreen, 2001). A consideration in new construction projects is that the higher initial cost of more efficient windows can be offset because smaller, less expensive heating and cooling systems can be afforded.

1.1.4 Water heating

Reducing the demand for hot water should be a top priority and can be implemented at virtually any facility through simple efficiency measures. Methods for reducing water-heating energy use include: maintaining equipment; implementing water conservation measures; reducing hot water temperatures; reducing heat losses from the system; utilizing waste heat sources; and replacing equipment with high-efficiency or renewable energy systems (BuildingGreen, 2001).

1.2 Ongoing maintenance

Currently, PSU's deferred maintenance costs for mechanical systems alone exceed \$70 million.

The importance of proper maintenance cannot be underestimated. Improper or delayed maintenance affects equipment efficiency, causing systems to consume more energy than is necessary. The U.S. Department of Energy estimates that an energy savings of 10-20% can be achieved simply by commissioning a building, or ensuring its efficient operation and proper maintenance of building systems (DOE, 2003). Currently, PSU's deferred maintenance costs for mechanical systems alone exceed \$70 million (FAP, 2003). PSU is not alone in this maintenance crisis; in fact, funding ongoing building maintenance is a well-known challenge for most institutions and facilities (DOE, 2003).

1.3 Conduct routine audits and assessments

Routine audits can help to identify efficiency and conservation opportunities: energy usage, lighting efficiencies, window leakage, insulation factors, occupancy levels, and usage patterns.

Goal 2: Incorporate renewable energy

Procure 5% of campus electricity from renewable energy resources by 2008, and 10% by 2013.

The attributes of clean, renewable sources and the importance they hold for sustainability were addressed in earlier sections of this proposal. Clearly, renewable energy is an area that the University must commit to as it strives for sustainable energy operations.

Action Items:

2.1 Purchase "green power"

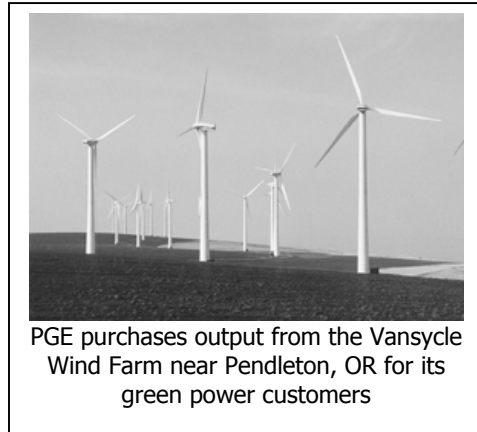
Green power purchases are a way for the University to exercise the choice to support the development of clean, renewable energy. PSU is fortunate that in the Portland metropolitan area there are options for pursuing green power purchases.

2.1.1 Portland General Electric

Through a partnership with Green Mountain Energy, PGE offers various renewable power options to its customers. Large energy consumers, such as PSU, are offered a green power "product" at a price premium of 1.7 cents/kWh. Under this option, 100% of the purchase is used to support energy from renewable sources, primarily the development of new, clean wind power.

Table 10 shows the pricing schedule for various quantities of green power PSU could purchase to offset its energy use from non-renewable sources. The values in this table are based upon 1.7

cents/kWh. It is important to note, however, that PGE has indicated that large green power purchasers may be offered a discounted rate. For instance, if PSU agrees to buy 4,000,000 kWh of green power, or 10% of its total electricity use, PGE may agree to sell at 1.4 cents/kWh. This would mean that the total cost to PSU would be \$56,000 per year, rather than \$68,000. The ultimate cost borne by the University is difficult to predict however, because contracts and agreements are negotiated directly with the utility and vary case-by-case.



Percentage of energy use offset by green power purchase	Green KWh	Annual Cost at 1.7 cents/kWh
5%	2,000,000	\$34,000
10%	4,000,000	\$68,000
15%	6,000,000	\$102,000
20%	8,000,000	\$136,000
25%	10,000,000	\$170,000
30%	12,000,000	\$204,000
40%	16,000,000	\$272,000
50%	20,000,000	\$340,000
75%	30,000,000	\$510,000
100%	40,000,000	\$680,000

Examples from other universities

There are numerous universities around the nation that are purchasing green power from their utilities. Typically, these universities have followed one of two paths: a student-led campaign to raise fees to pay a premium for renewable energy or a university administration decision to purchase green power. Below are examples of both scenarios.

Carnegie Mellon University – Pittsburgh, Pennsylvania

In May 2001, the administration at CMU decided to purchase wind power to “demonstrate the university's recognition of the importance of development of renewable, less environmentally damaging sources of energy, provide educational opportunities for students, faculty and staff, and help support the development of wind power generation in Western Pennsylvania” (CMU website). Today the university purchases 5% of its total electricity use from wind power, and at a price premium of about 2 cents/kWh. (CMU website)

University of Colorado – Boulder, Colorado

UC-Boulder was the first university in the country to purchase green power, and did so by raising student fees to cover the additional costs. In April 2000, students voted to increase their fees by \$1 per semester for four years to purchase wind power from their utility. The fee increase raises \$50,000 per year, enough to purchase 2 million kWh of wind power per year. (UC-Boulder website)

University of Pennsylvania – Philadelphia, Pennsylvania

In April 2003, the University of Pennsylvania signed a 10-year agreement to purchase 10% of its energy needs from wind power. This equates to 40 million kWh annually, representing the largest retail purchase of wind power in the United States. In the words of the University’s President, Judith Rodin, "We at Penn are pleased to be a national leader in the choice for clean energy and the development of the wind-generated power industry in Pennsylvania. Through this example of environmental stewardship, we can continue to raise the awareness of our students and the community about alternative fuel options" (Solaraccess.com, 4/22/2003).

2.1.2 Bonneville Environmental Foundation

The Bonneville Environmental Foundation (BEF) is a nonprofit organization that, among many things, markets green power products, or tags, to public utilities, businesses, government agencies, and individuals. A single BEF “green tag” is the equivalent of 1,000 kilowatt-hours of wind or solar electricity, and offsets 1,400 pounds of carbon dioxide. Tags are purchased on an

Percentage of energy use offset by green tag purchase	Green KWh	Annual Cost at \$15/1000 kWh
5%	2,000,000	\$30,000
10%	4,000,000	\$60,000
15%	6,000,000	\$90,000
20%	8,000,000	\$120,000
25%	10,000,000	\$150,000
30%	12,000,000	\$180,000
40%	16,000,000	\$240,000
50%	20,000,000	\$300,000
75%	30,000,000	\$450,000
100%	40,000,000	\$600,000

annual basis and at the rate of \$20/tag.

BEF will discount large tag purchases, and has been known to sell tags at a rate as low as \$15/tag for purchases greater than 1,000 tags, or 1,000,000 kWh. Table 11 shows the cost PSU would bear for purchasing tags to offset varying levels of energy use. These calculations are based on \$15/tag; however, BEF green tag contracts are also case-by-case.

2.2 Support solar photovoltaic installations on campus

Today, the only solar photovoltaic installation at PSU is a 1 KW system on the roof deck of Science Building 2. The installation was part of a 2001 summer course, "Solar Energy Technology Education," taught by Chemistry professor, Dr. Carl Wamser. The installation was funded by grants from NASA and PGE, and the students in the class assisted with the assembly and installation of the panels.

Currently, there is a proposal for a 25 KW photovoltaic installation on the rooftop of Cramer

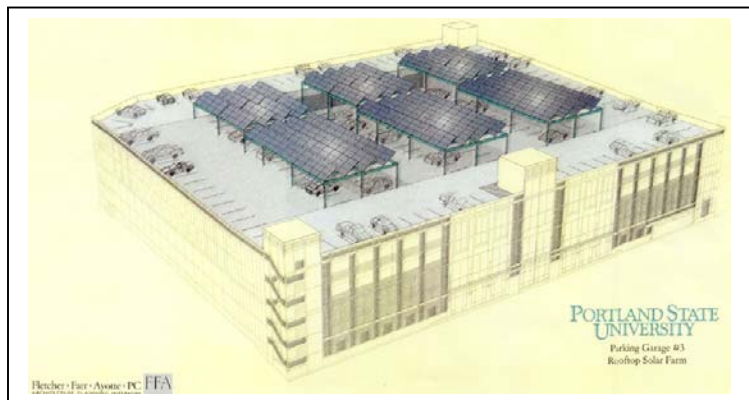


Students in Carl Wamser's 2001 summer course on solar energy assisted with the assembly and installation of a 1 KW photovoltaic system

Hall, anticipated for Fall 2003. The project proposal and summary table can be found in Appendix D. This project has the potential to offer unique educational and student research opportunities, as the proposed array will be comprised of a variety of panel and hardware types, allowing for a direct comparison of system types. Also, the project will present new partnership opportunities for the University with such organizations as the Energy Trust of Oregon, Bonneville Environmental Foundation, Oregon

Museum of Science and Industry, Portland General Electric, and Oregon Office of Energy.

Also, under general consideration at the University is an installation on a raised space frame on the top level of Parking Structure 3 (see picture). Estimates for the system have varied greatly, but the installation could be as large as 100 KW. If installed, it would by far be the largest photovoltaic project in the Northwest.



Examples from other universities

University of North Carolina – Chapel Hill, North Carolina

In February 2003, more than 74% of UNC-Chapel Hill students voted for a \$4 per semester increase to go towards renewable energy projects on campus. The new fee will go into effect in 2004 and will be reconsidered on the ballot every two years. The student

government will appoint a committee to determine how to best allocate the money towards various solar and energy efficiency projects on campus. (UNC-Chapel Hill website)

University of Vermont – Burlington, Vermont

In June 2000, UVM installed a 5 KW solar system. The cost of the project was about \$50,000, shared by the university, the Burlington Electric Department, and a Department of Energy grant. (UVM website)

Goal 3: Demonstrate new energy technologies and applications

Support the development of emerging energy technologies.

It is widely believed that a sustainable, clean energy campus ought to act as consumer *and* producer of energy, and, for this reason, PSU ought to explore demonstration projects for on-site power generation, or distributed generation (DG). As introduced earlier, distributed generation applies small-scale generating units (typically less than 30 MW) at or near consumer sites to meet specific customer needs, to support the existing power system, or both.

PSU could benefit from applications of distributed generation in three basic ways: (1) stand alone electricity generation; (2) standby power; and (3) combined heat and power (a.k.a. cogeneration). Combined heat and power (CHP) technologies have the greatest potential in campus settings, especially as viable technologies with high efficiencies are rapidly emerging. CHP technologies operate so efficiently because they capture the waste heat from power generation that is otherwise lost and utilize it for cooling, heating, and humidity control systems (DOE, 2003). In the U.S., conventional power generation facilities simply vent this waste heat into the air or water streams; in fact, the DOE estimates that as much as two-thirds of all the fuel used in the U.S. to generate electricity is wasted by releasing the unused thermal energy byproduct (DOE, 2003).

Many of the benefits previously discussed – long-term cost savings, reduction in campus emissions, enhanced educational opportunities, etc. – can be reaped by applying new, on-site energy technologies.

Action Items:

3.1 Employ Distributed Generation Technologies¹²

There are several commercially available distributed generation technologies that the University can explore. The following are brief descriptions of a few.

3.1.1 Combustion Turbines

For distributed generation, conventional combustion turbine (CT) generators range in size from about 500 kW up to 25 MW. They are fueled by natural gas, oil, or a

¹² Source: California Energy Commission, Distributed Energy Resource Guide, 2002.

combination of fuels ("dual fuel"). Modern single-cycle combustion turbine units typically have efficiencies in the range of 20 to 45% at full load.

Combustion turbines have relatively low installation costs, low emissions, and infrequent maintenance requirements. However, their low electric efficiency has limited turbines to primarily combined heat and power applications.

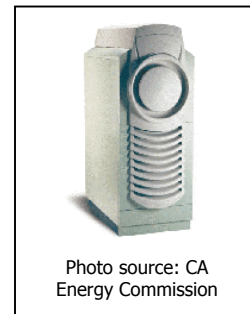
3.1.2 Reciprocating Engines

Reciprocating engines were developed more than 100 years ago and are the most common and most technically mature of all DG technologies. They are available in a wide range of sizes, from a small 5 kW system to large 7 MW generators.

Reciprocating engines use commonly available fuels, such as gasoline, natural gas, and diesel fuel. Reciprocating engines are widely available and currently are typically used for either continuous power or backup emergency power.

3.1.3 Microturbines

Microturbines are an emerging class of small-scale distributed power generation in the 25-500 kW size range. While microturbines are nearing commercial status, many of the installations are still considered field tests or are part of large-scale demonstrations.



3.1.4 Stirling Engines



Stirling-cycle engines were patented in 1816 and were common prior to World War I. They were popular because they had a better safety record than steam engines and used air as the working fluid. As steam engines improved, Stirling engines lost favor. Recent interest in DG, and growing use by the space and marine industries, has revived interest – and research and development investments – in Stirling engines. Stirling engines are generally found in small sizes (1 - 25 kW).

3.1.5 Fuel Cells

While the concept of fuel cells has been around for more than a century, the first practical application of fuel cells was in the 1960's by NASA. Today, NASA continues to rely on fuel cells to power space shuttles, and, because of continuous technology improvements and significant investment by auto companies, utilities, NASA, and the military, fuel cells are now expected to have wider applications within the next few years.

There are many types of fuel cells currently under development in the 5 kW-1000+ kW size range, and, while types of fuel cells differ, they all use the same basic electrochemical process. Ideally, fuel cells would use hydrogen for operation;

however, until hydrogen can be used directly as a fuel source, it must be extracted from hydrogen-rich sources such as gasoline, propane, or natural gas.

3.1.6 Photovoltaics

Photovoltaic solar panels are made up of discrete cells connected together that convert light radiation into electricity. The PV cells produce direct-current (DC) electricity, which must then be inverted for use in an AC system. Current units have efficiencies of 24% in the lab and 10% in actual use. Photovoltaic systems produce no emissions, are reliable, and require minimal maintenance to operate. They are currently available from a number of manufacturers for applications that range from 1-100 kW.

Table 12 shows a direct comparison among the current DG technologies.

Table 12: A comparison between distributed generation technologies							
	Commercial availability	Size range	Fuel	Electrical efficiency	Co-gen efficiency	Emissions	Capital costs/kW
Combustion Turbine	Yes	500 kW – 25 MW	Natural gas, liquid fuels	20 – 45 %	80 – 97 %	Low	\$300 – \$1,700
Reciprocating Engine	Yes	5 kW – 7 MW	Natural gas, liquid fuels	25 – 45 %	50 – 70 %	Requires controls for NO _x and CO ₂	\$300 – \$900
Microturbines	Limited	25 kW – 500 kW	Hydrogen, natural gas, propane, diesel	20 – 30 %	50 – 80 %	Low	\$700 – \$1,110
Stirling Engine	No	<1 kW – 25 kW	Fuel flexibility will be possible	12 – 20 %	50 – 70 %	Potential for very low	\$2,000 – \$50,000
Fuel Cell – PAFC¹³	Yes	100 kW – 200 kW	Natural gas, landfill or digester gas, diesel	36 – 42 %	70 – 96 %	Nearly zero	\$1,500 – \$5,500
Photovoltaics	Yes	< 1 kW – 100 kW	Sunlight	5 – 15 %	N/A	Zero	\$6,000 – \$10,000

Source: California Energy Commission, 2002. www.energy.ca.gov/distgen/index.html

The University should consider the feasibility of applying these new technologies when planning equipment change outs or new building projects, and investigate opportunities to partner with manufacturers and host a demonstration project on campus. Indeed,

¹³ *Phosphoric acid fuel cells* are just one fuel cell technology. There are currently three other types expected to reach the market by 2004 that are expected to achieve even higher efficiencies.

supporting new technologies and on-site power generation is a critical piece of sustainable energy planning and practices.

Goal 4: Effective measurement and communication

More effectively track and report energy data. Educate the campus community on energy use and conservation measures.

Effective measurement and communication are essential for the success of an energy management strategy. The first piece of this goal, tracking and reporting, is imperative in the evaluation of energy usage on campus and results from changes in energy demand and practices. The second piece, campus energy awareness, addresses the conservation, or behavioral, side of energy management, as energy education on campus promotes awareness and behaviors that could help to reduce demand for energy on campus.

Action Items:

4.1 Improve energy data reporting

Systematized energy data reporting is necessary to provide utility bill analysis, utility use and cost trending, forecasting, energy project tracking, and analysis and recommendations for controlling energy usage and costs. PSU recently purchased "Utility Cost Manager," an energy accounting software, to assist with these tasks. The software is currently being installed and will allow for vast improvements in energy data acquisition and manipulation.

4.2 Track progress with energy indicators

Indicators are measured variables used to track changes and trends. Table 13 suggests sample 'sustainable energy indicators' that the University can measure and use to report on a regular basis. The FY 2001-02 data shown in the table can be used as baseline measures in future analyses.

Table 13: Sample energy indicators	
	FY 2001-02
Total kWh consumed	41.7 million
Gross kWh/sq foot ¹⁴	15.1
Total therms consumed	977,823
Gross therms/sq foot ¹¹	.40
mBTU/sq foot	91.3
Renewable kWh	1,400
% Renewable	0%
CO ₂ emissions (pounds)	69,797,812
Dollars per mBTU	\$71.64
Dollars per square foot	\$0.80
Dollars per student	\$147.11

4.3 Improve internal communication

4.3.1 A Facilities & Planning newsletter can be developed to provide updates on campus planning activities, sustainability on campus, and energy conservation updates and tips.

¹⁴ Based on the 18 primary buildings analyzed in the BTU Analysis for this plan.

4.3.2 "Employee Awareness" educational efforts, such as seminars, speakers, brown bag lunches, etc., can help to bridge faculty and staff and address concerns people may have about campus operations and energy-related decisions.

4.4 Increase campus energy awareness

Raising energy awareness throughout the campus is an essential component of an effective sustainable energy program (Simpson, 2003). An energy awareness campaign can help to mobilize the campus community, create a climate for conservation, and better involve students and faculty in operational aspects of the campus. Further, this is a great opportunity to directly involve students in the work at Facilities & Planning, as a student intern can develop and organize a campus-wide campaign. The following are a few suggestions for components of such a campaign.

4.4.1 Communication with the campus community

On a large, busy campus, raising energy awareness is a difficult task and the key maybe to catch people's attention. There are common methods such as campus mailings, email notices, newspaper articles, and guest speakers. But, it may be necessary to think "outside the box" and get creative. An example from another university is placing signs in the entrance vestibules of campus buildings that provide the building's energy usage, costs, and CO₂ equivalent (Simpson, 2003).

4.4.2 Energy Awareness Month

The National Energy Awareness Month is October and PSU should take advantage of the materials and resources generated for this fanfare and plan outreach events and mailings on campus during this time.

4.4.3 Clean Energy Fair

PSU's first annual "Clean Energy Fair" was held April 21, 2003 and was an educational event on clean, efficient energy alternatives. There were approximately 25 organizations and vendors that tabled for the day, and a lunchtime speaker panel comprised of four prominent people in the energy field. There is great opportunity for this event to grow in the future and increase PSU's leadership role in the community on clean energy issues.



The City of Portland's Office of Sustainable Development demonstrated highly-efficient LED traffic signals at PSU's Clean Energy Fair.

4.4.4 Develop a suggestion program for campus input

A suggestion program is a simple way for faculty or students with ideas about energy management on campus to communicate with the Facilities & Planning office. This could be facilitated through the sustainability website or a drop box located

somewhere on campus. Especially innovative ideas that are carried through can be recognized in campus mailings, email announcements, or the student newspaper.

Examples from other universities

Brown University – Providence, Rhode Island

Students have been instrumental in Brown University's "Brown is Green" (BIG) campaign, and specifically in some of the campus conservation programs. Every semester students participate in research projects that identify high resource consumption problems on campus and recommend alternative solutions. One such project addressed refrigerator use in student dorms. Students in the class produced educational materials about the value of using shared refrigerators rather than personal, and pressured the university to replace older ones with newer more efficient models. Brown estimates a savings of approximately 20%. (Clugston, 2000)

C. Green Standards

In the previous sub-section, important energy management goals, benchmarks, and indicators are outlined for energy efficiency and the incorporation of renewable energy resources. In addition to these, it is important for a sustainable energy policy to recognize and set explicit standards for these areas, primarily for university officials and the campus energy management plan to speak to. Some examples include:

- Heating and cooling season temperature settings
 - Building HVAC and fan schedules
 - Computer operations
 - Restrictions on portable space heaters and lighting
 - Energy purchasing, including buying green power and Energy Star-rated equipment
 - Energy practices in student housing complexes
 - Alternative fuels and efficiency for fleet vehicles
 - Carbon dioxide emissions reductions
 - Green design for new construction and building upgrades, including U.S. Green Building Council LEED certification standards¹⁵
- (Simpson, 2003)

The last example, regarding green design, is an important area that deserves special attention. Across the U.S., universities are creating policies and standards that support environmentally sound and resource-efficient buildings, and PSU should follow suit. To PSU's credit, current campus construction projects, including Stephen Epler Hall, the Native American Center, and the Broadway Housing project, are incorporating many new, cutting-edge green building techniques. However, an adopted campus policy with explicit green building standards can provide leverage for future projects, and prevent higher upfront cost energy-saving measures – sometimes considered superfluous – from being pulled from a project's plan.

¹⁵ The U.S. Green Building Council's Leadership in Energy & Environmental Design (LEED) rating system program has emerged as the leading standard for evaluating and certifying green building attributes and performance (Clean Edge, 2002). See www.usgbc.org/.

Below a few examples from other universities are given.

Emory University – Atlanta, Georgia

In 2002, Emory University's Board of Trustees examined the U.S. Green Building Council's LEED program and determined that the cost of obtaining the LEED certification for all new construction projects would be quickly recovered through lower operating costs throughout the building's life. As a result, Emory University officially endorsed LEED for use as a guiding principle in the development of all the university's construction and renovation projects. (Clean Edge, 2002)

Los Angeles Community College District

In March 2002, students in the Los Angeles Community College District put pressure on administrators to commit to cleaner energy practices, and the result was a 25% renewable energy standard and the adoption of a building policy that requires all new buildings to be constructed with green design principles. (Clean Edge, 2002)

An adopted campus policy with explicit green building standards can provide leverage for future projects, and prevent higher upfront cost energy-saving measures – sometimes considered superfluous – from being pulled from a project's plan.

California University System

Influenced by the Los Angeles Community College System, the California University System released its own "Green Building Policy and Clean Energy Standards" in June 2003. Included in the policy are the following mandates:

- 10 megawatts of renewable energy be installed across the 10 campuses
- 10% of the university's utility purchased energy be from clean energy sources immediately and ramping up to 20% by 2017
- All new campus building across the state be built to green building standards (except acute care facilities)
- Reduction of system-wide energy use to 10% below 2000 levels by 2014
(www.universityofcalifornia.edu)

California's aggressive university energy policies have certainly raised the bar for campus energy sustainability, and clearly demonstrate the viability – and implications – of setting high standards for universities and colleges.

D. Sustainable Economics

Over the past several decades, the structure and function of U.S. universities has become decidedly more business-oriented, as university administrators are increasingly reliant on traditional economic criteria in decision-making and "bottom line" thinking (Green Destiny, 2003). As previously mentioned, creating sustainable institutions requires longer-term thinking, difficult organizational adjustments, and rethinking economics (Pearce, 2003).

Discussed here are three considerations for university decision-making that may better facilitate and institutionalize sustainability goals: (1) funding of development projects; (2) utility billing and accountability; and (3) new economic applications.

Project Funding

Currently, there is no built-in economic incentive to conserve university resources when designing and constructing new buildings. This problem – and a possible solution – is best illustrated in a recent article in *Planning for Higher Education*. While the article is specific to Penn State University, it closely applies to current organizational decision-making at PSU.

The article was written by a doctoral student at Penn State who examined the funding of capital and operational costs of development projects. He found that the decision-making concerning the funding of new construction and renovation was independent from that concerning the costs of maintaining and operating campus infrastructure (Pearce, 2003). At Penn State, like many public universities – including PSU – capital projects are funded by the state, the university's general fund, and gifts, while tuition and state appropriations fund operations and maintenance (Pearce, 2003).

This organizational structure leads to decisions that are not necessarily in the best long-term interest of the university community, as it is often cuts in other university budgets or increases in tuition that end up funding the operations and maintenance of new buildings or property acquisitions. Because the operating costs over a building's lifetime nearly equal the initial cost of a building's construction, the funding strains budgets – and student tuition – as new buildings are added to the campus footprint (Pearce, 2003). This is of particular concern to PSU, as, just in the next two years, nearly 750,000 square feet of occupied building space will be added to the management responsibilities to the Facilities & Planning office (see page 6), but no established fund existed for funding the operations and maintenance of these buildings.

At most universities, decision-making concerning the funding of new construction and renovation is independent from that concerning the costs of maintaining and operating campus infrastructure.

The author suggests one simple change that could correct this unfortunate policy flaw – something that PSU should consider. The author suggests that university administration require that for every development project, a fund be set aside to finance the operation and maintenance of that project. The effect of such a requirement would be that university planners would have incentive to design and construct more efficient buildings; i.e., the more efficiently a project or building was designed to operate, the smaller the additional fund would need to be (Pearce, 2003).

Utility Billing and Accountability

Equally important to the funding of building operations and maintenance is the consideration of the actual use of – and billing for – the campus buildings themselves. This issue ties directly back to campus energy awareness, but moves beyond energy education measures to end-user accountability. Currently, outside of Facilities & Planning, energy costs and impacts are invisible. And, not until departments – and the faculty and staff that they are comprised of – are made aware of and held accountable for their own energy consumption, will the vital connections be made between energy behaviors and the consequences – economical and environmental – of energy use. While not easy changes to implement, making the energy costs borne by the University transparent to the end-user will help to

Making the energy costs borne by the University transparent to the end-user will help to institutionalize – and justify – University policy and actions regarding sustainable energy practices.

institutionalize – and justify – University policy and actions regarding sustainable energy practices.

New Economic Applications

Decision-making to improve energy performance or reduce environmental impacts requires rethinking traditional, narrowly-focused economic analysis and incorporating full-cost analysis to include *long-term* economic costs, and true ecological and social costs. Several methods can be used for conducting economic analyses to support sustainable energy decisions. Discussed here are: Simple Payback, Life-Cycle Cost (LCC) Analysis, Environmental Life-Cycle Assessment (LCA), and the “Triple Bottom Line.”

Simple Payback Analysis

Simple payback analysis evaluates the economic worth of a project by calculating the time it takes to recover the initial capital costs of an energy saving project through avoided utility costs. It is most commonly thought of as a good initial assessment of risk, i.e., the quicker the payback the less risky the project (BuildingGreen, 2001). Currently, evaluation of any energy-related project at PSU involves this analysis method.

Life-Cycle Cost Analysis

Simple payback analysis is a good screening tool but ignores information after payback, or what happens after payback is achieved. Life-cycle cost (LCC) analysis attempts to quantify the “true” cost of a building over its anticipated lifetime, by including not only the initial capital cost, but also operations and maintenance (O&M) costs, energy and water costs, repair costs, replacement costs, and other significant costs of the assumed life of the measure of facility (BuildingGreen, 2001).

Life-cycle Costs Analysis Parameters

- Initial project costs
- Annual O&M costs
- Non-annually recurring O&M costs
- Energy and water costs
- Inflation
- Study period (usually the expected life of the facility or product)
- Discount rate
- Energy cost escalation rate

Source: BuildingGreen, 2001

Environmental Life-Cycle Assessment

Environmental LCA is used to analyze the potential environmental impacts that are associated with the entire life-cycle of a product, from the raw materials to final disposal of the product after its use (BuildingGreen, 2001). This is sometimes called “cradle-to-grave” to “cradle-to-cradle” analysis. It is useful for understanding the advantages and disadvantages of products from an environmental point of view (BuildingGreen, 2001).

The strength of Environmental LCA is its comprehensive approach. For instance, instead of choosing a product based only on its energy efficiency or recycled content, LCA provides information on the full range of environmental attributes. Unlike LCC, which expresses the outcome in dollars, LCA incorporates impacts in energy units and pollutants (BuildingGreen, 2001).

Triple-Bottom Line

Recently conveyed in Governor Ted Kulongoski's Sustainability Executive Order (June 2003)¹⁶, the "triple-bottom line" is a principle that broadens the scope of economic decision-making to account for environmental and social benefits of a project. See Appendix D (Cramer Hall Solar Photovoltaic Proposal) for an example of how it can be applied.

It is important to recognize that the issues presented in this sub-section are not easy to address, as sustainable economic thinking requires deep institutional – and cultural – changes. It is, however, an essential policy component to consider, as, at its core, sustainability entail changing the way we do business.

VI. Funding Sources and Partners

PSU is fortunate that, especially in the Northwest region, a wide variety of financing opportunities and incentives are available to help defray costs of energy efficiency retrofits, renewable energy investments, and green building projects. The following are brief descriptions of organizations and programs that PSU can pursue for partnerships and financial assistance in such projects.

A. Bonneville Environmental Foundation

Profile

The Bonneville Environmental Foundation (BEF) is a charitable, nonprofit organization founded in 1998. It encourages and funds renewable power projects in the region and markets green power products (tags) to public utilities, businesses, government agencies, and individuals.

Application/proposal process

BEF delivers funding through various means, including grants, loans, convertible loans, guarantees, and direct investments in renewable energy projects. The funding cycle is ongoing year-round. There are two steps in applying for funding: The Letter of Enquiry and The Proposal. The initial Letter of Enquiry is a description of the proposed renewable energy project and a concise explanation as to why the project would be of interest to the Foundation. Then, the Proposal is a more thorough narrative detailing the project background, goals, site considerations, financial arrangements, deliverables, and technical review.

Criteria for funding

In their materials, the BEF explicitly outlines the criteria for funding renewable energy projects.

Required criteria include:

- Preference given to projects that generate electricity
- Low environmental impact, environmental benefits are significant

¹⁶ The full text of the Executive Order can be found at www.sustainableoregon.net

- BEF share will not exceed 33% of capital costs and 0% of operating costs
- Project sponsors should have the appropriate experience and credentials (including technical and financial) to undertake the project
- The project (or specified project phase) can be completed within two years

Preferred criteria include:

- Not otherwise easily fundable
- Builds regional capability
- Enlarges consumer understanding
- Demonstration value
- Affords leverage

Contact information

Web: www.bonenvfdn.org

Address: 133 SW 2nd Avenue, Suite 410, Portland, OR 97204

Phone: 503-248-1905

Contact: Angus Duncan, President

B. The Climate Trust

Profile

The Climate Trust is a result of landmark legislation passed in the State of Oregon in 1997. House Bill 3283 established the first meaningful measure in the country to curb carbon dioxide, the most prevalent global warming gas. The bill requires all new energy facilities built in the state to curtail or displace a portion of their carbon dioxide emissions. If the plant developer chooses, they can opt to pay mitigation fees to the Climate Trust, who in turn directs the funds directly towards projects that prevent or displace carbon dioxide, including renewable energy projects.

Application/Proposal Process

The Climate Trust periodically issues a Request-for-Proposal (RFP) for projects that help to mitigate emissions of carbon dioxide.

Criteria for Funding

- Only projects that directly avoid, displace, or sequester carbon dioxide
- Carbon dioxide emissions must be quantifiable

Contact Information

Web: www.climatetrust.org

Address: 516 SE Morrison Street, Suite 300, Portland, OR 97214

Phone: 503-238-1915

Contact: Mike Burnett, Executive Director

C. Energy Trust of Oregon

Profile

The Energy Trust is a nonprofit organization promoting energy conservation and clean, renewable energy sources. As introduced earlier, the Energy Trust is allocated a fixed percentage of the public purpose charge collected from the state's two largest investor-

owned utilities, Portland General Electric and PacifiCorp, to invest in energy conservation and renewable energy projects. They began operation March 1, 2002.

Application/proposal process

As a PGE customer and contributor to the state's public purpose fund, PSU has access to the Energy Trust's energy efficiency and renewable energy program dollars. The Energy Trust offers incentives and services for building efficiency projects, including cash back incentives for lighting and HVAC retrofits, as well as energy audit and building commissioning services. Applying for these incentives requires a few submissions of paperwork – now mostly available as on-line forms. PSU has not yet drawn upon the Energy Trust's energy efficiency program and should look to explore it further in future projects.

As for renewable energy projects, requests for funding require submission of an application for either the Standard Solar Electric Program or Open Solicitation Program. The Standard Program offers a buy down rate of \$2.25 per watt and is capped at \$35,000 (as of August 2003). The Open Solicitation Program, on the other hand, is evaluated on a case-by-case basis and does not have a cap. Currently, the University is seeking funding through the Open Solicitation Program for the 25 KW photovoltaic installation on Cramer Hall. In general, the Open Solicitation application entails demonstrating how the project meets the criteria listed below.

Criteria for funding

- Create momentum
- Expansion capability/replicable
- Leverage other funding/builds on other programs
- High likelihood of success
- Long-term impact on market
- Resources can be integrated with utilities
- Cost-sharing

Contact Information

Web: www.energytrust.org

Address: 516 SE Morrison Street, Suite 300B, Portland, OR 97204

Phone: 503-493-8888

Contact: Peter West, Director of Renewable Energy

D. Oregon Office of Energy

Profile

The Oregon Office of Energy covers all fuels and energy uses, from home heating to industrial processes to transportation. To promote diversification of Oregon's energy portfolio, the Office offers incentives for residential, commercial, and industrial applications of alternative energy sources.

Application/proposal process

PSU is eligible for two Office of Energy conservation and renewable resource programs: Business Energy Tax Credit and State Energy Loan Program. The University has already

taken advantage of these state incentives for numerous campus projects and should continue to do so.

1. Business Energy Tax Credit (BETC)

The Oregon Office of Energy offers the Business Energy Tax Credit (BETC) to those who invest in energy conservation, recycling, renewable energy resources, alternative transportation projects, and sustainable building design. The tax credit is 35% of the eligible project costs and is taken over five years: 10% in the first and second years and 5% each year thereafter. Projects whose total costs are \$20,000 or less may claim the tax credit in one year. Table 14 below is a snapshot of the two scenarios: (1) eligible project costs greater than \$20,000 and (2) eligible project costs less than \$20,000.

The tax credit covers all costs directly related to the project, including equipment cost, engineering and design fees, materials, supplies and installation costs. For project owners without any tax liability, like PSU, there is the Pass-through Option. In this scenario, the 35% Business Energy Tax Credit is transferred to a "pass-through partner" for a lump-sum cash payment - the net present value - of the project cost. The net present value rate for the five-year Business Energy Tax Credit is 27%.

The BETC application process includes three forms (the Application for Preliminary Certification, a Supplemental Information Form, and the Pass-through Option Application) and a review cost (0.0075 X eligible project costs).

For many Facilities & Planning projects, the State's BETC Pass-through option has been considered and/or pursued. To date, PSU has submitted seven applications for BETC, totaling more than \$1.5 million in eligible project costs and over \$400,000 in payments to the University. These projects have included: mass transit subsidies, lighting retrofits, two sustainable building projects, and a higher efficiency UPS system. Pass-through partners have been secured for two of these projects.

Table 14: BETC Scenarios		
	Scenario 1	Scenario 2
Eligible Project Costs	\$100,000	\$15,000
Business Energy Tax Credit (35% of eligible project costs)	\$35,000	\$5,250
Year 1	\$10,000	\$5,250
Year 2	\$10,000	--
Year 3	\$5,000	--
Year 4	\$5,000	--
Year 5	\$5,000	--
Amount paid to PSU (net present value)	\$27,000 (27%)	\$5,025 (33.5%)

Source: Oregon Office of Energy

An alternative to the pass-through process is leasing. In this scenario, the University would simply lease the equipment or power system from the manufacturer or another 3rd party private entity, who in turn could claim the BETC themselves. There are three main

To date, PSU has submitted seven applications for the State's Business Energy Tax Credit, totaling more than \$1.5 million in eligible project costs and over \$400,000 in payments to the University.

advantages to this option: (1) the University would side-step the application process for the BETC; (2) the University would be relieved of ownership and maintenance responsibilities; and (3) the leaser would be eligible for federal tax incentives, including the Federal Investment Tax Credit and Modified Accelerated Cost Recovery System, that are not available to public institutions. This alternative may be compatible with a large-scale, highly visible project – such as a photovoltaic installation – but, of course, requires a 3rd party willing to absorb the risk and upfront capital costs.

2. State Energy Loan Program (SELP)

The SELP program offers low-interest loans for projects that:

- Save energy
- Produce energy from renewable resources such as water, wind, geothermal, solar, biomass, waste materials or waste heat
- Use recycled materials to create products
- Use alternative fuels

Contact Information

Web: www.energy.state.or.us

Address: 625 Marion St. N.E., Salem, OR 97301

Phone: 1-800-221-8035

Contact: Suzanne Dillard, Conservation Services Manager

E. Portland General Electric

Profile

PGE is Oregon's largest utility, serving more than 730,000 customers. As the utility that serves the Portland State campus, PGE is a likely partner in energy-saving or renewable energy projects.

Application/proposal process

The University would need to arrange a meeting with PGE to present a project proposal.

Criteria

As discussed earlier, PGE offers various green power options to its customers, which customers can pay slightly more for energy from renewable resources. PGE allocates revenues the green power program directly towards new renewable energy development and projects in its service territory. So, in deciding which projects to fund, the utility seeks those that: (1) will directly benefit PGE customers, (2) have high visibility in the community, and (3) generate a meaningful amount of electricity.

Contact Information

Web: www.portlandgeneral.com

Address: 121 SW Salmon Street, Portland, OR 97204

Phone: 503-464-8089

Contact: Thor Hinckley, Renewables Manager

F. Potential Sources for Funded Research

- Bonneville Power Administration
- Northwest Power Planning Council
- Oregon Office of Energy
- Portland Office of Sustainable Development
- U.S. Department of Energy
- National Aeronautics & Space Administration

VII. Conclusion

A sustainable energy campus is one that reduces energy consumption, energy waste and pollution, minimizes life-cycle costs, and creates healthy campus – and community – environments. This can be achieved through a variety of practices, including:

- maximizing energy efficiency and conservation opportunities
- investing in clean, renewable energy technologies
- employing on-site, distributed generation technologies
- raising energy awareness on campus
- setting clear energy policy goals and standards
- rethinking current decision-making to promote sustainable energy behaviors

The benefits of pursuing sustainable energy practices are clear and well documented. They provide a hedge against higher energy costs in the future and insulation from energy shortages and market fluctuations. They also include more environmentally sound energy practices and green buildings. There are also benefits to the larger community, including reduced air emissions, dependence on fossil fuels for electricity generation, and educational opportunities (Clean Edge, 2002).

This much is clear. But, what does this mean for PSU today? How can this be carried from paper to practice? Right now, PSU faces an interesting crossroads. Select university administrators have acknowledged support for sustainability and the desire to integrate sustainability principles into academics and operations. The Facilities & Planning office has begun to incorporate many of the energy efficiency, renewable energy, and green building ideas presented in this plan. Indeed, sustainability has a presence on the campus and, in many ways, PSU is on the right course. But, sustainability at PSU today is vulnerable to administrator, staff and student turnover and to changes in priorities as budgets tighten and tough administrative decisions are made.

This is an historic opportunity for PSU to claim leadership in campus sustainability and confirm its support of emerging ideas and paradigms that will undoubtedly shape our future. Sustainability is about the future and, formal university commitment to sustainable practices is good for PSU as we know it today, and for the long-term vitality of the University.

It is for these reasons that the University needs to institutionalize its commitment to sustainability through a campus policy and sub-policies that address specific areas of operations. On the basis of this proposal, the University can use energy as a launching point for these policies and establish an 'Energy Aware Team,' develop an energy management plan with clear goals and action items, and set standards for energy use, construction projects, and energy accounting on campus.

"Core sustainability" will occur only when all university decisions speak to the three E's (economics, environment, and equity), recognize what is in the greatest interest of future generations, and acknowledge the interconnectedness of campus operations and impacts. This poses a great challenge to PSU, as it means exceeding verbal support for sustainability principles by rethinking university strategies, procedures, and operations. It also requires creating a new vision for PSU, one that combines its namesake in community-based learning with that of sustainable campus planning.

In all, this is an historic opportunity for PSU to claim leadership in campus sustainability and confirm its support of emerging ideas and paradigms that will undoubtedly shape our future. Sustainability is about the future and, formal university commitment to sustainable practices is good for PSU as we know it today, and for the long-term vitality of the University.

Glossary of Energy Terms

Amps – the unit of electrical current

Boiler – Pressure vessel designed to transfer heat or electrical resistance to a fluid. In most boilers, the fluid is water in the form of liquid or steam.

British thermal unit (BTU) – a unit of energy equivalent to the amount of heat required to raise the temperature of 1 pound of water 1 degree Fahrenheit

Building envelope – the outer shell of a building, including walls, roof, windows, and doors

Chiller – mechanical device that generates cold liquid, which is circulated through cooling coils to cool the air supplied to a building

Cogeneration – the sequential use of energy to generate electricity and another form of useful thermal energy, such heat or steam

Commissioning – the process of ensuring that systems are designed, installed, functionally tested, and capable of being operated and maintained according to owner's operational needs.

Conservation – activities that reduce end-use demand for energy by reducing the service demanded

Distributed generation – applying small generating units at or near consumer sites

Efficiency – ratio of power output to input

End-use – how energy is used at its final stage

Green power – power generated from nonpolluting, renewable energy resources, such as wind, solar and geothermal

Inverter – a device that changes direct current (DC) to alternating current (AC)

Kilowatt – unit of power equal to 1000 watts

Kilowatt-hour – Unit of electric consumption equal to the work done by 1 kilowatt acting for 1 hour

Load – the demand upon the operating resources of a system; in the case of energy loads in buildings, the word generally refers to heating, cooling, and electrical (or demand) loads

Megawatt – unit of power equal to 1,000,000 watts

Payback – measurement of elapsed time between an initial investment and the point at which accumulated savings are sufficient to offset the initial investment

Photovoltaic – direct conversion of light into electrical energy

Sustainability – meeting the needs of the present without compromising the ability of future generations to meet their needs

Variable-speed drive (VSD) – a device used to adjust the speed of an AC motor to match load requirements

Watt – a measure of electrical power that is determined by multiplying the voltage by the amperage

Primary source: U.S. Department of Energy, Energy Star Building Manual

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Web Resources

Government Sites

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National Renewable Energy Laboratory, www.nrel.gov
Oregon Office of Energy, www.energy.state.or.us
Sustainable Oregon, www.sustainableoregon.net
U.S. Department of Energy, www.energy.gov
U.S. Energy Information System, www.eia.doe.gov
U.S. Environmental Protection Agency, Energy Star, www.energystar.gov

Non-profit Organizations

Bonneville Environmental Foundation, www.bonenvfdn.org
Center for Energy Efficiency & Renewable Technologies, www.cleanpower.org
Center for Resource Solutions, www.resource-solutions.org
Climate Solutions, www.climatesolutions.org
Energy Trust of Oregon, www.energytrust.org
New Rules Project, www.newrules.org/electricity/index.html
Northwest Energy Efficiency Alliance, www.nwalliance.org
Portland Energy Conservation, Inc., www.peci.org
Renewable Northwest Project, www.rnp.org
Sustainable Northwest, www.sustainablenorthwest.org
Union of Concerned Scientists, www.ucsusa.org

Trade Organizations

American Solar Energy Society, www.ases.org
American Wind Energy Association, www.awea.org
Solar Energy Association of Oregon, www.solaror.org/

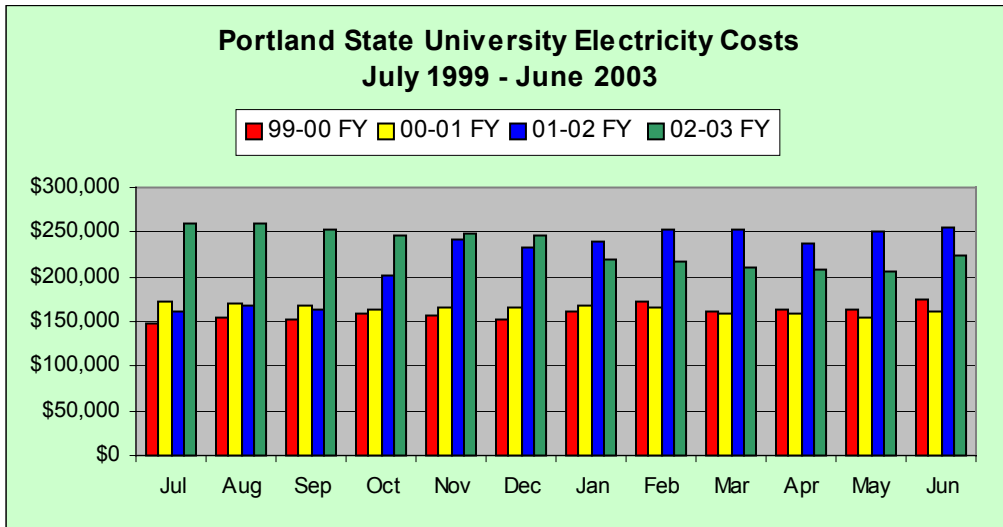
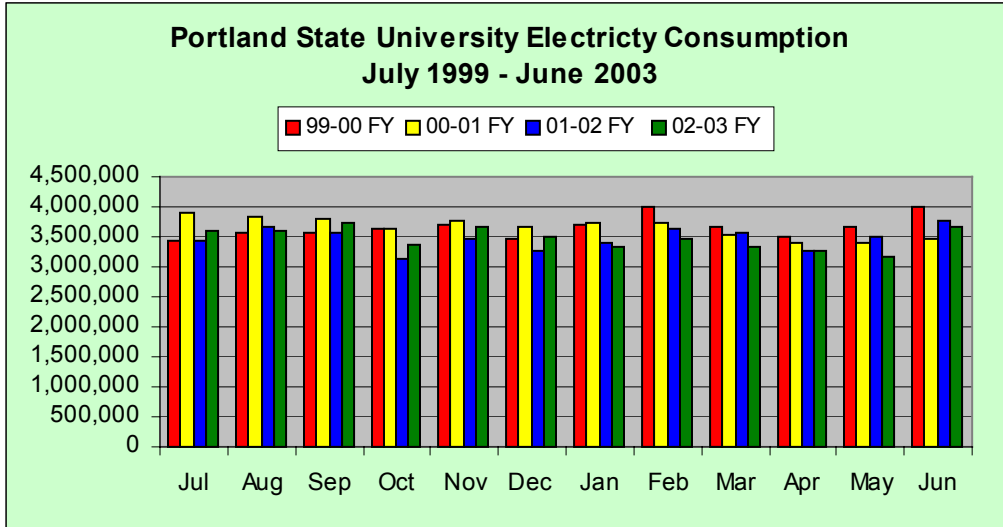
Appendices

Appendix B**PSU Building Inventory, 2002**

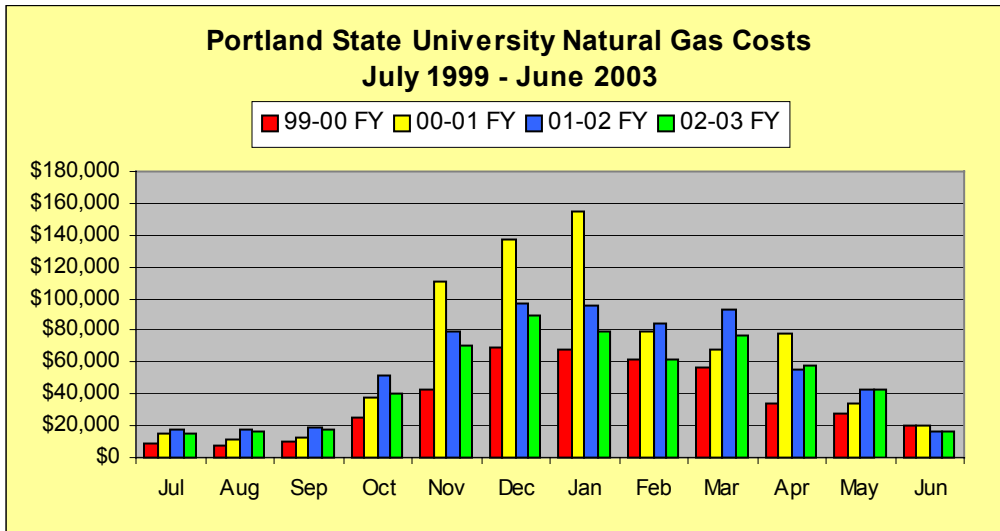
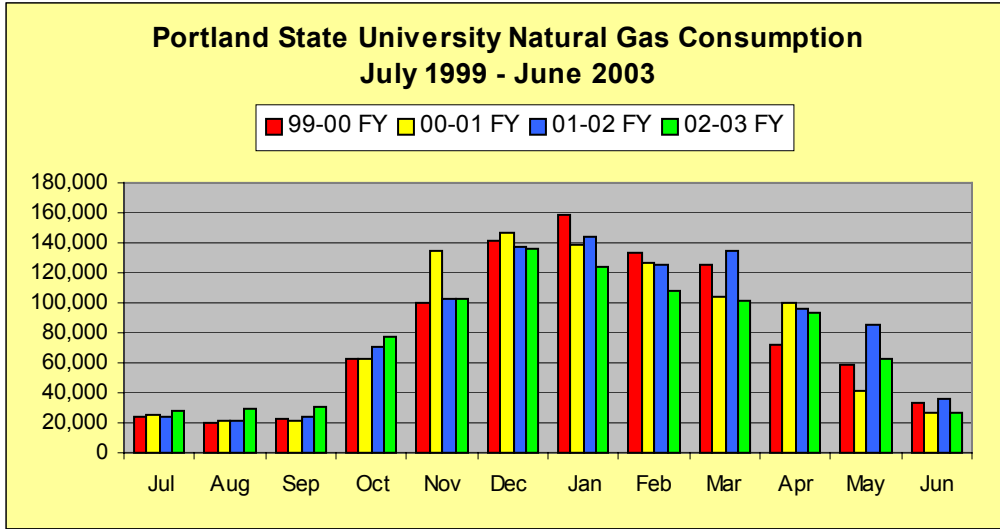
	Area (S.F.)	Year Built	Year Acquired	Address
Educational				
Campus & Grounds Building	10,722	1906	1965	1811 SW Tenth Ave
Campus Security Building	3,136	1967	1970	1939 SW Broadway Ave
Cramer Hall	241,573	1955, 1957	Built by PSU	1721 SW Broadway Ave
East Hall	23,389	1925	1966	1632 SW Hall St
Harder House	4,863	1901	1960	1604 SW Tenth Ave
Harrison St Building	2,029	1951	1972	1025 SW Harrison St
Helen Gordon Child Center	22,809	1938	1972	1609 SW Twelfth Ave
Library East	53,302	1958	Built by PSU	1825 SW Broadway Ave
Lincoln Hall	145,139	1912	1949	1620 SW Park Ave
Millar Library	194,783	1967, 1989	Built by PSU	1875 SW Park Ave
Neuberger Hall	233,671	1962, 1969	Built by PSU	724 SW Harrison St
SEAS Annex	64,767	1968	1976	1912 SW Sixth Ave
PCAT	53,465	1963	1988	1800 SW Sixth Ave
Peter W. Stott Center	223,335	1966	1966	930 SW Hall St
Recycling Center	644	1967	1967	1207 SW Montgomery St
School of Business Admin.	47,806	1987	Built by PSU	631 SW Harrison St
School of Education	53,293	1981	Built by PSU	615 SW Harrison St
School of Extended Studies	30,000	1957, 1964	Built by PSU	1633 SW Park Ave
Science 1	91,608	1966	Built by PSU	1025 SW Mill St
Science 2	214,015	1971, 1982	Built by PSU	1719 SW Tenth Ave
Shattuck Hall	93,659	1916	1969	1914 SW Park Ave
Simon Benson House	1,905	1890	2000	1803 SW Park Ave
Systems Science Building	4,770	1900	1963	1633 SW Eleventh Ave
University Honors Program	7,128	1893	1962	1632 SW Twelfth Ave
University Services	74,593	1971	NA	617 SW Montgomery St
Urban Center	133,407	1999	Built by PSU	506 SW Mill St
Distance Learning Center	13,899	2000	Built by PSU	506 SW Mill St
Sub-Total	2,043,710			
Auxilliary				
Art Building	26,592	Unk.	2001	1990-2000 SW Fifth Ave
Fifth Ave Business Center	38,031	Unk.	2002	2130-2136 SW Fifth Ave
Fourth Ave Building	217,282	1962, 1974	1997	1900 SW Fourth Ave
George C. Hoffmann Hall	9,638	1996	1996	1833 SW Eleventh Ave
Jackson St House	1,804	Unk.	2002	621 SW Jackson St
President's Residence	6,262	1941	1969	11650 Military
President's Garage	1,740	1941	1969	11650 Military
Sixth Ave Building	16,540	1953, 1968	1995	1950 SW Sixth Ave
Smith Student Union	178,448	1958, 1961-63	Built by PSU	1825 SW Broadway Ave
Sonitrol	1,800	Unk.	2002	1975 SW Sixth Ave
University Center	87,771	1969	Built by PSU	527 SW Hall St

Urban Center - Bookstore	27,434	1999	Built by PSU	506 SW Mill St
Urban Center - Tri-Met office	1,220	2000	Built by PSU	506 SW Mill St
West Heating Plant	6,300	1966	1966	SW Eleventh Ave
Sub-Total	620,862			
Parking				
Art Building Parking	4,802	Unk.	2001	1990-2000 SW Fifth Ave
Fifth Ave Bus. Center Parking	7,302	Unk.	2002	2130-2136 SW Fifth Ave
Fourth Ave Parking	154,691	1962	1997	1900 SW Fourth Ave
Parking 1	317,828	1966	Built by PSU	1872 SW Broadway Ave
Parking 2	97,667	1969	Built by PSU	1724 SW Broadway Ave
Parking 3	248,769	1978, 1981	Built by PSU	1631 SW Twelfth Ave
PCAT Parking	26,424	1963	1983	1800 SW Sixth Ave
Sixth Ave Building Parking	3,291	1953, 1968	1995	1950 SW Sixth Ave
University Center Parking	91,923	1969	1999	527 SW Hall St
Sub-Total	952,697			
Campus Total				
	3,617,269			
Housing				
Adeline	11,190	1918	1969	1208 SW Montgomery
Blackstone	40,655	1931	1969	1831 SW Park Ave
King Albert Building	31,950	1931	1969	1809 SW Eleventh Ave
Mary Ann Building	13,320	1910	1969	1824 SW Eleventh Ave
Montgomery Court	43,320	1916, 1925	1971	1802 SW Tenth Ave
Ondine Residence	121,239	1966	1976	1912 SW Sixth Ave
Parkway Building	40,500	1932	1969	1609 SW Park Ave
Saint Helens Building	36,280	1928	1969	1131 SW Montgomery St
Stratford Building	22,950	1927	1969	1609 SW Tenth Ave
West Hall	136,588	1986	Built by PSU	1705 SW Eleventh Ave
Sub-Total	497,992			
Housing Parking				
Ondine Residential Parking	24,056	1966	1976	1912 SW Sixth Ave
West Hall Parking	59,312	1986	Built by PSU	1705 SW Eleventh Ave
Sub-Total	83,368			
Housing Total				
	581,360			
University Total				
	4,198,629 square feet			

Appendix C



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Appendix D

Proposal: Cramer Hall Solar Photovoltaic Installation

Introduction

The time is ripe for Portland State University to fully embrace sustainability and demonstrate its recognition of the importance of investing in clean, renewable energy resources. Universities nationwide are making such investments and engaging new technologies that will undoubtedly shape our future. This proposal is for a 25-kilowatt solar photovoltaic installation on the rooftop of Cramer Hall. A 25-kilowatt array would be the largest in Portland and in the Oregon University System, drawing significant community and media attention and offering great potential to put PSU on the map as a clean energy leader in campus sustainability.

Project Objectives

There are three primary objectives of the proposed installation: (1) to “walk the talk”; (2) to provide educational opportunities for PSU and the Portland community; and (3) to support the burgeoning market for solar energy technologies.

(1) “Walking the talk”

A large-scale solar photovoltaic installation would serve as a meaningful testimony of PSU’s commitment to sustainability, an important part of which is nonpolluting, renewable energy practices. Indeed, a University investment in solar energy signifies support for decreasing reliance on fossil fuels for power, reducing environmental impacts, protecting public health, and enhancing educational opportunities.

(2) Educational opportunities

A photovoltaic array on campus would present new educational opportunities for students, faculty, and the Portland community. The proposed system would be comprised of a mix of panels and hardware types, allowing for a direct comparison of the solar equipment and the efficiency and energy output of each. A solar demonstration project of this nature would undoubtedly provide invaluable research material and classroom learning experiences for PSU students.

In addition, included in the proposal are estimates for state-of-the-art communications software that would track the energy output from the array and transmit the data to a network server, and then to university websites and educational kiosks. The data could also be transmitted to websites and educational displays in the community, such as OMSI, Oregon Office of Energy or Portland Public Schools, leading to new, unique community partnerships for PSU. Undoubtedly, the greatest attributes of this project would be enhanced educational and community partnership opportunities.

(3) Market influence

As a large energy consumer, PSU plays an important role in the regional energy market. It is critical that large entities and utility customers, such as PSU, send signals to the market for sustainable commodities and services, including renewable energy. Further, accounting project benefits beyond economics, or applying the “triple bottom line” principle shown in the accompanying spreadsheet, demonstrates the importance of valuing environmental and social benefits in financial decision-making.

Funding Opportunities

- Bonneville Environmental Foundation
- Energy Trust of Oregon
- Oregon Office of Energy - BETC and SELP
- Portland General Electric

Appendix D con't.

Proposal: Cramer Hall Solar Photovoltaic Installation

System Size (DC kWp)	25
Actual STC rating (DC kWp)	25.68
Estimated Output (AC kWp)	17.98
Number of PV modules in system	144
Average Annual Energy Production (kWh)	23,907

Estimated System Cost

Total Equipment Cost	\$	145,782
Shipping & Handling	\$	-
Custom Racking/Mounting (est. \$140/module)	\$	20,160
Design & Engineering	\$	2,000
Permitting	\$	1,500
Installation/PSU Supervision	\$	1,500
Installation/PSU Electrician	\$	3,500
Installation/Consulting	\$	2,000
Total Installed Cost \$		176,442
<i>Installed Cost per DC Watt \$</i>		<i>6.87</i>

Incentives and Credits

Energy Trust of Oregon Open Solicitation Grant	\$	57,780
Business Energy Tax Credit (net present value)	\$	47,639

"Triple Bottom Line"		
(1) Cost and Payback		
Total Cost	\$	176,442
Less Incentive Credits	\$	105,419
Less Donation/Other Grants	\$	-
Net Cost to PSU \$		71,023
<i>percentage of total</i>		<i>40%</i>
Annual Avoided Utility Costs	\$	1,619
Annual Green Tag Revenues	\$	2,391
<i>Payback Time (years)</i>		<i>36</i>
(2) Environmental Benefit		
Annual Carbon Dioxide Offset (lbs.)		31,390
Offset over 25 year system life (lbs.)		784,750
(3) Community Asset		
Educational value		+
Classroom research potential		+
University public relations		+
Community leadership		+
Oregon solar industry economic development		+

Optional Costs (not included above)

Solar Information Kiosk	\$	2,500
Computer Equipment (2 Dell GX60's, 1 monitor)	\$	1,220
Total Optional Costs		\$ 3,720

Current Utility Rate	\$	0.06770
Energy Trust Open Solicitation rate (per DC Watt)	\$	2.25
NWREC/BEF Green Tag Purchase rate (per kWh)	\$	0.10
NWREC/BEF Green Tag Contract Length (years)		5
BETC Net Present Value rate		27%
Est. Annual Energy Production (kWh/kW _{AC})		1329.58
Carbon Dioxide Offset (lbs per kWh)		1.313
DC -> AC derating factor		70%