2010 University of Oregon Campus Sustainability Assessment

Chris Stratton

This assessment evaluates the sustainability of the University of Oregon campus using three indicator categories: energy, water, and transportation. The University's performance for each category is evaluated using selected sustainability metrics. Future goals for those metrics are proposed as well as specific strategies for their achievement.

Terminal Project, Master of Science
Environmental Studies Program
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…and the entire Environmental Studies community at the University of Oregon

To the Reader

Dear Reader,

This assessment is an optimistic, forward-looking document. It is written with the hope that someone - someone like you - will pick up where I have left off and continue the work of evaluating the University of Oregon and nudging this institution towards sustainability. But before you take up this mantle, you should know that the institutional inertia of the University is considerable. Our institution has a reputation for sustainability, but based on my experience, in reality the University of Oregon is only slightly more "green" than the average institution in most respects.

However, this is not to say that we should seek to downplay the school's green reputation until it is well deserved. Quite the contrary; from my perspective, the school's green reputation is the sustainability reformer's greatest asset. Instead of an excuse to rest on our laurels, our reputation can be used as a standard that we (and our *administration*) must continually work to uphold…and not just in word, but in *deed*. Our reputation for sustainability can become what the University of Oregon is known for. It can become our most compelling recruitment tool.

In several departments and programs within the University, sustainability already *is* the reason students come here. For example, the University's Department of Architecture was recently ranked first in the nation for Sustainable Design Practice and Principles by *Architectural Record.*[1] Our Green Chemistry program is well known.[2] Our Environmental Studies program attracts outstanding students from across the globe. I could go on, but there are just too many examples to mention. The point is that, despite these shining individual examples, the University academic community's ethical values and environmental wisdom have not yet been systematically brought to bear on the operations of the University itself.[3]

This assessment is intended to offer an accurate evaluation of the University's environmental impacts with respect to energy, water, and transportation. But it is also intended to help substantiate demands for the University to systematically re-form campus operations under the principles of sustainability. From my perspective, heretofore there has been a pronounced absence of leadership among senior level University administration with regard to sustainability. Of course, I'm the kind of person who willingly spends two years of his life drafting a sustainability assessment for the campus, so my opinion may be atypical.

Thanks for reading, and for your efforts.

Chris Stratton
Eugene, Oregon, June 2010

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[1] http://archrecord.construction.com/features/0911BestArchSchools/0911BestArchSchools-2.asp
[2] http://greenchem.uoregon.edu/
[3] For an example of one such institutional re-envisioning, please see this interview with David Orr about his sustainable vision for my other alma mater, Oberlin College. http://www.postcarbon.org/blog-post/83610-an-interview-with-david-orr-author

Introduction

The word "sustainability" – or some variation of it – seems to be on everyone's tongue these days. And as of 2010, nearly every institution of higher education in North America has undertaken some kind of "sustainability initiative" on its campus. "Sustainable" is something a great many of us long to be.

What does "sustainability" mean?

Precisely because the term "sustainability" has such cache, many entities have tried to co-opt the term and interpret its meaning in a way that suits their own agenda.[4] The answer to the question "What is sustainability?" has been debated in countless books, scholarly articles, and in mass media over the last two decades. I do not wish to rehash those debates here.

I do, however, feel the need to explain briefly the understanding of "sustainability" that I was operating under while planning, researching, and writing this assessment. I would also like to address what I do *not* mean by "sustainability."

To me, *a sustainable way of life is one that can be continued in effective perpetuity without substitutability*.

Let me unpack those terms a bit. By "effective perpetuity", I mean that we live in such a way that can be continued indefinitely, and that when the end of our species does come, it will come as a result of events that are outside of our control. The "without substitutability" clause in my definition is in response to the popular "technological optimist" or "cornucopian" perspective, proffered today especially by mainstream neoclassical economists. This view holds that we needn't worry about the depletion of any specific resource or species or habitat, because the market will account for its depletion through the forces of supply and demand, and will ensure that an effectively identical substitute will come to fill its role in providing for our needs. Among this perspective's assumptions are 1) that everything in the world is a commodity whose value is determined by the market and 2) that nothing is irreplaceable. I believe that the notion of substitutability is antithetical to any meaningful definition of sustainability.[5]

In our efforts to assess the University of Oregon's progress towards sustainability, it is important to assure that we are operating under the same understanding of that term. And if we find that we are operating under different understandings of "sustainability", it behooves us to recognize those differences and explore their origins. My hope is that by describing my understanding of sustainability at the outset, I have provided explanatory

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[4] This is not to say that agendas are bad, but just that we should be upfront about them.

[5] It is because the traditional Bruntland Report (1987) description of sustainability leaves open the possibility of substitutability that I find that definition inadequate. ("development that meets the needs of the present without compromising the ability of future generations to meet their own needs.")

context for the metrics I chose to include in this assessment and the strategies I have suggested for improving our performance.

The structure of this sustainability assessment

This assessment is intended to be a follow-up to the 2007 University of Oregon Campus Sustainability Assessment.[6] That document contained eleven sustainability indicator categories; this one contains three. My intention with this assessment was to hone in on three categories that 1) are significant and 2) lend themselves well to quantitative evaluation. It is my hope that the structure I have developed in assessing these categories can be used by my successor(s) to assess the remaining sustainability indicator categories.

The three campus sustainability categories that I evaluate in this assessment are 1) energy, 2) water, and 3) transportation. Each of the three chapters has an Introduction section, followed by a Literature Review and a brief description of the Methodologies and Sources I used for my calculations. More detailed methodology descriptions are available in an appendix at the end of each chapter. I then discuss my Calculations and Findings. [more about this section below] Finally, in Discussion and Recommendations I offer specific policy suggestions for improving our performance for each category. Additional resources for each category are available as appendices at the end of their respective chapters.

In the Calculations and Findings portion of each chapter I have identified several metrics to help evaluate the University's progress towards sustainability. Each of these metrics is first introduced with a "report card". These report cards are intended to summarize our performance based on the metric, set future performance goals, and identify strategies whose adoption will help us achieve those goals.

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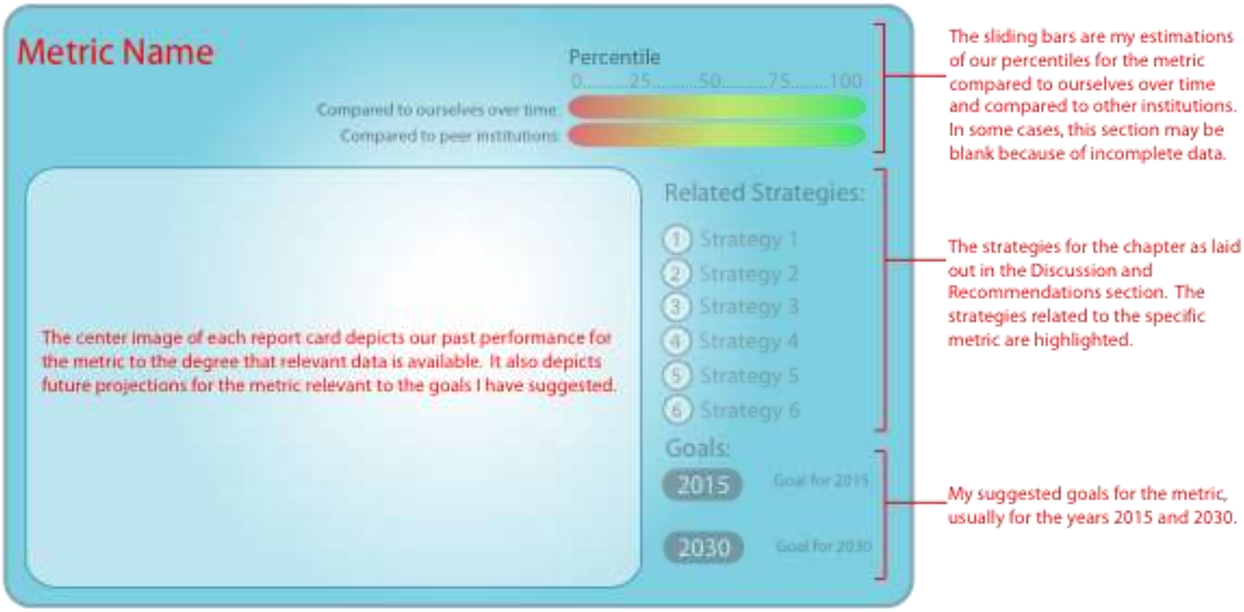
[6] http://sustainability.uoregon.edu/sites/sustainability.uoregon.edu/files/os-reports/campus_sust_assessment_-_may_2007_0.pdf

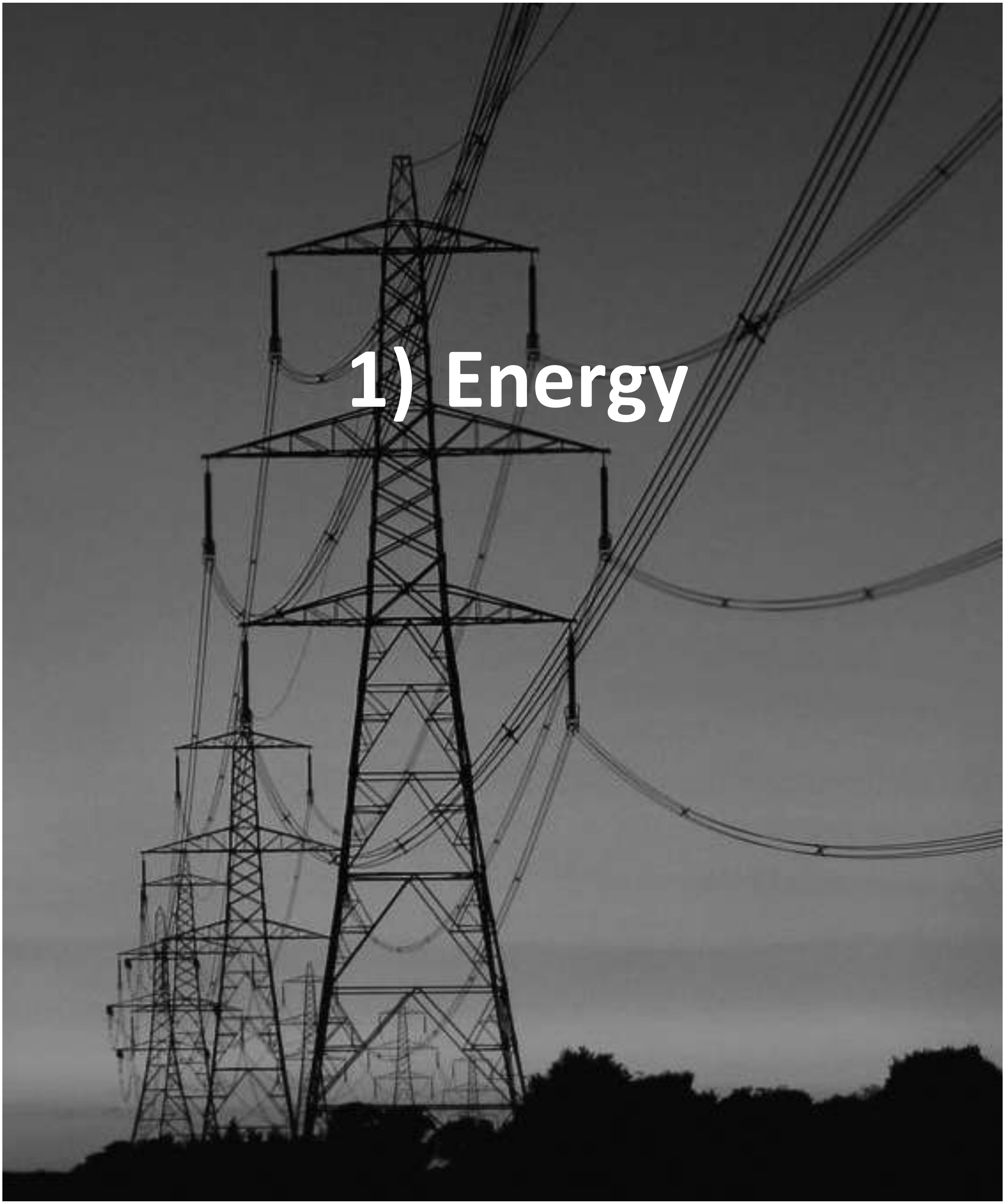
Report card overview:



About this assessment

I have created this assessment as partial fulfillment of the requirements for the Master of Science degree in Environmental Studies at the University of Oregon. Except where noted otherwise, I am solely responsible for the content of this assessment.

1) Energy



Introduction

Physics defines energy as the ability to do work. I have defined sustainability as living in a manner that can be continued in perpetuity.[7] The procurement and use of energy is an important component of working towards campus sustainability. For the purpose of this report, I will focus on the energy used to operate campus buildings because this category accounts for the large majority of campus energy use.

Energy on Earth takes many forms[8], but only has two ultimate sources: from the sun and from within the Earth itself. In order for energy sources to be sustainable, they must be derived from an infinite (or effectively infinite[9]) supply. The only effectively infinite energy supplies we have are gravity, geothermal radioactive decay, and the sun (a form of radiation from radioactive decay).[10] Solar energy can be harnessed directly through photovoltaic or solar thermal panels, or indirectly through wind turbines or by burning biomass, among other means. Gravitational energy takes many forms, including tides and geothermal heat.[11] Water turbines harness the combination of solar and gravitational energies that cause rivers to flow. Large-scale hydro power has historically been the primary source of renewable energy in the Pacific Northwest. Recently solar, wind, and tidal have begun to emerge as renewable energy sources our region.

Background

Everything we do on campus requires energy, and that energy has to come from somewhere. But we have a great deal of influence over how much energy we use to satisfy our needs and where that energy comes from. How much energy we use and how that energy is used constitute the **demand side** of energy. Where the energy we use comes from constitutes the **supply side** of energy.

From my perspective, demand-side strategies are less flashy than supply-side strategies (think adding insulation versus installing photovoltaics), and they may be much more inconvenient (think instituting urban growth boundaries versus just switching to biodiesel fuel). But, when utilized as a first option (before moving on to supply-side strategies) demand-side strategies:

- Tend to be more cost effective in both the short and long run, and
- Tend to address our environmental problems at a more fundamental, systemic level

7 Or least until some catastrophe not of our own making ends our species
8 http://www.fi.edu/guide/hughes/energytypes10.html
9 I say "effectively infinite" because they are of course not infinite, but for us, for all intents and purposes, they are. Our existence is continent upon the existence of the sun.
10 http://ecology.com/features/fossilvsrenewable/fossilvsrenewable.html
11 20% of geothermal heat comes from residual planetary accretion (gravitational energy released from a cooling Earth), and 80% comes from radioactive decay of elements within the Earth.

For these reasons, this report will suggest that the University of Oregon (UO) should exhaust all cost-effective demand-side energy strategies before moving on to supply-side strategies.

<u>The demand side of the University of Oregon's energy use:</u>

Because our submetering is incomplete, we cannot say for certain how we are using energy in University buildings at a granulated level of detail. However, the chart below shows how energy is generally used in US buildings.

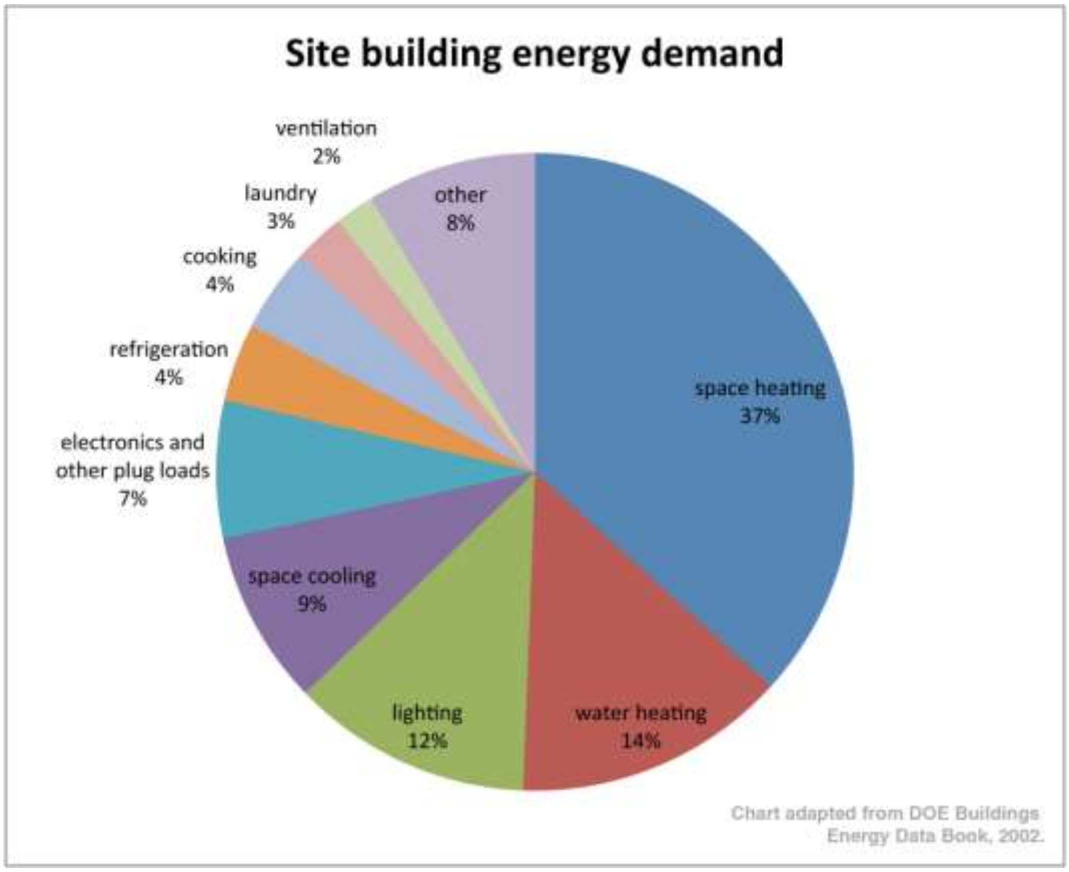


Figure 1.1: Building Operations Energy Use, US Average

<u>Supply Side</u>
The energy that enters the University of Oregon campus comes in two main forms: natural gas and electricity.

The University of Oregon purchases electricity and steam from the Eugene Water and Electric Board (EWEB). UO purchases natural gas from Northwest Natural. At their Central Power Station, UO burns natural gas (and occasionally distillate oil) to produce 60-pound steam and a small amount of electricity through co-generation.

Literature Review

The three primary sources that I examined in preparation for writing this report were the Association for the Advancement of Sustainability in Higher Education's (AASHE) Sustainability Tracking, Assessment, and Rating System (STARS)[12], the Sustainable Endowments Institute's (SEI) College Sustainability Report Card[13], and multiple campus sustainability assessments performed by other institutions.

STARS 1.0 was released in January 2010. The STARS system evaluates participating campuses using four rating levels, each with a minimum score:

Rating	Minimum
STARS Bronze	25
STARS Silver	45
STARS Gold	65
STARS Platinum	85

The STARS 1.0 assessment framework includes two energy-related credits:

Operations Credit 7 – Building Energy Consumption (8 points possible)

This credit is calculated based on a campus' energy use intensity percentage decrease since 2005.

Operations Credit 8 – Clean and Renewable Energy (7 points possible)

This credit is based on a campus' use of renewable energy. This credit includes:

- on-site production of renewable electricity
- on-site production of non-electric renewable energy (such as heat from biomass)
- catalyzing the development of off-site renewable energy sources and use of that energy on campus
- the purchase of renewable energy credits (RECs) from a certified source
- on-site co-generation of heat and electricity

STARS also includes credits for specific energy-related strategies, each worth up to 0.25 points, including temperature controls, lighting sensors, LED lighting, vending machine sensors, energy management systems, and energy metering

The energy assessment methodology of the Sustainable Endowment Institute's College Sustainability Report Card is not as clearly delimited as the methodology of the STARS

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[12] http://stars.aashe.org/
[13] http://www.greenreportcard.org/

framework. Their survey asks generally about energy efficiency initiatives on campus and sources of renewable energy on campus. But unlike STARS, SEI does not provide equations explaining how they calculate their scores.

The sustainability reports that I reviewed from other institutions considered energy efficiency and renewable energy, but their metrics were roughly the same as those used by the STARS assessment.

Methodology and Sources

I collected energy use data from Teri Jones, the Energy/Utilities Assistant for Capital Construction (the primary "point person" responsible for archiving utility use data for the University), and from Mark Nystrom, the Sustainability Graduate Student for the Office of Sustainability. The data came in the form of multiple Excel spreadsheets, which were based on energy bills from EWEB and NW Natural, from remote electronic metering, and from direct manual meter reading. Except where otherwise noted, all figures in this chapter are based on data obtained from Ms. Jones and Mr. Nystrom.

For a description of the methodology I used for the figures in the Energy chapter, please consult Appendix 1.6: .

Calculations and Findings

<u>Context</u>

Roughly one-third of University of Oregon's building operations site energy use is electricity and two-thirds is natural gas. The electricity we purchase is derived from large-scale hydroelectric (54%), coal (21%), natural gas (13%), RECs and on-site production (6%), nuclear (4%), wind (3%), and biomass (1%). Please note, these figures are represent *site* energy use. Total source energy is 56% from electricity and 44% from natural gas.

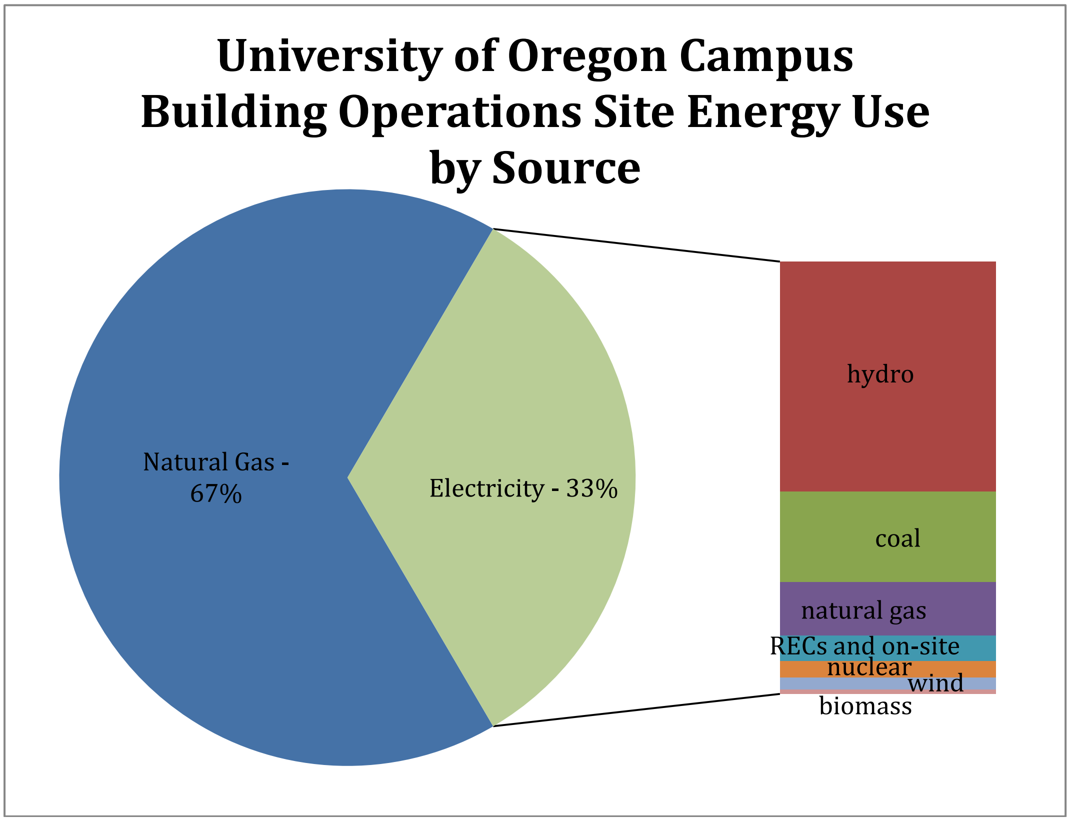

Figure 1.2: Building Energy Use by Source

The vast majority (92%) of all energy used by the University of Oregon is for the operation of buildings. These figures do not include energy used for campus maintenance because of the difficulty of estimation and the belief that campus maintenance energy use constitutes a negligible part of total University-related energy use.[14]

[14] Of course we can't know this for sure until we have determined a way to measure it.

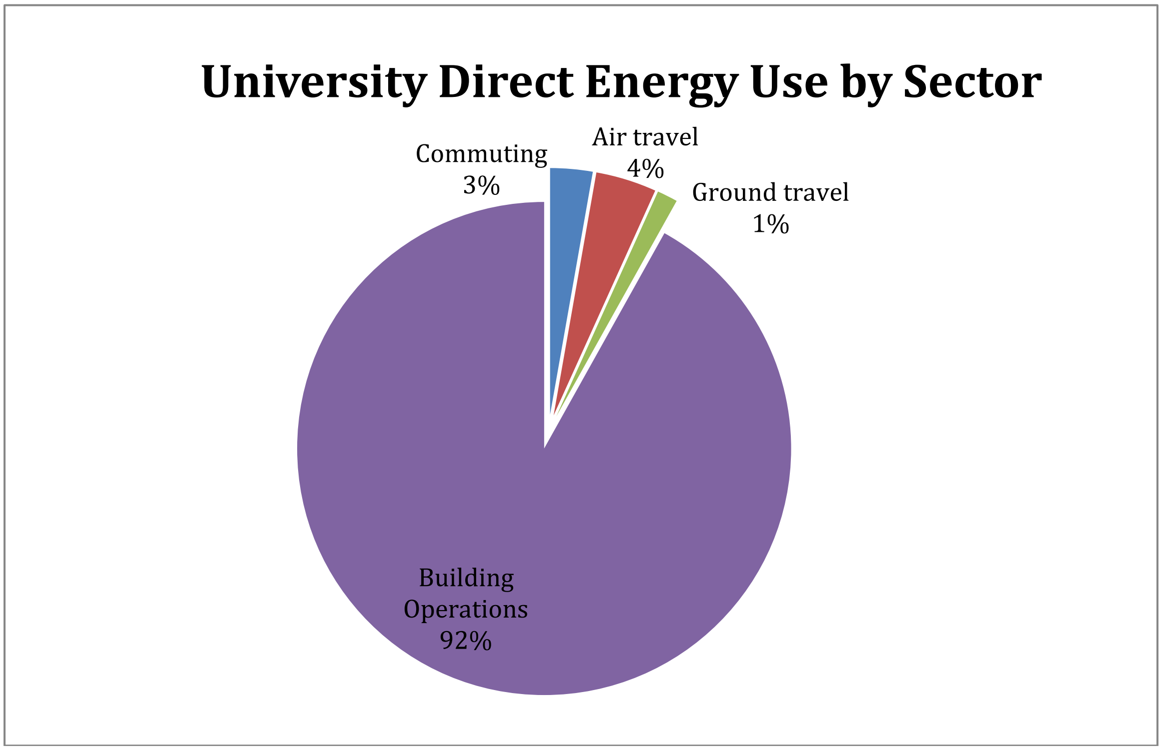

Figure 1.3: University Energy Use by Sector

Energy Sustainability Metrics

I would like to propose the following metrics to help us measure the sustainability of the University's energy use. I have chosen the following six metrics:

Metric 1: Submetering Percentage - indicates how well we understand our energy use.

Metric 2: Energy Use Intensity - indicates how efficiently we are using energy in our buildings.

Metric 3: Total Campus Energy Use - indicates how our total building operations energy use is changing over time, irrespective of changes in total campus building square footage.

Metric 4: Percent Renewables - indicates how sustainable are our sources of energy used in campus buildings.

Metric 5: Greenhouse Gas Emissions - indicates how carbon intensive our energy use is for all sectors of campus, including building operations.

Metric 6: LEED Certified Percentage - indicates how environmentally responsible our buildings are, including energy use but also measured comprehensively using an established evaluation framework.

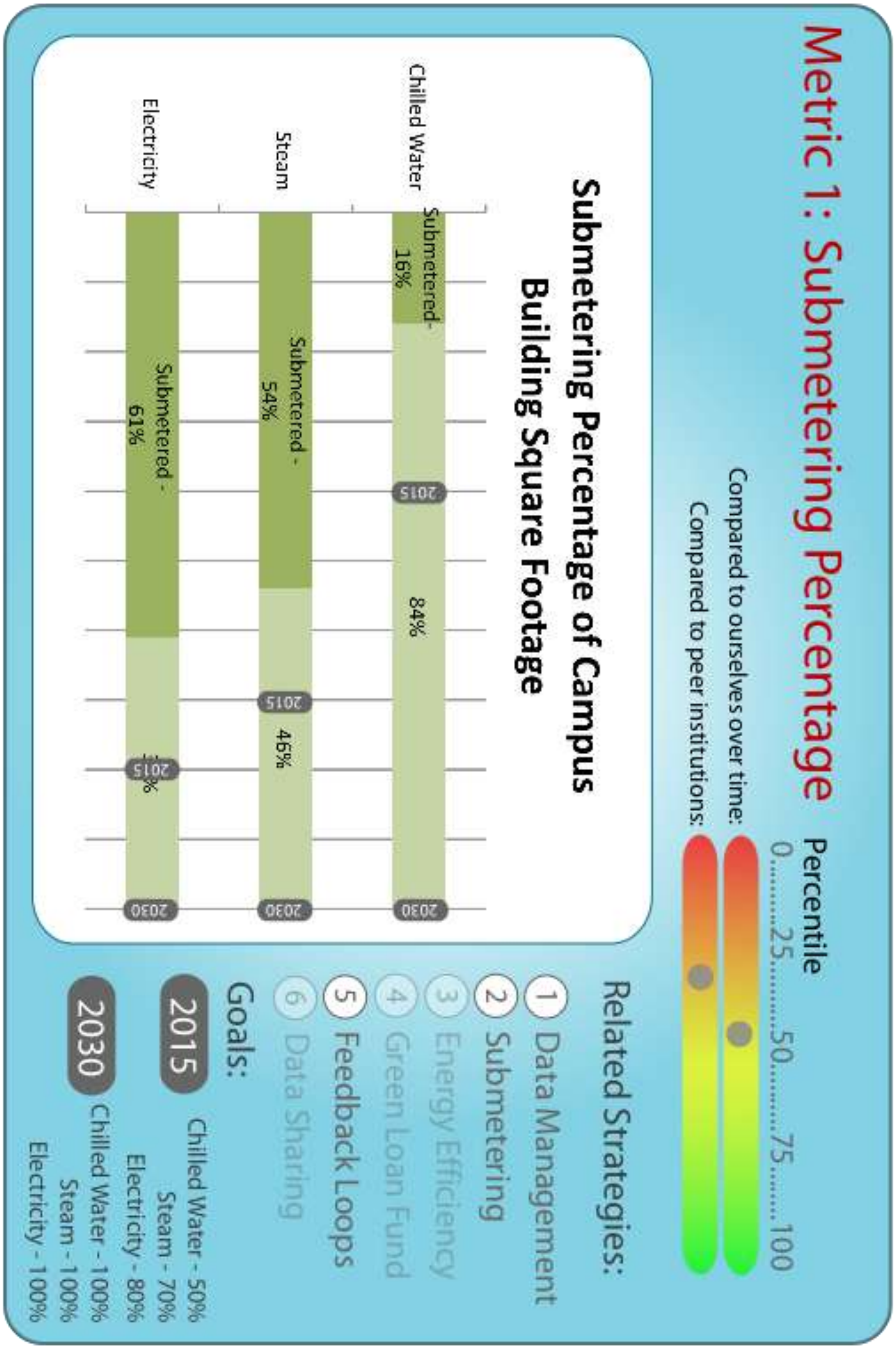

Figure 1.4: Energy Submetering

Metric 1: Submetering Percentage

Overview

Metering is the act of measuring how much a certain utility is being used. On the boundary of campus, there are meters that measure how much energy is entering campus. These meters are used by utility providers to determine how much energy the University is using and to charge us appropriately. These meters can tell us how much energy is being used by the entire campus, and we can track that Figure 1.over time, controlling for factors like yearly temperature fluctuations and increases in total campus square footage.

Total campus utility data is useful, but it cannot tell us which buildings are using the most energy or how we can prioritize our energy improvement resources most effectively. To identify the most energy intensive buildings, we need to know how much energy each building is using.

Submetering is the measurement of energy use at a scale smaller than the whole. In this case, submetering refers to the measurement of energy use at the *building* scale.[15] In addition to informing us how much energy each building is consuming, submetering also allows us to track whether or not various energy efficiency initiatives are having an impact. Submetering is a prerequisite for many of the feedback loop/incentive/behavior modification initiatives that can be used to reduce our energy use on campus. Charging individual departments for the amount of energy that they use is one such initiative. For more details about these initiatives, please see Strategy 5: Change energy users' behavior by closing information feedback loops in the Discussions and Recommendations section of this chapter.

Energy use in campus buildings comes in four main forms:

1. Natural Gas (Methane)
2. Electricity
3. Steam
4. Chilled Water

The majority of buildings on campus directly use only electricity, steam, and chilled water. The chilled water and steam are created by the Central Power Station using natural gas as a fuel and then distributed to individual buildings using a "district" system.

To get the complete picture with regard to a building's energy use, that building needs to be submetered for all forms of energy that it uses. For the majority of campus buildings, that means submetering for electricity, steam, and chilled water.[16]

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[15] For more refined energy use analysis, individual areas within larger buildings can themselves be submetered.
[16] A small percentage of University buildings use natural gas directly.

Goals

2015:
I propose a goal to increase our chilled water submetering percentage to 50% of campus square footage (from 16%) by 2015
I propose a goal to increase our steam submetering percentage to 70% of campus square footage (from 54%) by 2015
I propose a goal to increase our electricity submetering percentage to 80% of campus square footage (from 61%) by 2015

2030:
I propose a goal to have all university buildings submetered for all utilities by 2030.

These figures are based on current submetering percentages and on multiple new campus buildings coming on-line, all of which will be submetered. The goals also reflect Capital Construction's current initiative to retrofit existing buildings with submetering and to re-calibrate existing meters.

Recommendations for improving this metric:

- Examine submetering percentages for the campus over time.
- Compare our submetering percentages to those of other institutions.

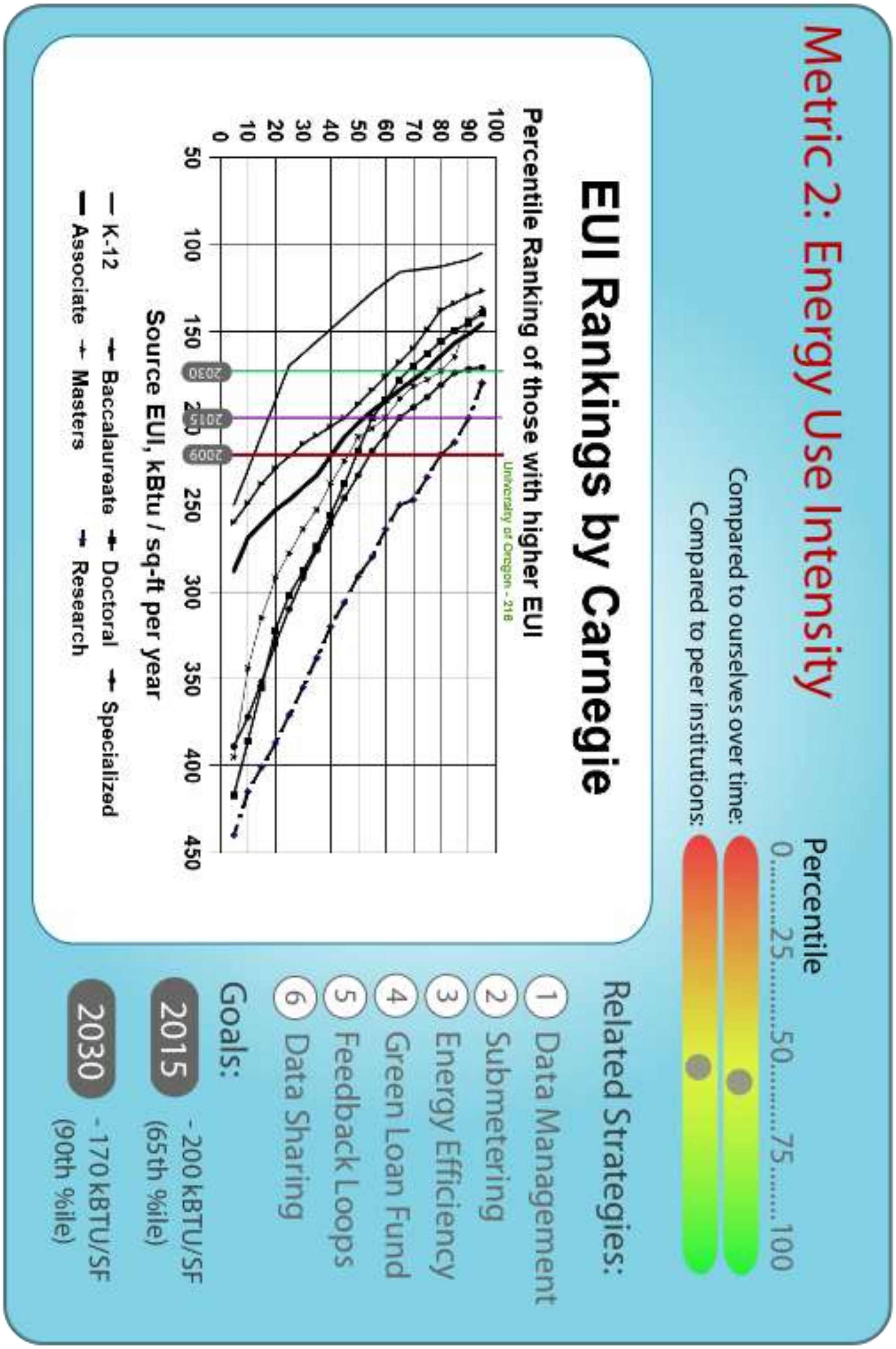

Figure 1.5: University of Oregon's Energy Use Intensity Percentile

Metric 2: Energy Use Intensity

Overview

One important metric that gives an indication of how efficiently the University of Oregon is using energy is campus energy use intensity (EUI). A building's EUI measures how much energy it consumes per unit area over the course of a year. This metric can be calculated for the campus as a whole and for individual buildings.

For more information about the methodology I used to calculate energy use intensity, please see Appendix 1.6: Energy Methodology Descriptions.

Using EUI to assess the energy efficiency of University of Oregon buildings

In addition to calculating EUI for individual buildings, it can also be calculated for the campus as a whole. I have calculated the University of Oregon's campus-wide EUI and plotted it on a chart from the Oak Ridge National Laboratory that plots EUI percentiles for various US institutions, separated into Carnegie classification.[17][18]

According to this chart our source EUI of 218 kBTU/GSF for 2009 puts at the 60th percentile compared to other institutions in our Doctoral Carnegie class. Keep in mind that the data used in this chart[19] are from 1998 and they are not controlled for heating/cooling load or building type distribution (although separating institutions by Carnegie class serves this latter purpose to some degree). These caveats notwithstanding, this chart gives us a general sense of where the energy efficiency of the University's buildings falls relative to those of other institutions.

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[17] http://classifications.carnegiefoundation.org/
[18] http://eber.ed.ornl.gov/commercialproducts/ORNL%20Higher%20Ed%20Energy%20Perf%20report.pdf
[19] The ORNL chart is the most recent EUI percentile comparison for colleges and university campuses that I could find

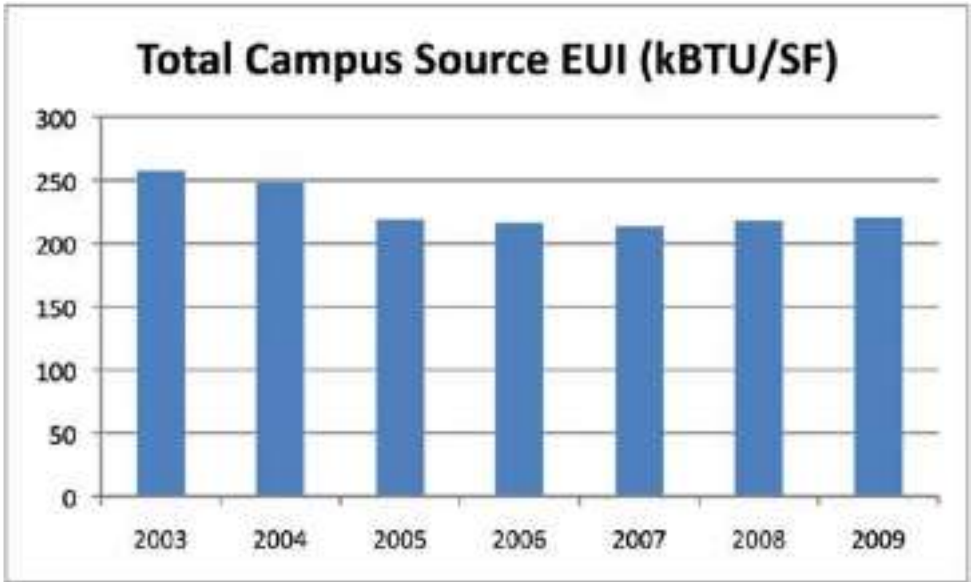

Figure 1.6: Total Campus Energy Use Intensity

Figure 1.6 shows how the University's energy use efficiency is changing over time. The EUI for the University has been relatively constant since 2005, hovering between 210 – 220 kBTU/GSF.

<u>Energy Use in Individual Building Types on Campus</u>

I have categorized UO building types into the following:

1. **Academic** – primary use is classrooms
2. **Athletics** – primary use is physical activity
3. **Laboratory** – primary use is physical/biological/chemical materials research
4. **Library** – used for housing books and academic work space
5. **Administration/Office** – primary is office workspaces
6. **Residential** – primary use is housing
7. **Student life** – primary use is open gathering spaces

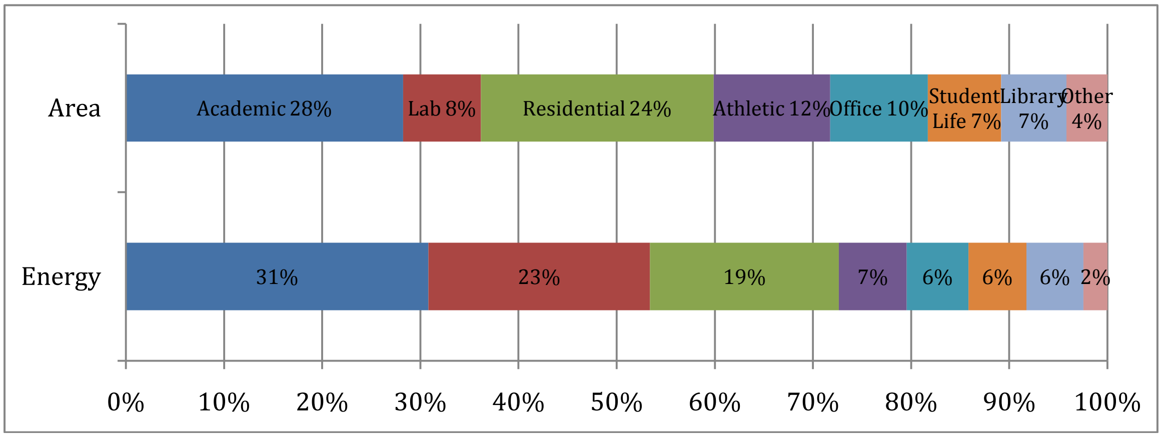

Figure 1.7: University Buildings Area and Energy Use Percentages

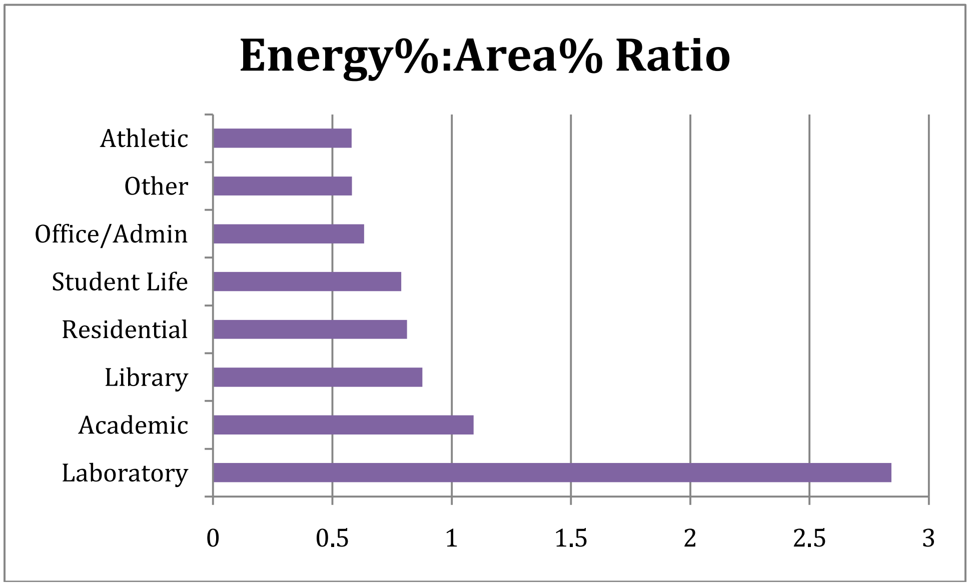

Figure 1.8: Building Energy Use Percentage to Building Area Percentage Ratio

Please see Appendix 1.3: EUI Percentiles for Representative University Buildings for EUI percentile graphs for representative University buildings of each building type.

<u>Prioritizing Efficiency Resources</u>

These data and the data in Appendix 1.3: EUI Percentiles for Representative University Buildings suggest that the Laboratory, Academic, and Residential campus building categories have the most potential for energy efficiency improvement. Granted, these conclusions are based on a small sample size and incomplete utility data.

The laboratory buildings on campus, especially Klamath Hall and Zebrafish International Resource Center, seem particularly ripe for energy efficiency improvements.

Goals

2015 – I propose the total energy use intensity for all University of Oregon buildings will be reduced to 200 kBTU/GSF (65^{th} percentile) by 2015
2030 – I propose the total energy use intensity for all University of Oregon buildings will be reduced to 170 kBTU/GSF (90^{th} percentile) by 2030

These goals are based on the implementation of multiple strategies on campus, including:

- Improved submetering
- Charging departments for energy use
- Implementation of the energy efficiency revolving loan fund

The 2030 average EUI of 170 kBTU/GSF doesn't mean that *every* building should be at that level. In addition to having an aggressively low *maximum* EUI for new buildings, we could designate one or more specific demonstration/prototype buildings that incorporate features that enable an extremely energy efficient building. The more successful features of this "test" building could be retrofit into existing buildings.

Recommendations for improving this metric:

- Normalize for yearly heating and cooling loads (this will entail separating out energy used for heating and cooling from other uses) – See Appendix 1.4: Normalizing EUI Calculations for Heating/Cooling Load.
- Improve the accuracy of site to source conversions by directly calculating source-specific efficiency values
- Compare University of Oregon data to the same data for the same time period from similar institutions in the same climate having the same types of buildings (in other words, control the EUI data for as many factors as possible).
- Track representative campus buildings over time

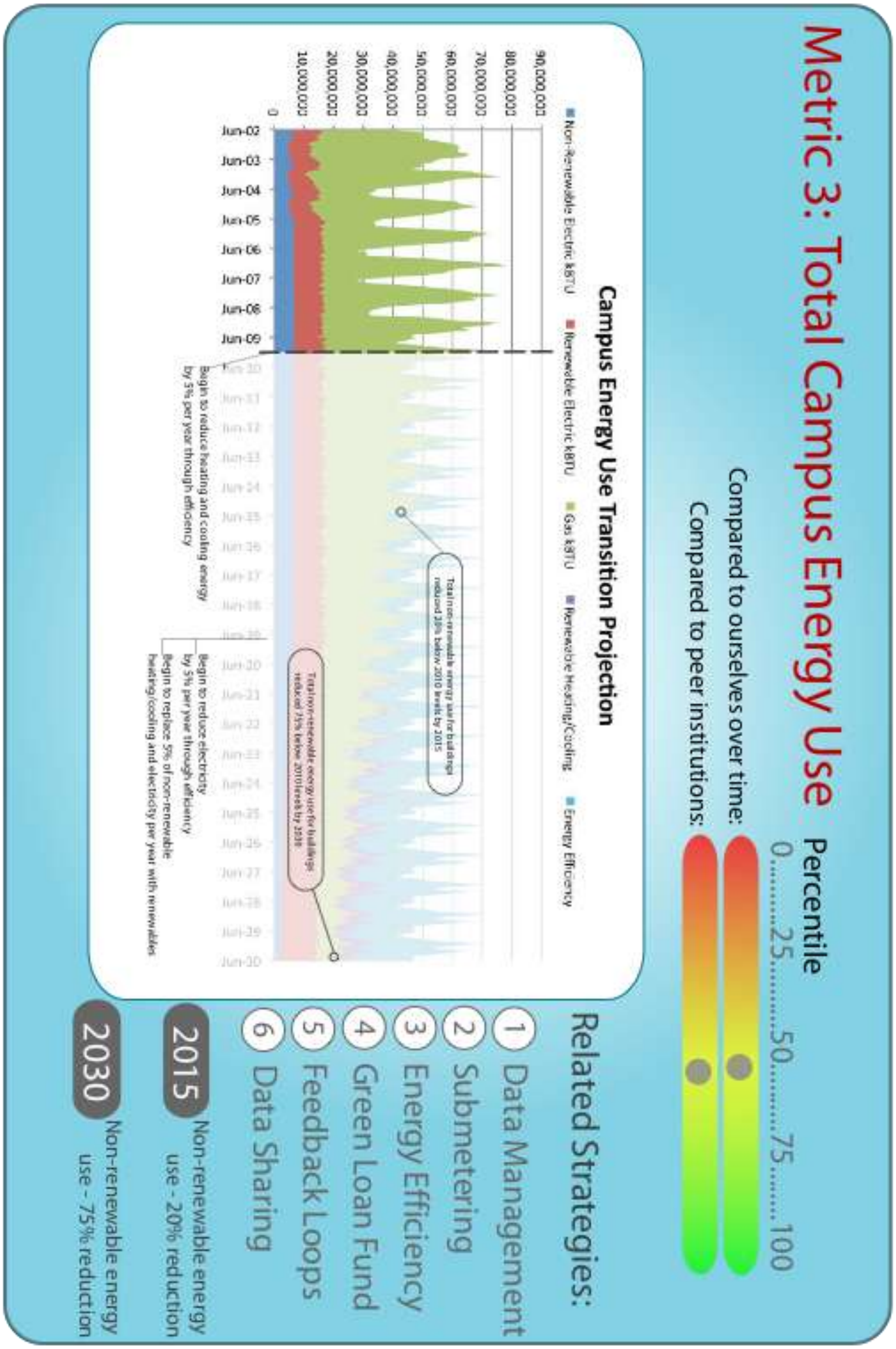

Figure 1.9: Total Campus Energy

Metric 3: Total Campus Energy Use

Overview

This metric measures how much energy the University's buildings are using in the aggregate, irrespective of changes to total campus square footage. Total campus energy use includes energy from natural gas and electricity. Electricity use is divided into renewably sourced and non-renewably sourced. Figure 1.10 shows the seasonal fluctuations in energy use (primarily with natural gas use) and the general energy use trend for University buildings.

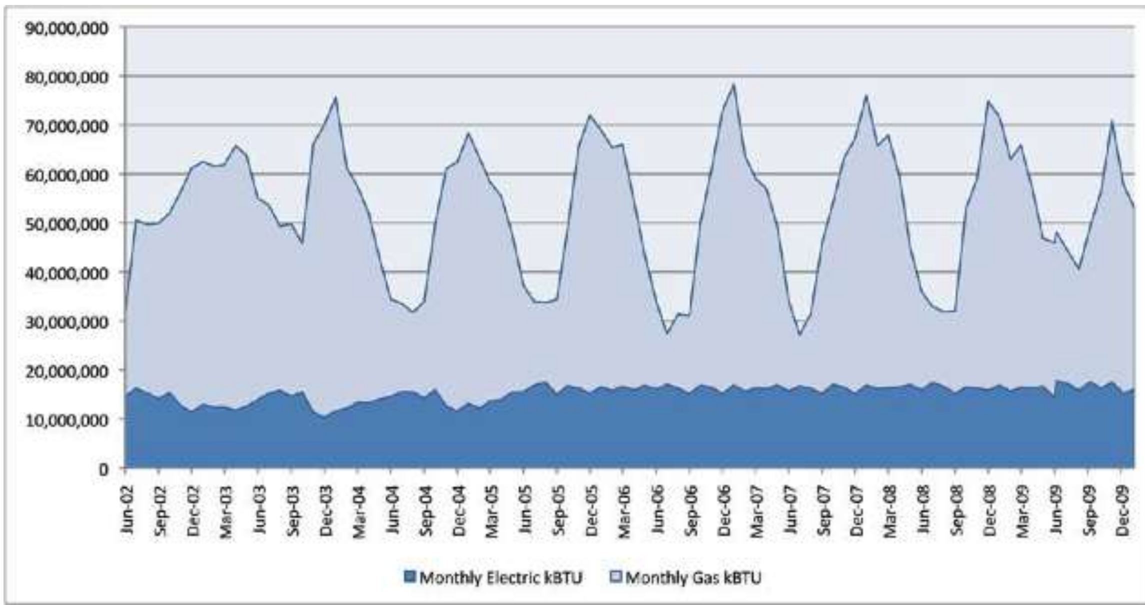

Figure 1.10: Total Campus Energy Use by Source

Total energy use should be considered along with energy use intensity. Even if our EUI is decreasing, our total energy use may be increasing. This is possible if new, large, yet relatively energy-efficient campus buildings come on line. The new 380,000-square-foot basketball arena is just such a building. It is projected to be LEED silver certified.[20] But sustainability is essentially about the recognition of physical and ecological limits, and the perpetual addition of new buildings on campus – even LEED-certified ones – is not sustainable.

The total energy use metric seeks to establish a baseline for how much total energy we're using on campus and to begin the process of first capping total energy use and then reducing it over time. This aspiration is made much more difficult by the fact that our total campus square footage continues to expand.

[20] Personal correspondence with Hoffman Construction representative, 13 October 2009.

Goals

2015: I propose a 20% reduction (based on 2010 levels) in non-renewable campus energy use by 2015
2030: I propose a 75% reduction (based on 2010 levels) in non-renewable campus energy use by 2030

The graph in the "report card" above shows a 5% yearly improvement in heating/cooling efficiency from 2010 onward. Beginning in 2020, it displays a 5% yearly efficiency improvement in electricity use and the gradual displacement of non-renewable electricity and heating/cooling energy sources with renewables. These goals are based on the University's adoption of all six strategies outlined in the Discussion and Recommendations of this report.

These energy figures do *not* take the increase of total campus square footage into consideration. Several significant campus buildings will be coming on line in the near future, and their presence will exert upward pressure on both total and non-renewable campus energy use.

Recommendations for improving this metric:

- Factor in projected increases in total campus square footage
- Separate heating and cooling energy use from other uses
- Consider the effects of climate change on heating and cooling loads
- Perform a regression analysis to get a trend line for total energy use
- Break renewable electricity into on-site and off-site production

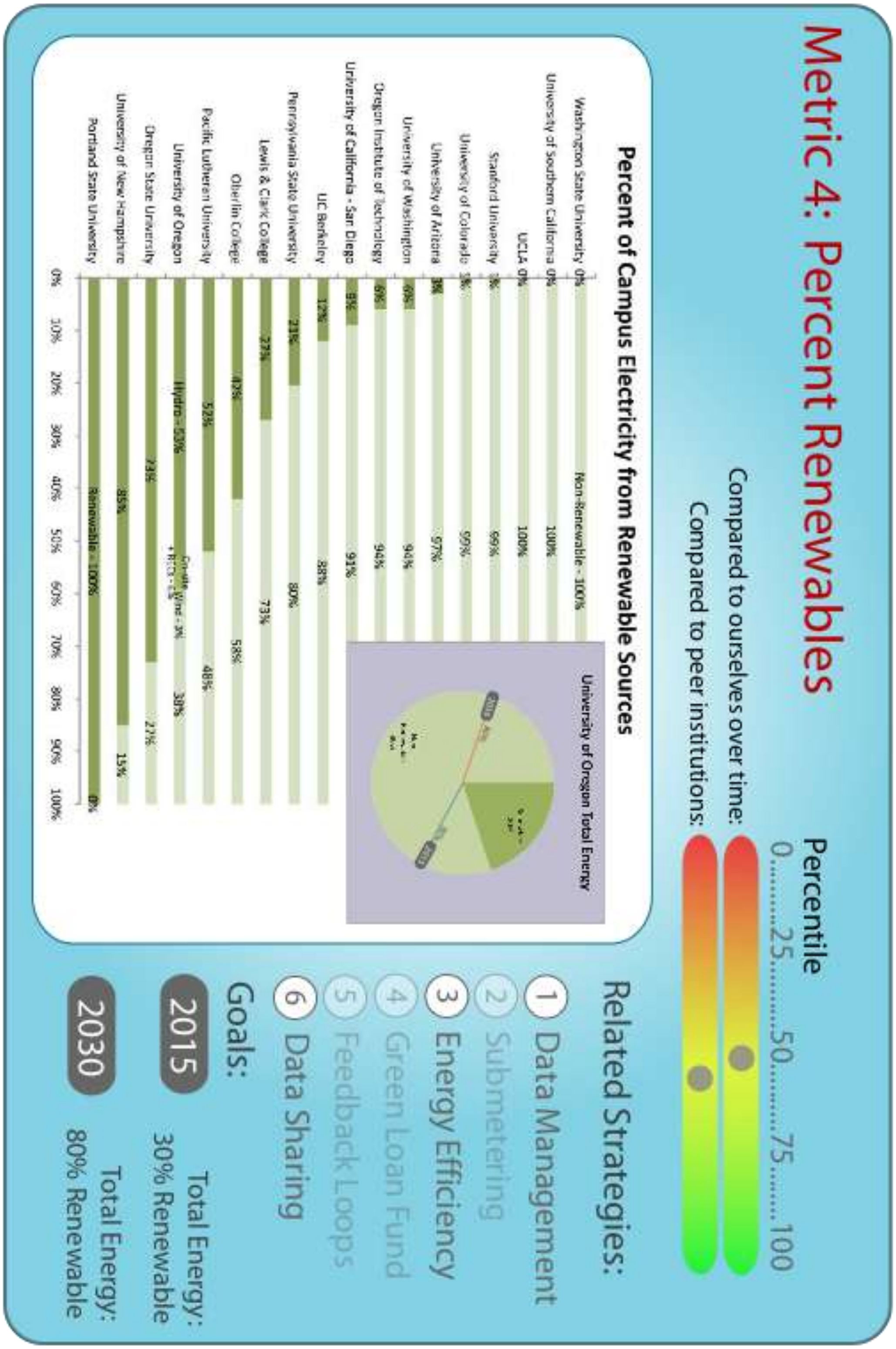

Figure 1.11: Percent Renewable Electricity and Energy

Metric 4: Percent Renewables

Overview

This metric indicates the percentage of energy used in University buildings that is derived from renewable sources. The University's renewable electricity percentage is compared to those of selected peer institutions. The renewable percentage of total energy is calculated for the University but not compared to peer institutions because renewable total energy data for other institutions is not widely available.

Currently, 20% of energy used in campus buildings is derived from renewable sources (primarily large-scale hydroelectric power). Campuses that have a significant percentage of their electricity coming from renewable sources tend to be purchasing that electricity in the form of Renewable Energy Credits (RECs). This approach is expensive and diverts resources away from addressing more fundamental energy problems. Many campuses that are currently purchasing RECs (such as Portland State University), are beginning to divert those funds toward more long-range approaches such as efficiency and on-site production of renewable energy. In the short and mid term, because it reduces total energy use, efficiency is the most cost-effective means of increasing the percentage of campus energy that is derived from renewable sources.

Goals

2015: I propose a goal for the University to have 30% of its total energy derived from renewable sources by 2015. This would come not from replacing non-renewable energy with renewable energy, but rather reducing all energy use through energy efficiency measures.

2030: I propose a goal for the University to have 80% of its total energy derived from renewable sources by 2030. This goal would be met through continued expansion of energy efficiency measures throughout campus buildings as well as the replacement of non-renewable electricity and heating sources with renewable ones beginning in 2020, as described above in Metric 3: Total Campus Energy Use.

Ways to improve the measurement of this metric in the future:

- Measure how the percentage of total campus renewables has changed over time
- Break up renewable energy on other campuses into base utility, purchased RECs and on-site production
- Compare UO's renewable total energy percentages to those of other institutions

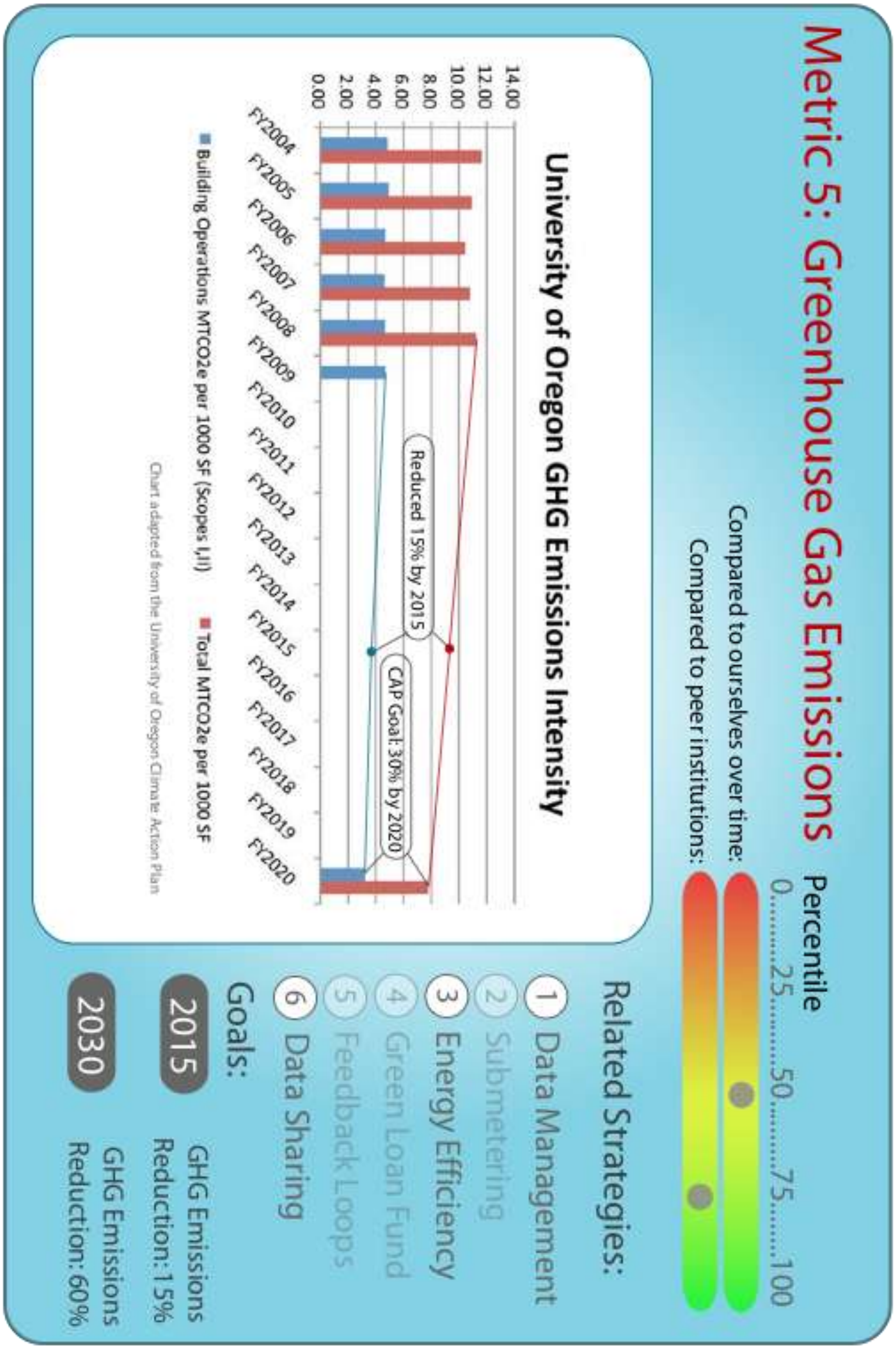

Figure 1.12: University Greenhouse Gas Emissions

Metric 5: Greenhouse Gas Emissions

Overview

This metric tracks greenhouse gas (GHG) emissions intensity for University buildings (Figure 1.14, blue bar) and for the University as a whole (red bar). Emissions intensity is measured in metric tons of carbon dioxide equivalent per one thousand gross square feet of campus building (MTCO2e/1000 GSF) per year. The blue bar includes direct (scope I) and indirect (scope II) emissions that come as a result of campus building operations. The red bar also includes University emissions (scopes I and II) from other sources, including transportation and University business-related travel. The red bar does not include the embodied energy of products used on campus (scope III emissions).

As is the case with energy use, reducing GHG emissions intensity does not by itself indicate an improvement of the University's sustainability; total University GHG emissions must also be considered.

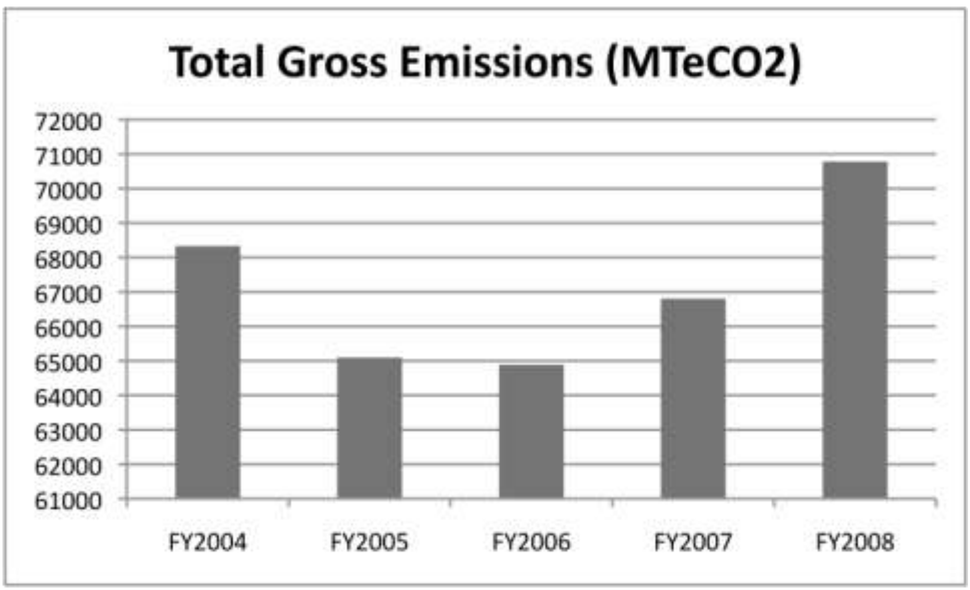

Figure 1.13: Total Gross Emissions

Total campus GHG emissions are trending upward in the last several years, while emissions intensities (normalized for square footage) are remaining relatively constant. This report defers to the recommendations of the recently released University of Oregon Climate Action Plan. The College and University Presidents Climate Commitment (which UO President Lariviere signed) calls for a reduction of total GHG emissions to 10% below 1990 levels by 2020. Since our emissions have increased roughly 23% from 1990 to 2008, our actual reduction over the next decade would be closer to 27%. And since our total square footage will increase significantly over that time, our per-square foot emissions intensity will need to decrease significantly for the entire campus.

Goals

2015: I propose a 15% reduction (from 2010 levels) of University GHG emissions intensity (to 9.5 MTCO2e/1000 GSF) by 2015. This goal is based on the GHG reduction projections laid out in the Climate Action Plan, and on the adoption of improved utility data management and the deployment of energy efficiency projects throughout campus

2030: I propose a 60% reduction of University GHG emissions intensity (to 7.5 MTCO2e/1000 GSF) by 2030. This figure is based on the Climate Action Plan and the increased adoption of renewably-sourced electricity and heating energy beginning in 2020, as well as comprehensive energy efficiency improvements. The construction of additional building on campus is certain to increase total University GHG emissions, but is likely to *decrease* GHG emissions intensity, because new buildings will be more energy efficient than existing buildings. This underlines the importance of capping total GHG emissions, not just reducing emissions intensity. Please consult the Climate Action Plan[21] for a discussion of specific total emissions reduction targets for the University.

Recommendations for improving this metric:

- Factor campus buildings that are proposed to be built and currently under discussion into emissions intensity goals and projections
- Compare UO's emissions intensity and total emissions data to those of peer institutions[22]

[21] http://sustainability.uoregon.edu/sites/sustainability.uoregon.edu/files/os-reports/CAP_2_0_0.pdf
[22] Other universities' greenhouse gas inventories and climate action plans are available at http://www.aashe.org/resources/climate_action_plans.php

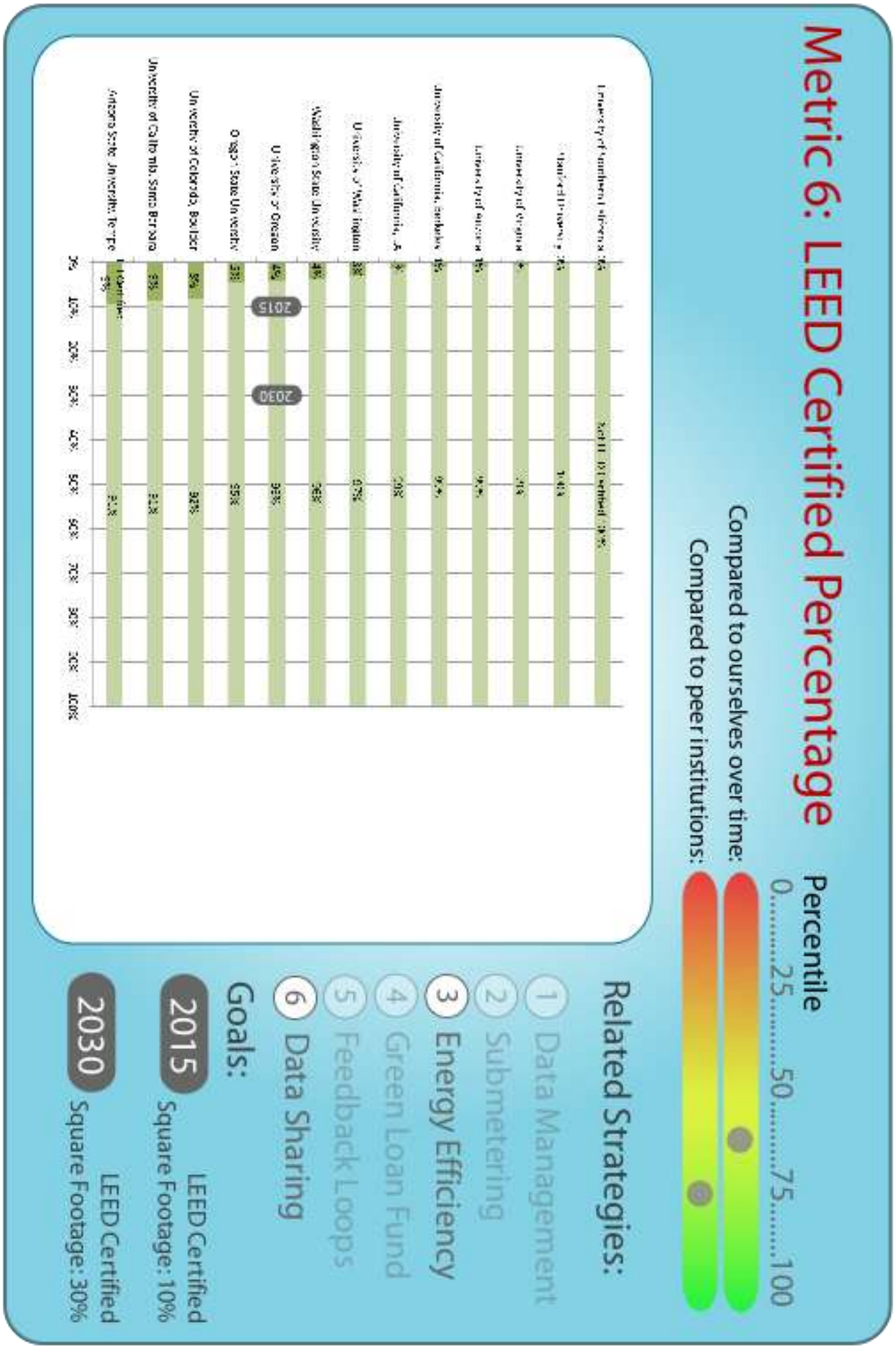

Figure 1.14: LEED Certified Building Square Footage Percentage

Metric 6: LEED Certified Percentage

Overview

This metric in intended to measure how "green" (broadly defined) our campus buildings are. The LEED (Leadership in Energy and Environmental Design) criteria include direct energy use considerations in addition to multiple other categories of consideration, including indoor air quality, material sourcing, recycled content, the promotion of non-motorized forms of transit, et cetera.[23] To assess how green our buildings are, this metric examines what percentage of total campus square footage is LEED certified.

Four percent of the University of Oregon's square footage is LEED certified. This is a low percentage, but still there are few institutions in the country that have higher percentages. These low numbers are due to the young age of the LEED standards, as well as the expense entailed in getting LEED certification.

Although the LEED framework has its detractors, it remains the most widely accepted certification system for identifying environmentally sensitive buildings. The high cost of LEED certification is similar to the purchasing of RECs in that it can serve to divert funds from energy efficiency and other measures. If a building meets LEED standards, it becomes no more environmentally responsible through the process of certification. It does, however, become a lot more expensive. And that money can used to reduce the campus' environmental impact in other ways.

However, if a building is LEED certified you can be assured that it has met certain standards. If a building is not certified or has been internally verified as LEED certified "equivalent", it may or may not actually meet the LEED standards. Moreover, the LEED framework can be a useful tool for holding both contractors' and funders' feet to the fire with regard to holding to their environmental commitments even when the project funds gets tight.

In 2004, the Oregon Department of Administrative Services (whose purview includes state universities) issued a policy manual for sustainable facilities development[24], and required all new campus construction to be internally audited using this manual. The manual is based on LEED 2.0. New building projects are required to achieve the equivalent of a LEED Silver rating, and all retrofit projects must achieve the equivalent of a LEED certified rating.

New university buildings must also meet State Energy Efficiency Design (SEED) standards[25], which, unlike LEED, require an 18-month post-occupancy energy evaluation period to verify that buildings are performing as designed.

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[23] http://www.usgbc.org/DocumentDownload.aspx?DocumentID=3330%20
[24] to comply with the governor's executive order (EO-00-07:EO-03-03) and Oregon state law (ORS 184.421 – 184.470)
[25] http://oregon.gov/ENERGY/CONS/SEED/Guidelines.shtml

Currently, Lillis Hall is the only building on campus that is LEED certified. The White Stag building in Portland, which the University holds a long-term lease on, and which was retrofitted by the University and other partners in 2007, is LEED certified. As mentioned earlier, a 380,000 square foot basketball arena is expected to be LEED certified and is slated for opening in late 2010.

Goals

Since the jury is still somewhat out with regard to the evolution of LEED and the University of Oregon, the goals for this metric may be considered tentative.

2015: I propose that 10% of total University building square footage be LEED certified by 2015. The addition of the basketball arena alone will likely get us near or at this figure.

2030: I propose that 30% of total University building square footage be LEED certified by 2030. This figure would likely include LEED certified building retrofits, as many campus buildings become repurposed over time. (See Straub, Hendricks, Friendly, Deady, et cetera.) This may also include new dorm buildings on campus, as the University is looking to both replace several existing residence halls on campus and expand its on-campus housing capacity in the coming years.

Recommendations for improving this metric:

- Develop a green building standard that is just as rigorous as LEED, but doesn't cost as much to certify
- Gather square footage data from other institutions directly instead of through a third party

Discussion and Recommendations

Based on the findings discussed above, my recommendations for improving the sustainability of the University's energy use focus on three themes:

1. Improve our understanding of University energy use
2. Replace non-renewable energy with efficiency
3. Replace non-renewable energy with on-site renewables

I believe that these themes should be addressed in the order that they are listed:

Until we have a better understanding of our energy use, we cannot make informed decisions about improving it. That is not to say that no action should be taken until we have complete information, but just that improved understanding should be the first overlapping theme that we begin to address.

Soon after beginning efforts to improve our energy use understanding, I believe we should move on to eliminating non-renewable energy use with energy efficiency.

Finally, after we have begun to exhaust cost-effective energy efficiency opportunities should we move on to replacing the remaining non-renewable electricity and heating sources with on-site renewables.

Strategies

Below, I will discuss six specific strategies for improving the sustainability of the University. These strategies align with the three themes discussed above, and are intended to help achieve the goals stated in the metrics section. However, before discussing these individual strategies, I would first like to establish a broad, overarching energy strategy for the campus, towards which all other strategies can be organized around.

That overarching strategy is for the administration of the University of Oregon to **declare a cap on campus use of non-renewable energy.**

The recently signed Climate Action Plan for the University of Oregon calls for a leveling off (cessation of increase) of total University-related carbon emissions by this year (2010). The energy used to operate campus building is responsible for the majority of University-related carbon emissions; yet currently there are no policies in place to operationalize this commitment to capping carbon emissions with respect to campus energy use.

This report calls for the University administration to declare a cap (at 2010 levels) on the total amount of non-renewable energy used to operate campus buildings. This cap will mean that the energy used to operate all new campus buildings will have to 1) come from exclusively renewable sources and/or 2) be offset by reducing energy demand elsewhere on campus through efficiency measures.

The following six strategies are intended to help the University transition to this campus energy carbon cap and to achieve the goals for each of the energy sustainability metrics laid out in the Calculations and Findings section.

Strategy 1: Improve utility data management
Strategy 2: Submeter campus energy use
Strategy 3: Invest in energy efficiency
Strategy 4: Remove initial capital barriers to energy efficiency projects
Strategy 5: Change energy users' behavior through feedback loops
Strategy 6: Compare sustainable energy data across institutions

Strategy 1: Improve energy data management

Why?
Currently, campus utility data is scattered and unwieldy. There are thirteen electricity accounts with three different utility companies, whose bills come in different formats and use differing billing periods (see Figure 1.15). The electricity bills for athletics buildings are separate and must currently be collected manually through the athletics office. Natural gas utility data is similarly convoluted.

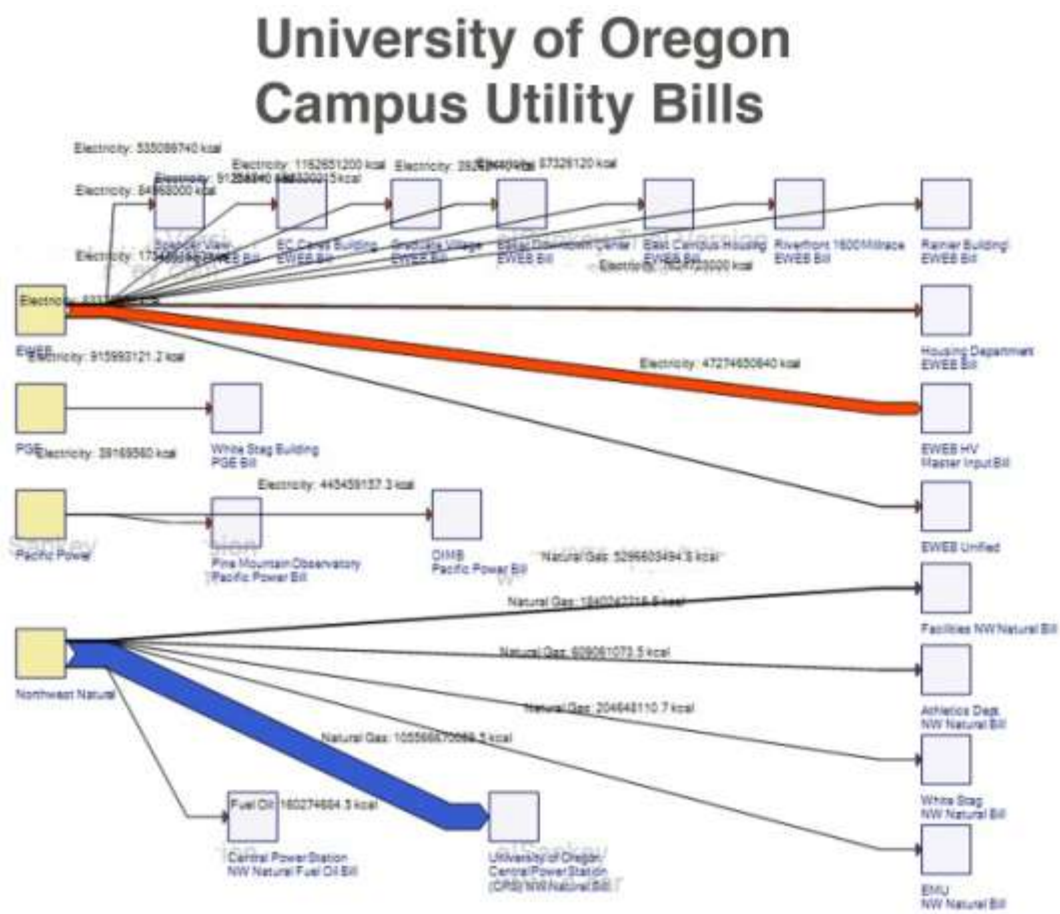

Figure 1.15: Campus Utility Bills

Very little of this utility data collection is automated, and any compilation and analysis that is done must be performed manually. Progress on the compilation of campus utility data is currently impeded by severe understaffing -- only *part* of one full-time facilities position (Teri Jones, Energy/Utilities Assistant in Capital Construction) is devoted to the collection and analysis of utility data for the *entire campus*.

How?

Create a centralized, automated, digital repository (Data Acquisition System)[26] for all campus utility data.

Hire additional staff to help create and maintain this repository. This position may fall under the aegis of Facilities and/or the Office of Sustainability. This position may be combined with the green campus loan fund administrator position proposed in Strategy 4: Remove initial capital barriers to campus energy efficiency projects.

Expand the use of electronic submetering on campus to reduce the need for manual meter reading.

[26] http://www.energystar.gov/index.cfm?c=assess_performance.gather_data

Consult with other organizations that have successfully implemented a digital data acquisition system for their utilities. The City of Eugene has such a system.

Strategy 2: Submeter campus energy use

Why?
Currently, only 61% of campus square footage is submetered (metered at the building level) for electricity. 54% of campus square footage is submetered for steam, and only 16% of campus square footage is currently submetered for chilled water. Without submetering, we have very little idea of how much energy a building is using.

Even though some long-serving facilities staff have good estimates of building usage based on years of experience, the information may be inaccurate and more importantly it exists only in their heads, making public access impossible. Not to mention, some day these people will retire.

Measuring utility use on a building level will allow us to identify buildings that have the most potential for improvement. Prioritizing our efficiency efforts on these buildings will maximize savings of both energy and money.

How?
Submeters can allow building managers to identify and eliminate wasted energy. After their up-front cost is recouped, submeters provide pure long-term savings through improved monitoring and data acquisition.

The primary impediment to submetering is its up-front cost. According to a report from the EPA's Energy Star program, typical submetering costs are in the neighborhood of $1600 per building.[27] This cost can be offset in multiple ways:

1) EWEB incentives
2) Establishing a green campus loan fund (see Strategy 4: Remove initial capital barriers to campus energy efficiency projects)
3) Charging departments for utilities use (see Strategy 5: Change energy users' behavior by closing information feedback loops)

Strategy 3: Invest in energy efficiency

Why?
Energy efficiency is not just low-hanging fruit; it is fruit that is lying on the ground.
- Steven Chu, US Secretary of Energy and Nobel Laureate[28]

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[27] http://www.energystar.gov/ia/business/higher_ed/Submeter_energy_use.pdf

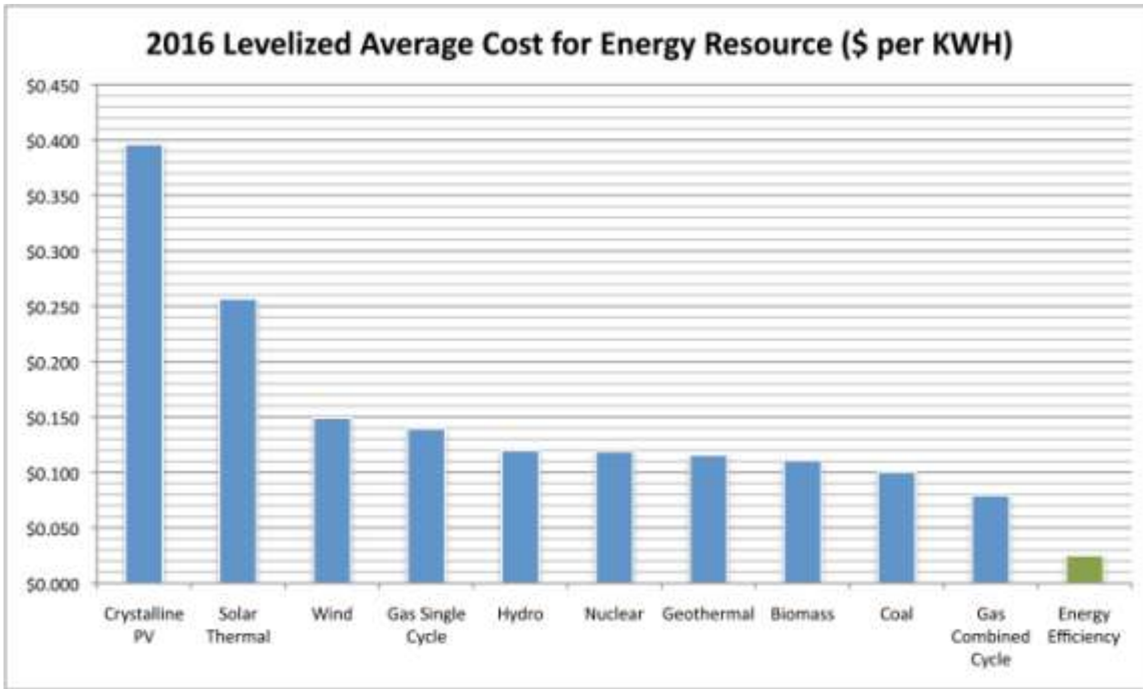

Figure 1.16: Levelized Average Cost for Selected Energy Resources[29][30]

Figure 1.16 above shows the life-cycle cost of various energy resources. These values do not consider subsidies, either in the form of direct government incentives (which would decrease the price of renewables) or ignored negative externalities (which would increase the price of non-renewables). This chart demonstrates that in the current environment, efficiency is by far the most cost-effective renewable method of meeting energy demand. On average, obviating a kilowatt-hour of energy through efficiency is more than four times less expensive than producing that same kilowatt-hour with the least expensive renewable energy source.

Energy doesn't have any value in and of itself. Energy only has value to the degree that it allows us to do the things we want and need to do – condition and light our buildings, cook our food, allow us to communicate, et cetera. It is these services that we want; energy is only our means to getting them. Energy efficiency can be thought of as the amount of these services we receive per unit of energy that we consume. The most cost-effective way to sustainably provide these services on campus is not by switching to solar, biomass, or wind. The most cost-effective way to sustainably provide these services is by finding ways to get the same services using less energy – that is, to improve campus energy efficiency.

Only after pursing all feasible campus energy efficiency measures should precious funding be channeled to the purchase of renewable energy. The energy use on any campus can be

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[28] *New Scientist*, 27 May, 2009.
[29] 2016 Levelized Cost of New Generation Resources from the Annual Energy Outlook 2010, http://www.eia.doe.gov/oiaf/aeo/pdf/2016levelized_costs_aeo2010.pdf
[30] Lazard Ltd., Levelized Cost of Energy Analysis – Version 3.0. New York, NY. 2009. http://bit.ly/agFmJA

made sustainable by purchasing or producing energy that comes exclusively from renewable sources. But because renewable energy currently carries a cost premium, this approach is cost prohibitive. Investing in energy efficiency both reduces monetary energy costs and improves campus sustainability by reducing the amount of non-renewable energy used (by reducing total energy used). But it also makes the eventual transition to an exclusively renewable energy portfolio more financially feasible because the amount of renewable energy that ultimately has to be purchased is much less.

How?
Use submetering data to determining campus buildings that have the most potential to increase their energy efficiency.

Once these buildings are identified, use both on-campus resources to identify and implement strategies for improving the buildings' energy efficiency. On-campus resources include the Energy Studies in Buildings Laboratory, Facilities, the Department of Architecture, Alison Kwok's lab, the Office of Sustainability, and Campus Planning. Potential off-campus resources include various energy efficiency consulting firms, such as McKinstry, Natural Logic, Optimal Energy, etc. However, the University of Oregon is uniquely blessed with so many energy efficiency resources on campus, it would seem a shame to waste both money and pedagogical opportunities by contracting with an outside firm.

Strategy 4: Remove initial capital barriers to campus energy efficiency projects

Why?
Initial capital costs are the primary impediment to realizing energy efficiency projects on campus

How?
Create a green campus revolving loan fund.

A green campus revolving loan fund would allow departments on campus to take on energy efficiency projects without having initial capital. After its establishment with initial capital, the fund will be replenished as the loans are paid back. This model is being used at institutions across the country, most prominently at Harvard University and the University of California – Berkeley. The average return on investment for Harvard's fund's projects is 27%.[31] The current value of their fund is approximately $12 million.

To assess applications and oversee the fund's distribution, an administrator position would need to be created. Initial capital from the fund could come from multiple sources, including a student fee, grants, or alumni donations.

[31] http://green.harvard.edu/loan-fund

For more information about these funds and their creation, please see Appendix 1.5: Establishing an Energy Efficiency Revolving Loan Fund.

Strategy 5: Change energy users' behavior by closing information feedback loops

Why?

Currently, campus energy users have no way of knowing how much energy they are using and no incentive to find out. By providing students and staff with information about their energy use and incentivizing energy efficiency, we can change their behavior and improve our use of utilities.

At Oberlin College, dorm energy efficiency competitions in 2005 resulted in a 32% drop in energy use in residence halls. This significant drop was caused solely from behavioral changes informed by real-time energy use feedback.[32] Combining these feel-good feedback incentives with financial incentives and physical energy efficiency improvements would lead to even more significant reductions in campus building energy use.

How?

1. Assess fees and credits to departments based on their energy use

Once building submetering takes place for electricity, departments and programs can be charged for how much electricity they are using. An average EUI for campus can be calculated. Departments that use less than average will be given a refund; departments that use more than average will be assessed a fee.

Alternately, departments can be charged based on their own historical energy use, normalized for changes in numbers of students and staff, as well as square footage.

Charging university departments for their utility use would be both technically difficult and politically unpopular. But the reality is that departments use different amounts of energy, and that energy costs money. It only fair that departments pay for the energy that they use.

People naturally become upset when they are required to pay for something that they have always regarded as free. Departments should be rewarded for improving their energy use in addition to being penalized for wasting energy. I propose that each department be allotted a certain energy allowance range[33] based on the square footage of the spaces that

[32] http://www.luciddesigngroup.com/download.php?id=20070117

they use and the nature of their deparment. This allowance will be covered by a flat energy fee assessed to the department each term. If the department's energy use is above this allowance, they will be assessed a per-kBTU fee based on their excess use. If the department's energy use falls below its allowance, they will be issued a per-kBTU credit based on their energy savings.

The energy use cost for buildings that are shared by multiple departments can be divided up according to the percentage of the building's square footage each department uses. Energy use in commonly-held rooms like classrooms can either be omitted from departments' bills or charged to departments according their hourly use.

An alternative method of incentivizing energy efficiency among departments could be to not charge departments that waste energy, but to just offer rebates to departments that use energy efficiently. This would not be as effective as a more comprehensive fee/rebate structure, but it may be more politically feasible in the short term.

2. Install educational utilities kiosks in the lobbies of large campus buildings to inform users of their energy use.

Figure 1.17: This campus-wide online tool (screen shot of mock-up image from Quality Attributes Software) will provide real-time utility use data both for individual buildings and for campus as a whole. This system is currently being configured for the University of Oregon campus and scheduled to be be available online by Fall 2010.

Figure 1.17: Campus-wide Dashboard

Figure 1.18: Individual building dashboard (screen shot from Lucid Design's online dashboard for Oberlin College's Adam Joseph Lewis Center for Environmental Studies[34]):

[34] http://www.oberlin.edu/ajlc/systems_energy_2.html

Figure 1.18: Individual Building Dashboard

These dashboards can provide the public and campus users alike with real-time information about the energy performance both of individual buildings and of campus as whole. Dashboards promote transparency and help campus users become more aware of the effects of their behaviors on the environment.

They can also be used to hold energy efficiency competitions within and between residence halls, to provide data for research, and to help evaluate on our own energy use compared to other campuses. Dashboards have the potential to be a powerful pedagogical tool.

Strategy 6: Compare sustainable energy data across institutions

Why?

We don't know how we are doing with regard to energy use relative to our peer institutions. By regularly compiling and sharing energy data, we can better assess our own progress, share what we've learned, and learn lessons from other institutions.

Over time, these comparisons can foster friendly competition, pushing each institution to improve its own performance.

How?

Establish a consortium of peer institutions to gather and compare energy data. This group could include the University of Oregon, Oregon State University, Portland State University, and perhaps the University of Washington. These institutions are of a similar size and type, and share the same geographical region and climate.

Share EUI numbers with peer institutions and share best practices. Information sharing could happen informally online and/or in a more structured format such as a yearly energy conference.

These conferences could be opportunities for university administrators, facilities personnel, and sustainability office staff to share information and teach others based on their own experience.

Appendices

Appendix 1.1: Energy Advisory Panel Members

G.Z. Brown, FAIA, Professor, Department of Architecture and Director of the Energy Studies in Buildings Laboratory, University of Oregon

Teri Jones, Energy/Utilities Assistant, University of Oregon Capital Construction

Rod Olsen, Energy Management Specialist, Eugene Water and Electric Board

Peter Reppe, Mechanical Engineer and Sustainability Specialist, SOLARC Architecture and Engineering

Fred Tepfer, AIA, Project Planning Manager, Campus Planning, University of Oregon

Appendix 1.2: Energy Resources

Rating Systems
Association for the Advancement of Sustainability in Higher Education (AASHE) – Sustainability Tracking Assessment and Rating System (STARS)
http://stars.aashe.org/
The Sustainable Endowments Institute – College Sustainability Report Card
http://www.greenreportcard.org/
U.S. Green Building Council (USGBC) – Leadership in Energy and Environmental Design (LEED)
http://www.usgbc.org/
The Cascadia USGBC chapter - Living Building Challenge
http://cascadiagbc.org/

Research Laboratories
The Oak Ridge National Laboratory
http://www.ornl.gov/
The Lawrence Berkeley National Laboratory
http://www.lbl.gov/
The University of Oregon Energy Studies in Buildings Laboratory
http://aaa.uoregon.edu/esbl/
The US Department of Energy's Energy Information Administration
http://www.eia.doe.gov/
The US Environmental Protection Agency Energy Star Program
http://www.energystar.gov/

Building Dashboards
Lucid Design Group
http://www.luciddesigngroup.com/
Quality Attributes Software
http://www.qualityattributes.com/

EUI Benchmarks
The EnergyIQ on-line assessment tool
http://energyiq.lbl.gov/benchmark.html
EPA's Energy Star Target Finder
http://www.energystar.gov/index.cfm?c=new_bldg_design.bus_target_finder

Appendix 1.3: EUI Percentiles for Representative University Buildings

The charts below examine the EUI of a representative building from each building category and compare their performance to that of similar buildings across the United States. The options for representative buildings on campus for each category were limited to the buildings for which there was available energy data. In some cases, these buildings may not be as "typical" as one would like. For example, Willamette Hall is used, but it may in fact be an atypical academic building because of its large atrium. Moreover, many the buildings that are used themselves have incomplete energy data, meaning that their actual energy use is slightly to significantly higher than indicated in the chart.

In some cases, comparable data for the specific building type was unavailable. In these cases, the data for the available building type most similar to the type in question was used. (For example, Willamette Hall's EUI is compared to the EUI values of US high schools.)

Academic – representative building: Willamette Hall

	Willamette Hall	Academics
Percent of Total Category Square Footage	7%	100%
Average Building Age (Years)	20.0	41.0
Average Building Square Footage	129,236	23,759

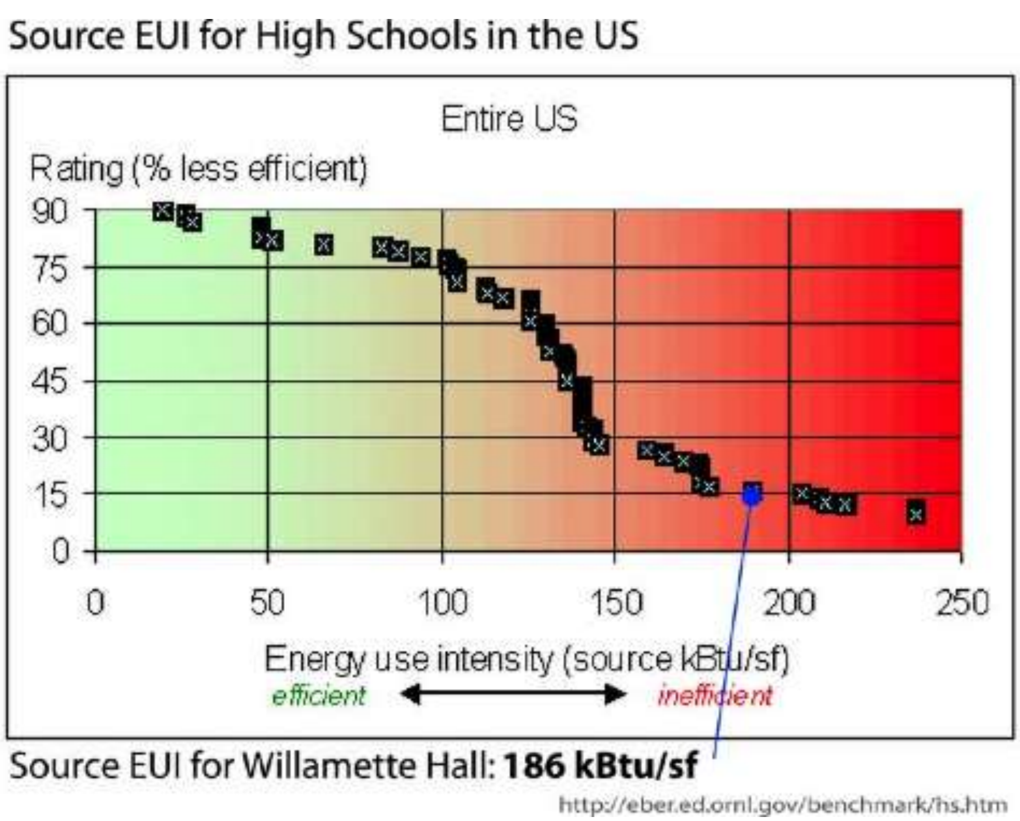

Figure 1.19: Willamette Hall EUI Compared to Peers

Library – representative building: Knight Library[35]

	Knight Library	Libraries
Percent of Total Category Square Footage	92%	100%
Average Building Age (Years)	46.8	58.6
Average Building Square Footage	392,275	141,511

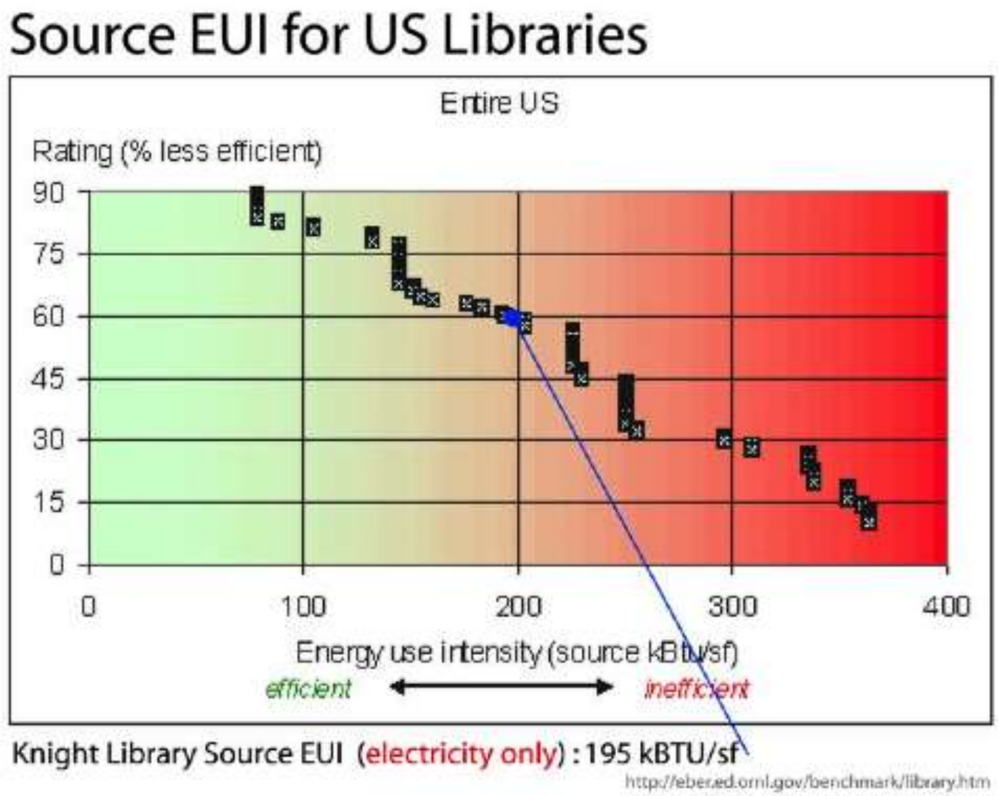

Figure 1.20: Knight Library EUI Compared to Peers

[35] The source EUI value for Knight Library is likely a vast underestimate as it *excludes* all energy used to heat and cool the building.

Residential – representative building: Hamilton Hall

	Hamilton Hall	Residential
Percent of Total Category Square Footage	12%	100%
Average Building Age (Years)	47.0	32.8
Average Building Square Footage	216,849	12,063

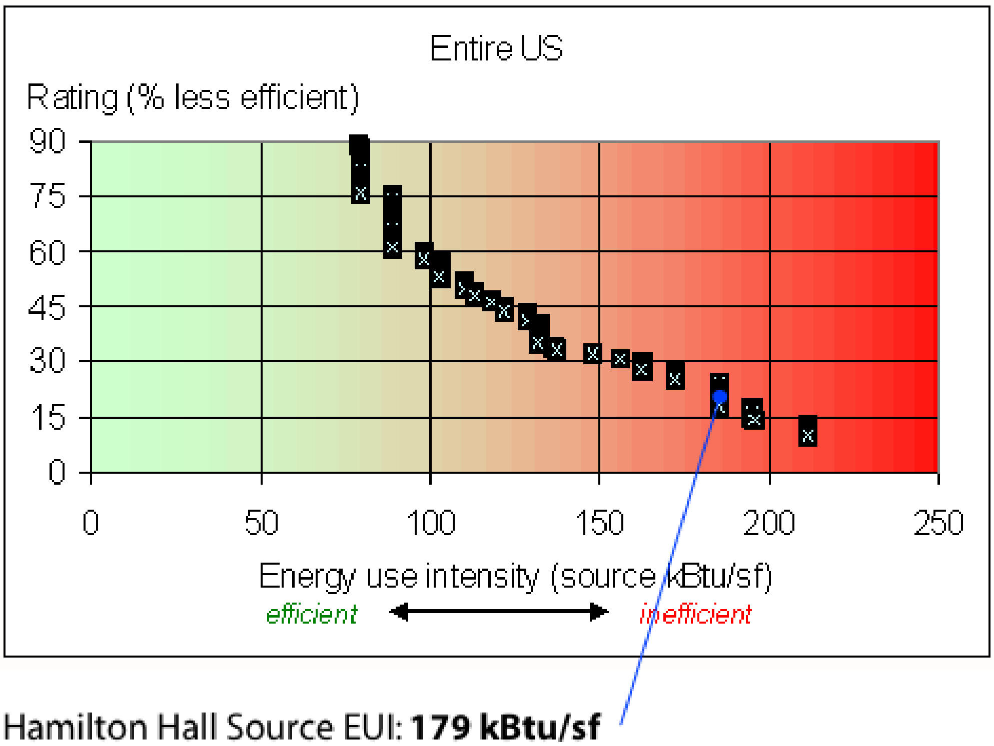

Figure 1.21: Hamilton Hall EUI Compared to Peers

Athletics – representative building: McArthur Court

	McArthur Court	Athletics
Percent of Total Category Square Footage	18%	100%
Average Building Age (Years)	80.0	21.5
Average Building Square Footage	133,416	31,656

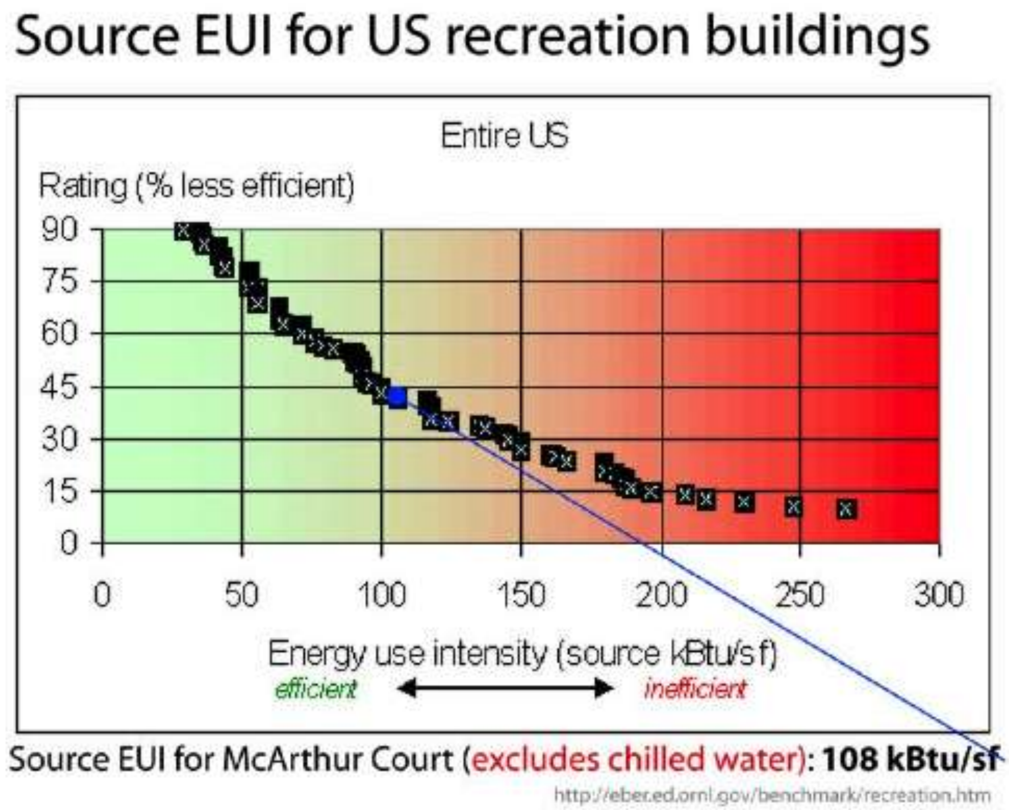

Figure 1.22: McArthur Court EUI Compared to Peers

Laboratory[36] – representative buildings: Klamath Hall, Zebrafish Intl. Resource Ctr.

	Klamath Hall	Zebrafish	Labs
Percent of Total Category Square Footage	27%	2%	100%
Average Building Age (Years)	41.0	8.0	33.3
Average Building Square Footage	139,164	12,351	18,811

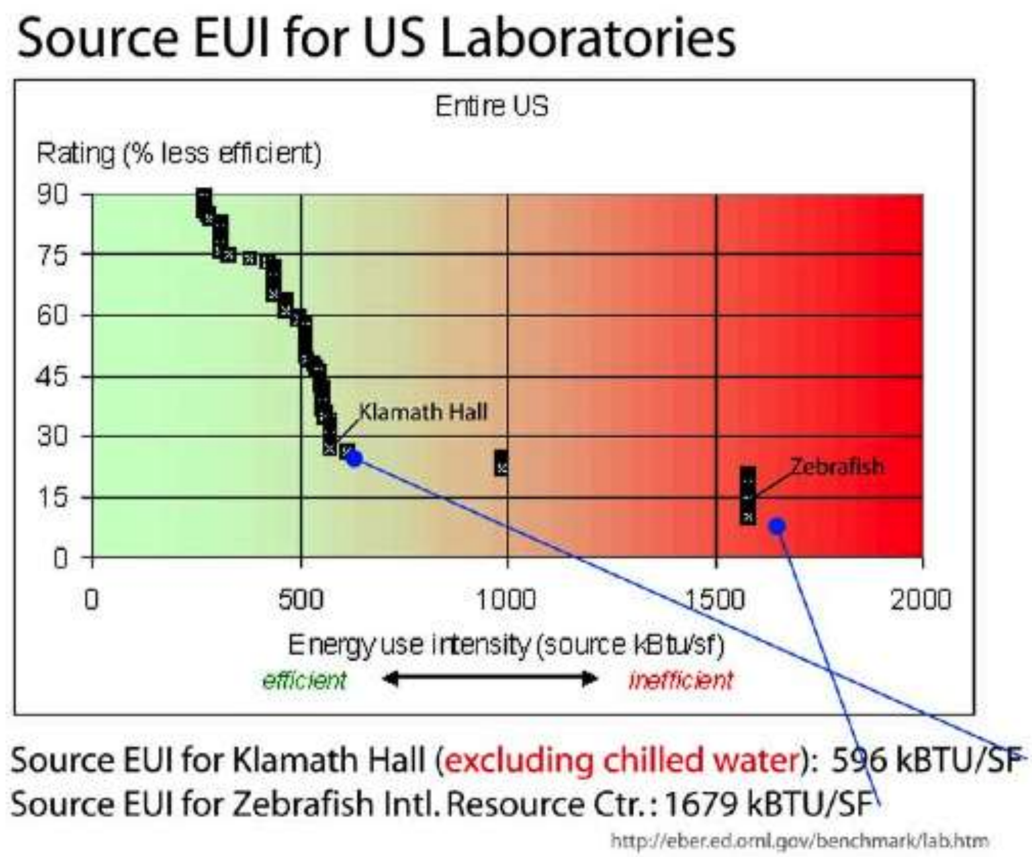

Figure 1.23: Klamath Hall and Zebrafish EUIs Compared to Peers

36 http://labs21benchmarking.lbl.gov/Graphing.php

Student Life – representative building: Erb Memorial Union

	Erb Memorial Union	Student Life
Percent of Total Category Square Footage	42%	100%
Average Building Age (Years)	58.0	25.9
Average Building Square Footage	203,315	59,871

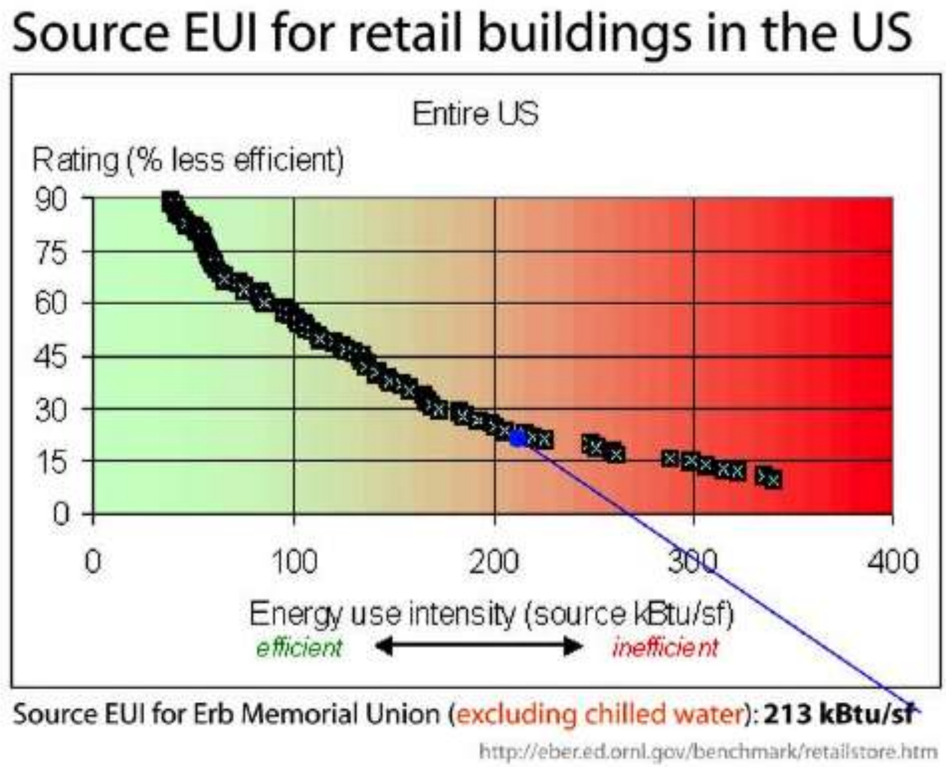

Figure 1.24: Erb Memorial Union EUI Compared to Peers

Administration/Office – representative building: Oregon Hall[37]

	Oregon Hall	Office/Admin
Percent of Total Category Square Footage	12%	100%
Average Building Age (Years)	34.0	42.4
Average Building Square Footage	78,828	19,838

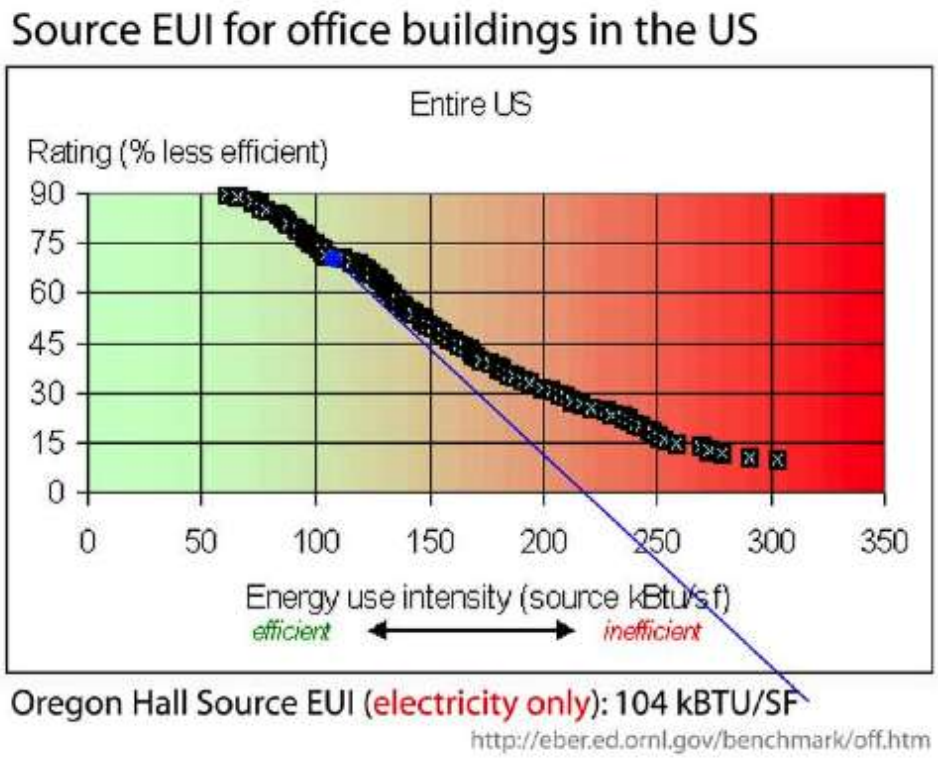

Figure 1.25: Oregon Hall EUI Compared to Peers

[37] The source EUI value for Oregon Hall is likely a vast underestimate as it *excludes* all energy used to heat and cool the building.

Appendix 1.4: Normalizing EUI Calculations for Heating/Cooling Load

Because energy is used to heat and cool buildings, the energy required to condition buildings depends on the climate of the surrounding area. The concept of the "degree day" is used to estimate the heating and cooling loads for a given region. There are both heating and cooling degree days.

In order to account for the climactic energy demands of different regions, we must determine how cold or hot the ambient outside temperature is relative to the temperature desired within the building. To calculate this, we first determine a desired inside temperature, say 65 degrees Fahrenheit[38]. We then determine the average temperature for each day for the given location. If the average temperature for one day is 50 degrees, then the difference between the ambient temperature and the desired temperature is 65-50=15 degrees. The duration measured is one day. And since the ambient temperature is lower than the desired temperature, these are *heating* degrees. Therefore, the climactic energy demand for that day is 15 *heating degree days*. If the outside temperature were 80 degrees instead of 50, the same calculation could be performed to determine the load to be 15 *cooling* degree days.

Just like you can factor for building size by dividing energy use by building square footage, you can factor for climate by dividing energy use by total degree days. However, the relationship between energy use and climate is not as reliable as the relationship between energy use and building size. In order to normalize EUI for temperature fluctuations, you need to determine how much of the total energy is being used to satisfy both heating and cooling loads. Needless to say, isolating energy use in this way is not a straightforward task, especially for an institution as large as the University of Oregon.[39]

Oregon's typical heating and cooling load (measured in degree days) is roughly 92% of the average load in the United States. Relative humidity is another factor that determines the cooling loads for buildings. Basing cooling load on the heat index (which considers both temperature and relative humidity) instead of just temperature would be especially appropriate when including comparisons to humid regions like the southeastern US.

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[38] Typically, we would choose one baseline temperature for winter, say 65 degrees, and a different baseline temperature for summer, say 75 degrees. But in this case, we'll just use a 65 degree baseline temperature year-round for the sake of simplicity.

[39] Jeff Kline in the Energy Studies for Buildings Laboratory (ESBL) showed me a diagram of a method they used to isolate heating and cooling energy for the University as part of a campus energy assessment the ESBL completed in 2004. They then used this heating/cooling energy figure along with the heating/cooling degree-day data over the same period to normalize campus energy use intensity for heating/cooling load.

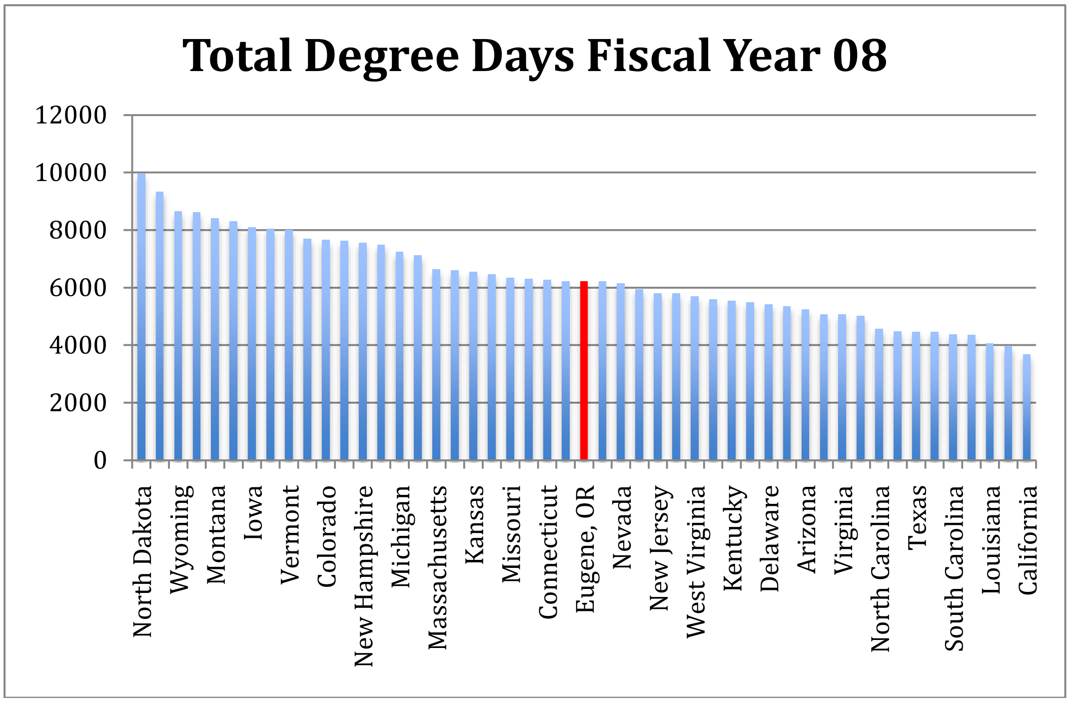

Figure 1.26: Total Degree Days of Heating/Cooling Load for Selected US Locations[40]

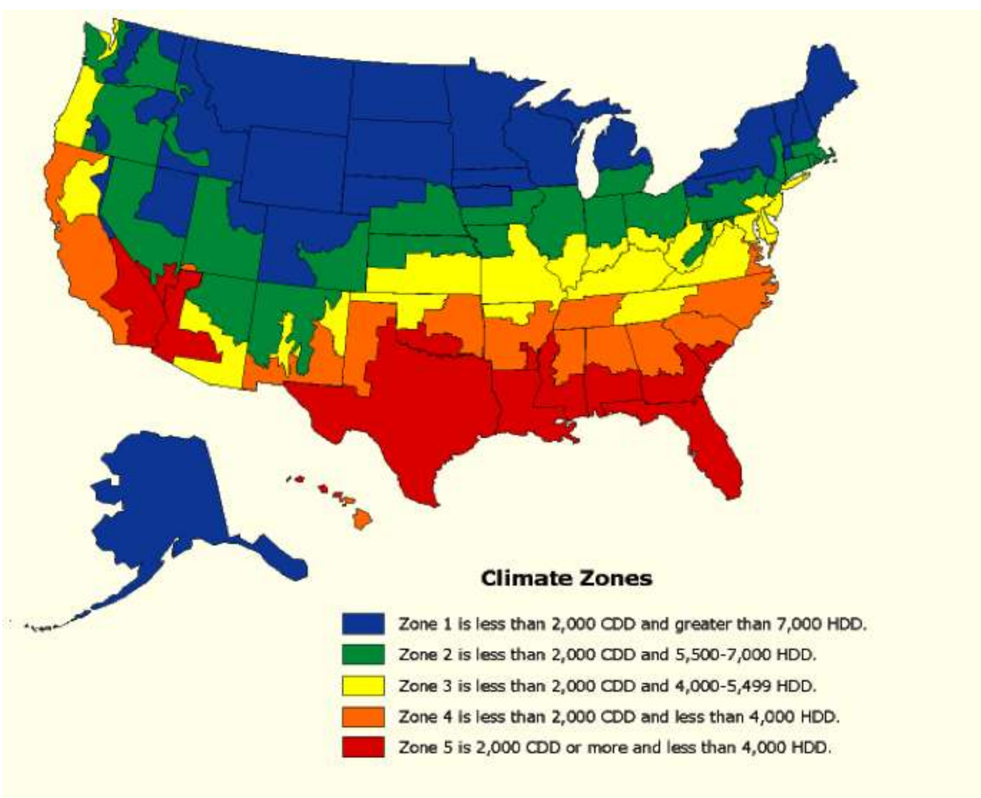

Figure 1.27: US Climate Zones[41]

[40] Data from the National Oceanic and Atmospheric Administration (http://vlb.ncdc.noaa.gov/oa/documentlibrary/hcs/hcs.html) and the Degree Days website (http://www.degreedays.net/)

Appendix 1.5: Establishing an Energy Efficiency Revolving Loan Fund

Schools across the country are beginning to institute revolving loan funds to provide initial capital for energy efficiency projects on their campuses. The details of these funds vary, but the basic model is that the loan provides the initial funds for campus energy efficiency projects that would otherwise be cost-prohibitive. The loan is paid back to the fund over time using a portion of the savings achieved by the project. The Harvard Green Campus Fund – the gold standard for campus revolving loan funds – assesses a 3% annual administrative fee in addition to the payments, and has a five-year maximum payback period for their projects. A small additional fee (perhaps 1%) could be applied to the loan to help it grow over time.

The University of Oregon currently has a Sustainability Fund that is administered by the Director of the Office of Sustainability. However, this fund differs in significant way from the revolving loan fund that I am discussing. The Sustainability Fund does not provide loans, but grants. This means that the projects that it funds do not have to pay for themselves. While in some senses this is good, it also means the fund is continually being depleted and continually needs to be replenished. The scope of projects that the fund can support is limited by this structure.[42]

Unlike the revolving loan fund, there are few constraints on the types of projects that can be supported by the existing Sustainability Fund. Again, in some senses, this flexibility is good. But again, unlike the revolving loan fund, it does not ensure that the projects supported can pay for themselves. For the record, I believe that these projects should not have to justify their value based on monetary grounds. However, the absence of repayment component makes the continued support of the fund somewhat difficult to justify from an administrative standpoint.

In the end, I believe there are roles for both the open-ended, student and faculty-initiated, smaller-scale projects created by the Sustainability Fund, and the more directed, department and facilities-initiated, larger-scale, cost-effective projects that would be created by a revolving loan fund.

The Association for the Advancement of Sustainability in Higher Education (AASHE) maintains a list of institutions that currently have mandatory student fees in place to support energy efficiency projects on campus.[43] Some of these schools utilize the revolving loan structure that I describe.

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[41] From the Energy Information Administration website (http://www.eia.doe.gov/emeu/recs/origin/origin_householder.html)
[42] For example, the maximum loan amount for Harvard's fund is $500,000 per project. In contrast, the University of Oregon Sustainability Fund currently distributes about $36,000 per year among *multiple* projects.
[43] http://www.aashe.org/resources/mandatory_energy_fees.php

Schools that currently have a revolving loan fund include:

Harvard University
University of California, Berkeley
University of California, Santa Barbara
University of Kansas
George Washington[44]
University of Pennsylvania
University of Connecticut
Massachusetts Institute of Technology
The Evergreen State College

AASHE has also published a guide to help institutions initiate the creation of a revolving loan fund on their campuses.[45]

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[44] http://media.www.gwhatchet.com/media/storage/paper332/news/2010/04/26/News/University.Unveils.Climate.Plan.Cornerstones-3912758.shtml

[45] Diebolt, A. and Den Herder-Thomas, T., *Creating a Campus Sustainability Revolving Loan Fund: A Guide for Students*, 2007
http://www.aashe.org/highlights/cerf.php
http://www.aashe.org/documents/resources/pdf/CERF.pdf

Appendix 1.6: Energy Methodology Descriptions

Calculating Energy Use Intensity

In order to add up all campus energy use, the measurements for each form of energy need to be converted to a single unit. In the United States, the most common energy unit is the British Thermal Unit (BTU). A BTU is the amount of energy required to raise the temperature of one pound of water one degree Fahrenheit at one atmosphere of air pressure.

Dividing the energy used by the building (kBTUs) by the area of the building (square feet) gives a unit of energy use that can be used to compare buildings of different sizes. This unit – expressed as thousands of BTUS (kBTUS) per Gross Square Footage (GSF – including interior walls, utility spaces, etc) per year – is referred to as energy use intensity.[46] The common unit for EUI in the United States is kBTU/sf per year. In the rest of the world, it's gigajoule/square meter per year.

Converting Site EUI to Source EUI

Energy use intensity is often talked of in terms of "Site" EUI and "Source" EUI. Site EUI is how much energy is being used directly on site. It can be determined by just gathering utility data of a given period. Source EUI considers how much energy was used to create the energy that is delivered on-site. It takes into account the (in)efficiency of converting the raw fuel into the desired form of energy and transmitting it to the site (in our case, the campus).

Multiple factors determine the difference between Site EUI and Source EUI, including how the energy is being produced, how old the energy plant is, and the length and condition of the transmission lines. These factors differ for every case considered, and determining an accurate Site to Source conversion factor for a specific location is a complex and difficult process. For this reason, the US Energy Information Administration gives national, general site to source conversion factors for different forms of energy.[47]

Other considerations when using EUI to compare energy efficiency across buildings

There are multiple factors that need to controlled for to compare the energy use intensities of buildings. Chief among these considerations are building type and heating/cooling load.

Building Type

Different building types require different amounts of energy because of the types of activities that occur inside them and the type of equipment they use. The typical research

[46] Also called the Energy Use Index
[47] www.architecture2030.org/.../2030_Challenge_Targets_National.pdf

building – with its scientific equipment, laboratories, fume hoods, etc – uses much more energy per square foot than the typical residence hall. Therefore it makes sense to, where possible, compare the EUI of individual buildings to the same kind of building elsewhere.

Heating/Cooling Load

Just as differences in building type affects the energy intensity of a building, so do the heating and cooling loads imposed by the climate in which the building exists. To control for this factor, the buildings under consideration should be in the same climate. Alternatively, the heating- and cooling-related energy use for each building would need to be normalized using temperature data for the specific year and location[48].

Because of the complexity involved in controlling EUI for heating and cooling load, I did not consider them in my calculations. Controlling for heating and cooling load is important for the accuracy of both internal EUI comparisons over time and for comparing the EUI of our buildings to those on other campuses. Future versions of this report should include EUI data normalized for heating and cooling load. For a more detailed discussion of heating and cooling load calculations, please see Appendix 1.4: Normalizing EUI Calculations for Heating/Cooling Load.

Explanation of Figures

Figure 1.2: Building Energy Use by Source

To calculate the energy use by source chart, I used the comprehensive utility data for fiscal year 2009 compiled by Mark Nystrom, the Sustainability Graduate Student for the Office of Sustainability. Mr. Nystrom's data came from Teri Jones, the Energy/Utilities Assistant for Capital Construction, as well as from direct communication with building operators and utility providers. To the best of my knowledge, his calculations included energy use from all University-related buildings. His figures included electricity, direct use natural gas, heating natural gas, steam, and fuel oil. The calculations were using *site* energy use.[49]

The electricity generation sources distribution information came from EWEB.[50]

Figure 1.3: University Energy Use by Sector

The energy use by sector data was created by adding up the total energy use for commuting, ground travel for University-related business, and air travel for University-related business. It does not include the energy used for the maintenance of campus grounds, campus security, or the student shuttle.

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[48] Some southern states also insist that not just temperature but *heat index* (which considers humidity) should be used to calculate cooling loads.

[49] If these figures are translated to *source* energy use, then the percentages switch to 56% coming from electricity and 44% coming from natural gas.

[50] http://www.eweb.org/greenpower/resources

Total energy use for commuting was estimated using the 2009 Commute Survey, which was conducted as part of a thesis completed by Larisa Varela in the Planning, Public Policy, and Management Program at the University of Oregon. I used the commute mode distribution for both staff and students and calculated an average commute distance for each mode based on the survey results. I then determined an average energy use per passenger mile for each mode.[51][52][53] I multiplied the energy use per passenger mile for each commute by the average commute distance for each mode to get the average commute energy expenditure for each mode. I then multiplied the commute mode distribution for staff and faculty by the total number of staff and non-residential students to determine how many commuters there are for each mode. I assumed 300 one-way commutes[54] per year for all users. I then multiplied the number of commutes for each mode by the average commute energy expenditure for that mode to get an estimate of total commute energy expenditure.

Total energy use for air travel was computed using air miles data calculated by Mark Nystrom, the Sustainability Graduate Student for the Office of Sustainability, as part of CO2 emissions estimates for the 2009 University of Oregon Climate Action Plan. The air miles were estimated based on a factor translating dollars spent on air travel to miles traveled. I used average passenger-mile energy use figures from the National Aerospace Laboratory.[55] I calculated total air travel energy use by multiplying total passenger-miles traveled by average air travel passenger-mile energy use.

University business-related ground travel was also calculated using mileage estimates created by Mr. Nystrom as part of the Climate Action Plan. I used the EPA average fuel-economy to calculate passenger-mile energy use.[56] I assumed an occupancy of one.

Figure 1.4: Energy Submetering

The submetering figures were calculated using the Meter Calibration Zones spreadsheet provided by Teri Jones, the Energy/Utilities Assistant in Capital Construction. This spreadsheet indicates which campus buildings have building-level meters for electricity, steam, chilled water, and water. I added up the square footages for the buildings that had building-level meters for each of the energy categories (electricity, steam, and chilled water) and divided each by total campus square footage to determine a submetering percentage for each energy category. This calculation assumes that every building on campus uses electricity, steam, and chilled water.

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[51] For walking and running energy use, I used this website: http://www.brianmac.co.uk/energyexp.htm

[52] For driving, I assumed an occupancy of one and used the average fuel efficiency from the this website: http://www.fueleconomy.gov/feg/FEG2010.pdf

[53] For busses, I assumed an average passenger load of 9 and used the energy use figures from these websites: http://www.nrel.gov/docs/fy00osti/26758.pdf
http://en.wikipedia.org/wiki/Fuel_efficiency_in_transportation#cite_note-39

[54] To come up with this estimate I considered three ten-week terms per year and two one-way commutes each weekday

[55] http://www.transportenvironment.org/docs/Publications/2005pubs/2005-12_nlr_aviation_fuel_efficiency.pdf

[56] http://www.fueleconomy.gov/feg/FEG2010.pdf

Figure 1.5: University of Oregon's Energy Use Intensity Percentile
The EUI for the University of Oregon used in this chart was calculated by using the same natural gas, electricity, steam, and fuel oil figures used in the calculations for figure one. These numbers (in kBTUs) represented the *site* energy use for the University. I then used the site to source conversion figures below to get *source* energy use for the University:

Fuel	Site to Source Conversion Factor[57]
Electricity	3.34
Natural Gas	1.05
District Heat	1.40
Fuel Oil	1.01

I summed these source energy figures and then divided by the total square footage for all University buildings to get the source EUI for the University. I then plotted that value on the "EUI Rankings by Carnegie" chart compiled by the Oak Ridge National Laboratory in 2000.[58]

Figure 1.6: Total Campus Energy Use Intensity
To calculate this chart I used the same methodology as for Figure 1.5 and repeated it using data from previous years.

Figure 1.7: University Buildings Area and Energy Use Percent
To get building category area percentages, I went through every building listed in the 2009 Sightlines Building Inventory for the University of Oregon and slotted each building listed into one of eight building categories: Academic, Laboratory, Residential, Office/Administrative, Athletics, Student Life, Library, and Other. I then summed the square footage totals for each category and divided by the total square footage to get an area percentage for each category.

For the energy use percentages, I used actual measured energy data for the few buildings that are submetered for energy. (please see Appendix 1.3: EUI Percentiles for Representative University Buildings for more details about these buildings.) For the remaining buildings, I found the average EUI (kBTU/square foot) for each building type, according to the US Energy Information Administration's 2003 Commercial Buildings Energy Consumption Survey[59], the US Environmental Protection Agency's and US Department of Energy's Target Finder tool[60], and the Architecture 2030 Challenge Targets table.[61] Some of the buildings didn't fit neatly into a type for which these sources have EUI data. In such cases, I attempted to match the building type to the most similar building type for which there is data. For example, there were no EUI data for student unions so I

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57 http://www.energystar.gov/ia/business/evaluate_performance/site_source.pdf
58 http://eber.ed.ornl.gov/commercialproducts/ORNL%20Higher%20Ed%20Energy%20Perf%20report.pdf
59 http://www.eia.doe.gov/emeu/cbecs/cbecs2003/detailed_tables_2003/detailed_tables_2003.html
60 http://www.energystar.gov/index.cfm?c=new_bldg_design.bus_target_finder
61 http://www.architecture2030.org/downloads/2030_Challenge_Targets_National.pdf

used EUI data for shopping malls (the most similar available building type) to approximate the energy use of the Erb Memorial Union. The EUIs for each building type were multiplied by the square footage of each building in that category to estimate yearly energy use for each building.

Because so much of the energy data for campus building categories is approximated, the figures in the energy percentage chart represent the *general* difference in energy use among building types more than they represent differences in energy use among *specific* buildings and building types on the University of Oregon campus.

Figure 1.8: Building Energy Use Percentage to Building Area Percentage Ratio
I created this chart by dividing the energy use percentage by the area percentage for each building category from Figure 1.6.

Figure 1.10: Total Campus Energy

I created the historical energy use data of this chart by adding up the monthly natural gas and electricity use for the campus. This data only includes electricity data from campus buildings (the EWEB HV bill and the EWEB Unified bill) and natural gas usage figures for the Central Power Station. Comprehensive energy use data for all University buildings is only available for fiscal year 2009 (it had never been compiled before), whereas more limited data is available from 2002. Based on the comprehensive 2009 assessment, the campus-building-only data in this chart represents approximately 60% of total University-related building operations energy use.

The renewable electricity percentages in this chart are based on current source distributions, and do not reflect any changes in EWEB electricity production sources over the time considered.

The future projections in this chart repeat the data for fiscal year 2009, initially substituting 5% annual efficiency for heating demand (the blue color on the chart) and then in 2020 adding a 5% electricity efficiency improvement (added to the blue area, offsetting non-renewable electricity) and a 5% annual offset of non-renewable heating sources with renewable sources (the purple color on the chart).

Figure 1.10: Total Campus Energy Use by Source
This figure just shows the historical data depicted in Figure 1.10 without separating out electricity into renewable and non-renewable.

Figure 1.13: Percent Renewable Electricity and Energy

I calculated the renewable electricity percentage for this chart from EWEB's electricity source information[62] in addition to the renewable energy credit (RECs) and on-site

[62] http://www.eweb.org/greenpower/resources

electricity generation percentages from the 2007 Campus Sustainability Assessment.[63] The renewable electricity percentages for other institutions were gathered from schools' responses to questions 29 and 31 in the campus surveys for the Sustainable Endowment Institute's 2009 Campus Sustainability Report Card.[64]
The renewable electricity data for Portland State University (PSU) came from their sustainability website.[65]

I calculated the total energy renewables percentage chart for the University of Oregon by adding natural gas and electricity energy use and then dividing the amount of renewably-sourced electrical energy by the total energy amount. This calculation was made under the assumption that no heating energy on campus is renewably sourced.

The goals for this metric are based on the assumption that the University will adopt a campus-wide cap on non-renewable energy use. At present, this assumption appears to be heroic.

Figure 1.14: University Greenhouse Gas Emissions

This chart was calculated based on the emissions figures provided in the 2009 University of Oregon Climate Action Plan (CAP).[66] The goals for this metric are based on those in the CAP. Please note that the CAP does not include Scope III emissions estimates.

Figure 1.13: Total Gross Emissions
I created this chart using total gross emissions data from the University of Oregon Climate Action Plan.[67]

Figure 1.16: LEED Certified Building Square Footage Percentage
I created this chart by compiling data from question 43 of the Sustainable Endowments Institute's Green Report Card, which provides the self-reported LEED certified square footage for each institution.[68] I then divided the LEED certified square footage by the institution's total gross square footage – provided in question 71 of the same survey – to determine LEED certified square footage percentage.

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63 http://sustainability.uoregon.edu/files/uploads/campus_sust_assessment_-_may_2007.pdf
64 Schools' surveys are available online at: http://www.greenreportcard.org/report-card-2010/schools/(**school_name)**/surveys/campus-survey, where the school's name is listed in the slot in the address labeled "(school_name)".
65 http://www.pdx.edu/sustainability/energy
I spoke with Noelle Studer-Spevak, PSU's Sustainability Coordinator (via telephone, 5/12/2010), and she confirmed that PSU is indeed using 100% renewably-derived electricity on campus. However, she indicated that the electricity came primarily through the purchase of RECs, and that they are in the process of diverting those funds away from RECs and towards improving energy efficiency and producing their own renewably-sourced electricity.
66 http://sustainability.uoregon.edu/sites/sustainability.uoregon.edu/files/os-reports/CAP_2_0_0.pdf
67 ibid.
68 Example of campus survey, available at http://www.greenreportcard.org/report-card-2010/schools/university-of-oregon-eugene/surveys/campus-survey

Figure 1.15: Campus Utility Bills
I created this chart by using the comprehensive University energy use data compiled by Mark Nystrom, Sustainability Graduate Student for the Office of Sustainability, to create an energy flow diagram for each utility from whom we purchase energy. The yellow boxes are the four utilities and each of the white boxes represents a separate utility bill that we receive. The width of each line represents how much energy is purchased through each bill during the course of a year.

Figure 1.16: Levelized Average Cost for Selected Energy Resources
I created this chart using data from publications of the US Department of Energy's Energy Information Administration[69] and Lazard Ltd.[70], an investment bank.

Figure 1.19: Willamette Hall EUI Compared to Peers
I calculated Willamette Hall's EUI by combining energy use data available for fiscal year 2009, summing it, and dividing that number of kBTUs by the building's square footage. Please note that Willamette Hall is not submetered for steam or chilled water, so those energy use values are not included in this calculation. With the inclusion of these figures the building's true EUI percentile would be significantly lower. Also, please note that data for university classroom buildings was not available, so Willamette Hall's energy use is being compared to that of US high schools (the most similar available building type).

The building category percentile graphs used for all figures in Appendix 1.3: EUI Percentiles for Representative University Buildings come from the Oak Ridge National Laboratory Buildings Technology Center.[71]

Figure 1.20: Knight Library EUI Compared to Peers
I calculated Knight Library's EUI by combining energy use data available for fiscal year 2009, summing it, and dividing that number of kBTUs by the building's square footage. Please note that Knight Library is only submetered for electricity, so energy use for heating the cooling the building is not included in this calculation. With the inclusion of these energy use values, the Knight Library's EUI percentile would be significantly lower. Knight Library was compared to other libraries throughout the United States.

Figure 1.21: Hamilton Hall EUI Compared to Peers
I calculated Hamilton Hall's EUI by combining energy use data available for fiscal year 2009, summing it, and dividing that number of kBTUs by the building's square footage. Please note that Hamilton Hall is not submetered for chilled water, so energy use for cooling is not included in this calculation. With the inclusion of cooling energy values, Hamilton Hall's EUI percentile would be slightly lower. Hamilton Hall's EUI is compared with those of high schools throughout the United States.

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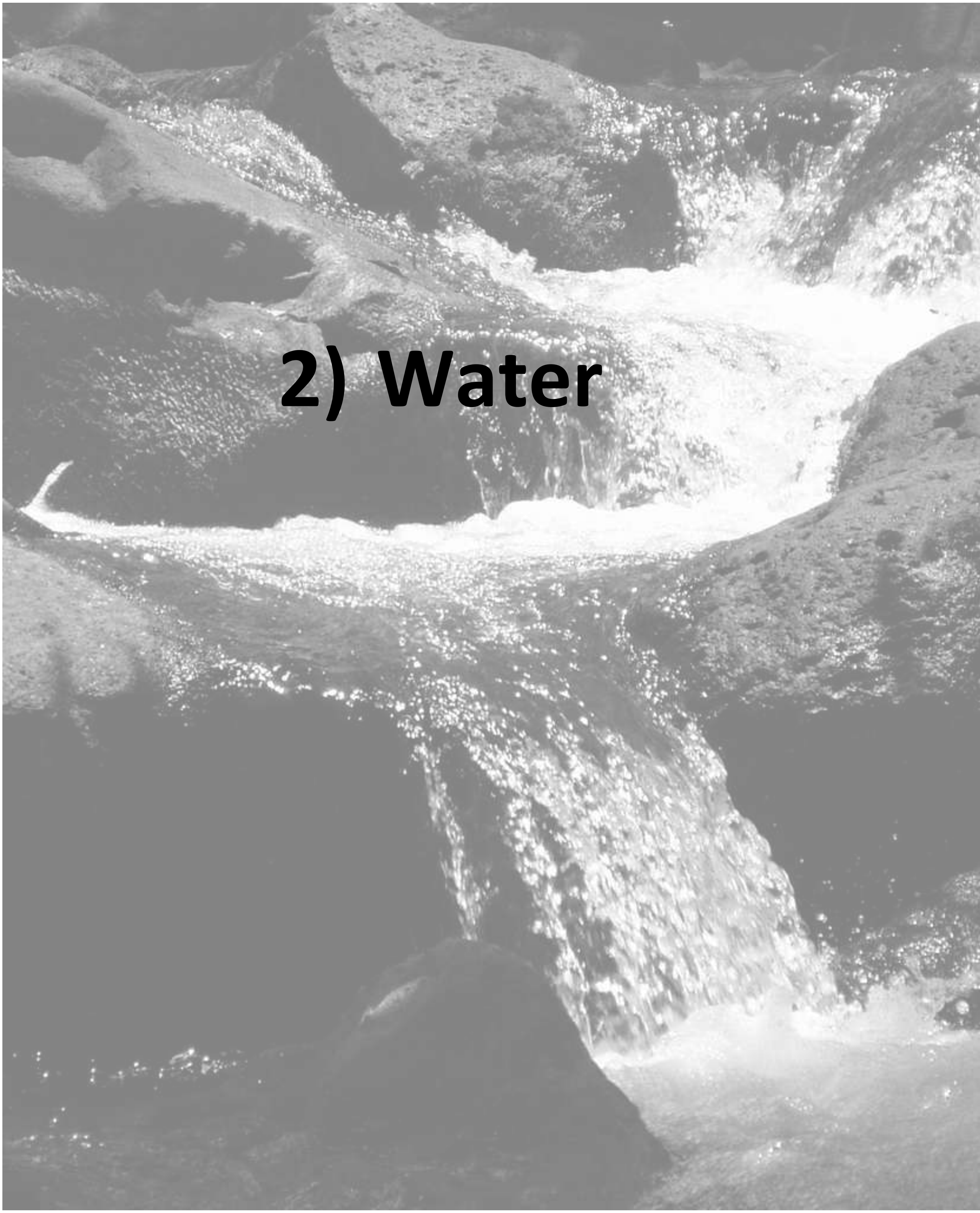
[69] 2016 Levelized Cost of New Generation Resources from the Annual Energy Outlook 2010, http://www.eia.doe.gov/oiaf/aeo/pdf/2016levelized_costs_aeo2010.pdf
[70] Lazard Ltd., Levelized Cost of Energy Analysis – Version 3.0. New York, NY. 2009. http://bit.ly/agFmJA
[71] http://eber.ed.ornl.gov/benchmark/bldgtype.htm

Figure 1.22: McArthur Court EUI Compared to Peers
I calculated McArthur Court's EUI by combining energy use data available for fiscal year 2009, summing it, and dividing that number of kBTUs by the building's square footage. Please note that McArthur Court is not submetered for chilled water, so energy use for cooling is not included in this calculation. With the inclusion of cooling energy values, the building's EUI percentile would be slightly lower. McArthur Court's EUI was compared to that of recreational buildings in the US.

Figure 1.23: Klamath Hall and Zebrafish EUIs Compared to Peers
I calculated the EUIs for Klamath Hall and the Zebrafish International Resource Center by combining energy use data available for fiscal year 2009, summing it, and dividing that number of kBTUs by the respective square footages of each building. Please note that chilled water energy use is not submetered for Klamath Hall. This indicates that the true EUI percentile for Klamath is slightly lower than that indicated on the chart. The EUIs of Klamath Hall and the Zebrafish International Resource Center are compared to those of other research laboratories throughout the United States.

Figure 1.24: Erb Memorial Union EUI Compared to Peers
I calculated the Erb Memorial Union's EUI by combining energy use data available for fiscal year 2009, summing it, and dividing that number of kBTUs by the building's square footage. Please note, the EMU's chilled water use is not submetered, so energy use for cooling is not included in this calculation. With the inclusion of cooling energy values, the EMU's EUI percentile would be slightly lower. The EMU's EUI was compared to that of retail establishments in the US.

Figure 1.25: Oregon Hall EUI Compared to Peers
I calculated the Oregon Hall's EUI by combining energy use data available for fiscal year 2009, summing it, and dividing that number of kBTUs by the building's square footage. Please note, Oregon Hall's chilled water and steam use is not submetered, so energy use for cooling and heating are not included in this calculation. With the inclusion of cooling and heating energy use values, Oregon Hall's EUI percentile would be significantly lower.



2) Water

Introduction

How do we judge whether or not we are using water sustainably at the University of Oregon? Because of the quantity of precipitation that we receive in Eugene, we are unlikely to run out of water. However, it is certainly possible to appropriate more than our fair share, and of course it is possible to foul our water to the degree that it is no longer capable of sustaining life.

How much water can the University of Oregon responsibly use, and how can we minimize our impacts on local riparian ecosystems? Could we move beyond conservation to a regenerative relationship with water wherein the University serves to both provide habitat and filter stormwater from surrounding areas before it reaches the Willamette River?

In this report I propose metrics to assess the sustainability of the University's use of water. I then present my research findings for these metrics, suggest future goals for each, and offer specific strategies for improvement.

Background

In addition to the qualitative questions about our impact on ecosystems, there are the quantitative questions regarding how much water we use, how we use that water, and where it comes from. "Where it comes from" constitutes the **supply side** of our water use. We can look at the supply side of our water by examining our climatic context. The "how much we use" and "how we use it" pieces constitute the **demand side** of our water use. We have little control over how much water is available to us, but we can control how much that water we use and how we use it.

Supply Side

The University of Oregon purchases its water from the Eugene Water and Electric Board. The water that EWEB supplies is sourced from the McKenzie River, east of Eugene.

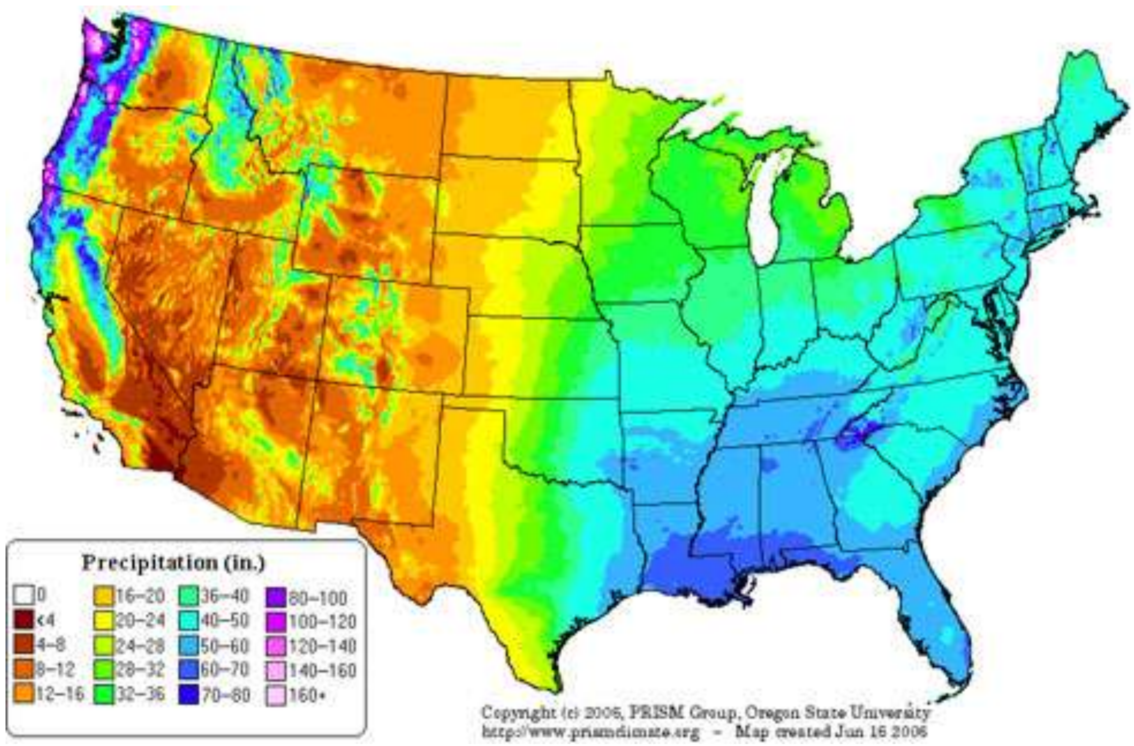


Figure 2.1: US Rainwater Context

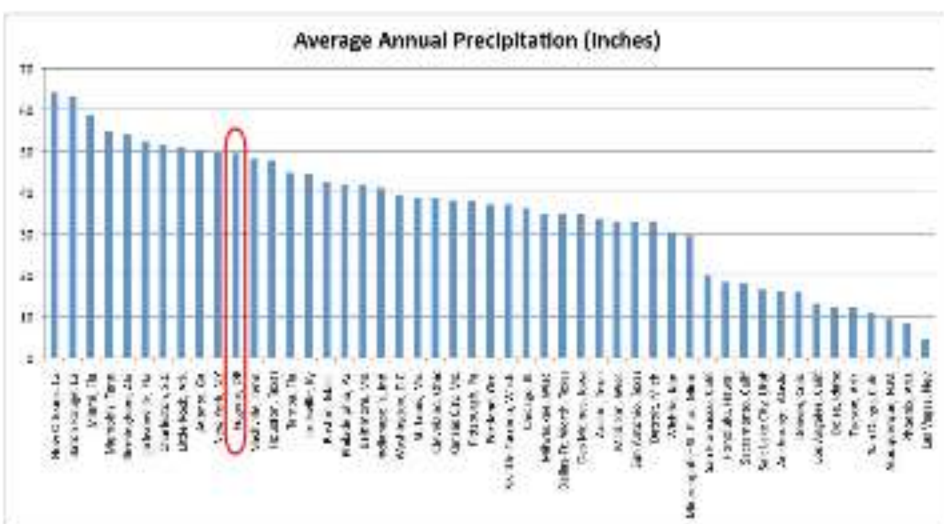


Figure 2.2: Average Annual Precipitation for Selected US Cities[72]

These graphs show that we get more annual precipitation than most of the country. But our water comes seasonally; most of the year we have "too much" rain, but during the summer, common intervals between rainfalls can be a month or more.

[72] Source: National Oceanic and Atmospheric Administration (NOAA)

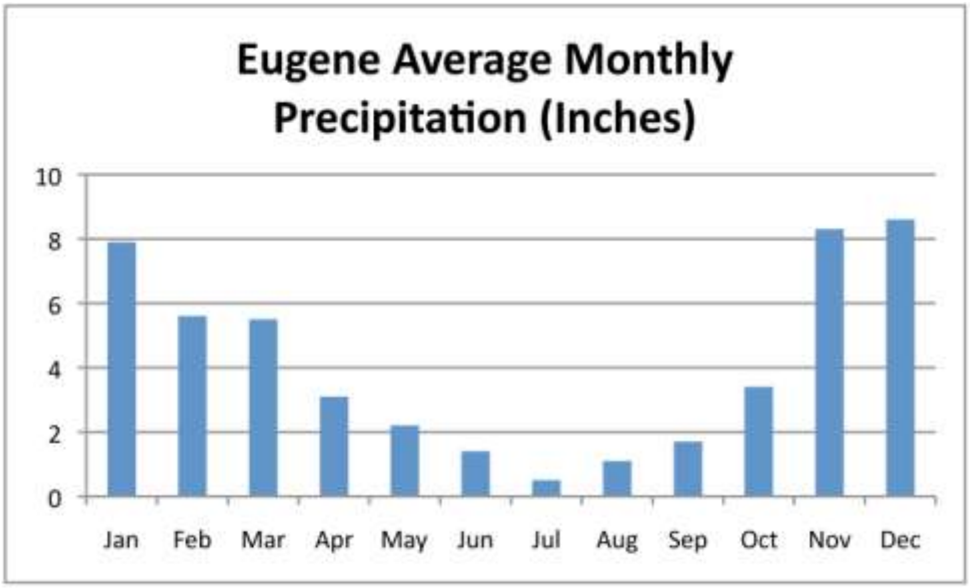


Figure 2.3: Eugene's Average Monthly Precipitation[73]

The pronounced seasonality of our rainfall has implications on which water conservation strategies work well here. For example, rainwater harvesting is commonly thought to be impractical here because cisterns would have to hold enough water for the entire summer and would not be used at all the rest of the year.

Demand Side

We've looked at where our water comes from (the supply side), now let's look at how we use water and how much of it we use – the demand side. We know in gross terms how much water we use. And that number has been falling of late due to various water conservation measures on campus, including the deployment of an automated irrigation system for campus grounds.

But the second question -- how do we use water? – is much more difficult to answer. The Eugene Water and Electric Board (EWEB) measures the amount of water that enters campus so they can charge the university for its use. Currently we have a poor understanding of how of our water is used. The pattern of seasonal fluctuation of water use over the summer months suggests that roughly half of our water use is attributable to irrigation and roughly half is attributable to building operations. But on the whole, our understanding of the University of Oregon's water use is very poor.

Literature Review

In addition to our own 2007 Campus Sustainability Assessment completed by the Office of Sustainability and by Environmental Studies masters students[74], the primary sources I

[73] Source: Western Regional Climate Center (wrcc@dri.edu)

examined in preparation for this report were the “Water Benchmarks for Offices and Public Buildings” report[75], completed for the Australian government in 2005, and Lane County Community College energy and water report[76], completed in 2006.

I chose the Australian study because that country has some of the most stringent water conservation policies in the world. I reasoned that if we could keep pace with their standards, then we would be doing well. However, when considering the Australian standards, it is good to keep in mind that they have a very different climate than us, and that water policies should be place-specific and not universally applied. However, the Australian examples give us a sense of how much water really is *necessary* to operate a building and a landscape. Moreover, during the most water-constrained season in Eugene – summer – our weather *does* resemble that of Australia.

I chose the Lane County Community College report because it provided a local assessment for a similar institution, and enabled me to begin to gather water use data to make water use comparisons between the University of Oregon and our peer institutions.

Methodology and Sources

The water use data for this chapter was provided by Teri Jones, the Energy/Utilities Assistant for Capital Construction and Vince Babkirk, the Landscape Maintenance Coordinator for Facilities Services.

For a detailed explanation of the methodology I used for each figure in the Water chapter, please consult Appendix 2.3: Water Figures Methodology Descriptions.

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[74] http://sustainability.uoregon.edu/sites/sustainability.uoregon.edu/files/os-reports/campus_sust_assessment_-_may_2007_0.pdf
[75] http://www.environment.gov.au/settlements/publications/government/water-benchmarks.html
76 http://www.lanecc.edu/sustainability/documents/energy-report-2006.pdf (the link says “energy”, but the report also includes water data)

Calculations and Findings

The following metrics are intended to assess the sustainability of the University of Oregon with regard to water.

Metric 1: Total Campus Water Use – indicates how our total water use has changed over time

Metric 2: Water Use Submetering Percentage – indicates how well we understand our water use

Metric 3: Water Use Intensity – indicates how efficiently we are using water

Metric 4: Percent of Irrigation from Collected Rainwater – indicates the degree to which we rely on sources outside campus to provide water for irrigation

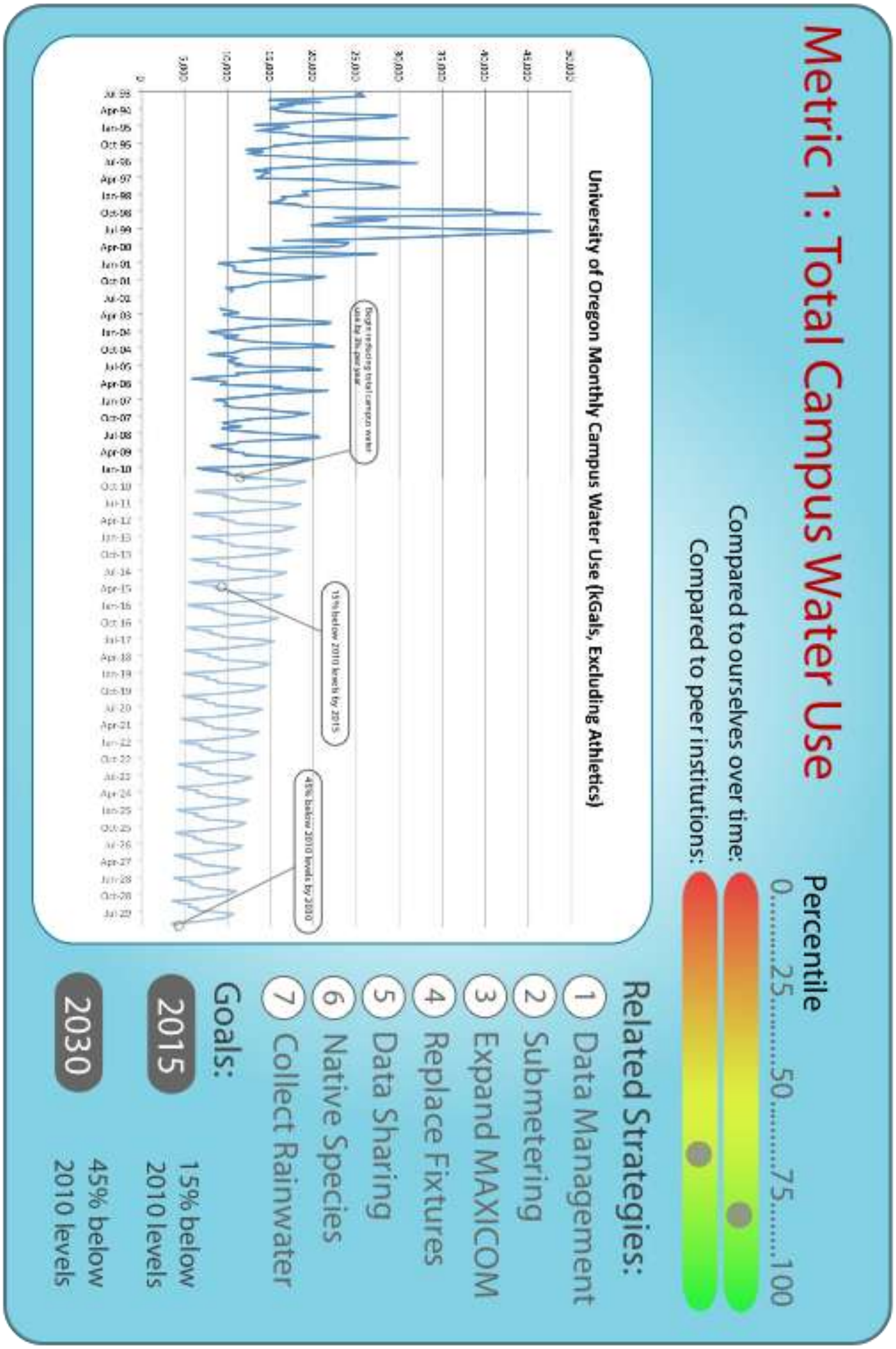

Figure 2.4: Total Campus Water Use

Metric 1: Total Campus Water Use

Overview

This metric examines the total quantity of water used on campus over time. This graph shows the seasonal fluctuations of water use and the irrigation spike during the summer months. Average water use dropped significantly in the early 2000s, coinciding with the deployment of an automated, evapotranspiration-based irrigation system[77] on parts of the campus. Average water use has continued to drop as the use of this system has expanded. Currently, around 50% of campus grounds square footage uses this automated irrigation system. Continued deployment of this system to other parts of campus is expected to result in continued declines in total water usage.

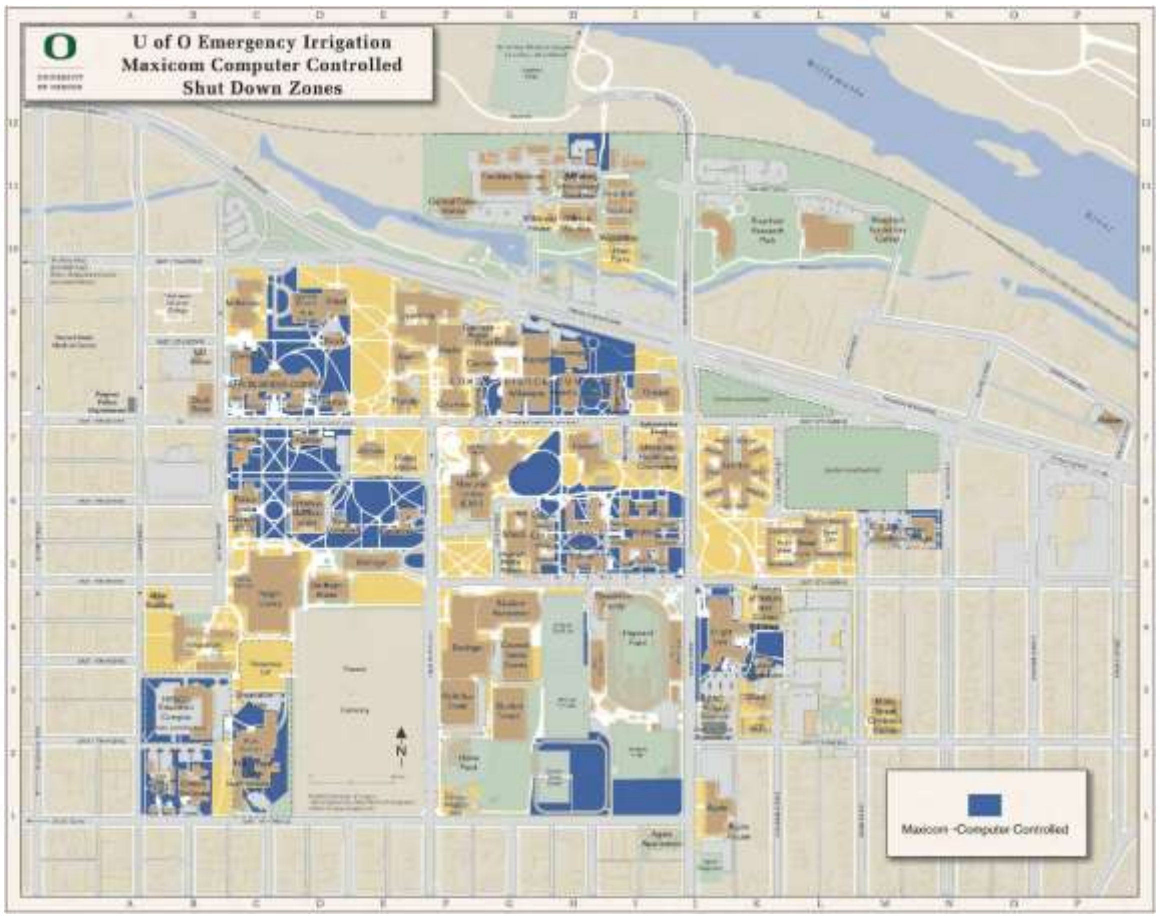

Figure 2.5: MAXICOM Irrigation System Deployment

Goals

2015: Total campus water use to be decreased 15% below 2010 levels by 2015
2030: Total campus water use to be decreased 45% below 2010 levels by 2030

[77] This system is called MAXICOM (Multi-Site Irrigation Central Control System) and is manufactured by a southern California-based company called Rain Bird.

I calculated these goals based on historical decreases in campus water use correlating with the deployment of the MAXICOM system. As long as the University is not purchasing additional land that has to be maintained, increases in total campus building square footage could actually serve to decrease our total campus water use, as a square foot of building requires less water than a square foot of landscape over the course of a year.

Recommendations for improving this metric:

- Factor in campus growth to total water use calculations
- Consider climate change in total water use calculations
- Determine the percentage of water use attributable to irrigation and the percentage attributable to buildings operations
- Perform a regression analysis to determine the slope of the water use decrease
- Include water use data from athletics
- Normalize water use for evapotranspiration loss and other weather-related factors

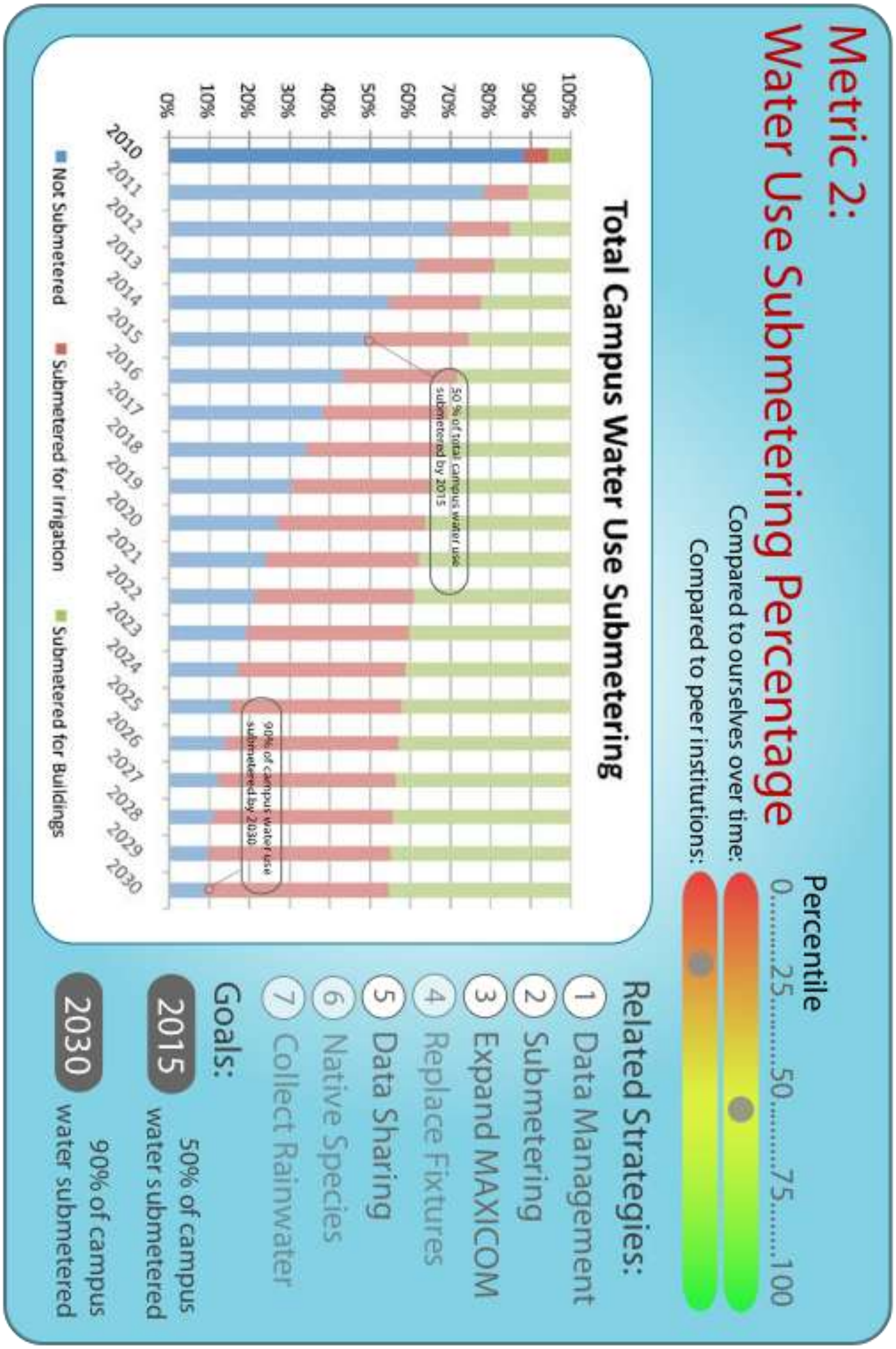

Figure 2.6: Water Use Submetering Percentage

Metric 2: Water Use Submetering Percentage

Overview

This metric examines the percentage of total campus water use that is being submetered at the building and irrigation cluster level. Currently, 6% of total campus water use is submetered by building and 6% of total campus water is submetered by irrigation cluster. These figures include all water controlled by the MAXICOM system. Irrigation water use data is available through the MAXICOM system; however, the system has not historically been used by Facilities staff to gather this data.

Currently we don't know how we're using 88% of the water that we purchase from EWEB. We can infer rough use distributions based on averages and building types and ages, but we only have actual measurements for 12% of the water that we use. This is an embarrassingly low percentage.

Goals

2015: By 2015, 50% of campus water use will be submetered
2030: By 2030, 90% of campus water use will be submetered

The goals for this metric are based on the expansion of the MAXICOM system and utilization of its flow sensors to collect irrigation water use data. Reaching the goal of having 50% of total campus water usage submetered by 2015 would also require a significant initiative to install electronic water meters in existing campus buildings. During the water advisory panel meeting for this project, it was suggested that MAXICOM could be used to manage water use and detect leaks within buildings, in addition to its use for irrigation. According to Jill Hoyenga, Water Management Specialist at EWEB, electronic water meters' ability to detect leaks makes their payback period relatively short.[78]

Recommendations for improving this metric:

- Determine funding options and payback periods for the installation of electronic water meters
- Improve accuracy of meter rollout timetables and revise submetering goals accordingly
- Collect historical data for water submetering

[78] Personal communication, 4/19/2010.

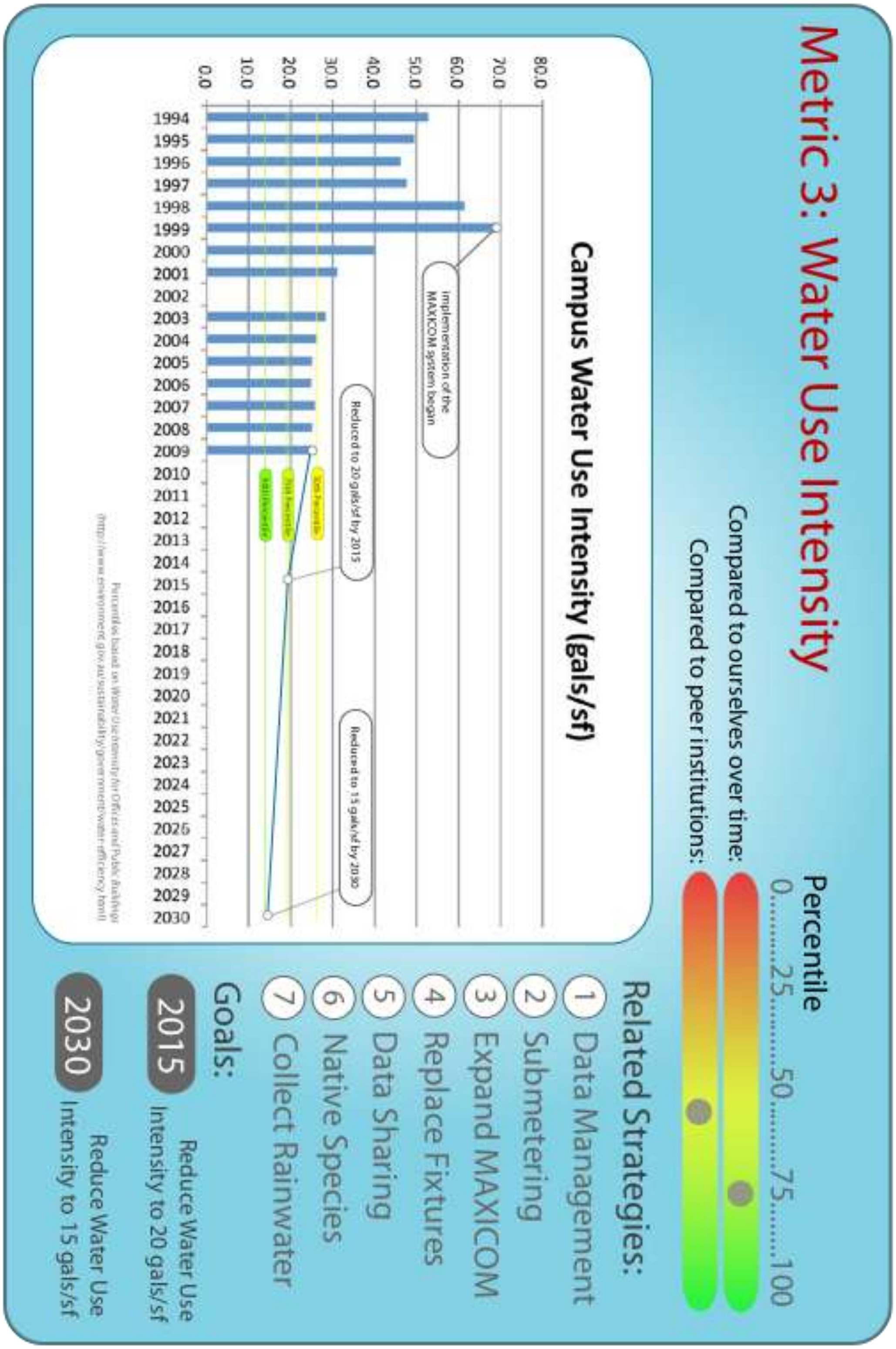

Figure 2.7: Water Use Intensity

Metric 3: Water Use Intensity

Overview
Like Metric 1 - Total Water Use, this metric seeks to determine the efficiency with which we are using water. It normalizes total water use by dividing by campus gross square footage. In theory, if the size of the campus stays the same and the percentage of campus square footage covered by buildings increases as more structures are erected, water use intensity should go down. According to John Reynolds, emeritus professor of architecture at the University of Oregon, this decrease would occur because a square foot of building typically requires significantly less water than a square foot of landscape.[79]

Goals
2015: By 2015, yearly water use intensity will be reduced to 20 gallons per gross square foot of campus buildings
2030: By 2030, yearly water use intensity will be reduced to 15 gallons per gross square foot of campus buildings

The goals for this metric are based on the implementation of all seven strategies, as well as a presumed increase in the percentage of total campus square footage that is devoted to buildings. The percentiles used for these goals come from a water use intensity report completed for the Australian government in 2005.[80]

Recommendations for improving this metric:

- Calculate water use intensity per campus user in addition to square footage
- Include water use for athletics in the calculations
- Determine how the construction of additional campus buildings will affect water use intensity
- Normalize water use for evapotranspiration loss and other weather-related factors

[79] Personal communication, 4/19/2010
[80] http://www.environment.gov.au/settlements/publications/government/water-benchmarks.html

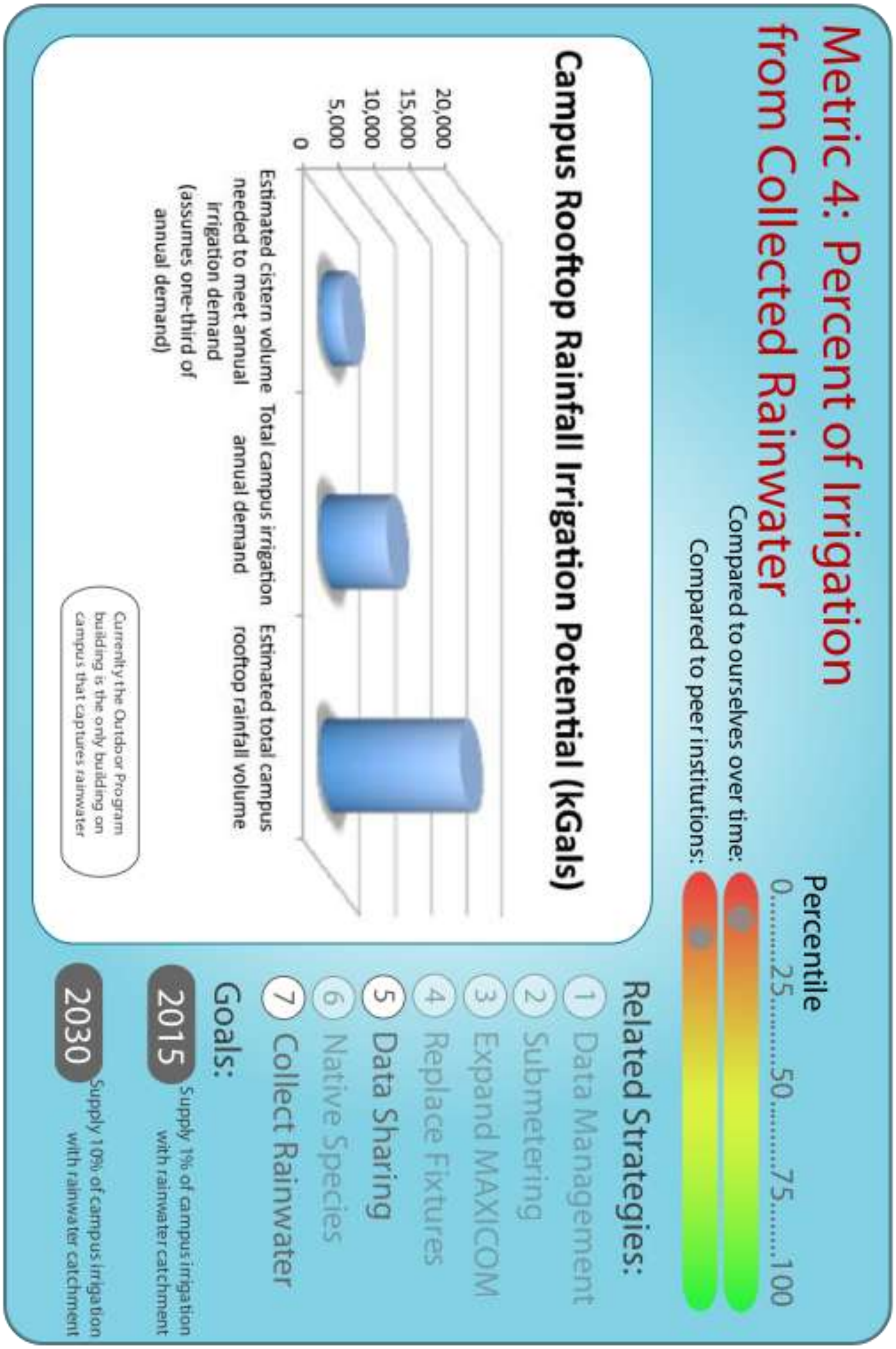

Figure 2.8: Percent of Irrigation from Collected Rainwater

Metric 4: Percent of Irrigation from Collected Rainwater

Overview
This metric measures the percentage of total campus irrigation that is being met using collected rainwater. Currently the University of Oregon Outdoor Program building is the only building on campus that collects rainwater. It does so by diverting the roof's downspout through a water filter and into two 1,500 gallon tanks.

Goals
2015: By 2015, one percent of campus irrigation demand (roughly 9,000 gallons) will be met with rainwater catchment
2030: By 2030, ten percent of campus irrigation demand (roughly 90,000 gallons) will be met with rainwater catchment

These goals are premised on increasing student demand for campus irrigation to be met with rainwater. Initial rainwater catchment projects can be initiated as educational and research tools by the departments of architecture and landscape architecture. However, for us to meet even 10% of campus irrigation demand with rainwater, the use of catchment systems will have to become incorporated as a standard design consideration for all campus retrofit and new construction projects.

Recommendations for improving this metric:

- Increase the accuracy of the cistern volume calculation using seasonal rainfall and irrigation demand data
- Increase the accuracy of the roof surface area calculation
- Including pricing and payback estimates for cisterns

Qualitative Considerations

A note on the University of Oregon's effect on riparian ecosystems

The University of Oregon campus is adjacent to multiple waterways, including the Willamette River. Any consideration of the University's sustainability with respect to water must include the effect of the campus on local riparian ecosystems. However, establishing a relationship between the University's operations and the health of local ecosystems is no easy task. In many senses, assessing the health of ecosystems adjacent to and within the University's campus is a qualitative determination that doesn't fit well into quantitative metrics. This doesn't make it any less important than other considerations, but it does make it harder to measure. One measure could be the quality of water re-entering the river, measured in terms of temperature and pollutants. These measures could also include the number of Department of Environmental Quality violations we receive each year.

Including in this report a substantive consideration of the University's effect on local ecosystems would have required a level of commitment and specialized knowledge that I cannot provide. The undertaking of such an assessment in the future could potentially be incorporated into the curricula of one or more campus departments. Departments that might align well include Biology, Chemistry, and/or Landscape Architecture.

Discussion and Recommendations

I would like to propose the following seven strategies to improve the sustainability of the University's water use relative to the metrics laid out in the previous section. The environmental impacts of the University on the surrounding hydrological systems appear to be relatively mild compared to the environmental impacts of the University related to energy and transportation. Still, we can improve.

Strategies

Strategy 1: Improve water use data management
Strategy 2: Submeter campus water use
Strategy 3: Expand use of the MAXICOM irrigation system
Strategy 4: Replace water fixtures in campus buildings
Strategy 5: Share data with campus users and peer institutions
Strategy 6: Plant native species and xeriscaping
Strategy 7: Collect rainwater for irrigation

Strategy 1: Improve water use data management

Why?
Currently there is no central location where comprehensive campus water use data is gathered. Facilities keeps track of total campus water usage, but they have inconsistent data from athletics and no irrigation submetered data. There is precious little water use data available currently; what data does exist should be organized in a central, digital location, and stored in a standardized, intuitive format. For example, the MAXICOM water use data exists, but it is currently being recorded in intervals as short as one minute, requiring the user to sift through a 42,000-row spreadsheet to examine one year's worth of data.

How?
Create a centralized, automated, digital repository (Data Acquisition System)[81] for all campus utility data, including water use data.

[81] http://www.energystar.gov/index.cfm?c=assess_performance.gather_data

Consult with other organizations that already do this. The City of Eugene uses such a system. As digital meters are added to buildings and irrigation systems their data can be incorporated into this automated repository. Additional Facilites and/or Office of Sustainability staff may need to be hired to help manage this repository, among other tasks.

Strategy 2: Submeter campus water use

Why?

Currently only twelve percent of total campus water use is submetered. This means that we have a very poor understanding of how the vast majority of campus water is used. If we wish to improve our use of water, we must first determine *how* we are using water. Until a larger percentage of our campus water use is submetered, we are operating in the dark. We have no basis for undertaking any additional water conservation measure until we have more submetering.[82]

Submetering will enable the University to identify where water is being used and instances where water can be used more efficiently. It will enable campus employees to establish a baseline of water use in buildings and identify problems with overuse. Electronic, real-time water submetering can allow staff to remotely monitor water use to identify leaks and turn off the valve and call for repair. In the present situation (with very little submetering, and almost no real-time electronic metering), a leak can go undetected indefinitely because it doesn't show up until the next month's bill, and even then it is lost in the macro-scale and regular fluctuations of water use for campus as a whole.

How?

Expand the use of MAXICOM (see Strategy 3: Expand use of the MAXICOM irrigation system) for campus irrigation and clarify the resulting water use data as described in Strategy 1. With the assistance and advice of EWEB, begin installing digital water submeters in campus buildings, beginning with the largest buildings. Explore the use of the MAXICOM system for buildings in addition to irrigation.

Strategy 3: Expand use of the MAXICOM irrigation system

Why?

The irrigation system has demonstrated significant water savings since its initial deployment. It also doubles as a digital remote submeter.

How?

Expansion of the system can be scheduled in conjunction with other construction projects on campus. If the project requires a trench to be made, then the same trench can be used to run the lines for the MAXICOM system.

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[82] The installation of the MAXICOM system *includes* submetering.

This map shows the areas where the MAXICOM system is currently being used on campus. MAXICOM areas are in blue. Traditional irrigation areas are in yellow.

Strategy 4: Replace water fixtures in campus buildings

Why?
Newer fixtures (sinks, aerators, toilets, waterless urinals, etc.) are much more water efficient than existing fixtures in many campus buildings. Of course the environmental impact of the creation, transport and eventual disposal of new fixtures should be balanced against the environmental benefits they provide.

How?
Some existing fixtures can just be modified; others would need to be replaced. For those that would need to be replaced, a determination would need to be made weighing the environmental impact of decreased water use intensity with the environmental impact of the creation, transport, and eventual disposal of the new fixture as well as the existing fixture.

Strategy 5: Share data with campus users and peer institutions

Why?
By sharing data about water use with other institutions, we can learn from them and help them improve their own practices. Also we can disseminate information and help change behavior by making our water use data available to both campus users and others via online digital "dashboards". This site would show water use data for individual buildings within campus and for campus as a whole.

How?
Create a digital online "dashboard" that shows real-time utility data for individual campus buildings and the campus as a whole. Such a website for the University of Oregon is currently under development. For more information and to see an example of an online "dashboard", please see Strategy 5: Share data with campus users and peer institutions in the Energy chapter of this assessment.

Establish a consortium of peer institutions to gather and compare water use data. This group could include the University of Oregon, Oregon State University, Portland State University, and perhaps the University of Washington. These institutions are similar in size and type, and exist in a similar geography and climate.

Strategy 6: Plant native species and xeriscaping

Why?
Native plant species tend to be better adapted to the local climate and use less water than non-native species. Granted, the campus, with it multiple hardscapes and buildings, does not constitute a "natural" microclimate for native species. Native species may not fare as well in the constructed campus environment as they would in a less human-dominated setting, but to the degree that they provide better habitat and require less maintenance than non-native species, they should be given preference. Xeriscaping is a type of landscaping that requires very little or no irrigation.

How?
Reduce "lawn" areas on campus in favor of drought-tolerant native polycultures. The impediments to the expansion of xeriscaping on campus are primarily aesthetic and cultural, not technical.

Strategy 7: Collect rainwater for irrigation

Why?
This utilization of rainwater intended to re-connect building users and maintenance people with the fluctuations in the availability of water instead of just relying on a tap year-round. It is also intended to decrease the University's reliance on water that has fallen as rain outside the boundaries of campus.

How?
Installation of integrated catchment, filtration, and cistern systems on campus, either above or below-ground. These systems can be used as pedagogical tools for campus users and visitors alike. Their design and construction could be undertaken as a project as part of the curriculum for the Landscape Architecture department. There multiple precedents for this kind of educational campus construction project, including the bioswale along Franklin Blvd., the Kiln Shed, the low concrete wall in the Lawrence Hall courtyard, et cetera.

Appendices

Appendix 2.1: Water Advisory Panel Members

Vince Babkirk, Landscape Maintenance Coordinator, University of Oregon Facilities Services

Jill Hoyenga, Water Management Services Supervisor, Eugene Water and Electric Board

John Reynolds, FAIA, Distinguished Professor Emeritus, Department of Architecture

Appendix 2.2: Water Resources

Assessments from Other Institutions
UC Santa Cruz water use survey
http://ppc.ucsc.edu/cp/projects/9000-021/planning/WES.pdf

Lane Community College – Proceedings from the National Conference on Sustainability for Community Colleges
http://lanecc.edu/sustainability/conferences/presentations.html

Rainwater Catchment Systems
American Rainwater Catchment Systems Association
http://www.arcsa.org/

Appendix 2.3: Water Figures Methodology Descriptions

Figure 2.4: Total Campus Water Use

I created this figure by gathering the monthly water use data for the University from Teri Jones, the Energy/Utilities Assistant for Capital Construction. These numbers came from the EWEB meters that monitor the water entering campus. This graph does not include water used by University athletics. Also, there is an eight-month period in 2002 for which water use data was not available.

I created the projected water use data using the most recent twelve-month period as a baseline and applying the use reduction goals for 2015 and 2030. These reductions assume a perfect distribution of efficiency measures between building operations base-load (the “valleys”) and irrigation (the “peaks”). This is unlikely. These projections also include a linear decrease in water use and no variation in weather-driven water demand over the period considered. These conditions are of course also unlikely.

Figure 2.6: Water Use Submetering Percentage

The only collected data for this chart are contained in the first bar, for 2010; every other bar on the chart represents speculated data. The submetering data for 2010 was determined by first adding up total water use for campus for fiscal year 2009, based on data I received from Teri Jones, the Energy/Utilities Assistant for Capital Construction. Next, I added up the quantity of water consumed in 2009 by all University buildings that are currently submetered for water and divided that number by total water use to determine the total percentage of campus water use that is submetered for buildings. These building-level numbers were from our own water meters within the individual buildings.

Finally, I gathered campus irrigation water use data. Only irrigation water that is controlled by our automated, evapotranspiration-based irrigation system is currently metered. This proprietary automated system – called the Multi-site Irrigation Central Control System (MAXICOM) – is not designed to monitor total water use over time, but rather to control and monitor instantaneous flow volumes. Measurement intervals vary depending on how much water is needed, but the interval periods can be as short as one minute – meaning thousands of rows of flow meter data over the course of a year. I consolidated this data and found the total volume used for irrigation, then divided that number by the total volume used by the University to determine the percentage of our water use that is submetered for irrigation.

To create the projected submetering data, I reduced the 2010 values incrementally each year such that they would meet the goals outlined for year 2015 and 2030, assuming that initial gains would be easier and that as a higher and higher percentage of water use was submetered, each additional submetered percentage would become harder and harder to achieve (diminishing marginal returns). This resulted in the non-linear submetering increase shown in the chart.

Figure 2.7: Water Use Intensity

I calculated water use intensity for the University by first aggregating monthly total campus water use values, collected from Teri Jones the Energy/Utilities Assistant for Capital Construction, into calendar year totals. I then tracked the total campus square footage for those years using the building inventory completed for the University by Sightlines, a facilities asset advisory firm.[83] I divided the total water use by total campus gross square footage to determine water use intensity for the campus for each year. Again, water data for portions of 2002 were unavailable; therefore, the entire year was omitted for this chart.

Figure 2.8: Percent of Irrigation from Collected Rainwater

I calculated campus rooftop irrigation potential by first estimating the square footage of all campus buildings. I estimated this value by placing an image file of an aerial view of campus within a Google SketchUp software. I then used the ruler tool in Google Earth to measure the length of an object on campus. I used this measurement to then correctly scale the aerial image in SketchUp. I then created a new layer and drew rectangles that approximated the footprints of all campus buildings. Finally, I measured the total square footage for that layer and came up with a total campus roof area of approximately two million square feet.

I took this estimated rooftop area and multiplied it by the same total average yearly precipitation figure for Eugene used in previous calculations. This gave me a rough value of the total volume of water falling on campus rooftops in a given year.

To calculate annual irrigation demand, based on the annual water usage data, I estimated that roughly half of all campus water use is for irrigation. Based on this estimate, I multiplied total annual campus water use for 2009 by 0.5 to get an estimation of annual irrigation water demand.

The Green Studio Handbook suggests that in general, cistern capacity should equal one-quarter of annual water demand.[84] Because our annual irrigation demand is so concentrated into three months of the year, I increased required cistern capacity from one-fourth to one-third of annual demand.

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[83] http://www.sightlines.com/

[84] pg. 245, Kwok, Alison and Grondzik, Walter, Green Studio Handbook, Architectural Press, Oxford, UK, 2007

3) Transportation

Introduction

How do we begin to judge how sustainable transportation is at the University of Oregon? Vehicle effects on the environment are multiple and varied and include habitat fragmentation, sprawling human development patterns, and climate change.

There are two primary categories of transportation on campus:

1) Commuting to and from campus
2) University business travel.

These categories exclude the transportation of the University's fleet itself (shuttles, security vehicles, facilities trucks and carts, et cetera) because this data is not readily available and because I believe it constitutes a very small part of the total impact for transportation. This is not to say that the University's fleet should not be made more sustainable, but just that it likely constitutes a very small piece of the pie.

Background

Category 1: Commuting to and from Campus

This category includes the daily commutes University employees and non-residential students make to campus.

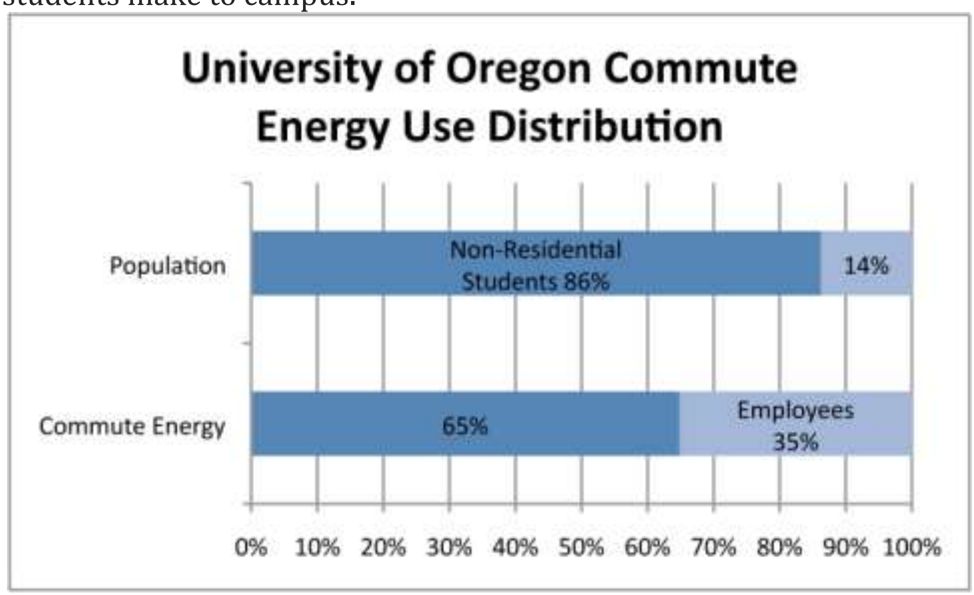

Figure 3.1: University of Oregon Commute Energy Use Distribution

Figure 3.1 shows that University employees use a disproportionate amount of energy for their commutes relative to their population. They constitute only 14% of total campus population, but use 35% of all the energy that is used for campus commutes. The average employee commute uses roughly 60% more energy than the average student commute. This difference is primarily due to the percentage of each population that drives to campus.

There are profound variations in the amount of energy used and the amount of carbon dioxide emitted for among the various commute modes that campus users employ.

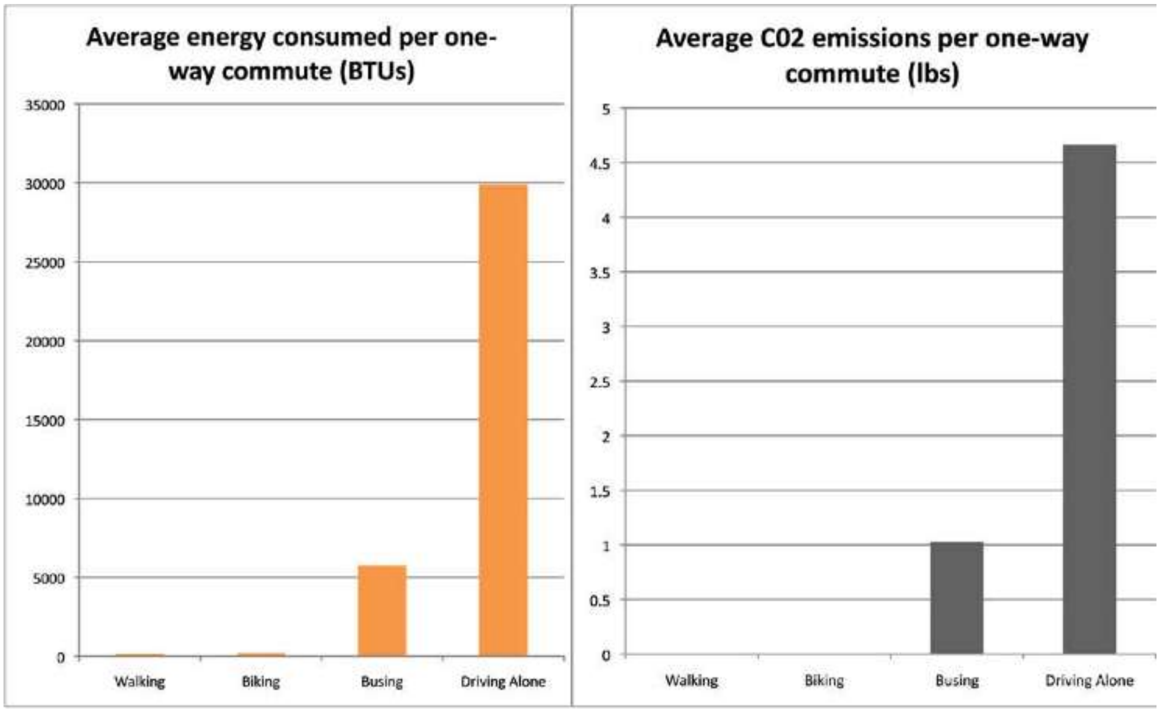

Figure 3.2: 2009 University of Oregon Average Energy Consumption and Emissions Per One-way Commute

Figure 3.2 demonstrates just how significant are the environmental impacts of driving alone to campus, compared to other commute modes.[85] These differences are the result of fuel type, distance traveled, and, perhaps most significantly, the percentage of the energy consumed that is being used to propel the passenger.[86]

Figure 3.3 and Figure 3.4 show the commute distribution of UO students and employees, examining those figures over time and in comparison to commute distributions from other PAC-10 universities.

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[85] Technically, there are CO2 emissions associated with walking and biking to campus due to increased respiration rate. But after some investigation I determined that these emissions are 1) negligible and 2) ostensibly derived from renewable sources. Effectively, they come from biofuels (that is, food).

[86] In the typical car, only about 1% of the energy consumed is being used to propel the driver. (http://www.irenew.org/factsheets/altfuels.html)

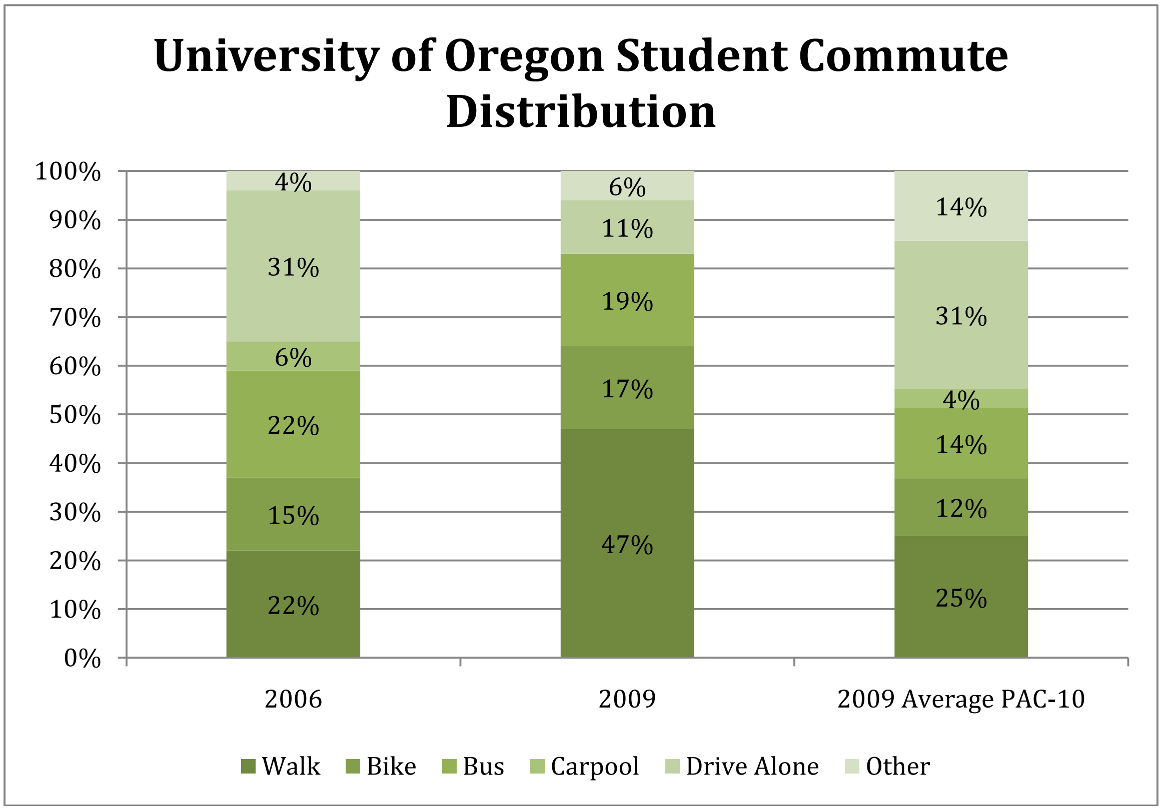

Figure 3.3: University of Oregon Student Commute Mode Distribution

Our student distribution has improved considerably since the 2006 survey. Statistical problems with the 2006 survey may serve to exaggerate the trend among students away from commuting by car. But the 2010 numbers are generally believed reliable. The percentage of students commuting alone by car (11%) is especially encouraging. The UO student numbers compare favorably to those of the average PAC-10 school, where 31% of students drive alone to campus and only 37% of students commute to campus via carbon-neutral means (compared to 64% at UO).

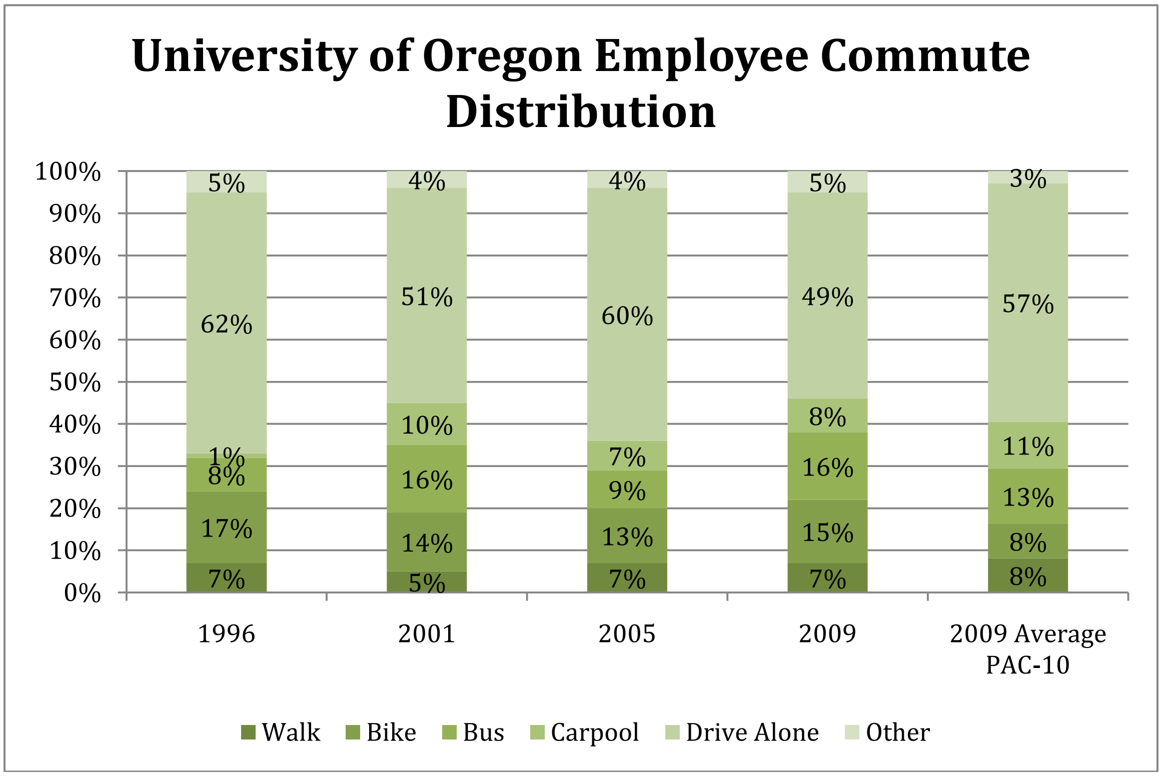

Figure 3.4: University of Oregon Employee Commute Mode Distribution

There is more data available for the University employee commute distribution, but there are fewer clear trends. As seen in Figure 3.4, the percentage of UO employees driving alone to campus (49%) is slightly lower than the average for average for PAC-10 employees (57%). The percentage of UO employees commuting to campus via a carbon-neutral means (22%) is slightly higher than the PAC-10 average (16%). In addition, the overall carbon-intensity of UO employees' commutes is lower than that of the average PAC-10 employee.

Category 2: University-related travel

The second primary transportation category is university-related travel. This category includes any travel that is done as part of the activities of the university, and includes conferences, research, study abroad, and athletic competitions. Remediating the environmental impacts of university-related travel is much more difficult than it is for commuting impacts because the problems associated with travel are more intractable and the alternatives fewer.

Virtually none of the energy used for university-related travel is from renewable sources, and this kind of travel has become fundamental to what it means to be an employee or a student at our university. This is a bad combination of circumstances, and it will not be easily, painlessly, or quickly remedied. University-related travel accounts for the majority of transportation energy used by the University and 83% of our transportation emissions.

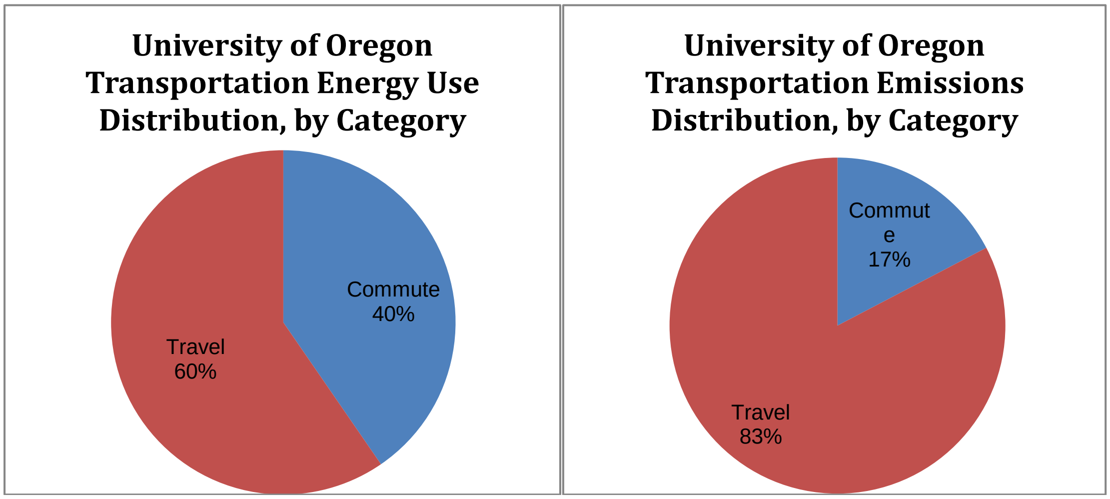

Figure 3.5: University of Oregon Transportation Energy Use and Emissions, by Category

Literature Review

In addition to the 2007 University of Oregon Campus Sustainability Assessment, completed by Environmental Studies master's students in collaboration with the Office of Sustainability[87], I consulted UC Berkeley's transportation sustainability framework[88], as well as two theoretically-oriented scholarly articles on establishing transportation sustainability standards.[89][90]

All of these sources emphasized the importance of considering social and economic, in addition to environmental, factors when assessing the sustainability of a transportation system. The UC Berkeley plan included initiatives to reduce total transportation-related fossil fuel usage and the promotion of dense development near campus through policy initiatives.

Methodology and Sources

The data for the Transportation chapter came from the 2007 University of Oregon Campus Sustainability Assessment, from five transportation surveys from 2009, 2006, 2005, 2001, and 1996, from the University of Oregon Climate Action Plan 2.0, and from various online sources. For a discussion of the origins and limitations of the surveys, as well as a description of the methodology I used to create every figure in the Transportation chapter, please see Appendix 3.3: Transportation Figures Methodology Descriptions.

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[87] http://sustainability.uoregon.edu/sites/sustainability.uoregon.edu/files/os-reports/campus_sust_assessment_-_may_2007_0.pdf
[88] http://sustainability.berkeley.edu/pages/transportation/overview.shtml
[89] Zegras, Christopher, Sustainable Transport Indicators and Assessment Methodologies, Paper for the Biannual Conference and Exhibit of the Clean Air Initiative for Latin American Cities, Sao Paulo, Brazil, 2006
[90] Jeon, C.M. and A. Amekudzi. Addressing Sustainability in Transportation Systems: Definitions, Indicators, and Metrics. *Journal of Infrastructure Systems*. March, 2005. pp. 31-50

Calculations and Findings

The following metrics attempt to measure the sustainability of the University's transportation and lay out goals relative to these metrics to be achieved by the years 2015 and 2030.

Metric 1: Average Campus Commute Carbon Intensity – indicates the amount of average environmental degradation caused by our commutes

Metric 2: Transportation Emissions per Scaled Campus User (SCU) – indicates the environmental degradation caused by all transportation for the average campus user

Metric 3: Transportation Energy per Scaled Campus User (SCU)Metric 3: Transportation Energy per Scaled Campus User (SCU) – indicates the amount of energy used by all transportation for the average campus user

Metric 4: Renewable Transportation Energy Percentage – indicates the percentage of all transportation-related energy consumption that is derived from renewable sources

Metric 5: Campus Parking Ratios – indicates the degree to which the University is encouraging carbon neutral transportation commute mode

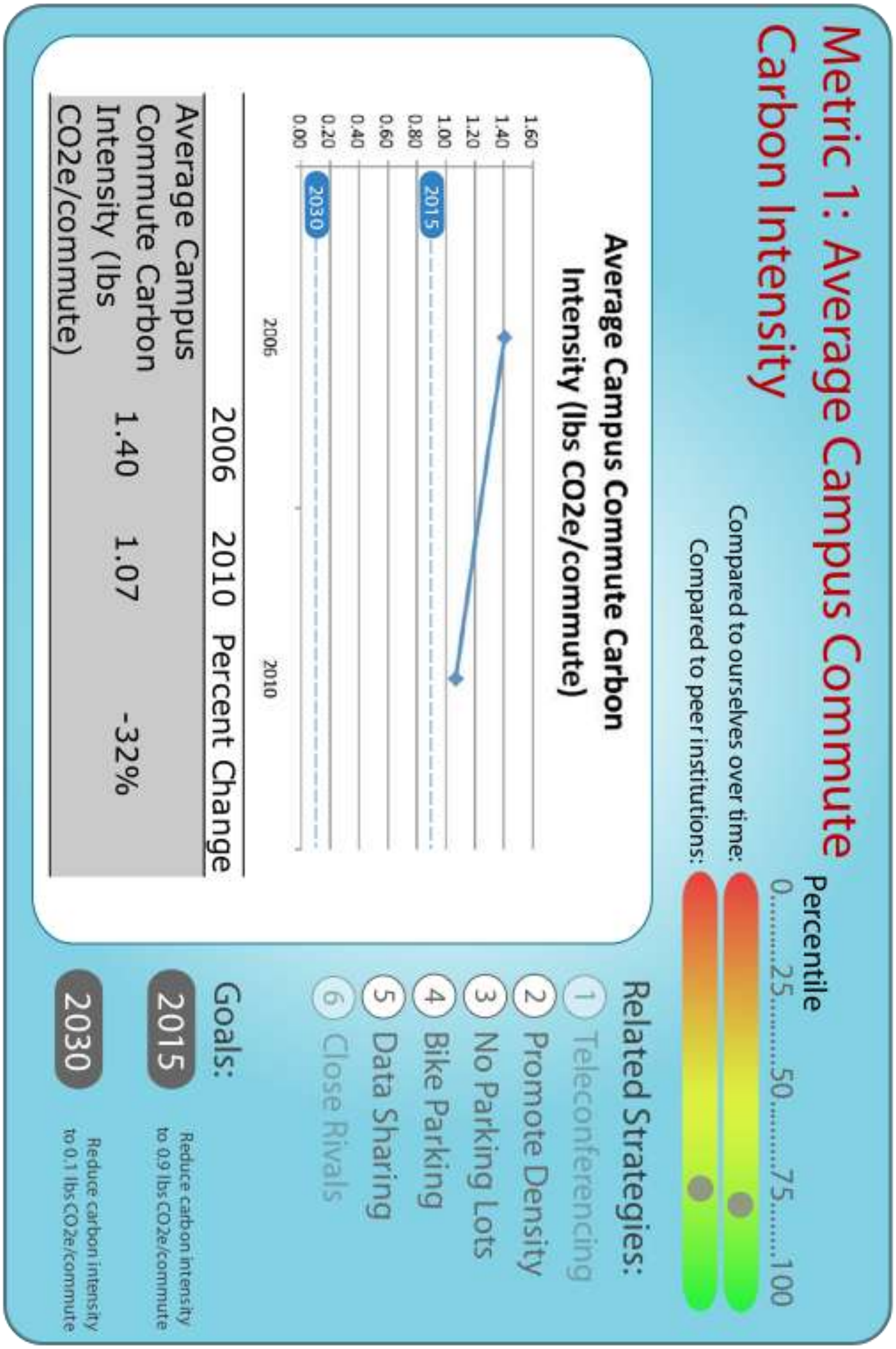

Figure 3.6: Average Campus Commute Carbon Intensity

Metric 1: Average Campus Commute Carbon Intensity

Overview
This metric measures how much C02-equivalent emissions we are emitting per average commute to campus. It is attempted to be a distillation of multiple commute sustainability considerations into a single metric. It takes into account commute distance and commute mode distribution among various campus populations.

Over the last four years, the average carbon intensity of our commutes appears to have dropped some 32%. While I'm sure we have made progress over time, it seems more likely that this decrease is due primarily to differing methodologies used in the 2006 and 2009 commute mode surveys. To be accurate, this metric (like many others) relies heavily on the validity and methodological consistency of our commute mode surveys.

Both the commute distance (related to Strategy 2: Promote dense development adjacent to campus) and the commute mode (related to Strategy 3: Establish a moratorium on new surface-level parking lots) and Strategy 4: Increase secure bike parking) affect commute carbon intensity.

Goals
2015: Reduce campus commute carbon intensity to 0.9 lbs of carbon dioxide equivalent per commute
2030: Reduce campus commute carbon intensity to 0.1 lbs of carbon dioxide equivalent per commute

These goals are based on the current trajectory of the metric (admittedly, from a very small sample size). They are also based on the expectation that dense mixed-use development will continue to occur adjacent to the University and that automobile parking near campus will becoming increasingly scarce and unnecessary. These goals are also based on the assumption that the next two decades will witness the widespread usurpation of the internal-combustion-engine-driven automobile by the electric-motor-driven automobile.

Recommendations for improving this metric:

- Improve accuracy of average commute distances from the various modes using commute surveys from 2006 and 2009
- Standardize commute survey and provide funding and institutional infrastructure to ensure that it is carried out at predictable, regular intervals
- Calculate the average annual total number of commutes for campus users with more rigor and accuracy

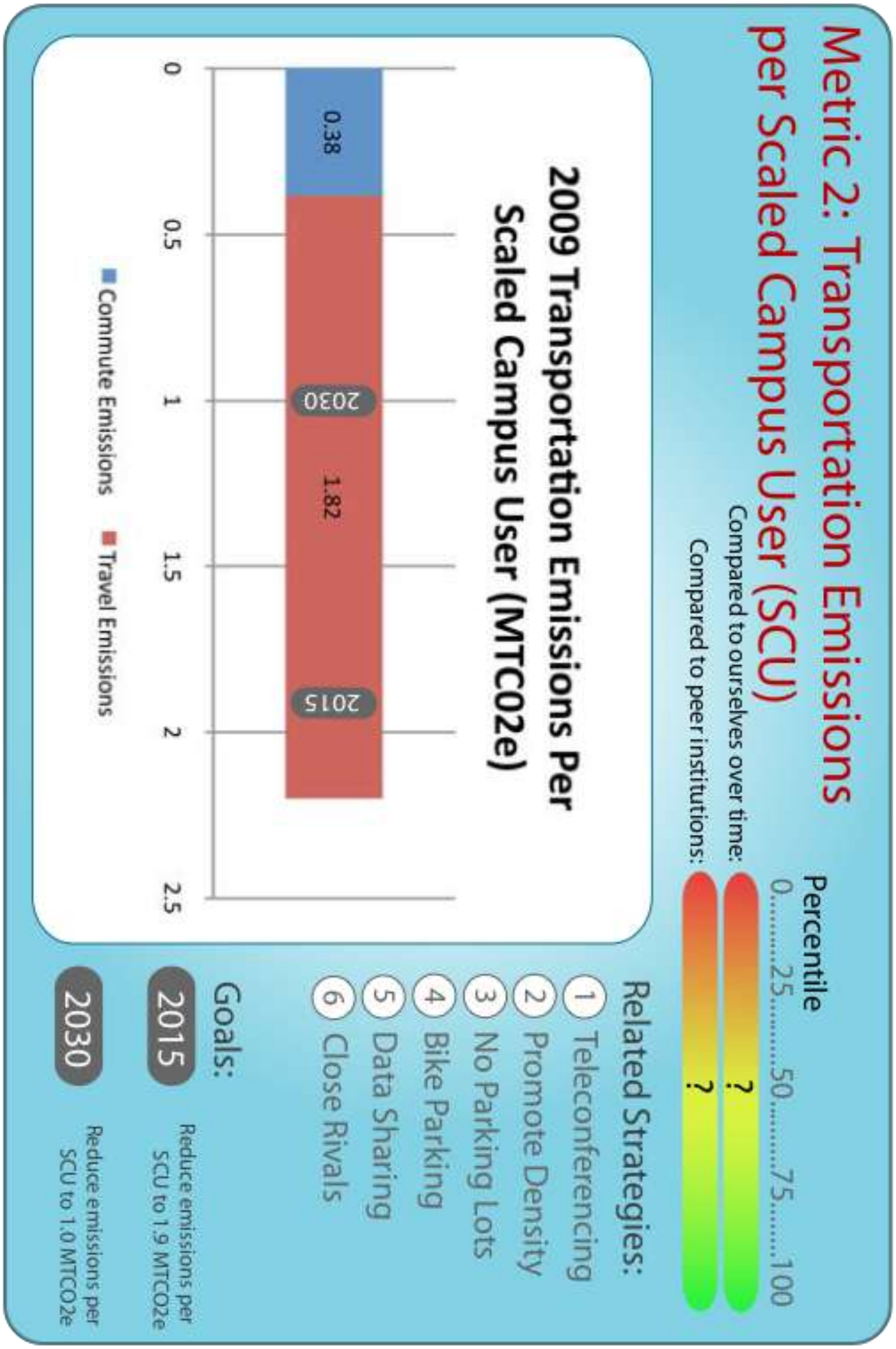

Figure 3.7: Transportation Emissions per Scaled Campus User

Metric 2: Transportation Emissions per Scaled Campus User (SCU)

Overview
This metric examines total transportation emission for the University, normalized for the number of people using our campus. It is intended to be a broad, inclusive measure of our progress with respect to transportation emissions. Its complement is the next metric, which looks at total energy use at the same scale. The data I used to assess this metric was provided by Teri Jones, the Energy/Utilities Assistant for Capital Construction.

Because this is the first time that we have the data for this metric, we can only document it now and then reassess it in the future to construct a trend line. Ideally, we could also compare our performance with those of other institutions. But while this metric could likely be calculated using existing data at other institutions, I know of no-one who has already done so.

Goals
2015: Reduce yearly transportation emissions per scaled campus user to 1.9 metric tons of carbon dioxide equivalent
2030: Reduce yearly transportation emissions per scaled campus user to 1.0 metric tons of carbon dioxide equivalent

This is the first year that the University has ever documented its total transportation emissions. The Office of Sustainability gathered comprehensive emissions data in order to draft the Climate Action Plan (CAP) required by our signing of the American College and University Presidents' Climate Commitment (ACUPCC). The goals for this metric were based on the emissions reduction goals laid out in the Climate Action Plan.

Recommendations for improving this metric:

- Repeat its calculation in coordination with the next comprehensive campus emissions inventory to establish trend lines
- Calculate this metric's value for peer institutions to determine how well we are doing compared to similar institutions. This can completed using other schools' Climate Action Plans, many of which are available on the APUCC website (http://acupcc.aashe.org/)
- Track air miles traveled for university business travel instead of converting dollars traveled to miles traveled
- Improve commute survey regularity and uniformity

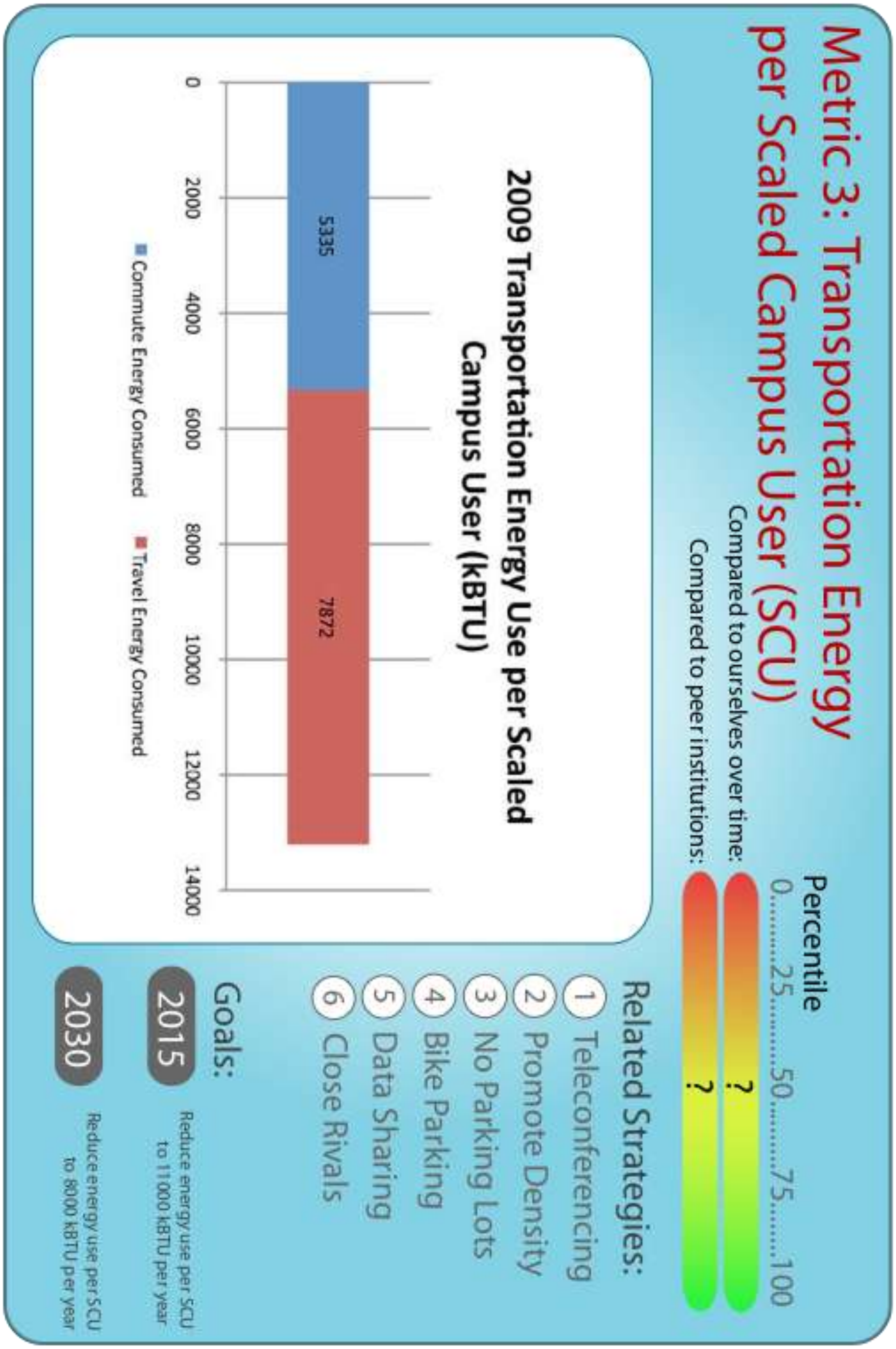

Figure 3.8: Transportation Energy Use per Scaled Campus User

Metric 3: Transportation Energy per Scaled Campus User (SCU)

Overview
This metric is intended to give a broad view of the amount of energy being used by the University for transportation, normalized for the number of campus users. While the use of energy is not inherently unsustainable, non-renewable energy sources tend to have a much higher energy density than non-renewable energy sources, and therefore higher energy use tends to be correlated with higher levels of environmental impact. Moreover, as discussed in the Energy chapter of this report, the lower your energy demand, the easier it is to meet that demand with renewable energy sources. The data I used to assess this metric was provided by Teri Jones, the Energy/Utilities Assistant for Capital Construction.

Because this is the first time that we have the data for this metric, we can only document it now and then reassess it in the future to construct a trend line. Ideally, we could also compare our performance with those of other institutions. But while this metric could likely be calculated using existing data at other institutions, I know of no-one who has already done so.

Goals
2015: Reduce energy use per scaled campus user to 11,000,000 British thermal units per year
2030: Reduce energy use per scaled campus user to 8,000,000 British thermal units per year

These goals are based on the adoption of all seven strategies discussed in this report. It is expected that most of the reductions will be made through behavioral changes with regard to commuting and commuting mode. Significant reductions can also be made through the widespread adoption of teleconferencing in lieu of air travel. The relatively modest reduction goal for 2030 is based on the assumption that we will continue to regularly use high-speed air travel during the next two decades.

Recommendations for improving this metric:

- Gather air and ground travel data from 2006 and combine with the 2006 commute survey to retroactively calculate a transportation energy per scaled campus user value for that year
- Track air miles traveled for university business travel instead of converting dollars traveled to miles traveled
- Improve commute survey regularity and uniformity
- Track this metric yearly to develop trend lines

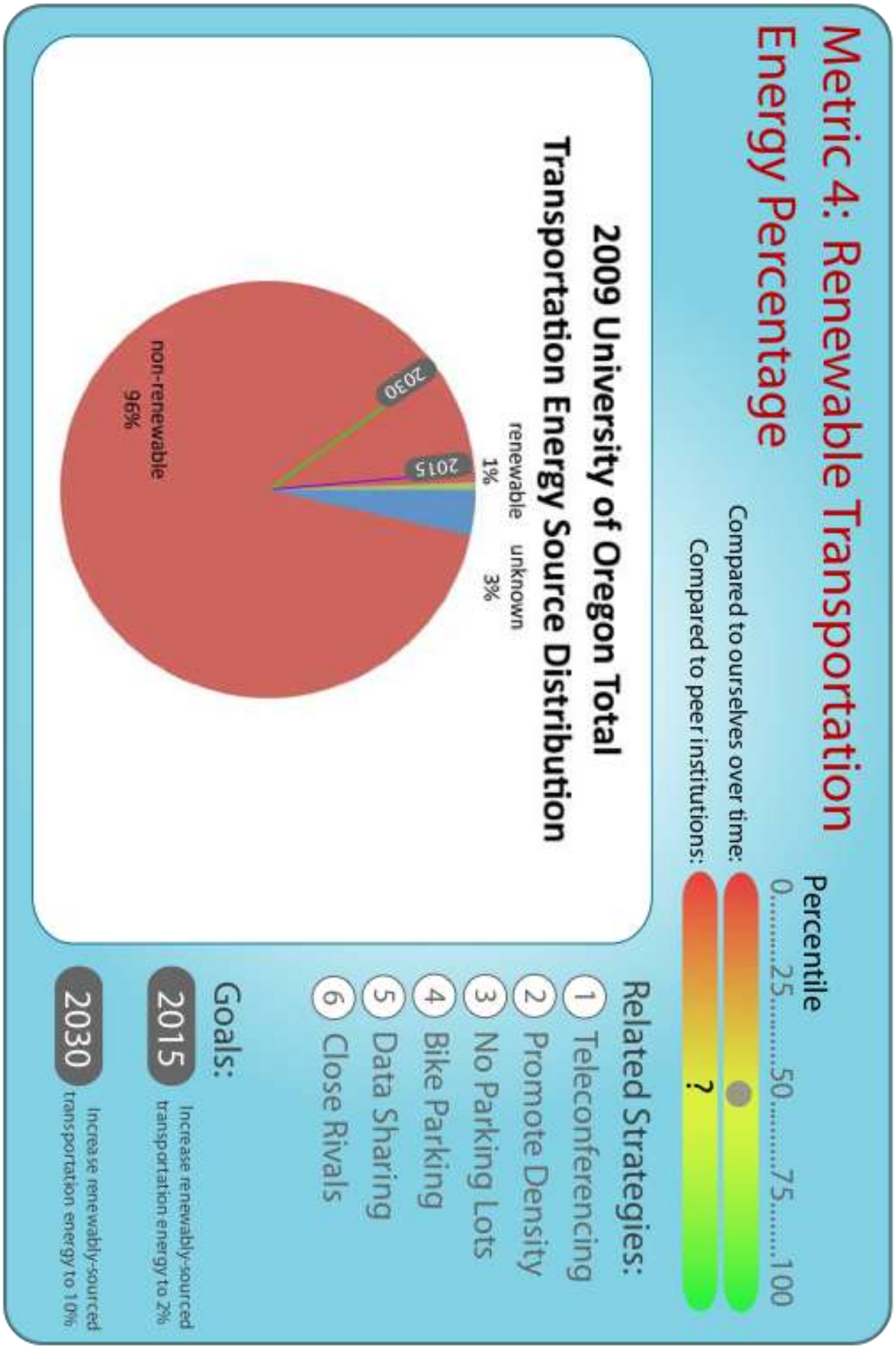

Figure 3.9: Renewable Transportation Energy Percentage

Metric 4: Renewable Transportation Energy Percentage

Overview
This metric is intended to provide a fundamental, provocative assessment of just how (un)sustainable our transportation energy use really is. It is intended to be a goad for times when we might become complacent with our progress relative to transportation sustainability; it is intended to remind us just how far we have to go.

Some reviewers have suggested that instead of renewable and non-renewable energy use, this metric should examine renewable and non-renewable miles traveled. This approach would still be subject to the kind of extreme disproportionate effects of each non-renewable traveler compared to renewable traveler (we are likely to travel farther using non-renewable energy than renewable), but to a lesser degree than using energy alone.

Goals
2015: Increase renewably-sourced transportation energy to 2% of total University transportation energy expenditures
2030: Increase renewably-source transportation energy to 10% of total University transportation energy expenditures

These goals seem extremely modest, but they would reflect a profound change in our transportation energy use. Their apparent modesty is due to the extreme disparity in the amount of energy consumed in the process of commuting to campus via car or bus via commuting by bike or walking. For instance, approximately 120 campus users have to bike to the university to consume the same amount of energy used by a single commuter who drives alone.[91] Non-renewable energy is just cheaper[92] than renewable energy, so we tend to use a whole lot more of it.

Recommendations for improving this metric:

- Track it over time using the 2006 commute survey and collecting air and ground university related travel data
- Switch to measuring renewable and non-renewable *miles traveled* instead of energy used?

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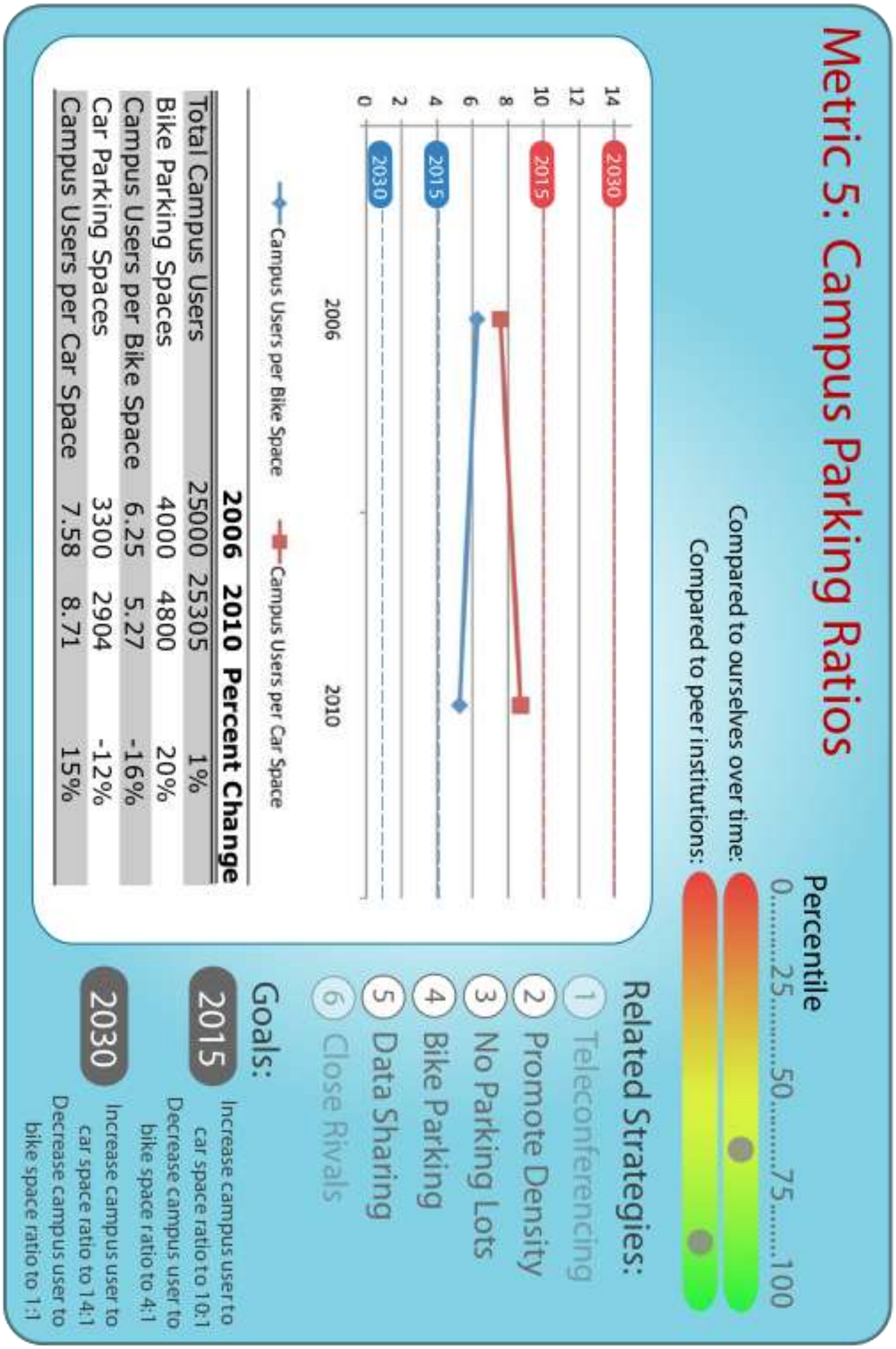
[91] To put this in perspective: If we had 20,000 campus commuters, and only 150 (0.75%) of them were driving alone, and everyone else was walking or biking, we would *still* be using more non-renewable commute energy than renewable commute energy
[92] Given our current economic system, which doesn't internalize the negative externalities of fossil fuels into their price



	2006	2010	Percent Change
Total Campus Users	25000	25305	1%
Bike Parking Spaces	4000	4800	20%
Campus Users per Bike Space	6.25	5.27	-16%
Car Parking Spaces	3300	2904	-12%
Campus Users per Car Space	7.58	8.71	15%

Figure 3.10: Campus Car and Bike Parking Ratios

Metric 5: Campus Parking Ratios

Overview
This metric examines how the ratio of car and bike parking spaces to total campus users is changing over time. While bike and car parking do not directly measure the most significant environmental impacts of commuting, they do provide a good indication of the University's commitment to incentivizing renewable means of transportation over non-renewable ones. This metric will likely be correlated with the commuting-related emissions and energy intensity metrics.

Over the last four years the campus user to bike space ratio has decreased by 1% and the campus users to car space ratio has increased by 11%. These are both encouraging trends.

One reviewer indicated that this metric should include parking changes that do not change the ratio of car spaces to total campus users, but that do promote less environmentally-damaging commuting behaviors. Examples of such changes include an increase in the number of preferential carpool-only and carshare-only spaces.

Goals
2015: Increase campus user to car parking space ratio to 10:1; decrease campus user to bike parking space ratio to 5:1
2030: Increase campus user to car parking space ratio to 14:1; decrease campus user to bike parking space ratio to 3:1

These goals are based on the current trajectory of these two figures, on new campus construction that will displace existing parking lots, and on the relative ease of installing bike parking relative to car parking. Continued dense development adjacent to campus will decrease commute distances and make walking or biking a much more attractive commute option than would be driving.

Recommendations for improving this metric:

- Increase the accuracy of the parking space figures by counting campus spots manually
- Include changes that do not change the parking space ratios but do promote less environmentally-damaging commute behaviors.

Discussion and Recommendations

Air Travel

The most severe environmental effects imposed by the University's transportation come from our air travel. Dealing with the environmental effects of our air travel is made all the more difficult by the fact that 1) it is hidden from everyday view and 2) there are few ready-made alternatives.

Two of the strategies below (1-Teleconferencing and 5-Close Rivals) seek to address the issue of university-related travel, but in reality they are just nipping the edges of the problem. Like many of the most significant environmental issues, the environmental problems associated with university business travel – especially air travel – cannot be solved through small changes or technological improvements. There are efforts to improve the energy efficiency and reduce the emissions associated with air travel (especially in Europe[93]), but there are no climate-neutral passenger airplanes on the horizon.[94]

In the end, it may be that because of the energy density that it requires, high-speed flight simply cannot be made possible without the use of fossil fuels. That is, high-speed flight may be inherently unsustainable. And yet the large-scale, willing abandonment of high-speed flight on sustainability grounds would require a cultural change that can scarcely be imagined.

Car Commutes

Another component of university transportation that has a significant environmental impact – both locally and globally – is car commutes to campus. If the 2009 survey is accurate, currently only 11% of our students currently commute to campus by driving alone. This is an encouraging figure; as is the prospect that we can continue to decrease it through the continuation of high-density mixed-use development adjacent to campus and a cap on campus car parking.

However, a full 49% of university staff commute to campus by car, according to the 2009 survey. Lowering this figure would require more significant changes than lowering the student figure because of the social justice and equity components involved. Unlike students, staff can neither live in campus dorms nor take out educational loans from family or the government to pay for living expenses.

For some staff, using a car to commute to campus is merely a preference of convenience. Shifting these people to more sustainable means of commuting would primarily be a matter of education and incentives. But for other staff, commuting by car is less about mere preference and more about real necessity. Many factors can affect a person's ability to

[93] http://www.euractiv.com/en/sustainability/greening-air-travel
[94] http://www.solarimpulse.com/

switch commuting modes, including family obligations, cultural barriers, residential location, and financial status.

Helping these people switch to more sustainable commuting modes will not just be a matter of education and incentives. Identifying and tailoring customized sustainable commute options for these staff will be a long and gradual process. The first step would be to include appropriate identifying questions in the next commute survey. Following the survey, the University could provide individualized consultations with staff to help them identify the sustainable commute options that could work best for them.

A Note on Carbon Offsets

Many institutions are currently seeking to reduce the environmental impact of their operations through the purchasing of "carbon offsets". These offsets are credits that can be purchased, with the funds going to environmental conservation and restoration projects all over the world. The rationale for this program is that the restoration projects will sequester the carbon that you have omitted, neutralizing your overall environmental impact.

In this author's opinion, these credits are counterproductive. They do nothing to address the behavioral source of our environmental problems and, worse, they have the potential to placate our environmental conscience and convince us that business as usual is okay after all. In general the more technologically-oriented, the more indirect, the more convenient the environmental remedy, the less substantive it tends to be.

Strategies

The strategies outlined below are intended to improve the University's sustainability with regard to transportation as measured by the metrics I have suggested.

Strategy 1: Encourage teleconferencing
Strategy 2: Promote dense development adjacent to campus
Strategy 3: Establish a moratorium on new surface level parking lots
Strategy 4: Increase secure bike parking
Strategy 5: Share water data with other institutions
Strategy 6: Preference close athletic opponents

Strategy 1: Encourage teleconferencing

Why?
Teleconferencing is the act of interacting with others via digital equipment, including dedicated cameras and high-resolution screens. It usually requires spaces specifically designed for teleconferencing, although spaces can be temporarily adapted for

teleconferencing. The "pro" of teleconferencing of course is that you don't have to expend the time, money, effort, energy, or emissions to meet people in person. The "cons" include high initial equipment cost, limited facility availability, and potentially a diminished meeting experience as compared to meeting in person.

Of course the construction, transportation, operation, and eventual disposal of teleconferencing equipment comes with its own environmental costs. However, it appears likely that the environmental "payback period" for such equipment will be relatively short given the number of flights they will obviate.

How?
The University would need to dedicate resources to encouraging the use of teleconferencing among faculty and students. This would include high-quality teleconferencing facilities that reasonably replicate an in-person experience. These facilities must be widely and regularly available. In addition, the University would need to expand the training opportunities to help ease people into using teleconferencing. On-demand assistance would need to be available to teleconference users as well.

There would also be the potential to divert would-be travel funds to the purchasing of teleconference facilities and even potentially to financial incentives to encourage the use to teleconferencing among faculty.

Considerations

1. How many teleconferencing rooms does the University currently have available? Where are they? Is it easy for someone to find out where they are and to use them?
2. How is conference travel usually funded? Does that funding structure lend itself to a transition to teleconferencing and incentives?
3. What is a typical environmental "payback period" for a teleconferencing facility? What is a typical *financial* payback period?

Strategy 2: Promote dense development adjacent to campus

Why?
Dense development means shorter commute distances and less incentive for car ownership. It simultaneously pushes commute mode toward less carbon intensive options and reduces the importance of commute mode because of the decreased commute distance. Promoting dense development is perhaps the most fundamental and effective way to increase the efficiency and reduce the environmental impacts of campus commuting.

How?
The University can continue to work with the city of Eugene to promote dense, mixed-use development adjacent to campus. This kind of development will not come about without controversy.

Strategy 3: Establish a moratorium on new surface-level parking lots

Why?
Parking lots reduce density and give an entire swath of land over exclusively to cars. Excessive car parking encourages people to drive to campus, decreasing commute energy efficiency and increasing commute carbon intensity.

How?
Meet code minimum parking requirements for new campus construction with dispersed on-street parking and/or above- or below-ground parking structures. Alternatively, the University can work out an arrangement with the city to provide fewer parking spaces than the code requires, in exchange for other construction concessions that the city has deemed to have priority.

Strategy 4: Increase secure bike parking

Why?
One of the primary obstacles to encouraging people to bike to campus is the paucity of covered, secure bike parking on campus.

How?
Secured bike lockers can be rented out in the same way that car parking spaces are provided. There can also be ground level bike storage incorporated into new campus buildings.

Strategy 5: Share water data with other institutions

Why?
We can learn what other institutions are doing to improve the sustainability of their transportation. Also, as we are among the nation's leading institutions with regard to sustainable campus commuting, we have a lot to teach others.

How?

Establish a consortium of peer institutions to gather and compare energy data. This group could include the University of Oregon, Oregon State University, Portland State University, and perhaps the University of Washington. We can hold regular sustainable transportation conferences. (Perhaps they should happen via teleconference?)

Our efforts can also be documented and shared online through a comprehensive campus "dashboard" that informs visitors of our campus transportation initiatives. For more information and to see an example of an online "dashboard", please see Strategy 5: Share data with campus users and peer institutions in the Energy chapter of this assessment.

Strategy 6: Preference close athletic opponents

Why?
One component of the university-related travel category that is most intractable – and likely the least up for debate – is athletic team travel. One small way to mitigate the environmental impacts of athletic travel could be to preference our opponents according to proximity. Of course the proximity of the opponent is not a typical factor that a coach considers when arranging next year's schedule.

How?
The athletics department could issue a policy stating that if a coach is considering potential opponents, preference should be given to the opponent that is closer to Eugene, all other considerations being equal.

Appendices

Appendix 3.1: Transportation Advisory Panel Members

Mark Gillem, AIA, AICP, Assistant Professor, Departments of Architecture and Landscape Architecture, University of Oregon

Tom Schwetz, Director of Development Services, Lane Transit District

Fred Tepfer, AIA, Project Planning Manager, Campus Planning

Appendix 3.2: Transportation Resources

Transportation Sustainability Assessments

University of California, Berkeley
http://sustainability.berkeley.edu/os/pages/plan/docs/2009_Campus_Sustainability_Plan.pdf#page=8

University of California, Santa Cruz
http://sustainability.ucsc.edu/sites/sustainability.ucsc.edu/files/docs/ucsc-assessment-transportation.pdf

The International Journal of Sustainable Transportation
Publisher: Taylor and Francis, London, UK
http://www.tandf.co.uk/journals/titles/15568318.asp

Appendix 3.3: Transportation Figures Methodology Descriptions

Figure 3.1: University of Oregon Commute Energy Use Distribution

I created this figure using the 2009 University of Oregon Transportation Survey. This survey was completed by Larisa Varela, as part of her unpublished master's thesis for the University of Oregon Planning, Public Policy, and Management program. The survey was completed by sending questionnaires to University students and staff via email through the Office of the Registrar.[95] I received the results of this survey from the Office of Sustainability in January 2010, but the document doesn't itself contain a methodology section, so I can't assess its accuracy. This document provides commute mode distributions for 4,238 University employees and 19,850 University students. I assume that the surveyors extrapolated percentages from a smaller sample rather than interviewing all individuals. But because I don't know the sample size, I cannot assess the survey's confidence interval or margin of error. The survey results do include specific commute distance values for 542 individual students and 461 individual staff who drive alone.[96]

To estimate average commute distances for other modes, I assumed the longest that people would be willing to commute by foot or bike is 15 minutes. I based this number on a US Department of Transportation study[97], and on personal experience. I assumed the average commute speed of 3 miles per hour for walking and 12 miles per hour for biking, making their outward commute bounds 0.75 miles and 3 miles, respectively. I halved these outward distances to estimate the median commute distance for each mode, meaning my median commute distance estimate for walking was 0.38 miles for walking and 1.5 miles for biking. While these figures seem reasonable, I fully admit that they are just rough estimates.

Finally, I assumed that the longest people would be willing to ride the bus is 20 minutes. This figure is higher because people generally value the avoidance of walking travel time more than mass transit travel time (meaning they are willing to tolerate longer commutes via mass transit).[98] I estimated average urban bus speed (with stops) to be 12 miles per hour[99], making the outward commute bound for bus 4 miles. Using the same method as my estimates for biking and walking, this makes the median bus commute 2 miles.

After establishing estimated distances for each commute mode, I then estimated the amount of energy consumed for each commute. For cars, I assumed an average fuel economy of 23 miles/gallon, based on the survey results. This resulted in an average passenger-mile expenditure for car commutes of 4600 BTU. For busses I assumed an

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95 This information is based on my own correspondence with Ms. Varela on June 2, 2010.
96 Median drive-alone commute distance was 3.9 miles for students and 4.0 miles for staff.
97 U.S. Department of Transportation, Characteristics of Urban Transportation Demand: An Update, 1988.
98 Small, Kenneth A., *Urban Transportation Economics*. Philadelphia: Harwood, 1992.
99 http://www.lightrailnow.org/myths/m_lrt012.htm

average fuel economy of 6 miles/gallon[100] and an average passenger load of 9.[101] This resulted in an average passenger-mile expenditure for bus commutes of 2300 BTU. I assumed a 400 BTU expenditure for walking per passenger-mile[102] and a 135 BTU expenditure for biking per passenger-mile.[103]

To estimate the number of commutes per person, I assumed 2 one-way commutes per weekday. With three 10-week academic terms per year, that comes out to 300 commutes per person per year.
I used the average commute distance and the average energy expenditure to come up with an average energy expenditure per commute for each mode. I used the survey numbers for students and staff to produce the population distribution chart. I used the commute mode distributions for both students and staff as well as the average commute energy expenditure to calculate total commute energy expenditure for each group. I calculated each group's percentage of total commute energy to create the commute energy expenditure percentage for each group.

Figure 3.2: 2009 University of Oregon Average Energy Consumption and Emissions Per One-way Commute

I created the "Average Energy Consumed per One-way Commute" chart using the methodology described in the explanation for Figure 3.1, above. To create the "Average CO2 Emissions per One-way Commute" chart, I converted the energy expenditure chart to emissions, assuming 0.000179 pounds of CO2 per BTU of diesel fuel burned for busses and 0.000156 pounds of CO2 per BTU of gasoline burned for cars.[104]

Figure 3.3: University of Oregon Student Commute Mode Distribution

To create the University Student Commute Mode Distribution chart, I used data from the 2009 University of Oregon Transportation Survey described above, as well as a similar survey from 2006[105], as described in the 2007 Campus Sustainability Assessment.[106]

These two surveys likely used different methodologies; therefore, their percentage figures for each commute mode are likely not directly comparable. I also received the PAC 10 transportation mode survey results from the Office of Sustainability with no methodology information for each school's study. Methodological uniformity between those surveys is

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[100] http://www.nrel.gov/docs/fy00osti/26758.pdf
[101]http://www.publications.parliament.uk/pa/cm200506/cmhansrd/vo050720/text/50720w26.htm#50720w26.html_sbhd1
[102] http://walking.about.com/cs/howtoloseweight/a/howcalburn.htm
[103] http://www.nutristrategy.com/fitness/cycling.htm
[104] http://www.epa.gov/oms/climate/420f05001.htm
[105] University of Oregon Student Transportation Survey, 2006
http://sustainability.uoregon.edu/sites/sustainability.uoregon.edu/files/os-reports/UO_transp_analysis_0.pdf
[106] http://sustainability.uoregon.edu/sites/sustainability.uoregon.edu/files/os-reports/campus_sust_assessment_-_may_2007_0.pdf

unlikely; therefore direct comparison of commute mode percentages using the PAC 10 data should also be accompanied with some degree of skepticism.

Figure 3.4: University of Oregon Employee Commute Mode Distribution

The commute mode distribution for the employee commute chart comes with caveats similar to those for the student commute mode distribution chart. The 2009 data for the University and for PAC 10 schools come from the same surveys described above. The 2005 percentages come from a report[107] completed by the Oregon Survey Research Lab.[108] The 2001 and 1996 data come from earlier versions of the 2005 "Choices" survey, as described in the 2007 Sustainability Assessment[109] The methodologies for each of these surveys likely differ, so, again, direct comparisons of transportation mode percentages should be made with caution.

Figure 3.5: University of Oregon Transportation Energy Use and Emissions, by Category

I calculated the commute energy expenditure and emissions data for this chart by adding up the total emissions for both staff and students using the data gathered in the creation of the Average CO2 Emissions per one-way Commute chart in Figure 3.2.

The total university business travel emissions were taken from the emissions inventory section of the 2010 Climate Action Plan Draft 2.0.[110] The University business travel total energy expenditure figure for the Energy Use Distribution chart was created using data gathered from Mark Nystrom, the Sustainability Graduate Student for the Office of Sustainability. Mr. Nystrom gathered air travel monetary expenditure data from the University and used a conversion factor to translate those dollar figures into an estimated number of air miles traveled. I then translated those miles traveled into energy used by multiplying miles traveled by 2136 BTUs -- an average energy expenditure per passenger-mile for air travel. [111]

Mr. Nystrom also provided me with ground travel mileage reimbursement data for University business travel. I converted the number of miles traveled into energy expended using the same process described in the energy expenditure calculations for driving alone in Figure 3.1. I combined air travel and ground travel to calculate total University business travel energy expenditure.

Figure 3.6: Average Campus Commute Carbon Intensity

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[107] 2005 University of Oregon Campus Transportation Analysis - Faculty & Staff http://sustainability.uoregon.edu/sites/sustainability.uoregon.edu/files/os-reports/choices2005_0.pdf

[108] https://scholarsbank.uoregon.edu/xmlui/handle/1794/996

[109] pg. 50. http://sustainability.uoregon.edu/sites/sustainability.uoregon.edu/files/os-reports/campus_sust_assessment_-_may_2007_0.pdf

[110] pg. 13. http://sustainability.uoregon.edu/sites/sustainability.uoregon.edu/files/os-reports/CAP_2_0_0.pdf

[111] http://www.transportenvironment.org/docs/Publications/2005pubs/2005-12_nlr_aviation_fuel_efficiency.pdf

To calculate 2010 average commute carbon intensity I added the total emissions estimates for all campus commutes as estimated in the description for Figure 3.1, and divided by the total number of commutes as estimated in that same calculation. To estimate 2006 commute carbon intensity, I used the same process, making modifications for the difference in student and staff populations as well as the commute mode percentage distribution.

Figure 3.7: Transportation Emissions per Scaled Campus User

I calculated scaled campus users for fiscal year 2008/09 using the same Good Company[112] formula used to calculate the values for 05/06 and 00/01 in the 2007 Campus Sustainability Assessment.[113]

Fiscal Year 2008/09	Full Time			Part Time			Scaled Campus Users
	Number	SCU FTE	Total SCU	Number	SCU FTE	Total SCU	
Faculty & Staff	*2919*	0.25	730	*1041.48*	0.125	130	860
Graduate Teaching/ Research Fellows	*0*	0.25	0	*1275.12*	0.08325	106	106
Student Employees	*0*	0.25	0	*2441.34*	0.0625	153	153
Enrolled Students	17865	0.15	2680	3641	0.075	273	2953
Residential Students	4109	1	4109	0	0.5	0	4109
Total			7518			662	**8180**

I then divided commute emissions and university business travel emissions by this scaled campus user figure to create Figure 3.7. I could not create a comparable graph for earlier years because 2009 is the first year for which we have calculated emissions totals attributable to university business travel.

Figure 3.8: Transportation Energy Use per Scaled Campus User

The process for creating this figure was identical to that for Figure 3.7, except that I divided total transportation energy expenditure (instead of total emissions) by the scaled campus user total.

I calculated this figure by first dividing transportation modes into renewable and non-renewable. I considered walking and biking renewable, "other" commute modes unknown, and busing, car-pooling, driving alone, ground travel, and air travel non-renewable. I then added up the total amount of transportation energy consumed for each of these categories.

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112 http://www.goodcompany.com/
113 pg. 66. http://sustainability.uoregon.edu/sites/sustainability.uoregon.edu/files/os-reports/campus_sust_assessment_-_may_2007_0.pdf

This methodology assumes that none of the fuel used for buses, driving, or flying came from renewable sources. It is likely that some very small portion of the energy used for these modes comes from biofuels and/or electricity that is renewably derived.

To calculate this figure, I first contacted Fred Tepfer in the planning office to find out how many car and bike parking spaces the campus has currently.[114] I then divided those numbers by the current total number of campus users, which includes full-time students, part-time students, and all staff. I then plotted those ratios with the ratios from the 2007 assessment.[115]

[114]Personal communication, 5/12/2010.
[115] Pg. 48

4) Conclusions

This sustainability assessment indicates that the University of Oregon is excelling in some areas and lagging in others. Moreover, the environmental implications of our performance in each category – energy, water, and transportation – are not equal. In my opinion, the implications of our energy use and transportation behaviors are much more significant than those for our water use. And effectively, the distinction between the "categories" of energy and transportation is itself somewhat contrived. In essence, transportation and energy are two facets of a single problem: our use of carbon-emitting fossil fuels.

Just as the environmental degradation caused by each category of activities shares a common cause, they also share some common solutions. I believe that woven throughout the specific strategies for each chapter are three broad strategies to reduce our environmental impacts:

1) Focus on reducing demand, not changing supply
2) Align users' incentives with desired sustainability outcomes
3) Provide consistent, transparent, up-to-date sustainability performance information to both campus users and the public

At the root of the University of Oregon's *un*sustainability is not an absence of technical or economic solutions, but rather an unsustainable culture, an unsustainable way of life. In order for our institution to become sustainable, we must undergo a cultural transformation. Technical and economic methods – that is, all the strategies I have proposed in this assessment -- can be used to help catalyze that cultural change, but we must always remember that these strategies are means, not ends. They define the *how*, but not the *why*. The *why* for these and all our other actions is defined by our values. And right now the University of Oregon seems to value our quarterback's pass efficiency rating a lot more than our buildings' energy efficiency rating. Until we begin to change our values, no matter how many of these strategies we adopt, the University of Oregon will not become a sustainable institution.

The University of Oregon can take immediate steps to demonstrate our commitment to becoming a sustainable institution:

1. Devote more staff resources to initiating and publicizing University sustainability efforts. These staff could be in Facilities, Administration, the Office of Sustainability, or some combination therein. Two such opportunities are the revolving loan fund administrator position and the additional utility data management staff described in Strategy 4: Remove initial capital barriers to campus energy efficiency projects and Strategy 1: Improve energy data management of the Energy chapter, respectively.

2. Issue a public statement from University leadership reiterating our commitment to pursue sustainability, along with a list of specific sustainability goals and our strategies for achieving them.

3. In collaboration with Director of the Office of Sustainability, devote the requisite institutional infrastructure to enable a standardized, comprehensive campus sustainability assessment to be published at regular intervals (every 2-3 years)

These actions would represent deliberate, tangible steps forward on the University of Oregon's path to sustainability.