WALTON HALL ENERGY ANALYSIS

AND

CONSERVATION RECOMMENDATIONS

by

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EXECUTIVE SUMMARY

This report describes the results of an energy use study done on Smith and Sweetser Halls, two residence halls in the Walton Complex, on the University of Oregon campus. It recommends conservation measures in the areas of space heating, hot water heating, water consumption, and electric lights and appliances.

The fuel that is consumed for most, by far, is steam (85%). Somewhat more than half of this is used for hot water heating, and the rest for space heating. Electricity (15% of fuel used) is used only for lights (6%) and appliances (9%). In addition to fuel, about 10% of the halls' "utility budget" goes to water for domestic uses (7%) and watering of adjacent lawns (3%).

The major problem areas for space heating are heat loss through single glazed and leaky windows. This accounts for approximately 75% of all building heat loss. The major users of electricity are small appliances (42%), lights (38%), and large appliances (19%). The major uses of water, including hot and cold, are showers (43%), lawn watering (28%), and toilets (17%).

A number of conservation measures have been identified and ranked in terms of cost and conservation potential. The most attractive of these fall in two categories: those with a relatively short payback period include radiator control knobs, storm windows, insulating drapes, and shower flow restrictors. Those which have no dollar cost at all but are simply voluntary behavioral adjustments on the part of the students include reducing time in the showers and reduction of some lighting levels.

I. INTRODUCTION

This report investigates the energy consumption in Smith and Sweetser Halls, of the Walton Hall Complex, on the University of Oregon campus. They are typical of many residence halls built on this campus during the 1950's, with very little insulation and by now obsolete and often poorly functioning mechanical systems. For most purposes they may be taken as representative of any two adjacent halls on campus, with the exception that Walton Complex does not have a kitchen or dining rooms, so the special energy problems associated with those functions will not be dealt with in this report. Another exception is that a pair of halls which does not include a major southern orientation on one side, as does Sweetser Hall, will have a greater heating load, due to smaller solar heat gain.

Information in this report was gathered from resident questionnaires, standard engineering calculations, and local utility records. Unfortunately, this latter was a minor source of information since electricity and steam are not metered for individual buildings on this campus. Therefore, calculations in this report must be viewed as estimates only, based on our best guess of energy use in the residence halls.

A graphic summary of consumption is shown in Figures 1 and 2. Figure 1 shows the relative uses of steam and electricity. By far the greater portion of energy is in the form of steam, with about as much consumed for heating hot water as for heating the buildings. Figure 2 differs from Figure 1 in that it shows the relative cost in dollars of these fuel sources, and includes water consumption. This information is further tabulated in the appendix.

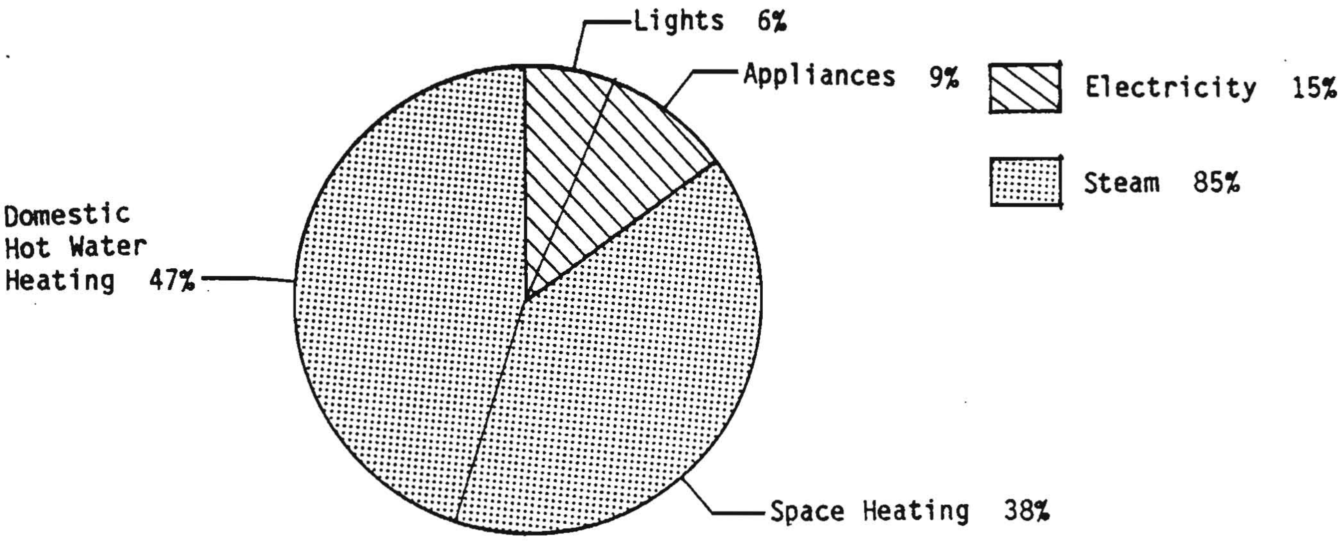

Figure 1. Major Energy Uses for Smith and Sweetser Halls.
Total Energy = 3840-4240 Million Btu/year, estimated.

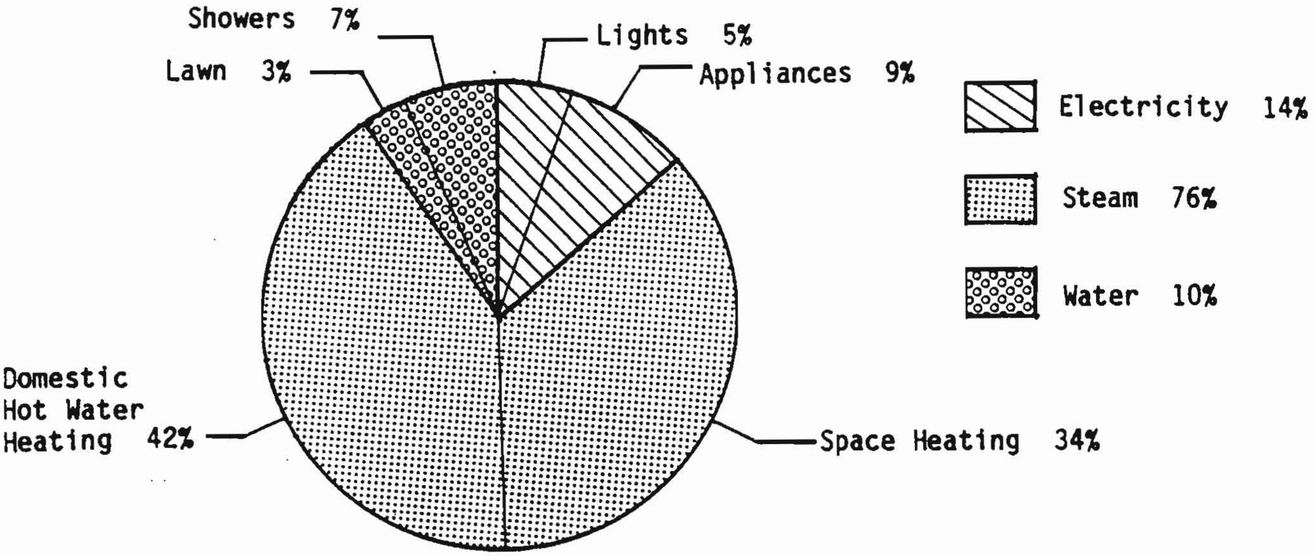

Figure 2. Major Utility Expenses for Smith and Sweetser Halls.
Total Expenses = $19,180-20,970 per year, estimated.

Smith and Sweetser Halls are three-story brick buildings, housing approximately 116 students in 66 rooms. Figure 3 shows the first floor of both buildings and Figure 4 shows their location on campus. On the ground floor, each has an associated lobby and lounge. The original kitchen and dining rooms have been remodeled and are now used for employee lounges and office space.

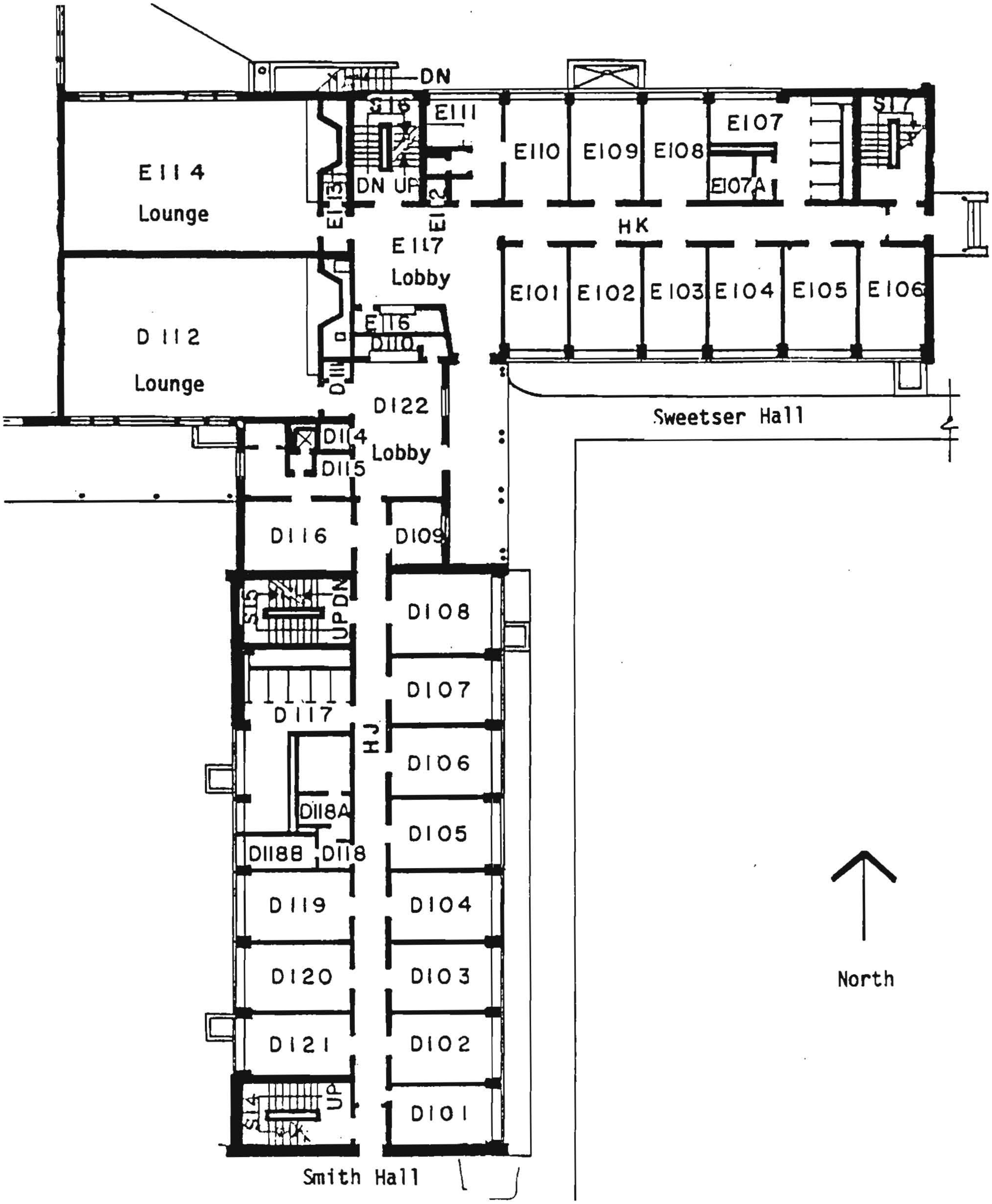

Figure 3. First Floor Plans, Smith and Sweetser Halls

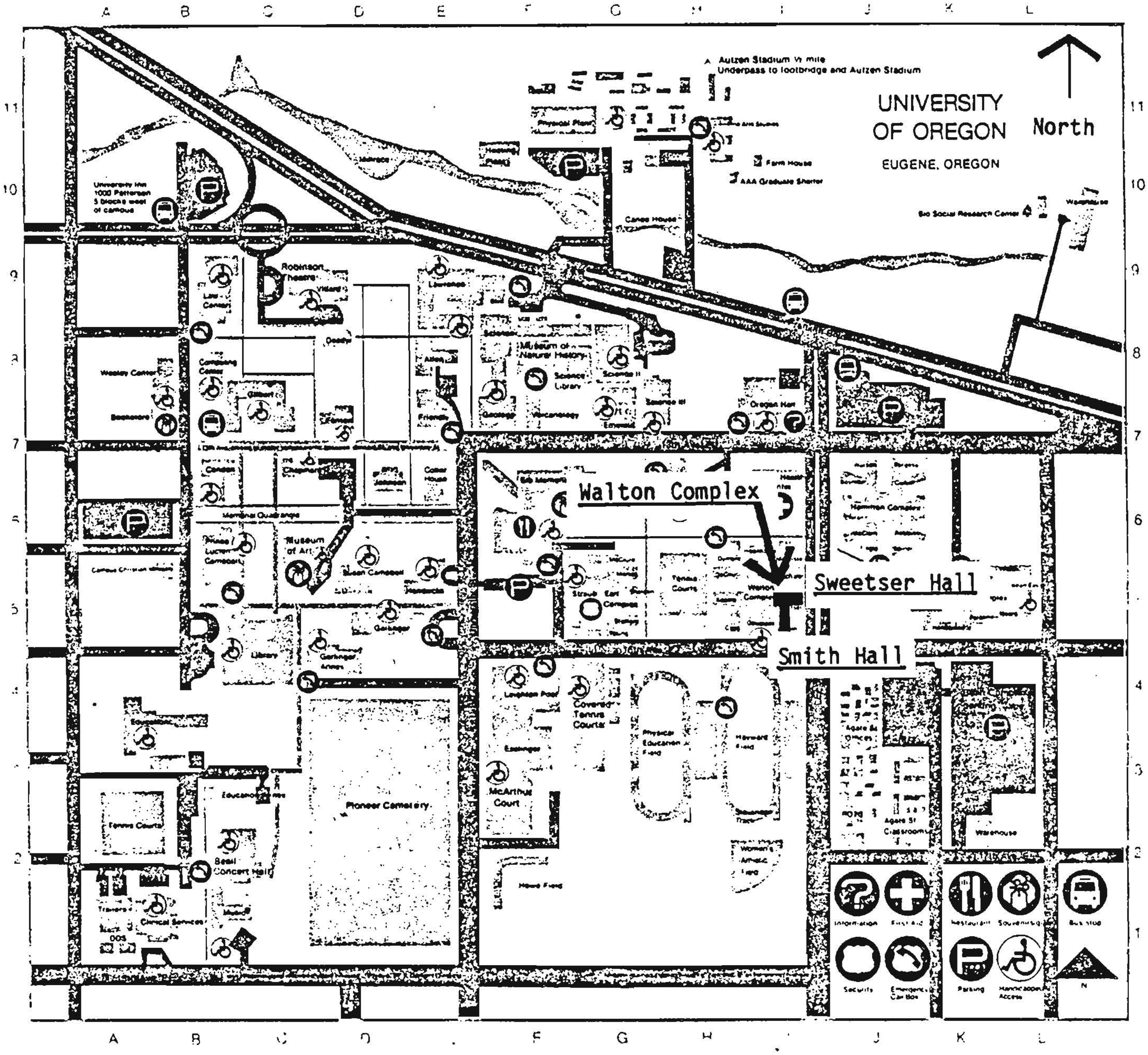

Figure 4. The University of Oregon Campus.

Sweetser Hall is a so-called "environmental hall", implying that energy conservation measures that require a committment and behavioral adjustment on the part of the residents will find greater acceptance here than in other halls around campus. However, in Sweetser, as well as in any hall, there appear to be two key requirements for any behaviorally dependent conservation measures to work. The residents must be educated about the inner workings of their buildings and the energy they are consuming, and they must be given some positive reinforcement for any conservation efforts.

II. THE MECHANICAL SYSTEMS AND THEIR COSTS

Hog fuel is used to produce steam which is used to generate electricity at the University Physical Plant. The steam is then used to produce chilled water and building space heat. The steam is delivered to the residence halls with an assumed 50% system efficiency loss. Radiators in every room have individual thermostats, many of which apparently do not work well. According to Earl Hemenway, the heating and ventilation supervisor of the University Physical Plant, the entire system is due for replacement.

The electricity generated at the Physical Plant satisfies only one third of the campus need and the remaining two thirds is purchased from the Eugene Water and Electric Board (EWEB) at higher and rapidly inflating rates.

The relationship between steam and electricity is an interesting one from the standpoint of conservation. If, through conservation, the need for steam heat drastically declines then the operation of the physical plant can slow down, but only if the needs for electricity and air conditioning (in other campus buildings) also decline. Otherwise, the University will need to buy expensive electricity from EWEB and not see a net benefit. Therefore, any conservation effort will need to focus on steam, air conditioning, and electricity simultaneously.

An increase in dependence on EWEB could prove to be terribly expensive in the future. Indeed, every effort should be made to minimize it. Fuel cost inflation could get worse if the wood products industry slump continues because that would affect the availability of relatively cheap hog fuel.

Another factor to bear in mind is a growing movement among electricity consumers to reverse the policy by which heavy users get lower rates per kilowatt hour than small, residential users. If and when EWEB agrees to this policy change, the rates to the University could increase dramatically.

Therefore, energy conservation measures which do not necessarily appear to be "cost-effective" in this report may indeed be so, and should be seriously considered in light of the uncertain future of energy prices.

There is an apparent contradiction in many efforts to reduce electrical useage. Because cheap electrical energy is used indirectly through appliances and lights to heat the buildings, any reduction in consumption will result in an increased demand for steam, which is currently more expensive at the building than electricity per energy unit.

Steam costs in this report are based on an assumed 50% system efficiency which is typical for steam systems of this age and type. The basic premise that steam is more expensive per btu than electricity would be true up to a 98% efficiency assumption. As long as the current situation continues, in which high infiltration rates result in excessive heat waste, it makes sense to conserve electricity. This reduces electrical costs per se but also reduces overheating and therefore decreases waste. However, when heat is not being wasted, it is more important to conserve steam, which is more expensive, at the building, than electricity. However, the production and therefore the costs of steam and electricity are linked to each other, so conservation must focus on both simultaneously.

Water is also purchased by the University from EWEB and, although locally abundant, may also be subject to future price hikes. Savings from water conservation efforts are not as dramatic as for steam and electricity, but should be considered. This is especially true if any conservation is seen as an educational program for the students as future consumers, in addition to a money-saving opportunity for the University.

III. ENERGY WASTE

A great deal of heat waste stems from open windows and the ubiquitous overheating which induces the open windows in the first place. This appears to be caused by a lack of thermal control in two ways.

First, control knobs on the individual radiators are (or are perceived as) inadequate for turning the heat down or off. Windows are frequently considered the controlling devices.

Second, the flow of steam from the University physical plant, controlled outside the building, is usually at a minimum and cannot be turned down any further without being turned off. Therefore it is usually turned off only for maintenance work and at the beginning of summer, according to Michael Hostetler, a physical plant employee.

If the individual radiators had new, effective control knobs, then the need for window opening during the heating season would be reduced dramatically.*

To compound this improvement, if the windows were weatherstripped and/or if the entire building were better insulated, then the heating season, ie., the number of days when steam heat would be required, would be greatly shortened. In any case, there appears to be a need for greater communication between those who control the steam from the physical plant and those who actually experience the indoor climate of the residence halls.

Although the use of existing curtains will do little to prevent nighttime heat loss, they will provide an enhanced perception of warmth to room occupants who would otherwise be radiating their body heat to the cold windows. This perception may assist in reducing the amount of time in the year considered to be in the "heating season".

Although it comprises less of the overall energy budget, electricity is frequently wasted as well. The most obvious example of this is in electric lights, which are left on during the day when daylight is sufficient and/or during the night when there is no one present. Some light reduction has been suggested; however, security will probably stand in the way of total elimination of nighttime lighting.

*Note: The need for fresh air is never completely eliminated, however, especially for smoking students. One idea would be to locate smokers in south-facing rooms so that the sun rather than the physical plant steam would replace the heat lost whenever they opened their windows.

Electrical appliances consume more electricity than lights, but in this area, minimum requirements are defined, not so much by physical needs as by social standards and fashions. Therefore, this consumption is simply itemized in

Appendix B, Part 4, with associated costs. Savings through use reduction can thus be easily calculated by adding the costs of any combination of appliances targeted for reduction.

IV. CONSERVATION MEASURES

The following conservation measures have been divided into four sections depending on the length of their respective payback periods. Within each section they are ranked by the amount of money they could save per year. Note that they are not mutually exclusive, so the estimates of energy and dollar savings are not additive.

Part A. Long Payback Periods

Energy conserving measures in this section have simple payback periods of more than five years. While more "feasible" in residential situations, most of these measures are not now economically attractive for the University because of its low energy rates and the lack of tax credits for conservation. However, they can produce energy savings and should be seriously considered in long range planning.

112 solar collectors. This is the number of collectors required to heat water (at current consumption levels) to 110°F. To heat water above this temperature would result in diminishing returns.

Add roof insulation. Savings are listed for three thicknesses of roof insulation. Since installation costs are the same for all three, the thicker insulation is cheaper per thickness than the low resistance material. Therefore, the thickest, R-12, is the best buy in spite of diminishing returns usually encountered in increasing R values. Careful engineering should be applied to this calculation when other conservation measures have been selected, since the actual point of diminishing returns will depend to a large extent on how much heat is being conserved in other ways. Also note that these cost estimates would be much lower if the roof needed reroofing anyway. According to Jon Kahananui, Walton Hall is scheduled for reroofing in 5-10 years.

Replace toilets. The existing toilets are assumed to use five gallons per flush as contrasted with modern flush valve toilets which use only three. This is an important conservation measure to keep in mind when the old toilets need to be replaced.

Heat exchangers. These estimates are based on information from Alan Boner, on his clothes dryer heat exchanger under development. Each estimate is made using the assumption the dryers not equipped with the heat exchanger will not be used.

Replace basement and stair lights. Lighting in these two areas can be accomplished with low wattage florescents instead of incandescents. There would be no cost for replacement heat since these spaces are unheated.

Table 1. Summary of Conservation Measures for Long Payback Periods

Description	Million Btu/yr Saved	Million Gal/yr Saved	$/year Saved	Initial Cost	Payback Period in Years
112 solar collectors	1480		6,650	196,000	29
Add R-12 insulation to roof	152		684	13,620	20
Add R-8 insulation to roof	130		585	12,340	21
Add R-4 insulation to roof	88		396	11,920	30
Replace toilets		0.32	128	16,500	129
Heat exchanger on one dryer per laundry room	40		92	500	5
Heat exchanger on two dryers per laundry room	40		92	1000	11
Heat exchanger on three dryers per laundry room	40		92	1500	16
Replace basement lights with florescents	16		74	990	13
Replace stair lights with florescents	5		21	430	20

Part B. Short Payback Periods

Energy conservation measures in this section, though requiring some capital investment, will pay for themselves in less than four years. They should be considered for immediate implementation whether or not there is grant support available. Detailed calculations for these items are provided in the appendix.

Install storm windows. For steel hinged windows, such as are found in Walton Hall, storm windows need to be interior horizontal sliders. They would be caulked and weatherstripped, thus alleviating part of the air infiltration problem as well as heat loss through the glass. (Weatherstripping is not physically feasible on the existing steel windows because of the unevenness of the gaps between window and frame around the perimeter.)

Install "window quilts". These insulated drapes will greatly reduce nighttime heat loss through the windows. Their relative benefit is smaller when applied to storm windows. Estimates are based on their being used consistently during the heating season.

Install flow restrictors in showers. This particularly attractive energy (and water) saver has a negligible payback period because of the high ratio of residents to showerheads that need to be retrofitted. The estimate assumes that the average shower length of 12 minutes will not increase. If the flow restrictors selected make the water flow feel distinctly weaker, this assumption may be in error.

Install control knobs on radiators. The most common complaint from residents of Walton Hall encountered during this study concerned overheating and the lack of control over room temperatures. Windows are commonly considered to be the "controlling device". This estimate assumes that the control knobs for the radiators will enable residents to turn their radiators all the way off, eliminating the need for excessive air infiltration throughout the year.

Table 2. Summary of Conservation Measures for Low Payback Periods

Description	Million Btu/yr Saved	Million Gal/yr Saved	$/year Saved	Initial Cost	Payback Period in years
Install "window quilts" on single glass	980		4410	7,175	1.6
Install storm windows	971		4370	16,400	3.8
Install flow restrictors in showers	597	0.80	3007	570	0.2
Install "window quilts" on double glass	451		2028	7,175	3.5
Install control knobs on individual radiators	340		1530	3,300	2.2

Part C. Zero Payback Periods

Conservation measures in this section can be accomplished solely by administrative or behavioral changes, with no capital investment required. However, a great deal of education of and dedication by the residents will be needed, and it is questionable if 100% cooperation would ever be possible. To approximate the motivation for conservation that private homeowners feel, two conditions must be met in the residence halls: residents must be given feedback on the amount of energy (or water) they are saving, and they must feel that they are somehow benefitting from the savings. One suggestion that might accomplish both conditions was to install meters in every hall (feedback) with monthly competitions between halls campus-wide (motivation).

Reduce shower length and/or frequency. This involves a change of habits and may be either simple or impossible.

Lawn watering. Water savings are listed for three levels of reduction of lawn watering.

Replace hot water with warm water in laundry cycles (maximum). The savings accomplished by using warm water instead of hot are impossible to estimate without knowing how often the hot cycle is currently used. The maximum estimate provided assumes that all residents currently use hot water and that all could switch to warm. If this is found to be untrue, the savings can be recalculated proportionally.

Flush toilets half as often. This is another change of habit that may be accomplished as easily as informing the students of the thousands of gallons that each of them flushes away every year. On the other hand, it may be impossible to sell the idea in a group living situation.

Consolidate laundry loads in large dryers. This is another item which is impossible to estimate accurately without knowing more about current laundry habits. The maximum estimate provided assumes that residents use the large, industrial-sized dryers for single wash loads, and that doubling up on loads could cut dryer usage in half.

Permanently turn off half of the basement lights. Lighting levels in the basement are excessive for an area that is little used. This estimate accounts for half the lights staying on 24 hours per day for security reasons.

Table 3. Summary of Conservation Measures for Zero Payback Periods

Description	Million MBTU/yr Saved	Million Gal/yr Saved	$/year Saved
Reduce the number of showers by one half and the length of time per shower by one third	1010	1.33	5077
Reduce the number of showers by one half	758	1.00	3811
Reduce the length of time per shower by one third	506	0.67	2545
Eliminate lawn watering altogether		1.3	520
Reduce lawn watering by half		0.65	260
Replace hot water with warm water in laundry cycles (max)	55		246
Flush toilets half as often		0.40	160
Reduce lawn watering by one fourth		0.32	120
Consolidate laundry loads in large dryers	16		73
Permanently turn off half of the basement lights	14		62

Part D. Negative Payback Periods

Conservation measures in this section are, in a sense, not conservation measures at all. The heat generated by electrical lights and appliances helps to heat the building. When electrical energy is conserved in the winter, steam energy must be increased to make up for it. Since steam costs about twice as much as electricity per btu at the building, conservation is actually more expensive than non-conservation. This situation would change if electricity costs inflated faster than steam costs. Until the building is better insulated and the extravagant waste of heat is ended, this is not really an issue, however, and these measures can be considered comparable with those in Part C. In any case, electricity conservation in the summer is true conservation.

Reduce lighting levels in public areas. Lighting levels in lobbies, lounges, toilet rooms, and corridors are unnecessarily high, and lights are frequently left on all night. This estimate assumes that on-time for lights in corridors, toilet rooms and lobbies can be cut from 24 to 6 hours per day, and that those for lounges can be cut from 12 to 6. These figures are based on results of a survey of hall residents.

Reduce general electricity useage by 10% or 20%. This can be accomplished in an infinite variety of ways, by personal conservation efforts by the residents. On the basis of a survey, a list was compiled of the electrical appliances used in the residence halls. The complete list is given in the appendix.

Reduce use of desk lamps by one or two hours. This particular use of electrical appliances was singled out because of the observation that, since student desks are located next to large windows, task lighting is frequently unnecessary but used nonetheless.

Replace light bulbs with Luxor brand at next relamping. These are incandescent bulbs which produce the same light as regular bulbs but with 10% fewer watts. Although they are more expensive than regular bulbs, they last disproportionately longer, so the added initial cost was not considered.

Table 4. Summary of Conservation Measures for Negative Payback Periods

Description	Million MBTU/yr Saved	Million Gal/yr Saved	$/year Saved	$ cost/yr for Replacement Heat
Reduce lighting levels in public places	116		531	630
Reduce general electricity useage by 20%	65		297	347
Reduce general electricity useage by 10%	32		148	174
Reduce use of desk lamps by two hours per day	23		104	122
Replace bulbs with Luxor at next relamping	22		102	99
Reduce use of desk lamps by one hour per day	11		52	61

V. THE UNIVERSITY HOUSING OFFICE

The University Housing Office is also located in Walton Hall, but was not intensely studied in this analysis. It is located in the south of the building and was created by remodeling the original kitchen and dining rooms for Smith and Sweetser Halls.

Like any other office, this office has thermal needs and characteristics which are quite different from the adjacent residential areas. Lights and equipment produce a source of heat year-round which means that less heat is needed in the winter for space-heating, and excess heat is a problem in the summer since there is no air-conditioning.

Without going into detailed calculations, it is possible to speculate briefly about some energy alternatives available for this unique residence hall/office situation.

Lighting levels, currently under detailed study by Diane Eidenbergber, an architecture student, are probably higher than they need to be for ordinary office tasks. Since most office work occurs during daylight hours, it is possible that a substantial proportion of light could be provided by indirect daylight. Using lower wattage bulbs and turning on fewer lights will help to alleviate over heating problems.

In addition, a great deal of unwanted heat is gained through the south-facing glass from the sun, in spite of transluscent overhangs outside. These overhangs could be covered with an opaque material (to be removed in the winter), or deciduous trees,and shrubs coculd be planted to protect the south of the building.

Since excess heat is generated in the office during periods when space heating is still required in the residential rooms, an air-to-air heat exchange system should be considered. Another heat recovery system could involve the use of excess heat in heating water - a year-round energy user.

Detailed study was not made on the office space because it is a situation unique to the south part of Walton Hall and not applicable to any other residence halls on campus.

APPENDIX A. Calculations for Selected Short Payback Period Conservation Measures

1. Install Control Knobs on Individual Radiators. Rationale: If residents can turn their radiators down or off with reliable thermostatic controls, they won't waste so much heat through open windows when the heaters are on. Assume: current infiltration rate is 1 1/2 air changes per hour, average.

Heat Loss = (air changes) x (building volume) x (.018)
x (degree hours)
= (1.5)(152,870)(.018)(123,010)
= 508 million BTU/year

Assume one air change per hour, with windows closed.
Heat Loss = (1.0)(152,870)(.018)(123,010)
= 338 MBTU/year
Savings = 508 - 338 = 170 MBTU/year
@50% system efficiency from plant where steam is paid for = 170/.5 = 340 MBTU/year
@4.50/MBTU= $1530/year
Initial cost = 66 controls @ $50 = 3300
Simple Payback Period = 3300/1530 = 2.2 years

Note: In effect, some heating contribution is made by lights and appliances, with an efficiency of close to 100%, but this has been omitted from calculations due to the rough approximation of the steam efficiency estimate.

2. Install Storm Windows

Rationale: Storm windows will save heat in two ways, by reducing heat loss through glass (skin loss) and by reducing infiltration since storm windows are caulked and weatherstripped.

Assume: radiator controls are in place. It doesn't make sense to make airtight a window which is open all the time.

Currently:

Heat Loss = 676 MBTU/year infiltration (see #1)
Heat Loss = 1306 MBTU/year through glass
Total = 1982 MTBU/year
After storm windows:
Heat Loss =
Infiltration factor x (lineal feet of crack) x (.018)(degree hours)/efficiency
= (21)(2788)(.018)(123,010)/0.5
= 260 MBTU infiltration (crack method)
Heat Loss = (new U/old U) x old. H.L.
= (.65/1.13) x 1306
= 751 MBTU/year through glass
Total = 1011

Savings = 1982 - 1011 = 971 MBTU/year
@ 4.50/MBTU = $4370/year
Initial Cost = $8/sq.ft. x 25 sq.ft./bay x 82 bays = $16,400
Simple Payback Period = 16,400/4370 = 3.8 years

3. Install window quilts on single glass. Assume: storm windows will <u>not</u> be installed. Heat Loss through glass is reduced by 75%

   Current Heat Loss through glass: 1306 MBTU/year
   Savings = 75% x 1306 = 980 MBTU/year
   @ $4.50/MBTU = $4410/year
   Initial cost = $3.50/sq.ft. x 25 sq.ft. x 82 bays = $7175
   Simple Payback Period = $7175/4410 = 1.6 years

4. Install window quilts on double glass. Assume: storm windows are in place. Heat loss through glass reduced by 60%

   Current heat loss through glass = 751 MBTU/year
   Savings = 60% x 751 = 451 MBTU
   @ $4.50/MBTU = $2028/year
   Initial cost = $7175
   Simple Payback Period = 7175/2028 = 3.5 years

5. Install flow restrictors in showers. Assume: current water consumption for showers is 60 gallons. Flow restrictors will reduce this by 40% to 36 gal. Steam which would have gone to heat this water is saved, at a rate of 1166 BTU/gal. of hot (125°) water. 64% of shower water is hot.

   Steam saved = 40% x 2.0 mill gal. x 1166 BTU/gal x 64% = 597 MBTU
   @ $4.50/MBTU = $2687
   Water saved = 40% x 2.0 million gal. = .8 million gal.
   @ $400/million gal. = $320
   Total saved = $3007/year
   Initial cost = 19 showerheads @ $30 = $570
   Simple payback period = 570/3007 = .2 years

APPENDIX B. Energy Consumption Tabulations

1. Summary of Energy Consumption in MBTU (million BTU). Electricity converted from kilowatt hours for purposes of comparison.

Electricity	MBTU
Appliances	358
Lights	223
Total Electricity	581

Steam	
Space Heating	1454 - 1794
Domestic Hot Water	1808 - 1866
Total Steam	3262 - 3660
Total Energy Consumed	3843 - 4241 MBTU/year

2. Summary of Heat Loss in MBTU (million BTU/year)

Source	Heat Loss
Walls	111
Glass	653
Roofs	128
Doors	10
Floors	65
Basement walls	59
Infiltration	338 - 508
Total	1364 - 1534
Less Internal Gain*	- 637
Net Loss	727 - 897 MBTU/year

@ 50% system efficiency, replacement heat = 1454 - 1794 MBTU/year

*For any pair of halls which do not have a major southern orientation, this internal gain figure should be decreased by, and the Net Loss increased by, 133 MBTU/year.

3. Summary of Electrical Consumption

Source	Kilowatt hours Per Year	MBTU Per Year	MBTU Per Heating Season	$ Cost Per Year
Lights (public)	47,200	161	96	736
Lights (rooms)	6,200	21	13	97
Lights (utility)	12,030	41	24	187
Laundry	10,120	34	20	158
Refrigerators	22,730	78	46	354
Misc. Appliances	72,290	246	147	$1128
Total	170,570	581	346	2660

Notes:

- "Public" spaces include lobbies, lounges, corridors, and toilet rooms. Room lights include built-ins only.

  Utility spaces include stairs and basement.

- Electricity not contributing to space heating: laundry washers and dryers and basement lights = 20 + 24 = 44 MBTU

- Electricity used for space heating: all except above = 346 - 44 = 302 MBTU/year

4. Summary of Consumption for Appliances

Source	Kilowatt hours Per Year	MBTU Per Year	MBTU Per Heating Season	$ Cost Per Year
Stereos	23,360	80	47	364
Refrigerators	22,730	78	46	355
Hot pots	22,580	77	45	352
Desk Lamps	9,930	34	20	155
Curling Iron	4,790	16	10	75
Clocks	3,550	12	7	55
Coffee Makers	2,730	9	6	43
Elec. Blankets	2,250	8	5	35
Televisions	1,130	4	2	18
Hair Dryers	880	3	2	14
Hand Dryers	750	3	2	12
Irons	350	1	1	5
TOTAL	95,030	325	193	$1,483

5. Summary of Hot and Cold Water Consumption in Million Gallons Per Year

Source	Hot Water (125°F)	Cold Water (55°F)	Total
Laundry*	0.05-0.10	0.1-0.15	0.2
Showers	1.3	0.7	2.0
Misc. Washing	0.2	0.1	0.3
Toilets	----	0.8	0.8
Lawn Watering	----	1.3	1.3
TOTAL	1.55-1.6	1.7-1.75	4.6

*Ranges given depend on temperature settings selected by individuals.

APPENDIX C. Energy Cost Calculations

1. Electricity - \$.0156/Kwh or \$4.57/million BTU. Approximately 2/3 of electricity used is from EWEB @ \$.0184/Kwh and 1/3 is generated by the University of Oregon Physical Plant @ \$.01/Kwh

   Average price = 2/3(.0184) + 1/3(.01) = \$.0156/Kwh
   Note: In fact, only electricity saved will be EWEB electricity. So payback periods based on this average price are conservative.

2. Steam - \$4.50/Million BTU, produced at the University of Oregon Physical Plant.

3. Water - \$.0004/gallon, purchased from EWEB = \$400/million gallons

4. Hot Water. To heat one gallon from 55°F to 125°F.

   Heat needed = 833 Btu/gal./100° Δt

   $\Delta t = 125^{\circ}F - 55^{\circ}F = 70^{\circ}F$.

   for $\Delta t = 70^{\circ}$, heat needed = 70% x 833/50% efficiency = 1166 Btuh/gallon

APPENDIX D. Walton Hall Building Description - Two Wings: Smith and Sweetser

1. Materials

Material	U-Value	Area	
Brick	0.4	5589	(includes chimney and "perforated" brick)
Glass	1.13	4696	
Metal Panel	0.1	2870	
Roof	0.12	8512	

2. Glass Areas in Square Feet

South Glass	1352
East Glass	1280
West Glass	940
North Glass	1124
TOTAL Glass Area	4696

3. Building Areas and Volumes

Space	Area in sq. ft.	Volume in cu. ft.
Lounges	1,570	14,915
Lobby	710	5,915
Corridors	2,350	19,575
Stairs	1,920	16,800
Rooms	10,400	86,630
Toilet Rooms	3,100	25,825
TOTAL	20,050	169,660

APPENDIX E. Miscellaneous Information and Assumptions

1. Climate

Degree hours for Eugene = 123,010 = number of hours per year below 65°F. Heating Season = Oct 16 - Apr 30 (Reynolds, p. 12) = 197 days. But of this period, building is occupied only 171 days. (Unoccupied circa Dec 16 - Jan 1 and Mar 20 - 28). Heating season of 197 used when considering non-occupant related items such as solar gain.

Solar heat gain: (Reynolds, p. 9) Averaged from October through April on vertical surface. South: 694 BTU/sq.ft./hr; east and west: 284 BTU/sq.ft./hr. Transmission loss through glass = 13%. For Smith Hall, solar gain from the west was reduced by 1/3 due to heavy shading by evergreen trees and walkway canopies to the west.

2. Infiltration Calculations

Approximate current leakage = 1 1/2 air changes per hour, averaged over entire heating season.

Minimum leakage after weatherstripping equivalent to "weatherstripped wood window, loose to average fit", see ASHRAE pp. 337 - 338.
More accurate estimates of infiltration would require close monitoring of open and closed windows, and the resulting air change rates.

3. Occupancy: 116 residents, 41 weeks per year (3 11-week terms and 1 8-week term). Assumed students spend an average of 16 hours per day in their room, 8 asleep and 8 at light to moderate activity.

4. Lighting

Light wattages used in all calculations are based on information provided in "Bulb Replacement and Conservation Study", a memo from Nancy Wright to the Light Maintenance Staff dated 2/23/82. It is assumed that all new wattages will be in place by Fall 1982. Any savings calculated in this study are in addition to those savings. (Savings due to this original relamping are approximately 21,150 kilowatt hours per year, or about $330.)

5. Internal Gains

The heat generated by laundry appliances and basement lights is not included in internal gain calculations because the basement is ostensibly not heated.

Curtains are kept open during daylight hours.

Since the building has no cooling system (other than natural ventilation), internal gains are calculated only for the heating season to determine if they benefit the heating load.

6. Miscellaneous Assumptions

Actual electrical appliance use is proportionately represented by resident user survey. This projected use is shown in Appendix B, part 4.

Water use: 32.3 laundry loads per year per person. One shower per day per person @ 12 minutes per shower and five gallon per minute. Eight gallons per person per day for additional washing. Estimates based on student survey.

7. Information Sources for Cost Estimates

Solar Collectors and Window Quilts	Energeia, Eugene
Roof Insulation	Acme Roofing, Eugene
Toilets	Means Cost Data
Heat Exchanger	Alan Boner, P.E., Eugene
Florescent Lights	Means Cost Data
Storm Windows	Interwest Insulation, Eugene
Flow Restrictors	Willy Hart, University Housing
Control Knobs	Earl Hemenway Physical Plant
Luxor Lamps	J. M. Johnson, Luxor Lighting, Eugene
Steam and Electricity	Bill Norwood, Physical Plant
Water	Eugene Water and Electric Board

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