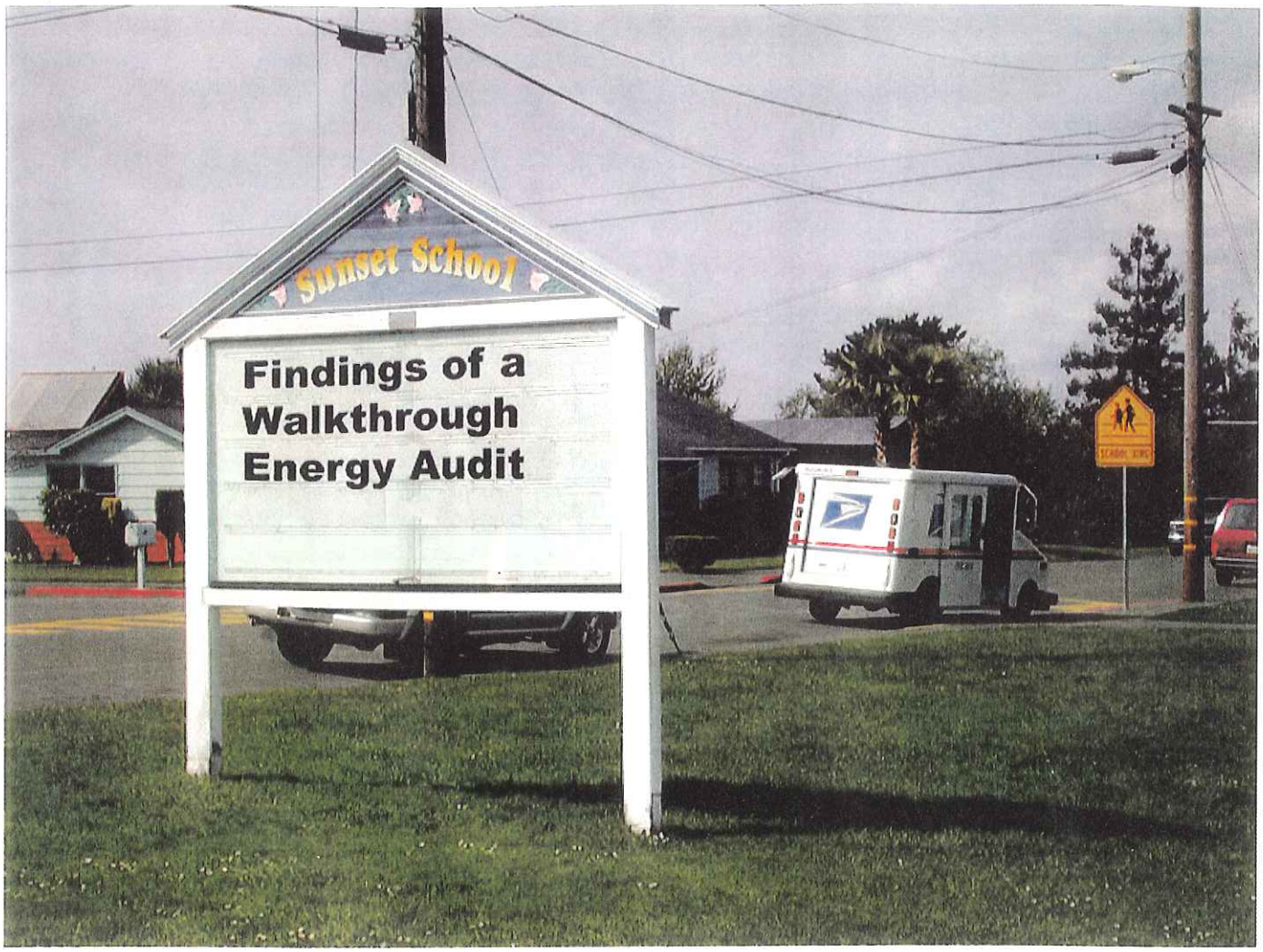

ENVS 310
Environmental Science Practicum
Spring 2001

By,
Sammie Baratta
Jennifer Bies
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Table of Contents

Appendix

1. Introduction

As part of Humboldt State University's Environmental Science Practicum Class (ENVS 310), we conducted a walk-through energy audit of Sunset School (see Section 8 for definintion). Our intention was to provide a broad foundation of findings for energy conservation measures that focus on Sunset School, but with quick-fix behavioral modifications that can be applied to all the schools within the Arcata School District. We conducted a brainstorming session to generate ideas about issues that needed to be addressed in our report (see Appendix A2). Our group spent a total of 186.25 hours on the entire development of this project (see Appendix A12 for breakdown).

2. Problem Statement

Given that the Arcata School District has seen an increase in energy costs, there is an opportunity to present findings on how to reduce energy consumption.

3. Objective

Our objective is to present findings from the walk-through energy audit on ways to reduce energy consumption to the Board of Directors of Arcata School District on May 14th 2001, using Sunset School as a case study.

- Perform a walk-through energy audit at Sunset School.
- Distinguish between behavioral and technological modifications.
- Provide referrals for grant funding sources and local professional contractors, to assist in the development and implementation of more in-depth energy audits and subsequent energy conservation measures.

4. Implementation Tactics

- Generate a summary report including all reference materials – to be distributed to the School Board, as well as to Dick Hansis.
- Present a summary of our findings for energy conservation measures to the Arcata School District Board members at 7pm on May 14th 2001.

- Create and distribute an informational newsletter that may educate faculty, administration, and custodial staff about potential behavioral changes that support energy conservation measures at Sunset School.

5. Objectives for Implementation

- Phase I -
    - Initial research tasks done by Friday 4/13.
    - Assign additional research if needed.
- Phase II –
    - Refined/Edited research tasks done by Friday 4/20.
    - Assign additional research if needed.
    - Begin compiling data into document format.
- Phase III –
    - Complete document by Friday 4/27.
    - Begin working on presentation.
- Phase IV –
    - Complete Power Point presentation by Friday 5/4.
- Phase V – Week of 5/7 – 5/13
    - Design newsletter.
    - Polish report and presentation.
- Phase VI
    - Present findings to the Board on 5/14.
    - Complete newsletter and distribute by 5/14.

6. Alternatives

If, by any chance, the Energy Audit presentation does not occur, we will have a written document as well as the newsletter to disseminate to the School Board.

7. Monitoring and Evaluation

One year after the project is complete an assessment could be done to determine whether the Arcata School District implemented the proposed recommendations. If

implementation does occur, an energy accounting analysis could be done to determine whether the solutions were effective in reducing energy consumption. The analysis would determine percent differences for energy cost and usage between the years 2001 and 2002. The impact of price changes can be quantified by:

$$Impact = (Unit\ Cost_{current\ year} - Unit\ Cost_{comparative\ year}) * (Energy\ Used_{current})$$

This analysis that should be done from year-to-year, regardless of any implemented energy conservation measures. Table 1 demonstrates an example of an energy accounting analysis.

Table 1. Energy Accounting and Analysis – Example

	1991	**1990**
Total energy used (BTU)	6,847	6,804
Difference	43	
% Difference	1%	
Total energy cost ($)	19,015	16,721
Difference	2,294	
%Difference	14%	

8. About Energy Audits

An energy audit is a *developing* understanding of the specific energy use patterns of a particular facility. There are three stages of an energy audit:

1. *The Walk-through audit* is a low cost visual survey. Information is collected on a broad, general scale to lay the foundation for a more detailed study in the next stage.
2. *The Mini-audit* uses tests and measures to quantify energy uses and losses, and quantifies the economics behind any changes implemented.

3. *Maxi-audit* is the most detailed stage. Model analyses are used to determine energy use patterns and predictions on a year-round basis, taking into account details such as weather data, and including many variables.

Our group performed a walk-through audit of Sunset School. Walk-through Energy Auditors provide Technical Auditors with an accurate inventory, and identify "fixes" which can quickly and inexpensively save energy. The continuing stages of the audit must be accurate, to identify and qualify the energy and cost savings that can be optimized through investment in energy savings measures. An energy audit is ongoing and changes constantly. If you stop asking questions, your energy audit is at a halt. When investing in renovations within the scope of modernization funds, aim for energy efficient measures.

There are also several types of audits that are required to create energy use profiles, these include:

1. *Envelope Audit*- This audit analyzes the building for losses or gains of energy due to leaks, building construction, doors, glass, lack of insulation, etc.

2.*Functional Audit*- This audit determines the amount of energy required for a particular function that includes, but is not limited to, heating, ventilation, building, lighting and hot water.

Table 2 demonstrates the percentage of energy that is typical for schools. Notice that the environmental control is where most of the energy is being used. The only environmental control for Sunset School is the heating systems.

Table 2. Energy Use in Schools

	Range %	**Norms%**
Environmental Control	45-80	65
Lighting and wall receptacles	10-20	15
Food service	5-10	7
Hot water	2-5	3
Special Functions	0-20	10

9. Findings

9.1. Low to High Cost Options - Technical

9.1.1.Building Design

The best way to save energy at Sunset School would actually involve a complete rebuild. This is not desirable or feasible at this time, with the limited funding available, and the limited time frames when school is not in session. However, one must acknowledge the inappropriate design of Sunset School before attempting to implement any energy conservation measures. Sunset school was built in the 1950's, before energy conservation was an issue. The country was growing at a rapid rate, and schools were needed to accommodate the population increase. Sunset school was built in such a way that the orientation of its windows is to the north. These windows take up most of the north facing walls. This is a fine design in Southern California, where it tends to be warm most of the year. However, in Arcata this is a bad design due to the colder climate.

North facing windows lose heat at a very fast rate compared to south facing windows. When the sun is shining, south facing windows actually transmit heat energy from the sun's rays, warming the interior rooms (see Figure 1). Sunset school has no south facing windows. In fact, the overhangs that line all but one wing's entire expanse of the south-facing walls actually block all direct insolation from the sun, shading the south side of the buildings continuously throughout the day. This arrangement creates a "double whammy" with no heat gain from the south, in the rare cases when the sun shines in Arcata, combined with substantial, constant heat loss throughout the windows along the entire north wall of the buildings.

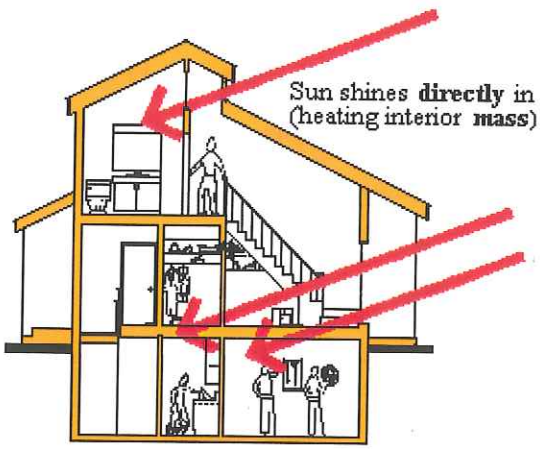

Figure 1. Example of passive solar heating

Arcata School District currently has plans to replace these windows with double paned windows, which will cut heat loss approximately by half. This is only a start. If curtains were shut at the end of the day, heat loss would occur slower overnight, decreasing demand on heaters in the morning. Currently curtains are constantly open in classrooms. This allows teachers more space for materials and projects along the ledges. However shorter curtains could allow for extra curriculum space, while still conserving heat. This compromise would work only if curtains were shut at the end of the instructional days and on particularly cold days.

Another design flaw concerns the doors to the classrooms. Since these doors open directly to the open air, heat is lost rapidly every time a door is opened. If an enclosed hallway were added to all the wings of the school (one wing already has one), then this heat loss could be minimized.

9.1.2.Phantom Power Loads

Phantom power loads are a source of electricity consumption that few people know about. A phantom load is an appliance that draws electricity continuously, even when it is turned off. One example is a television that remains plugged in, even though it is not in use. The television draws electricity to keep the tube

warm, so that the image will quickly appear when turned on. Older televisions do not have this trait - that's why they take so long for the picture to materialize. Other phantom loads include clocks in appliances such as coffee makers, microwaves and VCR's, radio boom box systems, newer computer power supplies, copying machines and monitors in sleep mode. To avoid wasting electricity on devices such as these, one can do a number of things. Connect appliances to a power strip with a switch that is turned off at the end of the day. Unplug electronic devices when they are not in use (do you really need that clock on the coffee maker?). Taking these measures may not seem like it would have a significant impact, but over time and with numerous devices, it adds up.

9.1.3.Lighting

Lighting is an important factor to consider for energy conservation in any building. There are several no cost or low cost solutions for conserving lighting energy. Some examples are: turn off the bathroom lights during the daytime, stagger/remove light bulbs, and place "please turn off lights before leaving" signs next to light switches.

High cost solutions include installing occupancy sensors and more efficient ballasts, such as electronic ballasts. Occupancy sensors are products that save lighting energy when spaces are unoccupied. The sensors are most applicable in spaces where occupancy is infrequent or unpredictable, such as offices, conference rooms, classrooms, hallways, and copy rooms. Electronic ballasts for fluorescent lighting systems are promoted as providing significant energy savings over magnetic ballasts.

More information on occupancy sensors and ballasts can be found on the National Lighting Product Information Program website. This program provides manufacturer-specific performance data on efficient lighting products. Their goal is to help consumers meet their lighting needs while using lighting effectively. They have reports on efficient lighting products such as those described above. All reports are available free in electronic format (Adobe Acrobat PDF). Appendix A3 has the Application Considerations section of a report on occupancy sensors. Other reports can be found through: www.lightingresource.com

Another helpful website with many resources for commercial and residential lighting information is the Lighting Research Center website: www.lrc.rpi.edu.

9.1.4. Windows

Approximately 25% of heat lost during winter months is lost through single-paned, worn-down windows. When choosing energy efficient windows, consider the following guidelines.

Energy-saving features

- Double panes reduce condensation, and provide an air space that acts as insulation to reduce the flow of heat through the window.
- Low-e coatings - Low emissivity coatings of silver or tin oxide permit visible light to pass through the window, but reflect shorter wavelength heat radiation back into the interior of the room. This process keeps heat in during the winter, and keeps heat out in the summer. It would be especially helpful at Sunset School due to the north-facing windows that provide precious little solar gain. It is important to contain the heat that costs so much to consume, and to capture what little visible light is actually available on site.
- Glazing generally insulates better than the edges of windows, so opt for larger panes of glass with a proportionally smaller edge area. Large panes allow the transmittance of more visible light and minimize the shading that occurs from the edge spacers.
- Aluminum edge spacers hold the panes of glass apart and are intended to provide airtight seals around the edges. Aluminum is an extremely conductive material and heat can be lost very rapidly through these spacers. Improved edge spacers can have a net effect of between 2-10 % improvement in window energy performance, depending on the other performance characteristics of the window. Choose windows with edge spacers that have long warranties against any defects with the air seals. Fogging and condensation will occur if this seal is broken, and any low-conductivity gas between the panes will leak out, thereby decreasing window energy performance.

- Low-conductivity gas-fill between the panes reduces the rate of heat flow through the window to the environment.
- Wood, vinyl or fiberglass frames/edge spacers conduct heat more slowly than aluminum or steel.

National Fenestration Rating Council (NFRC) – Rating System

- U-Value – measures the amount of heat in BTU's that moves through a square foot of windowpane in 1 hour, for every degree F difference in temperature between the interior and the exterior of the building. A lower U-value is better – 0.40 or lower
- Solar heat gain coefficient – the percentage of solar energy transmitted through a window. A value of 0.8 allows 80% of solar energy striking the glass through.
- Visible light transmittance – the percentage of visible light that passes through a window. A value of 0.6 allows 60% to pass through. Look for a rating of 0.6 or higher.

Installation of windows is a critical component of overall window performance as any gaps and air leaks created during installation nullify the high-rated performance of costly windows. Hire professionals to install the windows.

9.1.5. Heating System

The major cost incurred to the school district is due to heating consumption. The recommended Dry Bulb °F for classrooms and offices during occupied hours, at a maximum should be 68°. When the rooms are unoccupied, the setback temperature should be 55°.

There are two options for saving energy regarding heating. Sunset School should have routine servicing and repair/replacement of outdated equipment. According to the Consumer's Energy Handbook, periodic checkup and maintenance of heating equipment can reduce fuel consumption by 10%. If any repairs or replacements are done, ask each contractor who gives you an estimate how many years it will take before the amount saved by having new equipment will equal the cost of what you

paid for it. Keep in mind any projected fuel price increases. Locating and maintaining a professional relationship with a good heating specialist is an efficient way to ensure that equipment stays in top fuel-saving condition.

We consulted a heating specialist to evaluate the heating system at Sunset School. NCI offers free consultations, as well as supplies heating equipment. They were friendly, prompt and accurate. Ben Jones offered his services for consultation and these were his findings:

- Drop the ceilings in the two southern-most wings of Sunset School to the same height as the other wings. This will reduce the volume of air that needs to be heated. Add ducting to distribute heat more efficiently. Each room should have its own heater- estimated $400.00 per heater. Alternatively, for the heaters that are shared by two rooms, computers are available to control the temperatures in all of the affected rooms.
- Change intake filters quarterly.
- Dampers need regular maintenance (i.e. oiling annually).
- When thermostat box is locked, one can still raise the temperature. However one does not know what the temperature is rising to, as well as being unable to lower it. During the Conditions Survey, a teacher mentioned this problem, as well as how frustrating it can be.
- There is a switch on the thermostat control box that can be activated so that the keypad will not work.
- The thermostats already have timers, however the AA batteries in the back of the unit need to be replaced.

10. No Cost Options - Behavioral Modifications

Given the challenging, inappropriate design of the building at Sunset School, behavioral modifications can only have a limited influence on energy conservation measures. Yet, behavioral efforts can go into effect immediately at no cost to the school, beyond the extra time it takes to integrate new routines into a day's work. Here are some suggestions that could decrease the amount of energy consumed and/or lost to the environment:

During school hours

- Keep the doors closed when the heater is on.
- Keep the windows closed when the heater is on.
- Bring extra layers of clothing, and encourage students to do the same.
- Maintain an awareness of a more appropriate temperature setting for the thermostats in each classroom (65°-68° F).
- Turn off electrical appliances (computers, radios etc) when not in use, or better yet, unplug them to prevent phantom load electricity demands. A power strip will accomplish the same goals as unplugging items, but can effectively disconnect multiple items with one switch.

After school hours

- Close the curtains before you leave the classroom for the night.
- Take phantom load prevention measures (unplug electrical appliances at the end of the day).
- Consider using a common workspace (faculty room) after-hours to concentrate energy consumption in one area of the school.
- Turn down the thermostat setting to 50°- 55° F before you leave the classroom for the night.

These behavioral modifications can have an immediate influence on energy conservation measures at Sunset School, and should be supported by both faculty and custodial staff alike. Setting an example for the children can also increase their awareness of energy conservation, an essential perspective to extend to children, given the likelihood of ever-increasing energy shortages and subsequently, prices as well.

11. Summary of Arcata School District Budget

A major reason to conserve energy is that doing so will save money for the school district and the school. What follows is a summary of budgetary allocations at both

the Sunset School and the district level for 2000-2001. See Appendix A4 for a detailed breakdown of budget reports.

At Sunset School, for the period between July 1, 2000 and June 30, 2001, $6,800 was originally allocated for natural gas services. After December 2000, when natural gas prices increased, the budget was increased to $16,720 to meet projected increases of energy bills. That is about 2.5 times the originally budgeted amount. As of April 5, 2001, sixty percent of those funds had been spent. The electricity budget remained constant, at $19,000 for the year.

At the district level, the natural gas budget was increased from $21,800 to $41,320, again to meet projected energy bill increases. That is almost twice the original amount budgeted. Again, as of April 5, 2001 sixty percent of those funds had been expended. Electricity for the district remained at $45,000 (see Appendix A4).

The extra $19,520 for natural gas came out of district reserves. While the electricity budget remained constant, the California Public Utilities Commission (CPUC) is considering a 40 percent price increase. Due to power plants being offline for maintenance, the supply of electricity in California in the near future will be tight. Currently, the state is importing power from as far away as Canada, but those sources may "dry up" as the summer heats up, causing more demand in the West. Table 3 shows that although natural gas usage *decreased* between 1999 and 2000, overall cost for this decreased amount of usage was *greater* than the previous year. This provides extra incentive to implement energy conservation measures as soon as possible, as initial investments will pay off over time.

Ultimately, the money that the district uses to pay for utilities comes out of local taxpayers' pockets. The more money that is spent on utilities, the less funding gets to the students. Even though the money used to make up for natural gas prices came out of reserves this year, it comes out of the same overall fund that pays for all school related expenditures; from field trips to bus service, to the faculty and administrators salaries. Conserving as much energy as possible is a sure route to reducing spending on energy bills, and ensuring the maximum fund availability for classrooms.

	1999	2000
total elec... used		
diffe		
% diff		

Pay no mind to these top 2 tables - only the natural gas below ✓

to electrical cost ($)	12931.78	11415.48
difference	1516.3	
% difference	13	

	1999	2000
total energy cost ($)	20303.33	20930.5
difference	-627.17	
% difference	-3	

	1999	2000
total gas used (therms)	11968	9515.02
difference	2452.98	
% difference	26	
total gas cost ($)	7371.55	9515.02
difference	-2143.47	
% difference	-23	

Table 3. Expenditure Analysis for Natural Gas 1999-2000

12. Summary of Sunset School Observation

We conducted an observation of the physical conditions at Sunset School. We noted conditions of all the classrooms, workrooms, office, kitchen, multipurpose room and the bathrooms. We included the following parameters: Doors (open or closed), Lights (on or off), Heater (actual and set temperatures), windows (open or closed), curtains (open or closed) and if anyone was in the rooms. The observation was conducted throughout the day on March 9,2001, beginning at 8:00 am and ending at 5:30 pm. The conditions were sunny, but there were strong winds throughout the day. For a more detailed account, please see Appendix A5.

The following is a list of what we observed:

- The average room temperature was 67°, with a range of 59° to 74°. There were only a few rooms where the heater was completely shut off.

- All lights were on except for in two rooms. There was one room that the teacher had half the lights on.
- There were few rooms that had they door open consistently throughout the day. Conditions ranged from the door open with the heater off, to the door open with the heater set at 74°.
- All windows were closed.
- All curtains were open. We noted that they were all open and unable to be closed at night because of all the crafts and school supplies on the windowsill.
- Misc. Equipment: Mini lamps, fish tanks, computers, printers, radios, televisions, VCRs, fax machines, copy machines, microwaves, stoves, mini-fridges, heat lamps, kiln, soda machine, coffee pots.
- Several radios on that were not being used.
- The refrigerator is directly next to the oven.
- Heaters that are locked can be turned up but not down (this was also noted by the Heating consultant).
- A substitute teacher said they don't set heater-the janitors do.
- A ceiling was half open with insulation showing.
- Noticed a huge draft under the doors.
- A custodian stated that he shuts off heaters before the weekends on Friday, and that teachers don't like that. During the week he will set the thermostats at 60° or 62° F overnight. He stated that this is not in his job description, but he does so on his own initiative.

13. Summary of Survey

A survey about energy conservation was distributed to the staff and faculty of Sunset School. The purpose of the survey was to gauge the level of energy consciousness amongst the faculty and to hear their opinions about energy conservation measures at the school. One survey, with an attached letter (see Appendix A6), was placed in each teacher's box and extras were left in the office for those who did not have a box. There were a total of 17 surveys returned from Sunset school staff and faculty. The survey questions and responses can be found in

Appendix A7. Responses to a value or ranked question were rated on a scale of 1-10 (10 being the highest).

The energy survey found that all of the respondents highly value energy conservation (all responses ≥ 8). The respondents generally practice energy conservation in their daily lives (all responses ≥ 7 with 59% at 8) and highly value setting an energy conservation example for the students at Sunset Elementary (all responses ≥ 8). The respondents rated the level of student awareness about the current energy crisis all over the scale. Less than half of the respondents rated the student awareness level at 5 or lower. About 70% of the respondents rated the level of awareness between 6 and 8. The majority of the staff and faculty at Sunset said that it would highly affect their use of energy at the school if they could see the increase in cost of the school's energy bill. The increase in cost would only slightly affect 20% of the respondents.

The survey asked the respondents to rank 3 potential energy conservation measures for the school. All of the respondents highly support preset timing cycles for the heaters (all responses ≥ 8). A couple of respondents mentioned that the timers do not always need to be on and that they would like input into what the timing would be. The staff and faculty are mixed amongst their opinion about occupancy-sensor lighting. About half of the respondents highly ranked the lighting measure (≥ 7). The other half ranked the lighting measure at ≤ 6, with 30% of the respondents ranking the option at 1. Those respondents who ranked the lighting measure low commented that they like to control whether the lights are on or off. Therefore, it should be noted that it is possible to install the sensor lighting system while still retaining manual control of the lights. It was also mentioned that occupancy sensor lighting is difficult during parent conferences and when sitting quietly after school. The question regarding automatically closing doors was not clearly understood by many of the respondents (about 30% left question marks). It was also determined, after the distribution of the survey, that Sunset Elementary does have hydraulic doors that close on their own. However, of the respondents that did answer the question, about 60% ranked the option 8 or higher. Some of the technological energy conservation measures offered

by the respondents were: to install double-paned windows, lower ceilings, design a "conservation network" at the schools, and to use solar energy.

About 76% of the respondents admitted that they have the door open with the heater on every day or every 2-3 days. A comment regarding this behavior was that the heaters come on when they are not needed and that the temperature is set too high. The question was asked to the teachers, how many hours of after schoolwork *must* take place *in the classroom.* The reasoning behind this question was to determine if it would be a possibility to set aside one heated and lighted after hours workroom rather than using 5 or 6 heated and lighted classrooms. The average teacher at Sunset Elementary must spend 1.8 hours in the classroom for after hours work. The average temperature setting in the classrooms and office is 67.2°F (the range was 61 - 70°F). The staff and faculty behavioral suggestions for increasing energy conservation included: have discussions in the classroom/ education, constant reminders through letters and personal communication, and remind people to close the doors.

Eighty percent of the respondents either see a direct correlation between rising energy bills and decreased available funds in the classroom or expect to see one soon. Those respondents who do not see a correlation noted that there have always been low funds available for classrooms.

14. References for Continued Auditing Action and Conservation Measures

14.1. Potential Funding Sources

Lack of funding is one of the major barriers to enhancing energy efficiency at public schools. However, there are many funding sources through grant, loan, and rebate programs. The following is a list of possible programs that apply to the Arcata School District.

The Bright Schools Program

The Bright Schools Program is offered through the California Energy Commission. The program can help conduct and implement findings from a full energy audit. The following services are offered by the program: conducting

energy audits and feasibility studies, reviewing existing proposals and designs, providing equipment bid specifications, assisting with contractor selection, and assisting with installations. The program is offered to school districts at little or no cost. The Bright Schools Brochure can be found in Appendix A8, or for more information contact:

Judy Brewster
California Energy Commission
151 Ninth Street, MS-26
Sacramento, CA 95814
Phone: (916) 654-4053
E-mail: Jbrewste@energy.state.ca.us

The Green Schools Program

The Green Schools Program is offered through the Alliance to Save Energy. This program helps schools use energy efficiently through building retrofits, changes in operational and maintenance routines, and changes in the behavior of building users. It combines energy efficiency management and building retrofits with student involvement in planning and implementing school-wide behavior changes. The steps to getting the Greens Schools Program started can be found in Appendix A9. More information can be found on the Greens Schools website: www.ase.org/greenschools or call: (202) 857-0666

Energy Efficiency Financing

The California Energy Commission's Energy Efficiency Financing Program provides financing for schools through low-interest loans for projects such as feasibility studies, lighting, building insulation, heating and air conditioning modifications, automated energy management systems/controls, and energy generation. Approximately $10 million is available to finance technically and economically feasible projects.

> "Over the past five years, our school district has taken out Energy Commission loans totaling over $100,000 to install efficient lighting and heating and cooling systems at our two schools. These projects have benefited the district in several ways. First the district has saved an estimated $38,000 per year in reduced energy costs. Second, the installations have resulted in the creation of a district-wide Energy

Awareness Program which instills the energy efficiency ethic to our students- our future energy consumers and decision-makers."

-Bob Nixon, Supervisor of Maintenance Operations
Riverdale Unified School District

The Financing for Energy Efficiency brochure, application guidelines, and application can all be found in Appendix A10. To discuss eligibility call or e-mail:
Phone: (916) 654-4008
E-mail: nonres@energy.state.ca.us

Handbooks for Energy Efficiency

The California Energy Commission offers several handbooks on the subject of energy efficiency. The Arcata School District might be most interested in the handbook entitled "How to Finance Public Sector Energy Efficiency Projects." This guide addresses the needs of public sector agencies, including public school districts. Amongst the useful information provided in the guide is information on financing programs specific to public sector agencies. The handbook is available as an Adobe Acrobat Portable Document Format (PDF) file on the following website:

California Energy Commission website (see Appendix A11)
www.energy.ca.gov/reports/efficiency_handbooks/index.html,
Or the guide can be ordered by phone:
California Energy Commission Nonresidential Buildings Office
(916) 654-4008

Funding Announcements

The California Energy Commission has an automated e-mail system to alert you to its requests for proposals and other funding announcements being placed on-line. To subscribe to the list server, fill out the required information on the following website: www.energy.ca.gov/html/listservers.html

14.2. Local Referrals

Gabel Dodd – Environmental Engineer
Analysis and Modeling of Conservation Measures using EnergySoft LLC Software
1062 G Street

Arcata, CA 95521
(707) 825-8699

Martin Watson and Co. – Energy Consultants
1975 Norton Rd.
M^{c}Kinleyville, CA 95519
(707) 498-7919

Six Rivers Solar Inc
818 Broadway
Eureka, CA 95501
(707) 443-5652

Redwood Community Action Agency (RCAA)
Energy Assistance – Energy Demonstration Center
539 T Street
Eureka, CA 95501
(707) 444-3834 (*Calls accepted only on Mondays beginning at 9am)

NCI Service Company
Heating specialists- Free consultations
Ben Jones
P.O. Box 5507
Eureka, CA 95502
(707)445-8097

15. Conclusion

The Arcata School District's web page (http://www.nohum.k12.ca.us/asd/sunset/sarc/index.htm) states that new lighting will be installed in classrooms, including the multi-purpose room, windows will be replaced, and classroom doors and curtains will be improved due to safety codes. The kitchens are also another target area for remodeling in the school district. Recommendations include not placing the oven next to the refrigerator, and if any new appliances are purchased, keep in mind energy efficient appliances. These renovations are possible thanks to modernization funds, and are already scheduled to happen along an established timeline. Investing in energy efficient components similar to the findings detailed in previous sections, will manifest in greater savings over time.

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  P.O. Box 428
  White River Junction, VT 05001

Windows

- How to Purchase High Performance Windows – Video
  © September 2000 PG&E
  1-800-933-9555 / www.pge.com

- EnergySmart Renovation – Guidebook
  © August 2000 PG&E
  1-800-933-9555 / www.pge.com

Potential Funding Sources

- Energy Efficient Handbooks website.

  www.energy.ca.gov/reports/efficiency_handbooks/index.html

- Energy Efficiency Financing – California Energy Commission website.

  www.energy.gov/efficiency/financing/index.html

- Bright Schools Program- Information website.

  www.energy.ca.gov/efficiency/brightschools/info.html

Miscellaneous

- Keniry, Julian – EcoDemia

  © 1995 National Wildlife Federation

  Washington, DC

A2. Brainstorming for Energy Conservation at Arcata School District - Resulting Rankings

Key: No cost = NC Low Cost = LC High Cost = HC

A. Heat Conservation

With students in session:

- Close door - NC
- Close windows - NC
- Set Thermostat - NC
    - Lock box - NC
    - Educate on what degree setting to use - NC
- Extra clothing layers - NC
- Control of up and down temp - NC
- Thermostat Timers - LC
- Seal/weather-strip doors and windows - LC
- Insulate windows with film - LC/labor intensive
- Hot water heater insulate - LC
- Insulate ceiling - HC
- Change window to double pane - HC
- Lower ceilings – HC

After hours:

- Teacher's workroom - NC
- Close curtains - NC
- Custodian education - NC
- Custodians shut heat off - NC
- Multi-purpose Room- educate after school staff - NC
- Teachers shut off/educate - NC
- 1-2 hr timer shutoff - LC
- Space heater - LC short term/ HC long-term
- Modernize heating system, replace ducts/vents – HC

B. Electricity

Lighting:

- No lights on during day in bathroom - NC
- Stagger/remove bulbs - NC
- Signs next to switch - LC
- Desk lamps w/ compact florescent lights for after hours - LC
- Motion sensor triggered lighting – L-HC
- More efficient ballasts (electronic) - HC

(After hours security lighting?)

(Check if there's air conditioning – drama/library?)

Other:

- Computers/printers (sleep mode vs. off) - NC
- Phantom load reduction measures (i.e. unplug or power surge protectors – shut off) -LC
- Cafeteria refrigerators and stoves – increase efficiency - LC

  (Savings long-term - Do they need the older, small fridge?)

C. Communication

Between Administration – Faculty – Custodial:

- Provide faculty incentives – awards for achieving targets for entire school (awards<savings %)
- Show costs to employees – monthly bills for individual classrooms
- Show increasing prices for energy over time
- Budget breakout – what % goes to energy bills
- (Bi-) Annual de-briefing session
- Web page – update bi-annually about conservation measures taken
- Energy Fair

Between us – school:

- Newsletter
- Oral interviews, informal w/anyone interested
- Survey
- Web page – update bi-annually
- Refer to $ incentives (grants/rebate programs)
- Creative presentation to board

the lamps when no one is in the room. For example, if the sensitivity is too high, the sensor may react to motion in the hallway outside of the room and turn the lamps on. If the sensitivity is too low, the occupancy sensor might not be able to detect human motion at every point in the room, or it may turn off the lamps while people are in the room but moving very little. Because optimizing the sensitivity setting for ultrasonic occupancy sensors is site-specific, NLPIP recommends adjusting the sensitivity after installation.

Most occupancy sensors are shipped with the sensitivity setting at maximum, minimizing the risk of occupant complaints but increasing the potential for lamps being on when the room is unoccupied.

Time delay. Like passive infrared occupancy sensors, ultrasonic occupancy sensors have a time-delay feature that keeps the lamps on for a specific period after the time when the last motion was detected. Manufacturer-reported time delay ranges from 8 s to 32 min.

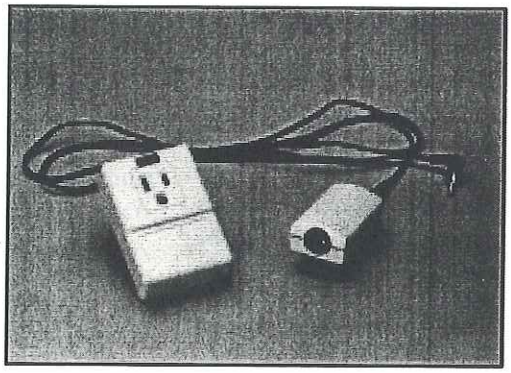
Dual-Technology (or Hybrid) Occupancy Sensors

Dual-technology occupancy sensors, sometimes called hybrid occupancy sensors, use two technologies, such as passive infrared and ultrasonic or passive infrared and microphonic, in combination to improve performance. NLPIP did not test dual-technology occupancy sensors for this report, but those reported by manufacturers are listed in the manufacturer-supplied data in Table 4 on pp. 28–29. These sensors are wall- or ceiling-mounted.

Passive infrared/ultrasonic. Most dual-technology occupancy sensors combine passive infrared and ultrasonic sensors in one product. They switch lamps on when both sensors detect motion. The device keeps the lamps on if either sensor detects motion, and turns them off, after a delay, if neither sensor detects motion. Because both sensors must detect motion before turning on lamps, dual technology products reduce the likelihood of lamps turning on due to false triggering (lamps turning on because of motion that is not caused by an occupant). Because only one sensor has to detect motion to keep lamps on, these products reduce the likelihood of lamps turning off while a space is occupied.

Passive infrared/microphonic. In addition to passive infrared/ultrasonic sensors, NLPIP also received information on a dual-technology occupancy sensor that combines passive infrared technology with a microphone. This hybrid occupancy sensor responds to sounds made by occupants, as well as motion. It switches lamps on when the infrared sensor detects motion and turns lamps off, after a delay, only if the infrared sensor detects no motion and the microphone detects no sound. For example, the sound of a person typing can keep the occupancy sensor from turning off the lamps, even though the motion involved in typing is very slight. The sensitivity of the microphone can be adjusted for different background noise levels. This dual-technology occupancy sensor is less expensive than infrared/ultrasonic occupancy sensors and, unlike many infrared occupancy sensors, can be effective in partitioned offices. However, the performance of this product has not been documented.

Controlling Task Lights and Desktop Equipment with Occupancy Sensors



MYTECH's CUBi-U30 Workspace Sensor

In addition to occupancy sensors designed to control general lighting systems, some products are available to control the "plug load" in an individual workstation. These devices can control not only task lights but also monitors, printers, radios, and other small electrical appliances. For example, Watt Stopper's ISOLe´ and MYTECH's CUBi-U30 are passive infrared sensors that control a device plugged into a single electrical outlet or several devices plugged into a power strip.

Hearing Aid Interference from Ultrasonic Sensors

The frequencies commonly used by ultrasonic occupancy sensors are 25, 27, 32 and 40 kHz. Physical plant engineers at California State University at Northridge received complaints of hearing aid interference at 25 and 27 kHz (Witter 1996). They subsequently recommended using only ultrasonic occupancy sensors with frequencies of 32 kHz and above. For similar reasons, New York City has set a minimum limit of 35 kHz in its ultrasonic occupancy sensor specification (Energy Investment Inc., 1996).

Manufacturers of ultrasonic occupancy sensors are aware of the possibility of hearing aid interference. Many are now either using higher frequencies exclusively or offering products at either higher or lower frequencies.

Application Considerations

The most suitable applications for occupancy sensors are in spaces where occupancy is infrequent or unpredictable, such as many offices, warehouses, conference rooms, classrooms, hallways, service corridors, lavatories, storage closets, or copy rooms. In areas where occupancy is

regimented and predictable, such as a factory floor, a time clock might be a more cost-effective lighting control solution.

Types of Motion

A primary consideration when selecting an occupancy sensor is the magnitude of motion required by the occupancy sensor for detection. For example, in hallways, an occupancy sensor needs only to be sensitive enough to detect a person walking. But in a data-entry office, an occupancy sensor must detect motions that are much smaller, such as typing.

NLPIP defines whole body motion as a *large* motion, arm motion as a *medium* motion, and hand motion as a *small* motion. Using these definitions, walking is a large motion, reaching for the telephone a medium motion, and typing a small motion.

Mounting Locations

The layout of the space should be considered carefully when selecting occupancy sensors. The optimum mounting location depends on the shape of the room, the expected locations of the occupants, potential obstacles such as desks, file cabinets, doors and partitions, and potential sources of extraneous motion, such as fluttering curtains or movement in adjacent hallways. Most occupancy sensors are ceiling-mounted or wall-mounted at the height of the typical light switch (42–48 inches). Some manufacturers also make units for mounting in the corner of a room or hallway or on the wall near the ceiling.

Wall. Wall-mounted occupancy sensors often replace standard manual switches or wall dimmers and are relatively easy to install in retrofit projects. Wall-switch replacement occupancy sensors are usually passive infrared sensors and require a clear line-of-sight to detect motion.

Wall-mounted sensors, usually mounted somewhat higher than switch-replacement sensors, can be either passive infrared or ultrasonic. The mounting height of these sensors, usually at eight feet or higher, reduces the risk of tampering that may occur with wall-switch replacement sensors.

Ceiling. Most ceiling-mounted occupancy sensors are surface-mounted; however, some are recessed into the ceiling. Ceiling-mounted passive infrared and ultrasonic occupancy sensors for corridor applications are available with multiple unidirectional detectors or transmitters aimed in different directions for mounting at corridor intersections. Occupancy sensors for corridor applications generally have long, narrow coverage patterns.

Corner. Corner-mounted passive infrared occupancy sensors have 90° vertical fields of view. The round and elliptical coverage patterns common among passive infrared occupancy sensors designed for mounting in the center of the ceiling can leave "dead spots" in the corners of a rectangular or square room if the coverage area does not entirely cover the room. If increasing the sensitivity of the sensor (if possible) does not reduce the dead spots, adding corner-mounted passive infrared occupancy sensors can be effective if occupant motion often occurs near the corners of the room. The only other alternative is to replace the ceiling-mounted sensor with one with a larger coverage area.

Manual Control Options

Occupancy sensors are generally used because they provide automatic control of lighting systems; they turn lamps on when they detect movement, turn them off when they do not detect movement. In many applications, fully automatic control of the lighting system may be desirable, and many of the occupancy sensors available today provide this type of operation. However, many other applications may be better served by occupancy sensors with some manual control options.

Manual "on" control. Some occupancy sensors provide the occupant with the option of turning the lamps on manually; others require the occupant to turn the lamps on manually. These products eliminate the potential for the lamps coming on when the room is unoccupied. Furthermore, an occupant may choose not to turn the lamps on if there is adequate daylight.

Manual "off" control. Some occupancy sensors provide the occupant with the option of turning the lamps off manually. These products are useful for applications where it

may be desirable to have the lamps off, even though the room is occupied. Examples include conference rooms and lecture halls where audiovisual presentations occur.

Override controls. In some situations, it may be desirable to disable the automatic functions of an occupancy sensor. These override functions usually require a special tool and may require the removal of the face plate. Once set in override mode, the sensor must be reset to resume the automatic functions.

Occupancy sensors have a variety of possible automatic, manual, and override functions. In many cases, switching between automatic and manual functions is very simple and easily accomplished by the occupant. Because of the many variations in combining automatic, manual, and override functions, NLPIP encourages specifiers to contact the manufacturers of the products they are considering to determine the options available.

System Configurations

Control modules. Wall-mounted occupancy sensors that replace standard wall switches are wired directly to the lighting system and use contacts within the occupancy sensor to switch the lighting load, as do some ceiling-mounted occupancy sensors. However, most other occupancy sensors require a separate control module that contains a relay to switch the lighting load. Control modules can be expensive to install because they require additional wiring and, because the modules usually are located in the ceiling, the installer must work on a ladder. However, systems with separate control modules offer the option of connecting many modules to one occupancy sensor, or the ability to connect many occupancy sensors to one load for increased coverage area. Some types of occupancy sensors can also be connected to a building automation system through the control module.

Photosensors. Occupancy sensors can be wired in series with photosensors that switch lamps on and off depending on available light. Using this combination, the lamps will not be automatically turned on if sufficient daylight is available even if the space is occupied.

Special photosensors are available that can be used with dimming electronic ballasts to control fluorescent lamp output over a continuous range. These photosensors can also be used in conjunction with occupancy sensors. See *Specifier Reports: Dimming Electronic Ballasts* for more information about dimming fluorescent lighting systems.

Some occupancy sensors include a built-in photosensor. When these products detect motion, they turn on lamps only when the illuminance is below a preset level. Once the lamps are on, these products will keep them on as long as motion is detected, even if daylight increases.

The columns in Tables 2–4 on pp. 16–29 labeled 'Daylight Sensor Availability' indicate either a built-in or added photosensor is available, or no photosensor is or can be attached.

Building automation systems. Occupancy sensors interface with a building automation system through a special type of control module that contains a microprocessor and a relay that is separate from the load switching relay. Table 5 on pp. 30–31 shows control modules that are designed to work with a building automation system in the column labeled master/slave option. *Lighting Answers: Controlling Lighting with Building Automation Systems* addresses questions about integrating occupancy sensors into the building automation system.

Electrical Requirements

Capacity. The relays used by most control modules and wall-switch replacement occupancy sensors are rated for a maximum load of 20 amperes (A). Some products also have a minimum load requirement, which is typically less than the power required to operate one two-lamp fluorescent luminaire. Large loads can require multiple control modules. Load capacities vary depending on whether the load is resistive (such as incandescent lighting) or inductive (such as fluorescent lighting). Maximum load capacities listed in Tables 2a , 2b, 3a, 3b, and 5 are reported in watts for fluorescent lighting loads. Minimum load requirement and maximum load capacity are not

reported for ceiling-mounted occupancy sensors because these sensors use a control module that dictates the limits.

Inrush current. Electronic ballasts use solid-state circuitry that can briefly draw a very high current when starting the lamps. For some electronic ballasts, this inrush current can exceed the 20 A rating of the relay for either a wall-mounted occupancy sensor or a control module, possibly destroying the relay. Inrush current is additive: if several electronic ballasts are connected to one control module, their combined inrush current can exceed the relay's rating. Most ballast manufacturers will provide their inrush current rating upon request; this rating should not exceed the maximum current rating for the occupancy sensor or the control module. Some occupancy sensors have a special circuit that delays switching the relay until the voltage cycle is at zero (called zero-crossing switching), thereby eliminating potential damage from inrush current.

Light Loggers

Some occupancy sensor manufacturers and several other companies make monitoring devices for monitoring occupancy and lighting use. These monitoring devices, sometimes called light loggers, contain both an occupancy sensor and a photosensor. Mounted within or near a lamp, they log the number of hours that a space is occupied and the number of hours that the lamp is on. Subtracting the former from the latter estimates the number of hours of "wasted light," hours during which the room was lighted, but unoccupied. More advanced loggers automatically calculate and print out occupancy/light usage profiles.

Some occupancy sensor manufacturers offer the use of light loggers free to potential customers. Telephone numbers for several light logger manufacturers are listed below.

Manufacturers of Occupancy Monitoring Devices (Light Loggers)

Electronic Product Design	(503) 741-0778
The Fleming Group	(510) 275-9185
Heath	(616) 925-2943
MYTECH	(512) 450-1100
North Fork Retrofit	(516) 477-2922
Pacific Science and Technology	(503) 388-4774
The Watt Stopper	(408) 988-5331
Xenergy	(617) 273-5700

Economic Considerations

NLPIP collected price information from occupancy sensor manufacturers; the results are shown in Tables 2–4 on pp. 16–29. Uninstalled occupancy sensor prices ranged from $46–$390, compared to less than $2 for a standard wall switch and switch plate. To justify this additional investment, users need to estimate the expected energy savings from the use of the occupancy sensors. Doing so requires determining the amount of time that lighting systems are left on when spaces are unoccupied. To do this, patterns of occupancy and lighting use must be monitored simultaneously. Some occupancy sensor manufacturers rent or lend occupancy monitoring devices to prospective clients to help them determine their potential savings. (See sidebar "Light Loggers".) Rea and Jaekel (1987) describe a number of other methods for monitoring occupancy and patterns of lighting use. The energy saving estimates can be used with the product cost information to conduct life cycle cost or payback analyses.

For example, consider a private office with a fluorescent lighting system that has active power of 500 watts (W) (or 0.5 kW). If the lamps are in use for 3000 hours (h) per year, the annual use is 1500 kilowatt hours (kWh), and if the energy cost per kWh is $0.10, the yearly energy cost is $150. If a monitoring device or a series of observations reveals that for 25 percent of the time, the space is unoccupied with lights left on, an occupancy sensor will yield $37.50 in annual energy savings (this assumes no time delay).

In addition to energy implications, occupancy sensors can also affect fluorescent lamp life. Occupancy sensors are likely to increase the frequency of switching of fluorescent lamps, which may shorten their lamp life. Lamp life ratings of fluorescent lamps are based on a 3 h lamp operating cycle. When the lamps are started more frequently, their operating life is reduced. However, occupancy sensors can actually decrease lamp replacement costs while reducing lamp life. Lamps may not have to be replaced as frequently because occupancy sensors will turn the lamps off, spreading the remaining lamp life over a longer period of time.

A4. Budget Breakdown

Simplified Budget Summary
(Source: District Budget Records 4-5-01)

District budget planned for 7-1-00 through 6-30-01

Line Item	Initial Budget	Revised Budget	Difference	% Un-encumbered
Natural Gas Services	$21,800	$41,320	$19,520	40.5
Electricity	$45,000	$45,000	$0	40.5

Notes:
1. Initial Budget- J5321- for period 7-1-00 to 12-31-00.
2. Revised Budget- J5327- for period 7-1-01 to 6-30-01.
3. % Un-encumbered (not spent) as of 4-5-01, under revised budget
4. According to Maureen at the District Office, difference came from Reserves

Sunset School budget planned for 7-1-00 through 6-30-01

Line Item	Initial Budget	Revised Budget	Difference	% Un-encumbered
Natural Gas Services	$6,800	$16,720	$9,920	41.0
Electricity	$19,000	$19,000	$0	53.9
Materials and Supplies	$77,751	$55,377	($22,374	65.6

Notes:
1. Initial Budget- J5315- for period 7-1-00 to 12-31-00.
2. Revised Budget- J5318- for period 7-1-01 to 6-30-01.
3. % Un-encumbered (not spent) as of 4-5-01, under revised budget
4. According to Maureen at the District Office, difference came from Reserves
5. Decrease in materials and supplies' budget should not be construed as related to energy expense budget. This decrease could be due to re-evaluation of Sunset School's needs in this area.

A5. Sunset School Observations

1=open Door	1=on Lights	Heat Actual	Heat Set	1=open Windows	1=open Curtain
0	1	67	X	0	1
1	1	69		0	1
1	1	67		0	1
0	0	71		0	1
0	0	70		0	1
1	0	68	X	0	1
1	1	68		0	1
0	0	68		0	1
0	0	68		0	1
0	1	68		0	1
1	1	61	X	0	1
1	1	69		0	1
1	1	69		0	1
1	1	68		0	1
1	1	68		0	1
1	1	68	X	0	0.5
1	1	67		0	1
0	1	67		0	1
1	1	68		0	1
0	0	65		0	1
1	1	59	X	0	1
0	1	68		0	1
1	1	67		0	1
0	1	71		0	1
0	0	67		0	1
1	1	CLOSED	X	0	1
1	1	70		0	1
0	0	74		0	1
0	0	71		0	1
0	0	67		0	1
0	0	69	X	0	1
0	0	68		0	1
0	0	68		0	1
0	0	68		0	1
0	0	63		0	1
0	1	70	X	0	1
0	0	70		0	1
0	1	70		0	1
0	1	70		0	1
0	0	68		0	1
0	1	70		0	1
0	1	68		0	1

Door	Lights	Heat	Heat	Windows	Curtains
		Actual	Set		
1	0	62		0	1
0	1	68		0	1
0	1	68		0	1
0	1	X		0	1
0	1	70		0	1
0	1	70		0	1
0	1	70		0	1
0	0	70		0	1
0	1	66		0	1
0	1	66		0	1
0	1	66		0	1
0	0	66		0	1
0	0	65		0	1
0	1	63		0	1
0	1	63		0	1
0	0	X		0	1
0	0	65		0	1
0	0	70		0	1
0	1	63		0	1
0	1	68		0	1
0	1	60		0	1
1	0	60		0	1
0	0	63		0	1
0	1	63		0	1
1	1	67		0	1
0	0.5	70		0	1
1	0.5	70		0	1
0	0	OFF		0	1
0	1	X		0	1
0	1	68		0	1
0	1	68		0	1
1	1	71		0	1
0	0	67		0	1
1	1	X		0	1
1	1	65		0	1
1	1	OFF		0	1
1	1	OFF		0	1
0	0	67		0	1
0	0	X		0	1
0	0	X		0	1
0	0	X		0	1
0	0	68		0	1
0	0	68		0	1
0	1	69		0	1

Door	Lights	Heat Actual	Heat Set	Windows	Curtains
0	1	OFF		0	1
1	1	OFF		0	1
0	0	OFF		0	1
1	1	68		0	1
0	1	69		0	1
0	1	68		0	1
1	0.5	68		0	1
1	1	68		0	1
0	0	67		0	1
0	1	X		0	1
0	1	71		0	1
1	0	68		0	1
1	1	68		0	1
0	0	68		0	1
X	X	X		0	1
0	1	67		0	1
1	0	67		0	1
0	0	67		0	1
0		67		0	1
X	X	X		0	1
0	1	68		0	1
1	0	X		0	1
0	1	71		0	1
0		70		0	1
1	1	N/A		0	N/A
1	1	N/A		0	N/A
1	1	N/A		0	N/A
1	1	N/A		0	N/A
1	1	N/A			
0	1	68/69	62	0	N/A
X	X	X		0	1
1	0	X		0	1
0	1	65		0	1
1	0.5	64		0	1
0	1	62		0	1
1		64		0	1

A6. Letter to Faculty (attached to survey)

Attention: All Interested Faculty

As you are already aware, we are a group of HSU students working on a general energy consumption/conservation assessment that we will present to the District School Board. We believe that you have a great deal of insight and knowledge about the Sunset School building and its environment, and would greatly appreciate any input that you would like to share with us on an informal and, post-meeting, strictly anonymous basis. We are distributing the surveys to get a sense of your experiences and perspectives, but we are limited to asking questions from an "outsider's" perspective. We feel that our recommendations to the Board could be greatly enhanced through individual comments and discussions that focus on your opinions and suggestions about energy consumption and conservation in *your* working environment. You can contact any of the group members at the following numbers to set up a time to meet either individually or in groups. Thank you for your time, and we look forward to meeting with you.

Jennifer Bies – e-mail: jab7@humboldt.edu / phone: 822-7123
Beverly Shaw – e-mail: bls14@humboldt.edu / phone: 822-3097
Todd Stephens – e-mail: tas29@humboldt.edu / phone: 822-1972
Sammie Baratta – e-mail: sbaratta@tidepool.com / phone: 822-9278

A7. Sunset School Energy Survey – Responses Included

Memorandum

To: Sunset School Faculty

From: Sammie Baratta, Jennifer Bies, Beverly Shaw, Todd Stephens

As students in Humboldt State University's Environmental Science Practicum class, we are administering the following survey. We would greatly appreciate your cooperation and input. The results of this survey will influence our recommendations for the most appropriate energy conservation measures at Sunset School. Please return the survey in the envelope provided, to the main office by Friday March 30th. Our intention is to retain anonymity at all costs. Please answer the following questions as candidly as possible. Do not write your name anywhere on the survey and if you are under 18, please do not participate in the survey.

Thanks for your time.

Section 1: Please answer the following questions on a scale of 1-10 (10 being highest)

1. How much do you value the practice of energy conservation?

   1 2 3 4 5 6 7 8 9 10

   8 = 6% **9** = 12% **10** = 82%

2. How often do you practice or apply energy conservation in your daily life?

   1 2 3 4 5 6 7 8 9 10

   7 = 6% **8** = 59% **9** = 12% **10** = 24%

3. How much do you value setting an example for your students that supports energy conservation?

   1 2 3 4 5 6 7 8 9 10

   8 = 20% **9** = 10% **10** = 70%

4. In general, how would you rate the level of student awareness regarding the current energy crisis?

1 2 3 4 5 6 7 8 9 10

1 = 10% **3** = 10% **4** = 10% **5** = 10% **6** = 30% **7** = 30% **8** = 10%

5. If you were able to see the cost increase of the energy bill for Sunset Elementary, how much would it affect your use of energy in the classroom?

1 2 3 4 5 6 7 8 9 10

5 = 10 % **6** = 10% **7** = 10% **8** = 10% **9** = 10% **10** = 50%

- But I have always been aware of conserving energy.

6. How would you rank your support of the following potential energy conservation measures?

a.) Preset timing cycles for heaters:

1 2 3 4 5 6 7 8 9 10

8 = 20 % **9** = 10% **10** = 60%

- As long as we had an input into what the timing was.
- Half the time they don't need to be on.
- We have this now.

b.) Motion sensitive lighting:

1 2 3 4 5 6 7 8 9 10

1 = 30% **5** = 10% **6** = 10% **7** = 10% **8** = 20% **10** = 20%

- Difficult when parent conferencing or sitting after school.
- Been there, done that, again, I'm better at turning off when it's necessary & when I'm ready.
- [re: 6b and 6c] Are these real solutions for what we have in place?
- I like to have my lights off while children are in the classroom- i.e., quiet time, change mood, for videos, overhead, etc. I like to have control over lighting!

c.) Automatically closing doors?

1 2 3 4 5 6 7 8 9 10

1 = 20% **2** = 10% **3** = 10% **5** = 10% **8** = 10% **10** = 50%

- I like to control my <u>own doors</u>!
- The doors at the end of the inside hallway are permanently open- just because no one has seen fit to fix them so that the students themselves can enter and exit.
- Don't know what these are- or are they what we already have?

d) Do you have any other technological suggestions that could conserve energy?

- New double-paned insulated windows
- Lower ceilings in classrooms
- Design a whole "conservation network", that includes water conservation, waste reduction etc. Would make the whole school take on responsibilities individually. Education and conservation in the forefront create an "ambiance" of awareness, that is contagious.
- Use solar energy.
- Insulate windows – remodeling in 2 years!

Section 2:

7. How often do you have the heater on with the door or windows open?

Everyday of the week Every 2-3 days One day per week Never

every day = 38% 2-3 days = 38% 1 day = 13% never = 13%

- [the heater] comes on when not needed- temp. set too high
- I would turn it [the heater] off if I had access.
- Briefly entering & exiting class- then we close the door.

8. On average how many hours do you work after school, which **must** take place *in the classroom*?

Average = 1.8 hours

9. What is the average temperature setting on the thermostat in your classroom?

Average = 67.2°F

10. Do you have any suggestions for behavioral changes that would increase energy conservation?
    - Have discussions in classrooms showing how much energy even 1 light bulb uses when in use.
    - Heaters are slow to respond, inefficient gas blowers, loud noises, too hot – too cold.
    - Education
    - Constant reminders – in writing on bulletin board, in mailboxes. Have someone stop by rooms and comment on conservation or lack of.
    - Have people come in and close the door when they are "visiting" in the office.
    - Some basic keeping doors closed would help- much better windows & insulation would help. Behavioral? Don't know.

11. Do you see a direct correlation between rising energy bills and decreased available funds for the classroom?
    - Not yet… but I suspect this will be coming soon!
    - We have always had *decreased* funds for classroom since I started teaching.
    - Yes (times 4)

- We will soon enough.
- No- but I'm sure this will be taken into account in the future. Public schools have always had to fight for money!
- No.
- Sure.
- Not yet.
- Yes.
- Not yet.

A8. Bright Schools Brochure

ENERGY-EFFICIENT SCHOOLS FOR A BRIGHTER FUTURE

MOST SCHOOLS SPEND MORE MONEY ON ENERGY EACH YEAR THAN ON SCHOOL SUPPLIES

But yours doesn't need to. You can lower your school's energy bills using off-the-shelf, energy-efficient lighting and HVAC systems. Energy-efficient equipment reduces annual maintenance costs and can conserve finite resources and improve air quality. Many administrators have said that our recommendations and assistance led to better learning environments and increased test scores. And savings from these systems are proven - typically reducing annual utility bills an average of 20 percent. Just imagine where you could spend those savings.

The Bright Schools Program Can Help!
Whether you are building a new school, modernizing an existing one or just wondering how your school can save on energy bills, the Bright Schools Program can help. This California Energy Commission program offers specific services to help you become more energy wise, such as identifying cost-effective energy-efficient systems to meet your needs and providing design and implementation assistance -- at little or no cost to you.

New School Construction
Schools built with energy-efficient designs will cost less to operate, offering continuous savings and leaving more money for education. Many new schools incorporate equipment and building measures that barely meet recommended energy-efficiency standards. However, many of these designs could be improved with little or no additional expense. Bright Schools provides technical assistance early in the design phase, before the plans are solidified. The savings accumulate from the first day of operation! For new school construction, Bright Schools can:

- Provide design consultation
- Identify cost-effective energy-saving measures
- Compare different technologies
- Develop specifications for energy-efficient equipment
- Help select architects and other design professionals with school construction and energy-efficiency expertise
- Review construction plans
- Complete value engineering of specific energy-efficiency measures

Maintenance and Energy Audits
Bright Schools can help you get the most from your modernization and maintenance investments. With an evaluation of your five-year deferred maintenance plans or an energy audit of you facilities, you could identify energy-related projects that should be implemented immediately as part of a comprehensive Bright Schools energy package. Schools planning major renovations can benefit from our technical assistance. The program can also help you get loans to obtain the matching funds required by some State programs. For school modernization and deferred maintenance efforts, Bright Schools can:

- Conduct energy audits and feasibility studies
- Review existing proposals and designs
- Provide equipment bid specifications
- Assist with contractor selection
- Assist with installations

How much does Bright Schools Technical Assistance cost?
The Bright Schools Program provides technical assistance at no cost to the school district. If requests exceed our budgeted funds, however, we reserve the right to limit the number of schools receiving assistance within any school district or organization, or to require a sharing of the assistance cost.

Bright Schools Collaborates with Key State Programs
Our staff works closely with the Office of Public School Construction, the Division of the State Architect, and the California Department of Education to ensure that recommended projects meet program eligibility requirements. We can help you secure low-interest loans to provide all or a portion of the funds you need for your energy-related deferred maintenance project, or to match modernization funding from other State programs.

Download Brochure
Bright Schools Brochure is available in Adobe Portable Document Format (PDF). For more information about PDF files or to download Acrobat Reader, please visit Adobe's Web site at www.adobe.com.

A9. Green Schools Program

Green Schools

Using Energy Efficiency to Strengthen Schools

Getting Started...

It's easy to start and maintain a Green School in your community. The Alliance to Save Energy and your community partners can help tailor the program to your school's particular needs. First, consider the following steps:

Step 1. Identify a Green Schools "champion" who knows the school system well and can provide the vision and initial drive to get the program started. The champion finds internal support for the program, identifies and convenes partners, promotes activities, and troubleshoots problems.

Step 2. Establish a Green Schools team within the school building. Involving students, teachers, principals, custodians, and even parents will enhance the program's reach and effectiveness.

Step 3. Build partnerships within your school and with local organizations and businesses. These partnerships can be a great source of technical, educational, and financial resources.

Step 4. Adapt the project to your school's priorities and curriculum. Making the program "your own" will help energy efficiency become a regular part of your school's culture and will likely result in greater long-term savings.

Step 5. Identify curriculum tie-ins. There are many ways that the Green Schools program can support your school's curriculum. It focuses on education through hands-on experience--key concepts tie in with science, math, social studies, and economics curricula.

Step 6. Develop an agreement with the school district administration to return a percentage of savings to the individual schools that achieved them, to involve both facilities and instructional staff, and to establish their criteria for energy efficient retrofits.

Step 7. Establish a strong link between energy and the environment. Protection of the environment is a strong motivator. The project helps students and adults understand that more than 80% of pollution results from the production, consumption, and disposal of energy-and that actions they take really do make a difference.

Step 8. Establish a baseline of energy use, which makes it possible to measure the project's success and to identify problem areas.

Step 9. Determine the need for retrofits. Consider what new equipment and/or energy-efficient technology your school might need. Before recommending the purchase of new equipment, be sure to identify the criteria that decisionmakers need in order to invest in new equipment, such as payback period and legally mandated requirements.

Step 10. Maintain high visibility for the program to encourage participation. The program is most successful when the whole school and others in the district are involved. An effective strategy is to communicate plans and achievements with key stakeholders in the school community.

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Where to Get Help

The Alliance to Save Energy

The Alliance provides the following materials to Green Schools participants free of charge.

- Green Schools *Key Learning Concepts* outlines specific theoretical and applied educational objectives that can be incorporated into your school's curriculum
- *Annotated Bibliography of Green Schools Instructional Resources* lists materials that support the teaching of key learning concepts and provides a brief summary of classroom lessons on energy, efficiency, and the environment
- Curriculum materials

The Alliance can also facilitate the partnership-building process, conduct workshops for Green Schools teams, and provide ideas for funding building retrofits. If you are ready to make the next step, fill out the online Green Schools form and a Green Schools staff person will contact you.

A10. Financing for Energy Efficiency Brochure & Application

Who is Eligible?

- **Schools**
- **Hospitals**
- **Cities**
- **Counties**
- **Special Districts**
- **Public Care Institutions**

What Types of Projects are Eligible?

Purchase and installation of commercially available energy efficient equipment with proven energy savings, including but not limited to:

- **Lighting**
- **Motors and pumps**
- **Heating and air conditioning systems**
- **Automated energy management systems and controls**
- **Cogeneration equipment**
- **Streetlights**
- **Traffic signal lamps**

What Types of Facilities are Eligible?

Existing buildings or other energy using facilities. Some new buildings and facilities. Call to discuss eligibility.

How Much Is Available?

Loans can finance up to 100 percent of the costs of energy efficiency projects. A 25 percent match may be required for cities and counties. Call to check on funding availability.

Criteria For Loan Approval

Energy efficiency projects must be technically and economically feasible. Loans must be repaid from savings within 11 years, including principal and interest. Call to determine the maximum simple payback required for project eligibility.

$$\text{Simple Payback (yrs)} = \frac{\text{Amount of Loan (\$)}}{\text{Anticipated Annual Energy Cost Savings (\$/yr)}}$$

Interest Rates

Rates offered are extremely competitive and set periodically according to state procedures. Call to check on applicable interest rate.

Loan Security Requirements

For public entities, loans are secured by a promissory note and a loan agreement between the applicant and the Energy Commission.

Nonprofit organizations may be required to secure the loan through sufficient assets, a deed of trust, certificate of deposit, or other means as determined by the Energy Commission.

Repayment Terms

The repayment schedule is based on the annual projected energy cost savings from the aggregated project(s), using energy costs and operating schedules at the time of loan approval. In some cases, the loan repayment schedule can be extended up to 11 years.

Applicants will be billed twice a year after the projects are completed.

How Will Funds Be Disbursed?

The funds are available on a reimbursement basis. Receipts or invoices for expenses incurred must be submitted with each reimbursement request. In some cases, purchase orders for equipment or sevices may be accepted in lieu of actual receipts. The final 10 percent of the funds will be retained until the project is completed. Interest is charged on the unpaid principal computed from the date of each disbursement to the borrower.

Call the Energy Commission at (916) 654-4008
for information on funding availability, project eligibility
and application requirements.

The Application

Call the Energy Commission to Discuss Eligibility (916) 654-4008

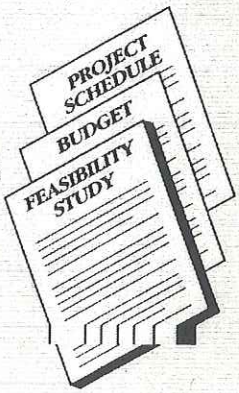
How Do I Apply?

First, call the Energy Commission to discuss your project.

Next, complete the enclosed loan application, and provide:

- A feasibility study that describes the proposed energy efficiency projects, including calculations and assumptions to support the technical feasibility and energy savings
- A proposed budget detailing all project costs
- A schedule for implementation of the recommended projects
- An original or certified copy of a signed resolution from your governing board authorizing the application for the loan and authority to undertake the project

Fill out the enclosed Loan Application



Attach to Loan Application

When Should I Submit My Application?

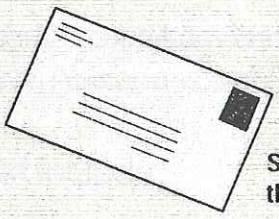
This is a continuously open program with no final filing date. Applications for funding will be accepted on a first come, first served continuous basis, reviewed by a technical review committee, scored, and awarded based on project merit. The Energy Commission reserves the right to close the solicitation period at any time.

Obtain Authorization

Where Do I Submit My Application?

Send your complete application package to:

California Energy Commission
Nonresidential Buildings Office
1516 Ninth Street, MS 26
Sacramento, CA 95814



Send Your Application to the Energy Commission

Energy Commission staff will review your application and contact you within 15 days. It may be necessary to arrange a site visit to discuss your project and loan request. Final approval occurs at an Energy Commission business meeting.

Approval from the Energy Commission

Call the Energy Commission to Discuss Eligibility (916) 654-4008

APPLICATION FOR ENERGY COMMISSION FINANCING

Applicant _____

Mailing Address _____ City _____ Zip _____

Street Address _____ City _____ Zip _____

To the best of my knowledge and belief, data in this application are correct and complete.

Contact Person _____ Signature _____

Title _____ Date _____

Phone Number ( ) _____ Fax Number ( ) _____ E-Mail _____

Total project costs (include all installation costs) _____

Amount requested from the Energy Commission _____

Tentative project start date _____

Tentative project completion date _____

Please include in your application package:

1. A resolution from your governing board (see sample enclosed)
2. A feasibility study for your project (see below)
3. IRS Letter of Determination (private nonprofit organizations, only)
4. A copy of most recent financial statement audit covering a 12-month period (private nonprofit organizations, only)

A Feasibility Study for your Project must include:

1. A description of your energy project.
2. An estimate of annual savings (dollars and kilowatt-hours or therms) and include all assumptions used in your calculations.
3. A proposed budget detailing project costs.
4. For all power generation projects, describe the schedule and status of any air quality permit requirements/applications.
5. A discussion of any costs associated with asbestos removal or demolition and removal of existing equipment required before the energy project can be installed.

RESOLUTION NO._____

Resolution of _____
(INSTITUTION OR ORGANIZATION)

WHEREAS, the California Energy Commission provides loans to schools, hospitals, local governments, special districts and public care institutions to finance energy efficiency improvements;

NOW THEREFORE, BE IT RESOLVED, that _____ authorizes
(GOVERNING BODY)
_____ to apply for an energy efficiency loan from the California
(INSTITUTION OR ORGANIZATION)
Energy Commission to implement energy efficiency measures.

BE IT ALSO RESOLVED, that if recommended for funding by the California Energy Commission, the _____ authorizes
(GOVERNING BODY)
_____ to accept a loan up to $ _____.
(INSTITUTION OR ORGANIZATION) (LOAN AMOUNT REQUESTED)

BE IT ALSO RESOLVED, that the amount of the loan will be paid in full, plus interest, under the terms and conditions of the Loan Agreement and Promissory Note of the California Energy Commission.

BE IT FURTHER RESOLVED, that _____ is hereby
(TITLE OF AUTHORIZED OFFICIAL)
authorized and empowered to execute in the name of _____,
(INSTITUTION OR ORGANIZATION)
all necessary documents to implement and carry out the purpose of this resolution, and to undertake all actions necessary to undertake and complete the energy efficiency projects.

Passed, Approved and Adopted this _____ day of _____, _____.
MONTH YEAR

AUTHORIZED REPRESENTATIVE:

_____
(SIGNATURE)

_____
(TYPE NAME AND TITLE)

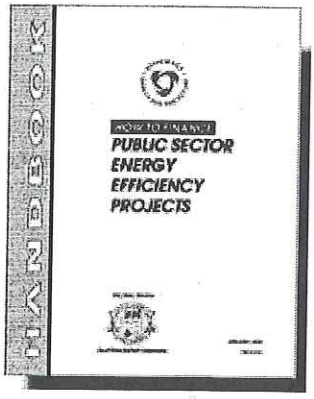
A11. California Energy Commission Handbook

Handbooks For Energy Efficiency

The following documents are available as an Adobe Acrobat Portable Document Format (PDF) file. In order to download, navigate and print these files, you will need the **free** Acrobat Reader software installed in and configured for your computer. You can get the software from Adobe Systems Incorporated's Web site.

You can also order these documents from the Commission's Nonresidential Buildings Office by calling 916-654-4008.

Directions: Download an Acrobat PDF version of each of the handbooks by clicking on its hyperlink.



How to Finance Public Sector Energy Efficiency Projects

Publication Number: 400-00-001A
January 2000
(60 pages, 512 kilobytes)

Description: Many organizations see the lack of funds as a major barrier to energy efficiency projects. Our research indicates that there are many project funding sources. In many cases, the funding can be structured so that the projects can be repaid from energy savings, negating the need for up-front capital and eliminating lack of capital as a project barrier.

This guide addresses the special needs of public sector agencies such as city and county governments, public school districts, hospitals, and special districts, such as water and wastewater treatment districts. It discusses the criteria for evaluating the cost-effectiveness of energy efficiency projects, the various financing options, and financing programs specific to public sector agencies.

A12. Group Hours - Breakdown

Total Hours For Project =	186.25

Research

Beverly	11.5
Jen	8.75
Todd	2.5
Sammie	9
Group x 4	0
Total	**31.75**

Writing-includes Powerpoint

Beverly	9
Jen	3
Todd	8
Sammie	9.25
Group x2	6
Group x3	9
Group x4	36
Total	**80.25**

Networking- includes phone calls, e-mails and meetings

Beverly	1
Jen	3.75
Todd	4.75
Sammie	2.75
Group x 4	10
Total	**22.25**

Formatting- includes editing and proof-reading

Jen	20
Todd	3
Beverly	1
Sammie	1
Total	**25**

On site evaluations- includes field work

Beverly	1
Jen	2.5
Todd	4
Sammie	3.5
Group x2	4
Group x3	0
Group x4	12
Total	**27**

May 14, 2001

Issue 1

Sunset School Energy Conservation Newsletter

As you may have noticed there is an active participation in Energy Conservation throughout the United States. Sunset School is one of these participants. Humboldt State University Environmental Science students conducted a written survey and analysis of the physical conditions at Sunset. The type of audit performed was a Walk-Through Energy Audit. This type of Audit is a visual survey, which collects information on a broad, general scale to lay the foundation for a more detailed study in the next stage.

First of all, thank you to those who participated in the survey. The survey results indicate that the staff and faculty at Sunset School highly value energy conservation and that they practice energy conservation in their daily lives. All of the respondents of the survey highly ranked timing cycles for heaters, as long as they are able to have some input about the setting of the heaters. About half of you support motion sensored lighting and the other half do not. The reason for the mixed ranking of this energy conservation measure seems to be about having control over whether the lights are on or off. It should be noted that it is possible to have motion sensored lighting installed while retaining the option for human control.

The majority of the respondents admitted that they have the doors open while the heater is on at least 2-3 days during the week. The average reported temperature setting in the classroom is 67.2°F (this average is consistent with what the HSU students observed). The reason the doors are open with the heater on may be due to a mixture of high temperature settings and inefficient heaters that are shared by two rooms.

About half of the respondents see a direct correlation between rising energy bills and decreased available funds for the classroom, while the other half does not. While it is true that public schools have always had funding problems for the classrooms, the current energy crisis is not helping the situation. Besides the negative environmental impacts of energy use, another major reason to conserve energy is that doing so will save money for the school district and Sunset. What follows is a summary of budgetary allocations at Sunset School for 2000-2001.

At Sunset School, for the period between July 1, 2000 and June 30, 2001, $6,800 was allocated for natural gas services. After December 2000- when natural gas prices increased, the budget increased to $16,720. That is about 2.5 times the originally budgeted amount. As of April 5, 2001, sixty percent of those funds had been spent.

The extra money for natural gas came out of district reserves. While the electricity budget remained constant, the California Public Utilities Commission (CPUC) is considering a 40 percent price increase. Due to power plants being offline for maintenance, the supply of electricity in California in the near future will be tight. Currently, the State is importing power from as far away as Canada, but those sources may "dry up" as the summer heats up, causing more demand in the West.

Ultimately, the money that the district uses to pay for utilities comes out of local taxpayers' pockets. The more money spent on utilities, means less goes to the students. Even though the money used to make up for natural gas prices came out of reserves this year, it comes out of

the same pocket that pays everything school related; from field trips to bus service to the faculty and administrators' salaries. Conserving as much energy as possible is a sure route to conserving money.

Sunset School was built in such a way that the orientation of its windows is to the north. These windows take up most of the north facing walls. This is a fine design for Southern California, where it tends to be warm most of the year. However, in Arcata this is bad design due to the colder climate. North facing windows lose heat at a very fast rate compared to south facing windows. When the sun is shining, south facing windows actually transmit heat energy from the sun's rays, warming the interior rooms. Sunset School has no south facing windows. In fact, the overhangs that line the entire expanse of the south facing walls actually block all direct warming from the sun, shading the south side of the buildings continuously throughout the day. This arrangement creates a "double whammy" with no heat gain from the south, combined with substantial, constant heat loss throughout the windows along the entire north wall of the buildings.

Arcata School District currently has plans to replace these windows with double paned windows, which will cut heat loss approximately by half. This is only a start. If curtains were shut at the end of the day, heat loss would occur slower over night, decreasing demand on heaters in the morning. Currently curtains are constantly open in classrooms. This allows teachers more space for materials and projects along the ledges. However shorter curtains could allow for extra curriculum space, while still conserving heat. This compromise would work only if curtains were shut at the end of the instructional days and on particularly cold days. It is solutions such as this that will help the school conserve energy.

The average school uses 40-80% of their energy for environmental control (i.e. Heating). Behavior modifications are quick and simple solutions to reduce this high energy consumption component. The following is what you can do to help Sunset School be energy efficient.

<u>During school hours</u>

- Keep the doors and windows closed when the heater is on.
- Bring extra layers of clothing, and encourage students to do the same.
- Maintain an awareness of a more appropriate temperature setting for the thermostats in each classroom (65°-68° F).
- Turn off electrical appliances (computers, radios etc) when not in use, or better yet, unplug them to prevent phantom load electricity demands.

<u>After school hours</u>

- Close the curtains before you leave the classroom for the night.
- Take phantom load prevention measures (unplug electrical appliances at the end of the day).
- Consider using a common workspace (faculty room) after-hours to concentrate energy consumption in one area of the school.
- Turn down the thermostat setting to 50°- 55° F before you leave the classroom for the night.

These behavioral modifications can have an immediate influence on energy conservation measures at Sunset School, and should be supported by both faculty and custodial staff alike. Setting an example for the children can also increase their awareness of energy conservation, an essential perspective to extend to children, given the likelihood of ever-increasing energy shortages and subsequently, prices as well.

The HSU Environmental Science students' objective is to present findings from the Walk-Through Energy Audit to the Board of Directors of Arcata School District on May 14th 2001, 7:00 p.m. using Sunset School as a case study, on ways to reduce their energy consumption. There is a document about the findings on Sunset's Walk Through Audit available at the district office. Included in the document is a list of potential funding sources for energy conservation measures. If anyone would like to follow up on these sources, please contact the district office. Thank you for your time and *energy* (ha-ha). Best of luck making your school an Energy Smart School!!!!!!!!!!!!!