

ENERGY CONSERVATION AND AMERICAN SCHOOLS

By

Andrew C.K. Elston

Advised by

William Preston

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Senior Project

Social Sciences Department

College of Liberal Arts

CALIFORNIA POLYTECHNIC STATE UNIVERSITY

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Table of Contents

1	Title Page
2	Table of Contents
3	Research Proposal
4-9	Annotated Bibliography
10	Outline
11-36	Text
37-38	Bibliography

Research Proposal

The research area I have chosen to study is energy use in the United States, more specifically the energy used in American schools where I plan on evaluating schools in the Lucia Mar Unified School District located on California Central Coast. The object of this study will be to identify areas of high energy use in schools that could be mitigated or countered by more energy efficient practices or renewable energy sources like solar PV.

Methods to offset energy use have already begun on a small scale in Lucia Mar at the Oceano Elementary School. A teacher named Jim DeCecco has taken it upon himself to start recycling and composting programs and has set up a 1KW solar array to educate students about the benefits of solar PV. I plan on interviewing DeCecco to find out what sort of programs he has in mind for the future and if these methods could be adopted on a wider scale to encompass possibly all of Lucia Mar.

At Nipomo High School, where I graduated from in 2007, they are currently the least energy efficient school in the entire district because it relies almost entirely on portable classrooms with their own AC units. I also plan on meeting with Mr. Olejczek of Nipomo High who was recently awarded a \$10,000 PG&E Energy Grant to build a mobile green classroom, similar to the solar house at Cal Poly. In addition, with the help of Lucia Mar's Sustainability Coordinator Erin English, I plan on examining the current district-wide energy budget and what she plans for the future of Lucia Mar. I would also like to know what she thinks can be done now to offset energy intensive uses around the school, primarily stadium lighting and classroom heating/cooling. With this information, hopefully a more environmentally friendly and forward thinking approach to energy use will be adopted on a larger scale in our school districts.

Annotated Bibliography

"America's Schools Use Wind Energy to Further Their Goals." National Renewable Energy Laboratory, Aug. 2004. Web. 2 March 2012. <<http://www.nrel.gov/docs/fy04osti/35512.pdf>>.

This article covered the implementation of wind turbines throughout school districts in states situated along the wind belt. It will be helpful information for my project because it covers costs and payback period for wind power, showing how feasible it can be for certain areas that fit the right conditions.

"California's Smart Grid." *Smart Grid*. California Public Utilities Commission, 19 Apr. 2012. Web. 3 May 2012. <<http://www.cpuc.ca.gov/PUC/energy/smartgrid.htm>>.

This report issued by the California Public Utilities Commission gives an overview of the smart grid and what it can do in terms of savings for the state. It also gives a brief history of the aging electrical infrastructure that exists in California today. It will be helpful for my project because it gives further proof as to why our 100+ year old transmission system desperately needs upgrading.

DeCecco, Jim. "Oceano Elementary School Energy Use." Personal interview. 3 May 2012. Detailed personal interview with 5th grade teacher Jim DeCecco of Oceano Elementary School regarding ways to implement energy conservation among his students and discussion of the existing programs at the school. This will be beneficial to my project because it is valuable first hand knowledge that is essential to better understand energy use in the school district.

Fernandez, Thomas. "Colorado Springs School District 11 – Achieving Healthy Indoor Learning Environments Through Energy Efficiency Upgrades." Web. 27 Jan. 2012.

<[http://www.energystar.gov/ia/business/k12_schools/ENERGY_STAR_Case_Study-](http://www.energystar.gov/ia/business/k12_schools/ENERGY_STAR_Case_Study-Achieving_Healthy_Indoor_Environments_CG0807.pdf?cd02-8eb0)

[Achieving_Healthy_Indoor_Environments_CG0807.pdf?cd02-8eb0](http://www.energystar.gov/ia/business/k12_schools/ENERGY_STAR_Case_Study-Achieving_Healthy_Indoor_Environments_CG0807.pdf?cd02-8eb0)>. In this case study from

Colorado, Fernandez covers the amount of savings gained by performing simple energy efficiency upgrades throughout Colorado's school districts. Through HVAC upgrades and sustainable design

practices, Fernandez explains that better air quality and student health was achieved while simultaneously saving nearly a million dollars in energy savings per year. This data will be useful to my project because it covers the health benefits experienced by students in the school district, as well as the financial savings from retrofitting their HVAC systems.

Graunke, Ryan, and Ann C. Wilkie. "Diverting Food Waste for Bioenergy." University of Florida Soil and Water Science, 9 Aug. 2011. Web. 1 Feb. 2012.

<http://www.sebioenergy.org/2011/speakers/Graunke.pdf>. Graunke details the amount of food waste that is produced in the US and how this waste can be converted into useful bioenergy. He also explains how anaerobic digesters can be implemented safely and with minimal cost to produce clean biogas and biofertilizer. This analysis will be helpful to my project because it includes useful information regarding biofuels and composting techniques that can be applied to the business sector as well as to schools.

Gurley, Robin, William Hussar, Val Plisko, and Marilyn Seastrom. "Effects of Energy Needs and Expenditures on U.S. Public Schools." *National Center for Education Statistics (NCES)*. 18 June 2003. Web. 01 Feb. 2012. <http://nces.ed.gov/surveys/frss/publications/2003018/>. This report includes detailed information regarding cost per student for school districts which have carried out energy efficient retrofitting versus school districts that took no action. The authors also concluded that nearly all of the schools that experienced an energy budget shortfall attributed it to increases in the cost per unit of energy. This information will be useful to my project because it shows a correlation between rising energy costs and budget woes throughout US school districts, further reinforcing the practicality of retrofitting or implementing energy efficient building in school design.

English, Erin. "LMUSD Energy Use." Personal interview. 3 May 2012.

Detailed personal interview with LMUSD Energy Coordinator Erin English regarding ways to implement energy conservation throughout the school district and discussion of the existing programs at the school and their costs. This will be beneficial to my project because it is valuable first hand

knowledge that is essential to better understand energy use in the school district.

Ivey, Kristyn, Larry Schoff, and Carolyn Sarno. "Guide to Maintaining and Operating Energy Smart Schools." *US Department of Energy: Energy Efficiency & Renewable Energy*. National School Boards Association. Web. 3 Feb. 2012.

http://apps1.eere.energy.gov/buildings/publications/pdfs/energysmartschools/ess_o-and-m_guide.pdf. This guide provides information intended for school district management and administrators that allows them to address specific energy efficiency goals and integrate strategies into new and existing energy policies. The guide primarily focuses on cost-benefit analysis, however it also includes energy saving strategies that can be employed by teaching staff and custodial workers to provide immediate savings. This information will be helpful to my project because it focuses on what can be done at the administration level as well as on-campus changes that can be adopted to offset wasted energy.

Kats, Gregory. "Greening America's Schools Costs and Benefits." (2006): 1-26. The US Green Building Council, Oct. 2006. Web. 1 Feb. 2012. [http://www.usgbc.org/ShowFile.aspx?](http://www.usgbc.org/ShowFile.aspx?DocumentID=2908)

[DocumentID=2908](http://www.usgbc.org/ShowFile.aspx?DocumentID=2908)>. Kats analyzes the lasting benefits of building green schools, including financial benefits, energy and water costs, teacher retention, and lowered health costs. An analysis of 30 schools is included and provides a compelling argument for green building and design. Kats' findings will be helpful to my project because it includes sociological benefits of energy efficient school design as well as information regarding the financial benefits of green building.

Rylander, Carole K. "Energy-Efficient Education Cutting Energy Costs in Schools." Texas School Performance Review. Web. 27 Jan. 2012.

http://www.lbb.state.tx.us/Perf_Rvw_PubEd/Other/Energy_Efficient/Energy_Efficient.pdf>.

Rylander details an energy policy that will be implemented in Texas school districts as well as on individual campuses, catering to each school's specific needs, location, and design. She demonstrates that every school is different and should have input from each staff member to identify problem areas

to allocate funds better, such as deciding whether or not a retrofitting or complete remodel is required. This work will be helpful to my project because it demonstrates a unique approach to outfitting each school in order to be more energy efficient instead of a broad policy change that is applied to every school in the state.

Souza, Pauline, and Erin English. "Local Leaders in Sustainability: Greening Schools From The Inside and Across Boundaries." 1-104. Web. 3 Feb. 2012. <http://www.green-technology.org/gccccollege-gcschools/images/Local_Leaders_In_Sustainability_1.pdf>. This report covers planned and future sustainability initiatives that have been proposed for the Lucia Mar Unified School District. The information provided in this report will prove very useful to my project because it was written by Erin English, the Sustainability Coordinator for LMUSD with whom I will be working with towards the end of my project when I turn my focus to Nipomo High School.

"Smart Grid Annual Report." *California's Smart Grid*. California Public Utilities Commission, Dec. 2011. Web. 1 May 2012. <<http://www.cpuc.ca.gov/NR/ronlyres/3B475B48-58CF-4541-9ACE-2EEA7B374336/0/SmartGridAnnualReporttotheGovernorandtheLegislature.pdf>>.

This report gives a run down of what the future goals are for the California smart grid, as well as its weaknesses pointed out by opponents. It will help my project because it shows both sides of the argument for and against a unified smart grid system in California.

"Sustainable Schools - Energy Incentives." *State of California - Energy Incentives*. California Department of General Services, 10 Apr. 2008. Web. 7 March 2012. <<http://www.sustainableschools.dgs.ca.gov/SustainableSchools/financing/energy.html>>.

This article cites the many financial incentives that are in place in California by public utility companies to help boost the renewable energy market. It will be beneficial to my project because it shows the availability of loans and grants and the amount matched by energy companies when retrofitting takes place.

USA. Department of Energy. Office of Building Technology. *Energy Design Guidelines for High Performance Schools*. By Mark Ginsberg, Daniel Sze, and Lani MacRae. 12 Mar. 2011. Web. Feb. 2012. <<http://www.nrel.gov/docs/fy02osti/29105.pdf>>. Various national laboratories and sustainable building industry leaders examine cost efficient applications of natural lighting, renewable energy, and energy-efficient building designs adopted in US schools. They also provide case studies that examine long and short term financial and energy savings. This will be beneficial to my project because it provides concrete examples of schools that have made energy conscious alterations that have reduced energy demand as well as cost.

"Waste Reduction and Energy Conservation in Schools." *Http://www.wratt.org*. Waste Reduction and Technology Transfer Foundation, Mar. 2003. Web. 1 Feb. 2012. <<http://www.wratt.org/pubs/school.pdf>>. This publication details ways to promote energy saving practices in schools and incentive methods. For example, schools with higher savings could allocate energy money that is saved for other school uses. It also focuses on shifting electrical loads and demand during peak hours by having machinery cycle on at different times of the day instead of all at once. While this work does not cover complete upgrades or large scale changes, it does have good information on small scale upgrades and changes that can be implemented at very low cost and have almost immediate savings. This data will help my project because it incorporates very low cost and small scale upgrades that can be used in school districts that experience underfunding or those that cannot afford to make larger changes at this time.

Whitaker, Roy. "How Seaford School District Met the Mark for Energy Efficiency." *Energystar.gov*. Web. 27 Jan. 2012. <http://www.energystar.gov/ia/business/k12_schools/ENERGY_STAR_Case_Study-How_to_Meet_the_Mark_for_Energy_Efficiency_CG0807.pdf?cd02-8eb0>. This case study examines the energy saving practices that were implemented in the Seaford School District in Delaware which ended up saving them over 8 billion kBtus of energy per year. Whitaker explains that through the

support from various tax credits, the school board, tax payers, and staff members, their school district was able to offset the CO2 emissions produced by over 50 homes per year. This work will be useful to my project because it provides an East Coast case study that examines not only the financial means necessary to reduce a school's carbon footprint, but also the social and community input involved in making this change.

Outline

I. Introduction

A. Energy Use of the United States

B. Energy Use of California

II. American Schools

A. Need For Conservation

B. Government Incentives

C. Case Studies

III. Lucia Mar School District

A. Nipomo High School

B. Challenges

C. Oceano Elementary School

IV. Summary and Conclusion

I. Introduction

Energy use in the United States is increasing at an alarming rate; today's scarcity of fossil fuels combined with ever increasing fuel prices is a clear sign that a large scale move towards renewable energy will be inevitable. The benefits that can be gained from this switch to renewable sources of energy would be enormous including improved air quality and respiratory health, decreased dependence on foreign oil, and an increase in domestic jobs. Additionally, it would be a logical investment in the safety of our environment and allow future generations to work with instead of against it.

American schools would benefit highly from the implementation of renewable resources and energy conservation practices. Educating students about the importance of conservation and renewable energy while showing them these benefits first hand is key in establishing a low impact lifestyle. Teaching students at an early age simple ways to offset wasted energy and to conserve whenever possible will help lay the foundation for a more sustainable future. By implementing environmentally friendly ways to generate, store, and conserve energy at school while demonstrating these benefits to students, we will be able to lower energy loads and at the same time gear younger generations towards more sustainable energy practices.

In the Lucia Mar School District, Nipomo High School is the least energy efficient school in the entire district. However with a newly appointed, progressively geared Sustainability Coordinator and numerous faculty who are addressing these energy woes on their own accord, NHS is a prime candidate for implementing sustainable energy sources on a large scale. With financial aid in the form of a grant from PG&E and technical assistance from enthusiastic teachers, it is my hope that NHS will promote the use of cost efficient and low-demand energy upgrades and pave the way for the rest of the schools in the district to do the same.

A. Energy Use in the United States

The United States may be the most powerful nation in the world but it is also the most resource hungry, consuming roughly 25 percent of the world's energy for less than 5 percent of its population. The average amount of energy used per person in the US is staggering, the Energy Information Administration estimates the average American consumes as much energy as is stored in seven gallons of gasoline, daily. The EIA breaks down U.S. energy consumption by sector (see figure 1 to better illustrates these figures), with industrial taking up 30 percent, transportation 29 percent, residential 22 percent, and commercial consuming 19 percent (Energy Consumption, 2011).

When it comes to electrical energy the US consumes a massive amount but recently has been narrowly surpassed as the top producer and consumer by China. Still our nation consumes nearly 20 percent of the world's entire supply of electricity, with total annual energy consumption of 4,151 billion kilowatt hours (California's Smart Grid, 2012). Annual energy consumption for the average American is unnecessarily high, our extravagant lifestyles and energy inefficient practices that have become commonplace for most has made a huge impact on our energy demands. Large sized sports utility vehicles with sub-par fuel efficiency, standardized electrical prices that do not reflect energy load, and incandescent bulbs that are as efficient now as they were in 1879 (14 lumens per watt, ~10% lighting efficiency) are just a few examples of energy that is wasted on a day to day basis that can be remedied at very minimal cost (California's Smart Grid, 2012). Conservation efforts such as turning off lighting/heating/cooling when not in use or upgrading a bulb that consumes less energy and emits more lumens per watt (CFL and LED lights emit 66 lumens/watt, T8 Fluorescent average 92 lumens/watt) are ways to reduce the US energy load cheaply and efficiently, but for many Americans is considered an inconvenience and is therefore ignored.

B. Energy Use in California

There have been proposals to mitigate wasted energy in the private sector by introducing ways to mirror the actual cost of energy to drive down consumption, one of those being the Smart Grid

System. In California in particular there has been a push for a massive energy system overhaul that began in 2008 to implement this Smart Grid system in order to drive down electricity cost, prevent rolling blackouts/brownouts (which many Californians remember plagued Governor Gray Davis' term during the state energy crisis in the summer of 2000), and to modernize the aging energy infrastructure that has been operating in much the same way for over 100 years (Smart Grid Annual Report, 2011). The President of the California Public Utilities Commission (CPUC), Michael Peevey comments on why an upgrade to the Smart Grid will benefit the state, "Smart Grid is the foundation for the transformation of the electric industry from a passive and reactive system to one that is more reliable, efficient, and cost effective. Smart Grid will...save money, help utilities deliver power, and increase our use of renewable resources" (Smart Grid Annual Report, 2011). With Smart Grid technology, people will be more informed of the real time cost of their energy use as opposed to paying a constant price no matter what the load on the grid is (which as of now is about 12 cents per kilowatt hour), resulting in a more balanced use of energy according to the CPUC.

California being the most populous state, and with energy consumption only surpassed by Texas, has a lot to gain from upgrading its existing energy infrastructure (see figure 2 for energy consumption by state). Privacy concerns over electrical usage data has led skeptics of the Smart Grid to boycott the upgrade and even resulted in city ordinances in Marin County and Santa Cruz that ban the mandatory implementation of smart meters. The CPUC cites greater control over energy use in the home as one of the most important benefits of using the Smart Grid. For example, setting up a user's meter to shut off a certain appliance during hours that experience a particularly heavy load, or remotely shutting off heating or cooling systems when energy usage is about to push that user's energy cost into the next price tier (Smart Grid Annual Report, 2011).

II. American Schools

A study conducted by the National Center for Education Statistics (NCES) evaluated the effects of energy needs on public schools and concluded there is a strong correlation between rising energy

costs and budget shortfalls experienced throughout US school districts (Gurley, Hussar, Plisko, Seastrom, 2003). The authors also documented nearly all of the schools that experienced an energy budget shortfall and attributed it to an increase in the cost per unit of energy, where nearly 75 percent of respondents believed that increases in energy costs posed a major threat to the quality of student instruction (Gurley et al., 2003). With nationwide financial problems resulting from energy budget issues on the rise, there is a strong need now, more than ever, to conserve wasted energy and perform low-cost upgrades and retrofitting of inefficient energy intensive equipment in US schools.

A. Need For Conservation

Most public schools today are built according to outdated building codes and as quickly as possible which results in inefficient and high energy demand buildings as well as poor student health. Studies have shown that very few states regulate indoor air quality in schools or provide for minimum ventilation standards, which have been linked to a rise in respiratory illness, increased absenteeism, and declining test scores (Kats, 2006).

An increased reliance on portable units when constructing new schools provides for a fast turn over rate and a significantly shorter time from when construction starts to when a district is able to open the school. However, this method also leads to exorbitantly high energy costs in the long run and less flexibility in the overall design and layout of a school. A study of the costs and benefits of “greening” schools in America done by Gregory Kats of Capital E, a green building firm, found when reviewing 30 existing green schools that the average overall cost to retrofit or upgrade existing schools to be more energy efficient was less than 2 percent (average of 1.65) more than building a conventional school, or about \$3 per square foot (Kats, 2006). The same study found energy savings on average of over 30 percent and as high as 59 percent; other benefits included improved student health and well-being, lower amounts of water and air pollution, and more money available to allocate towards better compensating teachers and staff.

Green schools consume on average thirty-three percent less energy than conventional schools,

with the majority of savings coming from HVAC and lighting costs (these savings are better illustrated in the graph on Figure 3). Through better energy performance, schools that meet LEED certification or adopt green building techniques save money in the long term primarily by utilizing more efficient lighting in the form of LED or T8 fluorescents, greater use of daylight and sensors, and more efficient heating and cooling systems accompanied by better insulated walls and roofs (Kats, 2006). Kats also found a significant reduction in emissions as a result of greening schools; with residential, commercial, and industrial buildings using 45 percent of the nation's energy and nearly 75 percent of the electricity. Green building will reduce those demands through environmentally conscious building and would have a dramatic effect on public health (see Figure 3 for energy and water savings). The study also points out that children are growing, requiring them to breathe in more air relative to their body size than do adults, as a result they are more adversely affected by toxics and pollutants common in schools. With respiratory illnesses on the rise, this is an important positive factor in the overall health consequences of environmentally conscious building. Green schools are estimated to offset 1,200 lbs of nitrogen oxides (NO_x), 1,300 lbs of sulfur dioxide (SO₂), 585,000 lbs of carbon dioxide (CO₂), and 150 lbs of coarse particulate matter per school per year (Ivey, Schoff, Sarno, 2011). The amount of health, social, and financial savings that would be incurred by implementing these types of buildings will continue to mount, making energy efficiency an increasingly valued benefit of greening our schools.

B. Government Incentives

Provided primarily through funding from the American Recovery and Reinvestment Act of 2009, tax breaks and government incentives have been awarded to schools for implementing low-energy retrofitting and various types of heating and lighting upgrades. Statewide, California utility companies are providing rebates for schools that incorporate renewables or green building design in order to lower energy loads and reduce energy costs. San Diego Gas and Electric is providing incentives of up to 50 percent of project costs for the installation of new self-generation equipment including photovoltaics, fuel cells, and micro-turbines while the Sacramento Municipal Utility District

provides \$.10 per square foot of cool roofing and \$500 per Kw and \$375 per Kw for improved efficiency lighting and HVAC systems, respectively (Sustainable Schools - Energy Incentives, 2008).

In California, over twenty state-wide energy programs provide services ranging from free energy audits to rebates based on savings per Kw reduced, with the most substantial returns being awarded to photovoltaic installations and HVAC upgrades (Sustainable Schools - Energy Incentives, 2008). Southern California Edison, Southern California Gas, PG & E and numerous other public utilities provide similar incentives and funding for cool roofing materials, HVAC and renewable energy implementation with many of these programs extending to the general public as well, as long as they meet the size requirements. Most of these rebates are allocated on a first come first serve basis until funds run out, and with the state budget cuts heavily affecting our public schools, many districts simply do not have the funds to undertake these efficiency upgrades.

D. Case Studies

For states that occupy the wind belt of the US, wind energy projects are able to supply schools with clean renewable energy as well as provide a source of revenue for school districts. Iowa is currently leading the way in developing school wind projects, with eight schools that have turbines ranging from 50 kilowatts to 750 kilowatts (America's Schools Use Wind Energy to Further Their Goals, 2004). Wind turbines were first implemented in Iowa schools in 1993 when the Department of Energy awarded a \$119,000 grant to the Spirit Lake Community School District for a 250 Kw system, and within 8 years the district had saved \$124,900 on electric bills, leading them to install a second, even larger 750 kilowatt turbine in 2001. The findings from the same report state that after both turbines are paid off in 2007, they will bring in revenue estimated at \$120,000 per year which will be put towards enhancing school programs (America's Schools Use Wind Energy to Further Their Goals, 2004).

In the Lac Qui Parle Valley District, schools were able to use their windy conditions and an interest-free \$200,000 state loan to their advantage by erecting the first Minnesota school district

turbine. The 225 kilowatt system is used to generate income when school is out of session by selling back the power that is generated to Ottertail Power, shortening their anticipated 10 year payback period and providing a nearly maintenance-free source of renewable energy for the district (America's Schools Use Wind Energy to Further Their Goals, 2004). While not all states are well suited for wind turbine energy, However, ones that do are taking full advantage to offset energy costs and provide a future source of income for the school once the system is paid off. For example, at Minnesota's Carleton College the school dedicated a 1.65 megawatt turbine system in 2004 that is anticipated to offset nearly 40 percent of the college's electricity use (America's Schools Use Wind Energy to Further Their Goals, 2004). Wind turbines are able to be paid for in a relatively short period of time, this coupled with low or interest-free state loans has caused many windy states to incorporate them on their campuses in order to educate students, provide income for the school, and help generate a greater interest in wind power.

An energy evaluation of Texas schools found great variation among schools in money being allocated towards energy use, primarily towards HVAC and lighting. The report cites American primary and secondary schools as using upwards of \$6 billion each year on energy, and Texas public schools spending nearly \$660 million for utility costs alone, of which \$450 million was for electricity used to heat, cool, and light their facilities (Rylander, 2011). Rylander worked with the Texas Education Agency (TEA) to build an energy policy that is unique for each location and tailored to suite individual campus' needs based on their location and design. She demonstrates that every school is different and should have input from each staff member to identify problem areas to allocate funds better, such as deciding whether or not to simply retrofit existing equipment or completely remodel a school. Through this approach, Texas schools were able to create a viable energy plan that focuses on keeping operating costs down by reducing energy waste while providing a safer and more comfortable learning environment for students (Rylander, 2011).

The Seaford School District in Delaware has also experienced noticeable and immediate savings when upgrading their existing energy management system, all at relatively low cost and with a

rapid payback period. Low cost upgrades completed throughout the school district include simple fixes like upgrading their lighting to T8 fluorescents, installing commercial grade high-insulation windows, new programmable lighting timers, as well as upgrading their hot water tanks (which was an \$1,800 investment that paid off in less than 6 months). As a result, the district was able to save \$100,000 in annual energy costs and offset 1 million lbs of CO₂ per year, for a district-wide offset of CO₂ emissions equivalent to approximately 53 households (Whitaker, 2012). Seaford SD was able to successfully demonstrate that while large scale upgrades may not always be economically viable, small scale retrofitting of existing energy inefficient equipment can have a profound effect on energy costs and these simple fixes are often very practical and low-tech.

Colorado Springs School District 11 found a significant positive correlation between student test scores and the learning environment they are taught in, in particular the air quality and use of natural lighting in the classroom. School District 11 took advantage of a state program called Rebuild Colorado to assist them in funding a retrofit of their outdated HVAC equipment and maximizing the use of natural daylight, as well as installing demand control ventilation that operates via CO₂ sensors; their Energy Manager Thomas Fernandez acknowledged, “energy efficiency, good indoor air-quality and improved test scores go hand in hand” (Fernandez, 1, 2012). With their energy upgrades in place, SD 11 was able to achieve \$928,000 in annual energy savings and was recognized as one of the most efficient school districts in the state (Fernandez, 2012).

A study at the University of Florida was done to find a better way to offset the state's 1.7 million tons of food waste to harness usable energy from it through anaerobic digestion, producing bio gas and bio fertilizers (Graunke, 2011). This form of conservation is often overlooked because of the unpleasantness of dealing with concentrated methane, however it is carbon neutral, renewable, and gets rid of food waste that would otherwise take up landfill space and produces an energy source that offsets fossil fuel use. The study found at an elementary school in Gainesville, Florida that the 7.2 tons of food waste the school generates annually could amount to a methane potential of 19,000-28,000 cubic feet

of CH₄ (Graunke, 2011). When applied to the entire Florida public school system, Graunke concluded that those schools could yield an annual methane potential of 85-128 million cubic feet of CH₄, while the food waste from the entire state could generate 4.8-7.2 billion cubic feet of CH₄.

III. Lucia Mar Unified School District

The school system in California is the largest in the country, with one third of the nation's children attending a K-12 school in our state. With its large number of students (55 million students, 5 million faculty), the primary goal has been to focus on size and the speed at which a school can be setup, because of this nearly one third of Californian students are taught in relocatable buildings (Souza, Pauline, English, 2011). Portable classrooms provide for quick school setup but run very high energy costs because of their own separate air-conditioning units and almost complete lack of insulation; many campuses in the Lucia Mar Unified School District make use of a large number of relocatables, of which Nipomo High School relies almost entirely upon.

A. Nipomo High School

One of the key problems with the current setup of many schools throughout LMUSD is the way they were built and situated, with setup speed being the primary focus which has resulted in many long-term financial problems for the district. When talking to Erin English about why portable classrooms were used so often she cited short-term costs as the key deciding factor for many of the schools, as well as a mandated percentage of portables required per school. A regular fixed position building costs \$275-\$300 per square foot to construct, while a portable costs half that (English). Relocatable rooms are also quick to setup and move, and can be laid in rows like barracks to maximize the number of students that can be accommodated in a given space.

While these immediate results seem to be important in getting a school up and running as fast as possible, the long-term drawbacks add up quickly. The cost to move a portable class room varies from \$10,000 to \$50,000, and they use anywhere from 20 percent to 100 percent more energy than a fixed-place building (English). In total, Lucia Mar has 250 relocatable classrooms district wide; at the most

conservative estimate it would cost nearly \$2.5 million to remove them and could cost up to \$12.5 million, and that does not factor in the cost required for fixed-place buildings needed to replace them. Aside from their ease of setup and immediate convenience, portable classrooms are plagued with problems such as lacking a centralized heating and cooling system, poor insulation, expensive AC units for each classroom, and they make poor use of natural daylight resulting in high electrical lighting costs.

Overall, English attributes one of the biggest challenges to upgrading existing facilities not as a technical problem but rather a social one, trying to deal with people and the gap of knowledge when it comes to explaining energy efficiency. She notes that when it comes to conservation, we naturally are creatures of habit and that it takes time and constant reminders to get people to change their ways (see figure 7 for benefits of electricity savings from conservation at NHS). Teachers and council members are overwhelmingly in support of lowering energy demands, but when it comes to effort on their part that is needed to reduce costs they are either resistant to changes made, or fall back on old habits (see figure 4 for district wide electricity savings). For example, English cited dozens of email complaints she received from teachers across the district when their classroom trash can numbers were reduced and recycling bins were increased to promote more recycling by students. Ten thousand dollars worth of recycling bins were donated by waste management and distributed throughout the district where they saw an increase in the rate of recycling from 10 to 50 percent (see figure 5 for the monthly waste service costs for each school). “Another common problem I come across is people approaching me with the 'solar goggles' perspective...everyone is infatuated with photovoltaics and eager to install them, when real immediate results can be had for free through simple conservation efforts” (English).

When asked about energy conservation education and the role it plays in creating an energy conscious lifestyle, English pointed out that seeing real tangible results is the best way to go about educating someone about the benefits of energy conservation. “If you show someone a building that is an energy efficient success story, then that building itself can be the tool you use to educate someone

about potential benefits of conservation” (English). For example, the community gardens that have been on display for years at Harloe Elementary School led to many schools in the district to do the same in order to educate students about composting and recycling materials. Describing benefits of energy conservation and citing figures or pointing at graphs are one thing, but showing a skeptic the actual results or recorded financial savings that resulted from conservation usually makes a much greater impact.

B. Challenges

There are many factors that come into play when vying for council members and voters' approval for energy efficiency projects. The Oceano Community Center which hosts adult education classes was retrofitted with LED light fixtures on the day I interviewed English. Another hurdle that she noted is simply trying to schedule or coordinate an efficiency upgrade. Finding the time to perform a retrofit for a gymnasium of that size requires 3 days of down time, it also has to be achieved with a payback period that people find acceptable. Members of the Board for LMUSD agreed that better and more efficient lighting was a good idea, however the cost and down time required made them doubtful of the project, “I was surrounded by skeptics, these LED fixtures might make or break my job here,” English jokingly remarked.

A simple wiring mistake had the light fixtures operating at less than half their operating power, and as soon as the word got out that the lights “were worse than before” English had to explain that it was only a wiring mix up. After a quick fix the lights were operating to their full potential, and at a fraction of the cost of the old fixtures they had replaced. She pointed out afterward that everyone seems to focus on every hiccup that occurs, citing the difficulty she has to face in convincing people of the positive results that can be had.

Another major difficulty is justifying costs that are required for an upgrade or in implementing a new efficiency system, “The biggest challenge I face is to monetize sustainability” (English). California is host to numerous energy-efficiency incentives, however these incentives were turned

down because there was not enough money available to the District to invest in them. LMUSD has been in desperate need of increased state funding, but with the recent state-wide budget cuts issued to balance the state deficit, English is forced to make use of the existing funds available (see figure 6 for gas conservation savings at NHS). “Because of the lack of funds to upgrade existing systems on a large scale, conservation is the most financially viable and important measure we can use to lower our District's energy use...the savings are immediate and it doesn't cost anything to flick a switch or turn down the thermostat” (English).

The less than ideal budget situation that LMUSD is in right now has led English to establish a comprehensive three-step energy strategy for the district to adopt. The first step is conservation that focuses on using existing equipment wisely and reducing waste energy, it is the cheapest and most immediate method to get energy saving results at no additional cost (Souza et al., 2011). English noted that while this step should theoretically be the easiest way to cut back on energy use, in practice it is much harder to enforce because people want to see results but do not want to have to change their daily routine.

The second step of the LMUSD energy strategy is to increase efficiency by incorporating higher efficiency equipment for new buildings or upgrading existing equipment (Souza et al., 2011). While this method can save a substantial amount in terms of energy costs in the long run when replacing outdated or inefficient equipment, English stated that it is still conservation that has a greater effect on cutting wasted energy, typically at a very low or non-existent cost to the district. “Right now, the most economical upgrade that gives you the most bang for your buck is changing gymnasium lighting to LED or high-pressure sodium lighting. It's cheap and people can see the difference immediately” (English). While upgrading outdated equipment can have a noticeable impact on a school's energy bill, lack of funding still makes conservation the most cost effective strategy to reduce energy consumption in the district.

The third and last step of the energy strategy proposed by English to the school district is the

installation of on-site renewable energy to offset utility bills (Souza et al., 2011). This step is the most costly and the last step to improve overall energy efficiency in the district, however it is usually the type of action that the public want to see happen first. “Convincing people that they play a larger role in energy waste than the outdated equipment they use is difficult, no one is ever eager to admit they are at fault” (English). Public utility companies provide low or interest-free loans for many of the renewable energy options available to the district. Solar thermal pool systems that would offset gas used in heating as well as reduce wear and tear on pool heaters are offered interest-free for schools by So Cal Gas up to \$100,000 with a 3 year payback period (Souza et al., 2011). Once again, while these offers seem attractive and advertise a short payback time, there simply is not enough money in the district's budget to upgrade all of the existing pools. In fact, immense savings were noted by simply increasing the hours of pool covering by 25 percent at Arroyo Grande and Nipomo High Schools, another example of saving through conservation methods, estimated at \$28,000-\$40,000 annually (Souza et al., 2011).

C. Oceano Elementary

Jim DeCecco, a 5th grade teacher at Oceano Elementary School has taken it upon himself to increase energy efficiency awareness for his students. Oceano Elementary is unique in comparison to the surrounding elementary schools; it is located in a low-income part of town with 90 percent of the students qualifying for the reduced lunch program, and many of them are English language learners or only speak Spanish at home (DeCecco). Getting children interested in saving energy is difficult to begin with, and adding a language barrier to the mix does not make it much easier. However, DeCecco is very optimistic and has made significant progress in getting his students involved at school and at home. DeCecco's classroom has also worked hard on drafting a comprehensive energy guide, using part of their \$5,000 PG&E Bright Ideas Grant to write up a pamphlet of ways to save money and energy at home, which was then translated into Spanish by his students. “It's important to get the kids involved and interested in the work they're doing, without any interest in the material it's just another assignment for them...and for our bilingual students it gives them knowledge that they can take to their families and

hopefully apply to energy practices at home also” (DeCecco).

The faculty at Oceano Elementary has taken energy savings into their own hands by starting up its own composting program, increasing recycling, planting a community garden, and creating fun and creative incentives to get kids to reduce their energy use at school and especially at home. DeCecco commented that more than half of his students live within a few blocks of the school and many of them used to rely on rides from their parents, this prompted him to create a reward program for kids who rode their bikes to class. He started a “Bike to School Day” that takes place once a month and had shirts printed for the students who took part in the event which reads “Bike Posse.” This student biker gang that DeCecco organized takes a bike ride to Doc. Bernstein's Ice Cream Parlor in the Arroyo Grande Village once a month to advertise their no-impact transportation and are rewarded for their advertising and exercise with free ice cream. The promotion of bicycle transportation has been well received by parents and students alike, with 52 percent of Oceano Elementary's students riding their bike to school once a month or more.

DeCecco has reached out to members of the community for help in contributing to a positive energy conscious form of education to try and get his kids more enthusiastic about energy savings. For example, the manager at the Arroyo Grande Trader Joes allows a \$50 per month allowance of product from the store to be donated to the classroom as a type of reward incentive to promote biking to school, typically in the form of nutrition bars and juice boxes. DeCecco also employs his own energy conscious currency or “class dollars” which are rewarded to students when they collect recyclables, bike to school, or perform well in class which they can then use towards class raffles or prizes provided through donations or out of his own pocket. “Creating a positive feedback system is essential in getting kids involved and it ingrains sustainable practices into their daily lives. My students sort and collect recyclables in order to be rewarded and they don't treat it like it's garbage, it's simply a means to an end...and in this case that end is a Cliff Bar or Juicebox” (DeCecco).

Oceano Elementary also has its own composting program that is student run, as well as a

community flower bed and vegetable garden started by Cathy DeCecco which is also harvested and maintained by the students. Because of how close Oceano Elementary is to the Pismo-Oceano Vegetable Exchange (POVE) packing company where many of the student's parents work, DeCecco was able to coordinate the donation of large packaging bins in order to start an earthworm compost project. As the composting project began to gain momentum, the original 2 donated bins grew to 4 bins, which eventually doubled to the number they have today at 8 composting bins that are roughly 4ft x 4ft x 4ft each, more than enough to accommodate the lunch-time food scraps that is quickly digested by the worms. Because it is an elementary school, the majority of the food scraps that are discarded are vegetables that the kids do not want to eat, however, luckily the worms are impartial as long as the foam trays are not thrown in with the food to be digested. “Because of the smell, I usually end up having to remind kids to rotate the food in the bins, or I end up doing it myself. But usually they're happy to help, however they lose their enthusiasm during hotter weather when the smell gets a lot stronger...” (DeCecco).

The flower beds and raised vegetable garden on the other hand are quite popular among the younger students who are enthusiastic to weed the beds and watch the progress of the artichokes and squash that thrive there. Many of the students at Oceano Elementary have family members that work in agriculture, “By showing them the benefits of community grown food sources and having them take pride in what they grow, our students in turn will value something more when they play a role in producing and harvesting it” (DeCecco). Oceano Elementary has received less than adequate funding from the school district to implement major energy upgrades. However, through localized community effort and low or no-cost fixes and conservation practices they have been able to reduce the schools' electrical consumption by over 10 percent and total energy use during summer school by 28 percent.

IV. Summary and Conclusion

The United States consumes a disproportionate amount of energy for the amount of people it serves, with California being the second most consumptive state in total energy behind Texas. Even though per capita energy consumption for California is very low because of its high population, energy conservation should still be addressed immediately. With fossil fuel energy sources being rapidly depleted, action needs to be taken in order to shift our focus away from non-renewable sources of energy and more towards renewable sources. However, because of the current high cost of photovoltaic arrays, wind turbines, and other renewables, the most cost efficient strategy that can cut consumption by one third is simply through conservation.

Many schools throughout the US have addressed energy efficiency issues in a variety of ways, from implementing expensive wind turbines that generate nearly half of a schools energy load, to simple and cheap measures like installing T8 fluorescent bulbs or covering a swimming pool for longer periods to prevent evaporation. Green building applied to schools has a low cost premium averaging 1.65 percent and is able to reduce energy usage and water savings by 33 percent, however most schools have been built without using green building methods, again making conservation the most viable immediate response to address energy savings.

Government incentives have been made available for improved energy efficiency since the 2009 American Recovery and Reinvestment Act, however most school districts lack the proper funding to pay their financial obligation. Large energy companies like PG&E offer no-interest loans to schools for energy upgrades, but they have to prove that the system will pay itself off in 10 years by supplying an analysis or report, which often costs money that the school districts once again do not have. Simple ways to conserve the amount of energy used each day is the quickest and cheapest form of cutting costs, however it is not easy to change people's minds or daily habits from "business as usual."

In the Lucia Mar Unified School District, one of the biggest energy users is the abundant number of portable classrooms still in use. They are extremely expensive to move and replace, and they require up to twice the energy needs of a fixed-place building due to their poor insulation and overall energy inefficient HVAC setup. There is an unanimous consensus throughout the district that energy efficiency and cut backs on wasted energy need to be increased, but not many people want to be inconvenienced by performing an extra step or sacrificing their normal routine.

In order to make progress without receiving opposition from the school board, people like Erin English and Jim DeCecco are forced to find ways to lower energy use while incurring the smallest financial cost imaginable. Increasing energy efficiency and cutting back on wasted energy is viewed by them mainly as a social problem, not a simple technical fix; people's habits and mindsets have to be changed, not just their lighting or thermostats.

In conclusion, energy conservation should be at the forefront of every school district's agenda to achieve immediate low or no-cost modifications. Even though massive solar arrays or micro-turbines give the appearance of saving a great deal of energy, which they do, the real issue that needs to be addressed before renewables are brought into the equation is bringing energy consumption down to a record low before it is replaced with a renewable source of energy. Because of the recent state-wide cuts that have been made in order to balance California's budget, the cheapest and fastest method to achieve energy savings should be conservation first.

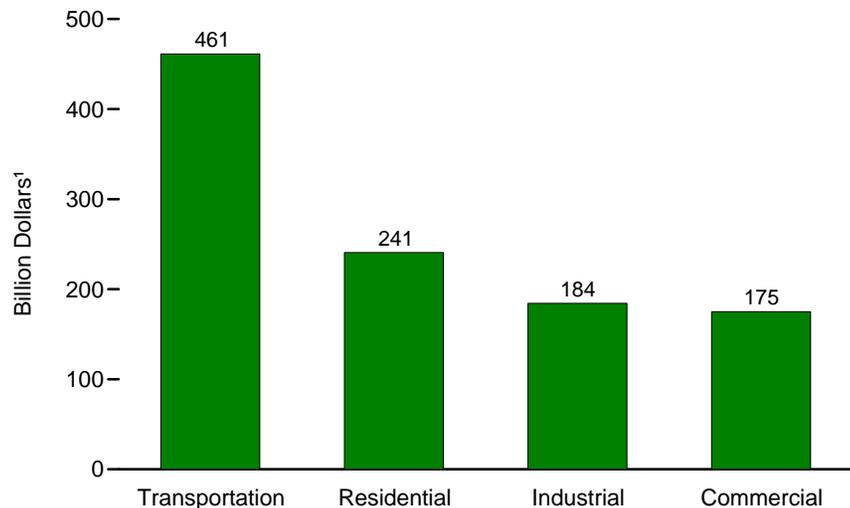
Because the problem of wasted energy seems to be heavily affected by social trends and habits, the most effective way to get people to change is by providing rewards or incentives. PG&E did it on a financial level by supplying half of the cost of a micro-turbine, and Jim DeCecco applied the same reasoning to his 5th grade class by giving them “Bike Posse” shirts and energy bars in exchange for recycling bottles in school. A positive feedback reward method seems to be more effective in achieving change than telling someone that their way of doing things is flawed and needs to be changed.

The most successful results I witnessed during this research project has been the approach that was used at Oceano Elementary School. The teachers at that school were able to reverse the energy inefficiency trends by supplying incentives and rewards for positive behavior. Among them were; educational tools and multilingual information pamphlets for students and parents, and promoting an entertaining environment and a sense of community, as seen during the 50+ student “Bike Posse” rides through town to Doc Bernstein's. While this may be an overly simplistic view to a complex issue, I believe the same reasoning applies to large scale energy practices in schools and in the private sector. When people do not have the financial means to upgrade a faulty system, as is the case with the school districts in California, then some kind of incentive needs to be applied in order to spur individuals to take action.

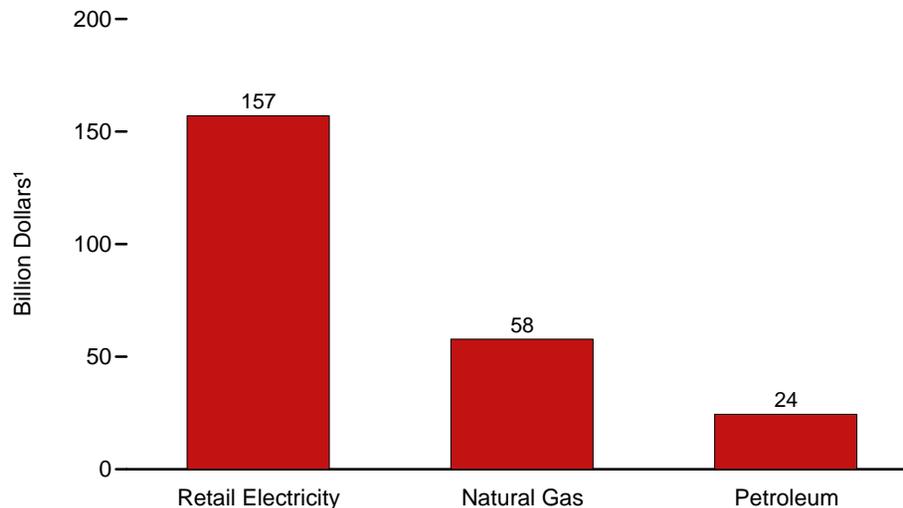
As it stands, large scale photovoltaic setups are on every district board member's mind, but the financial capital to support such a large project is not available at this time. Private loans are available, but board members being hesitant of a proposition made by an energy company that claims they have nothing to gain from such an investment is understandable. The most important modification to our schools that should be made first is to use existing equipment wisely and reduce wasted energy through conservation.

Figure 3.6 Consumer Expenditure Estimates for Energy by End-Use Sector, 2009

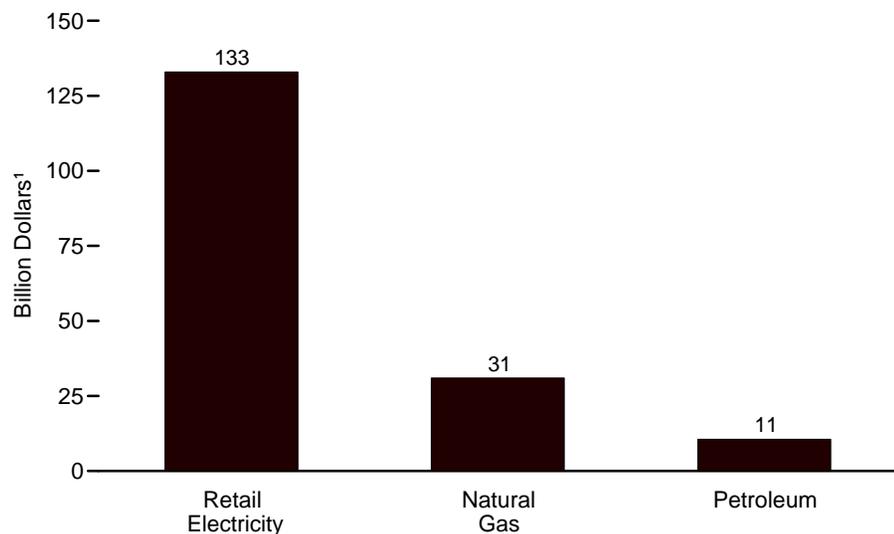
By Sector



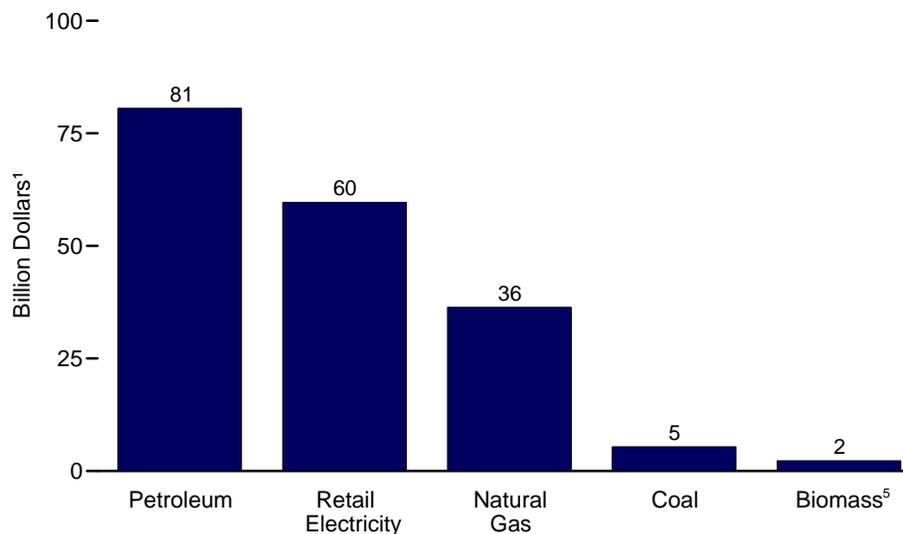
Residential Sector by Major Source²



Commercial Sector by Major Source³



Industrial Sector by Major Source⁴



¹ Prices are not adjusted for inflation. See "Nominal Dollars" in Glossary.

² Expenditures for coal and wood and wood-derived fuels are not displayed.

³ Expenditures for coal, wood and wood-derived fuels, and biomass waste are not displayed.

⁴ Expenditures for imports and exports of coal coke are not displayed.

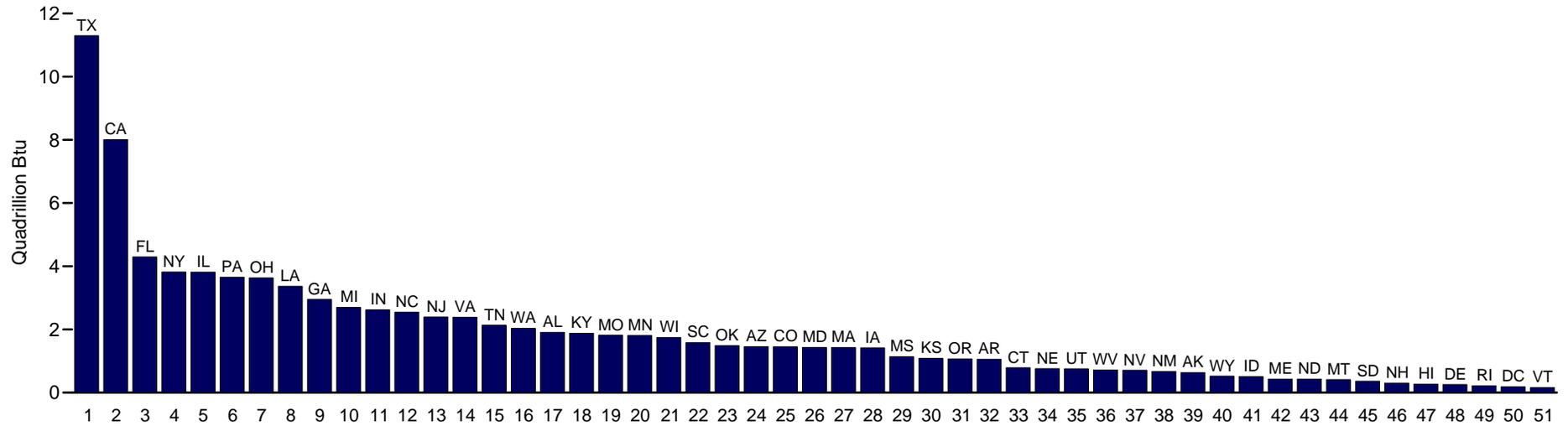
⁵ Wood and wood-derived fuels, and biomass waste; excludes fuel ethanol and biodiesel.

Notes: • Petroleum accounts for nearly all transportation sector expenditures. • There are no direct fuel costs for hydroelectric, geothermal, wind, or solar energy. • Totals may not equal the sum of components due to independent rounding.

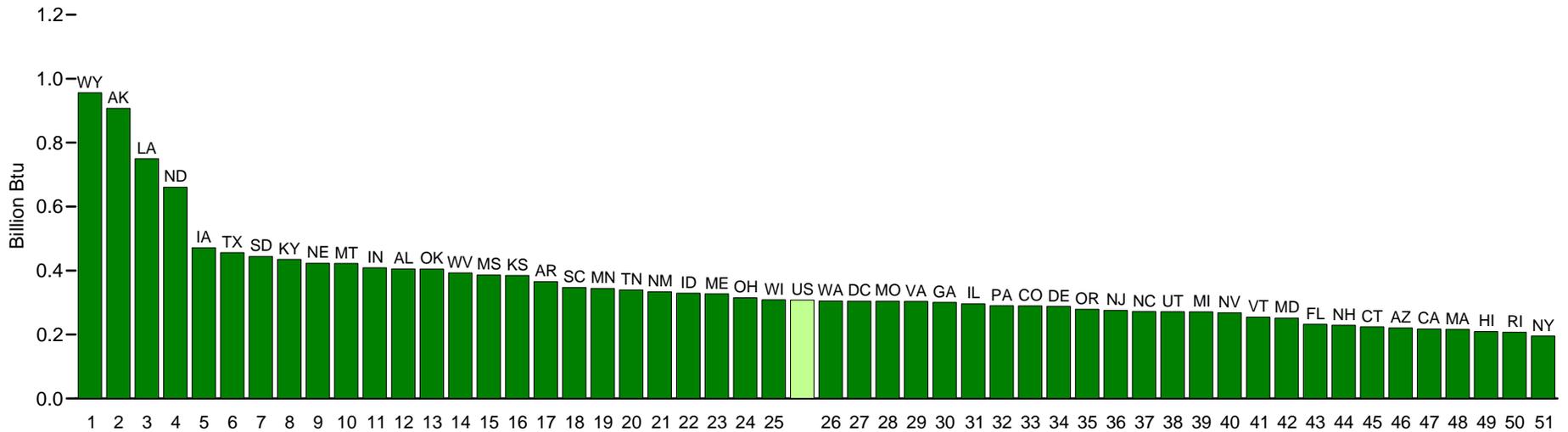
Source: Table 3.6.

Figure 1.6 State-Level Energy Consumption Estimates and Estimated Consumption per Person, 2009

Consumption



Consumption per Person



Source: Table 1.6.

source: www.eia.gov

TABLE B: SCHOOL BUILDINGS ANALYZED IN THIS REPORT⁹

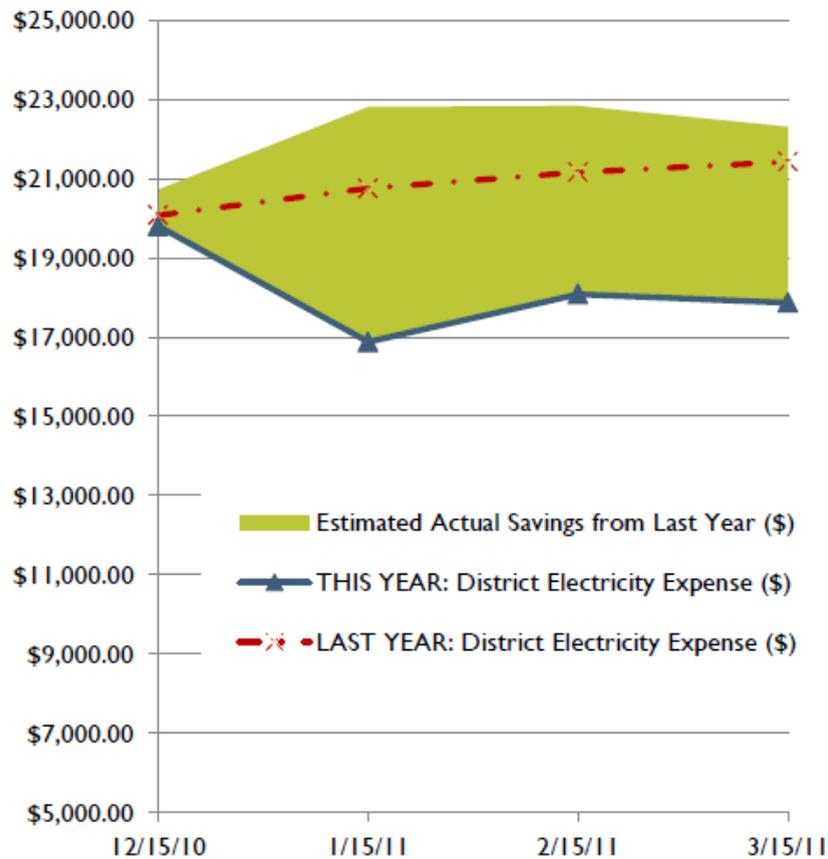
Name	State	Year Completed	2005 MA-CHPS	LEED Score	LEED Level or Equivalent	Cost premium	Energy Savings	Water Savings
Ash Creek Intermediate School	OR	2002			CERTIFIED	0.00%	30%	20%
Ashland High School*	MA	2005	19			1.91%	29%	
Berkshire Hills*	MA	2004	27			3.99%	34%	0%
Blackstone Valley Tech*	MA	2005	27			0.91%	32%	12%
Capuano	MA	2003		26	CERTIFIED	3.60%	41%	
Canby Middle School	OR	2006		40	GOLD	0.00%	47%	30%
Clackamas	OR	2002		33	SILVER	0.30%	38%	20%
Clearview Elementary	PA	2002	49	42	GOLD	1.30%	59%	39%
Crocker Farm School	MA	2001	37			1.07%	32%	62%
C-TEC	OH	2006	35	38	SILVER	0.53%	23%	45%
The Dalles Middle School	OR	2002			SILVER	0.50%	50%	20%
Danvers*	MA	2005	25			3.79%	23%	7%
Dedham*	MA	2006	32			2.89%	29%	78%
Lincoln Heights Elementary School	WA	2006			SILVER		30%	20%
Melrose Middle School	MA	2007	36			1.36%	20%	20%
Model Green School	IL	2004		34	SILVER	2.02%	29%	35%
Newton South High School	MA	2006		32	CERTIFIED	0.99%	30%	20%
Prairie Crossing Charter School	IL	2004		34	SILVER	3.00%	48%	16%
Punahou School	HI	2004		43	GOLD	6.27%	43%	50%
Third Creek Elementary	NC	2002		39	GOLD	1.52%	26%	63%
Twin Valley Elementary	PA	2004	41	35	SILVER	1.50%	49%	42%
Summerfield Elementary School	NJ	2006	42	44	GOLD	0.78%	32%	35%
Washington Middle School	WA	2006		40	GOLD	3.03%	25%	40%
Whitman-Hanson*	MA	2005	35			1.50%	35%	38%
Williamstown Elementary School	MA	2002	37			0.00%	31%	
Willow School Phase 1	NJ	2003		39	GOLD		25%	34%
Woburn High School*	MA	2006	32			3.07%	30%	50%
Woodward Academy Classroom	GA	2002		34	SILVER	0.00%	31%	23%
Woodward Academy Dining	GA	2003		27	CERTIFIED	0.10%	23%	25%
Wrightsville Elementary School	PA	2003		38	SILVER	0.40%	30%	23%
AVERAGE						1.65%	33.4%	32.1%

U.S. Green Building Council, [usgbc.org](http://www.usgbc.org) (<http://www.usgbc.org/ShowFile.aspx?DocumentID=2908>)

Ex: Nipomo High School

\$16,000 Electricity Savings in four months @ NHS

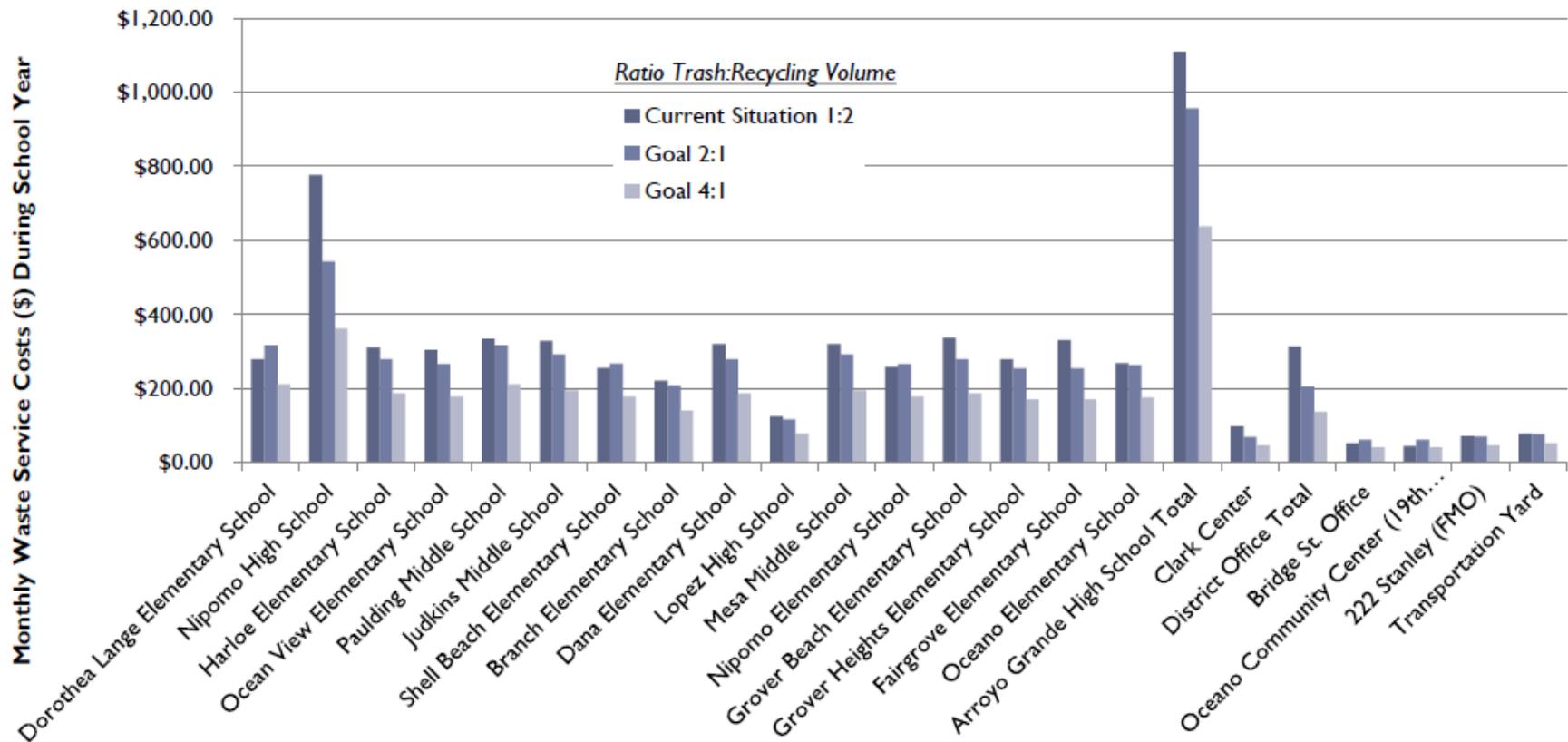
NHS Electricity Expenses: Last Year vs. This Year (11/15- 3/15)



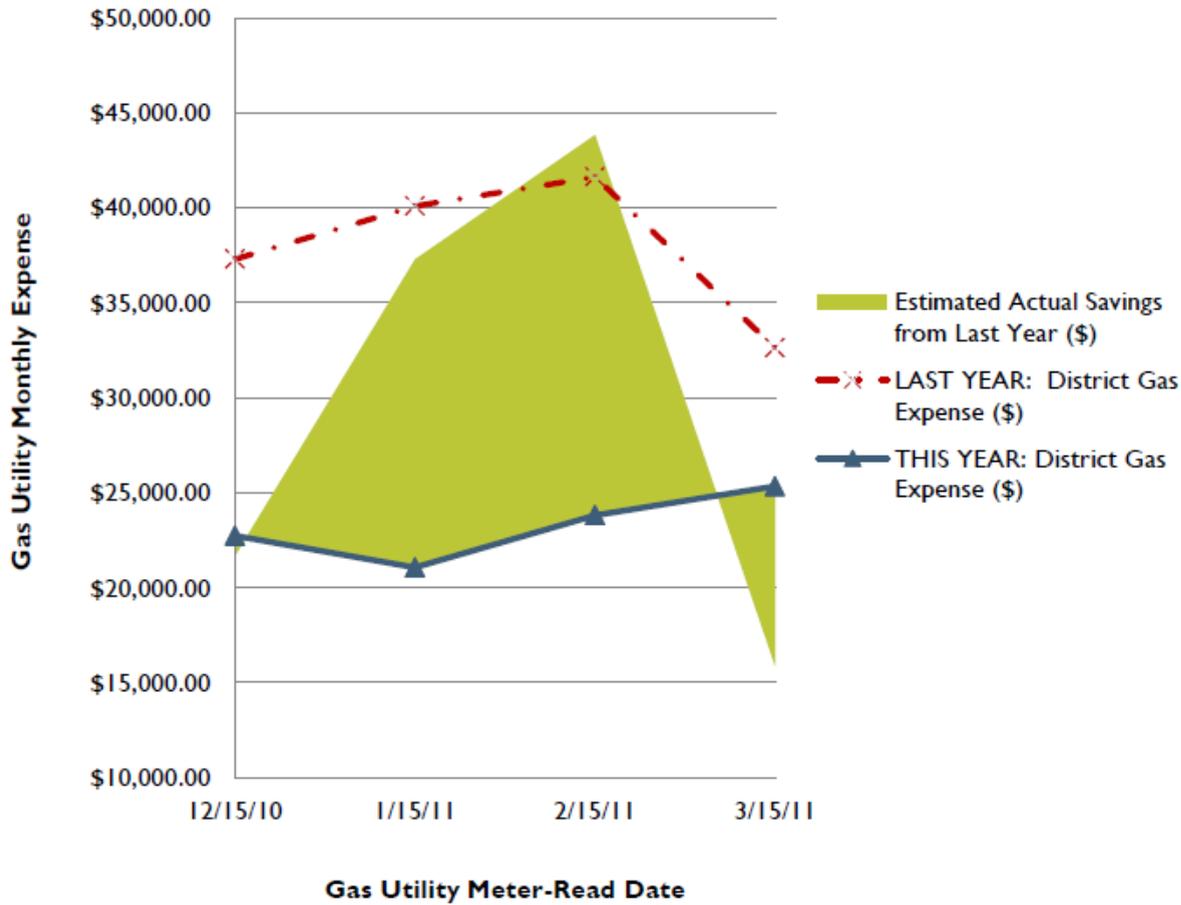
Recycling Saves Us Money

Projected Monthly Savings from Waste Diversion

- ▶ District can save \$6,000 to \$40,000 per year from recycling
- ▶ It costs the district 50% less to recycle, by volume, than to throw it away



Gas Expenses: Last Year vs. This Year (11/15– 3/15)



\$46,000 Savings from Gas Conservation

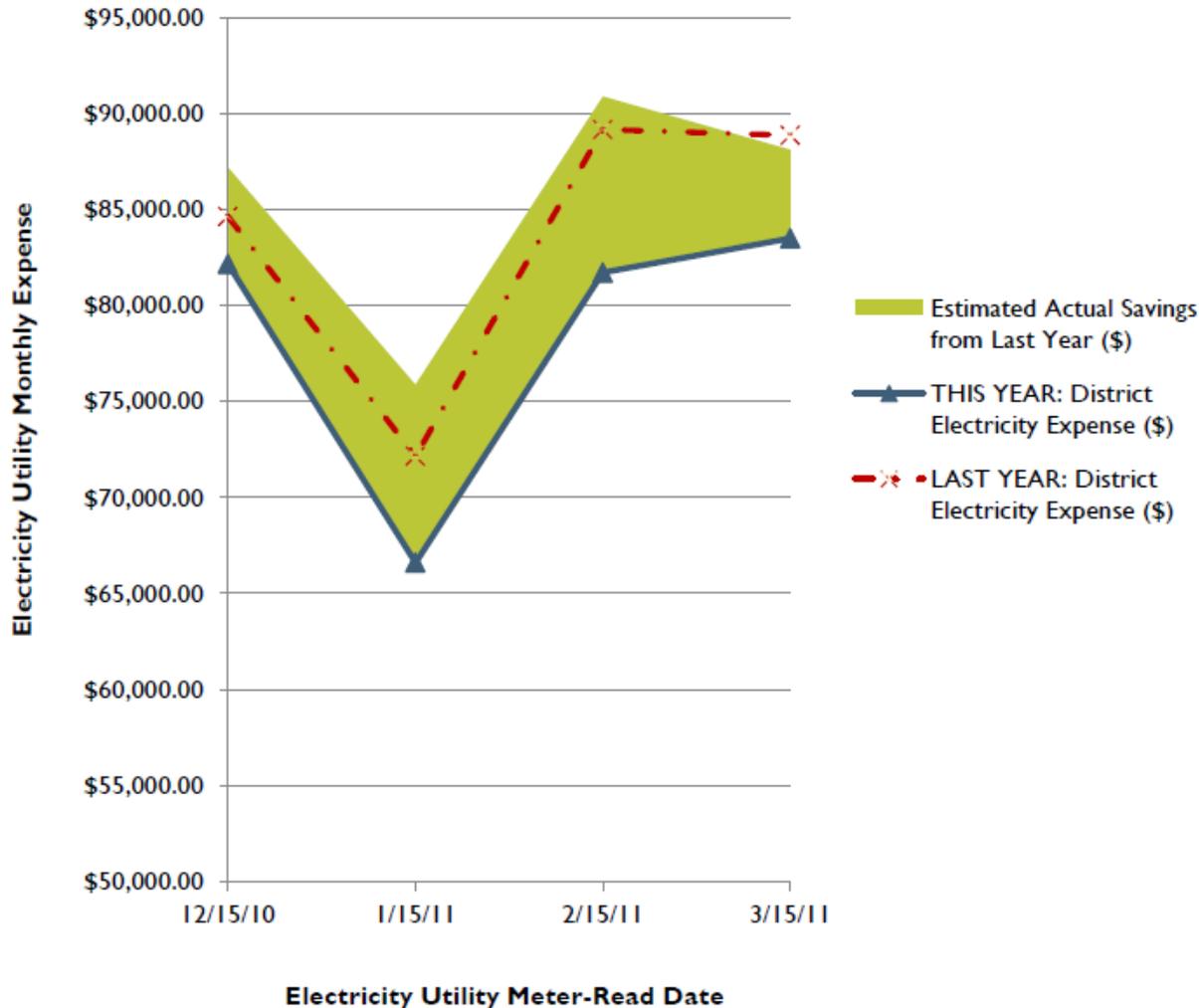
Conservation measures affecting gas savings since 11/15/2010 include:

- Egg-timers for HVAC control*
- Winter Recess Power Down Plan
- Everyday Power Down Plan
- Commissioning of automated building control (DDC) systems at seven sites
- Commissioning of Chiller Plant DDC System at NHS
- Pool Covering Policy at AGHS & NHS

Estimated actual cost savings from last year account for changes in rate structures and gas costs.

* Implemented prior to 11/15/2010

Electricity Expenses: Last Year vs. This Year (11/15– 3/15)



\$45,000 Savings from Electricity Conservation

Conservation measures affecting electricity savings since 11/15/2010 include:

- Egg-timers for HVAC control*
- Winter Recess Power Down Plan
- Everyday Power Down Plan
- Commissioning of automated building control (DDC) systems at seven sites
- Commissioning of Chiller Plant DDC System at NHS

Estimated actual cost savings from last year account for changes in rate structures and electricity costs.

* Implemented prior to 11/15/2010

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