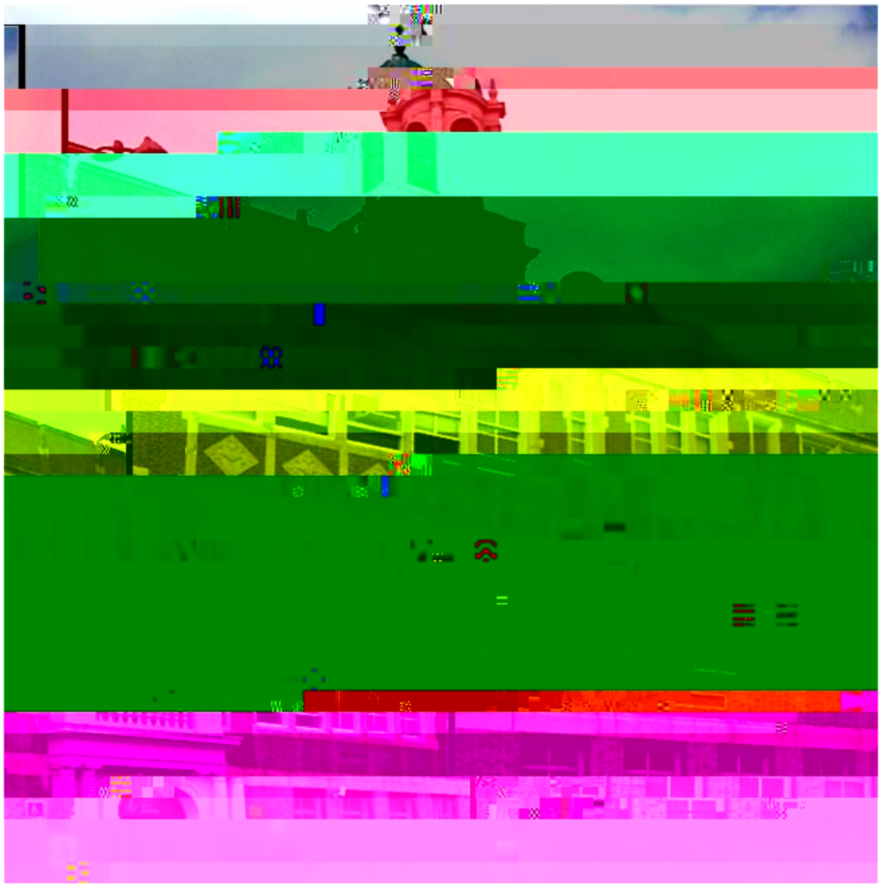
B'More Green Schools:
Increasing Efficiency and Enhancing Education



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Forward

The Environmental Science and Studies (ESS) Senior Seminar class is taken by students who are completing their academic major and getting ready to graduate. The course consists of a semester-long project. The course objective is for the students to bring to the project the knowledge, skills and abilities they have developed through their academic study and use them to address a specific environmental question or problem that someone in our community would like addressed. This year we were asked by Ms. Anne Draddy and Mr. Jason Mathias, of the Baltimore City Department of General Services, to assist them in their efforts to reduce energy use and greenhouse gas emissions of the Baltimore City schools. Mr. Mathias indicated that he wanted the class to consider the school he was suggesting, the Academy for College and Career Exploration (ACCE), as a model institution. ACCE occupies one of the historic school buildings. He was hoping that the students would be able to come up with suggestions that would be applicable to other school buildings as well.

The class was fortunate in his suggestion of ACCE because their administration, teachers and students were open to this study. ACCE had also been awarded a grant by the Baltimore Energy Challenge. The project had the support of the Principal, Ms. Quinhon Goodlowe, the Lead Science teacher, Ms. Victoria Mathew and an enthusiastic student Green Team. The Towson students had a very positive experience visiting and working with ACCE.

The school consumes energy and uses natural resources as it goes about its business of educating students; the Towson students also realized that the students in the school were not only the beneficiaries of the energy being expended, they were the future of Baltimore! Therefore, it was important that not only should the school receive upgrades and retrofits should funds be available, but that the students in the school learn about these changes, why they were being made, why energy conservation was so important; what better place to learn these important lessons than in a classroom. Hopefully the school can become even more of a living classroom and accepted into the Maryland Green Schools Program.

The student authors are responsible for this project. They explored the issues and pulled the information together. I provided guidance and help as requested.

Jane L. Wolfson, Ph.D., Director, Environmental Science and Studies Program
ENVS 491 Senior Seminar, Fall 2012

Introduction

The 2008 EmPOWER Maryland Energy Efficiency Act requires the state to reduce energy consumption by 15% and Greenhouse Gas (GHG) emissions by 25% by the year 2015 (Maryland Energy Administration, 2009). In 2008, the state of Maryland was estimated to import 30% of its power from neighboring states and regional energy transmission lines had reached peak capacity (Maryland Energy Administration, 2009). PJM Interconnection, which organizes the movement of wholesale electricity in

damaged brick exterior, damaged HVAC heating and cooling elements (Jacobs Report, 2012). The full report lists all the details (Jacobs Report, 2012). Old buildings routinely require upgrades and retrofits which are costly propositions. It is noteworthy that while the physical structure of the school has its challenges, the students at the school are there by choice and appreciate what the school offers, such as small classes and dedicated teachers.

The Baltimore City Department of General Services, in response to its mandate to reduce energy use in Baltimore City, approached us to develop a plan appropriate for this school. ACCE could act as a model to implement change within the entire BCPS system. We focus on two elements, the physical structure and the educational mission of the school. While certain retrofits will be needed to address the

Reducing Energy Use through Equipment Retrofits and Upgrades

Energy Audit

Building upgrades intended to improve energy efficiency should start with an exploration of where and how energy is(o)-2 hot and cold spots both inside and out again indicating places where the seal is faulty (Regal Services, 2012).

Many Baltimore City schools are in historic but energy inefficient buildings that produce high utility bills. According to Energy Star, the least efficient schools use three times more energy than schools that have been retrofitted and are among the best performers in terms of energy use (Energy Star, 2012). Improving energy efficiency should be a priority for all school systems so that less money is being spent on energy and more money is going to improving the learning environment. Every student is entitled to a comfortable learning environment and a quality education; both require a financial investment. Investing in an energy audit is the first step for these schools to take in order to improve energy efficiency in a fiscally responsible way.

Lighting for Learning

The lighting system in a building consumes, on average, 35% of energy used in a building in the United States (Clark, 2008). Changes in technology over the last several years have led to new fixtures and lamps that provide more light from less energy (Clark, 2008). Therefore, if an older lighting system is in place, it could be consuming more energy than necessary for the amount of light it provides. Reducing the energy consumption from lighting has two components: upgrading technology on a regular basis and practicing responsible use of lights (Smith, 2011). The lighting system at ACCE has been updated within the past ten years. The wiring system for the school is up to date and many of the lamps in the ceiling fixtures have been converted to T8 lamps. However, additional upgrades are needed to make the lighting system in the building more energy efficient.

In some situations, what is missing is routine maintenance of fixtures that impact energy demands; over time lamps and fixtures accumulate dirt, dust, and oils from the air decreasing the amount of light being emitted by the lamps (Peterson, 2012). Removing settled dust, grease and oils from the lamps and light bulbs can increase light output or lumens by up to 20%, that's 20% more light for the same amount of energy (Peterson, 2012). Dirty bulbs make the room dim because less light is illuminating surfaces (Peterson, 2012). Scheduling regular lamp replacement in a building maximizes the

s by using fewer lights (Fetters, 2002). Depending on how the lamps are wired, some darkened bulbs can cause the entire fixture to go out since the circuit is no longer complete; it is helpful to replace these bulbs as soon as possible to have the maximum available lumens. To reduce energy use, removing lights that are not needed is another easy way to cut back; some areas are over lit for their functions. Energy can also be saved by taking advantage of naturally lit areas. By leaving window shades open and installing skylights, light can easily find its way into the room illuminating the space (Smith, 2011). ACCE, as with all schools, would benefit

LEDs. Tube fluorescent bulbs cannot be dimmed and will not work with this system. There are many situations where a lower amount of light could be used instead of having the light on a constant high setting. Reducing light use translates to a reduction in energy use. The amount of energy saved varies from each type of light bulb and the appropriate level if dimming. Using compact fluorescent light bulbs and dimmers together allow the energy savings to be mirrored by the amount of light being used; dimming the light by 30% would result in a 30% energy savings (Oldroyd, 2012). By having dimming controls on lights, the user is in control of how much energy is being used.

Fluorescent lights are now available in many different sizes, and the new fixtures produce increased light output from smaller more efficient fluorescent tubes (Hozler, 2003). At one time T12 light bulbs were routinely installed in buildings, but today T12 bulbs are outdated and smaller more efficient T8 and T5 bulbs are now available and recommended (note, the smaller the number, the smaller the diameter of the tube and the greater the energy-efficiency) (Parpal, 2006). Since T8 tubes are smaller in diameter than the T12 tubes, they are more energy-efficient than the T12 (Parpal, 2006). Older T12 bulbs also lack efficiency due to an outdated power supply system of the fixtures for which they were made; this technology has also been updated to a more efficient electronic power supply. This upgrade occurs in the lamps fixtures themselves. New lamps use a new more efficient electronic power supply that results in a 40% reduction in consumption of electricity over older models; they produce the sam consetio(en e)4(fs)-luo(th)-8(i)5(s)-5( )

are small lenses and have tiny chips placed on a heat-conducting material to produce light using less fans. Energy Star fans cut costs of cooling by 45% when compared to air conditioning units (Energy Star, 2012). The proper rotation of fans is important; clockwise in winter and counter-clockwise in summer helps to move hot and cool air in the proper fashion depending on the season (Energy Star, 2012). While

officials and designers to help determine the best ventilation methods for each school s unique situation, its location and climate, as well as the age of the school (EPA, 2012a). The School Advanced Ventilation Engineering Software (SAVES) package is a tool to help school officials assess the potential financial payback and indoor humidity control benefits of Energy Recovery Ventilation (ERV) systems for school applications (EPA, 2012a). The software, available for free download, is a tool that will allow schools to choose a proper ventilation method within a school building.

The greatest source of energy inefficiencies in a large building, like ACCE and similar Baltimore such as chillers. For instance, when observing air conditioners within controlled areas of a building, a unit that is too large will use more energy than is necessary to cool the building and does not allow for good climate control; similarly, an undersized unit will constantly run and cause mechanical problems which can get expensive and keep the controlled areas from ever reaching the desired temperature (Efficiency Partnership, 2012).

The boiler system used at ACCE is a condensing boiler, which allows for higher energy efficiency than previous models such as non-condensing boilers (DOE, 2012b). This is due to the fact that water vapor is able to condense inside the boiler as a result of the exhaust fumes not exceeding the dew point (approximately 135 degrees Fahrenheit), which allows for water vapor to condense on a secondary heat exchange surface (HPAC Engineering, 2012). This condensation is able to heat the incoming water being distributed to the system, resulting in a reduction in the amount of the heat the boiler needs to produce compared to a non-condensing boiler (HPAC Engineering, 2012).

The efficiency of a boiler is measured by annual fuel utilization efficiency (AFUE), which reflects the amount of heat produced by a boiler for the total energy used by the system (DOE, 2012b). Boiler systems, depending on factors such as age and fuel source, can have an AFUE that ranges from 70% to 98% (a system is more efficient as the AFUE number increases)(DOE, 2012b). Most condensing boilers systems have an AFUE that is between 90-98% (DOE, 2012b). The generic design of the natural gas utilizing boiler system at ACCE is shown below in figure 1.

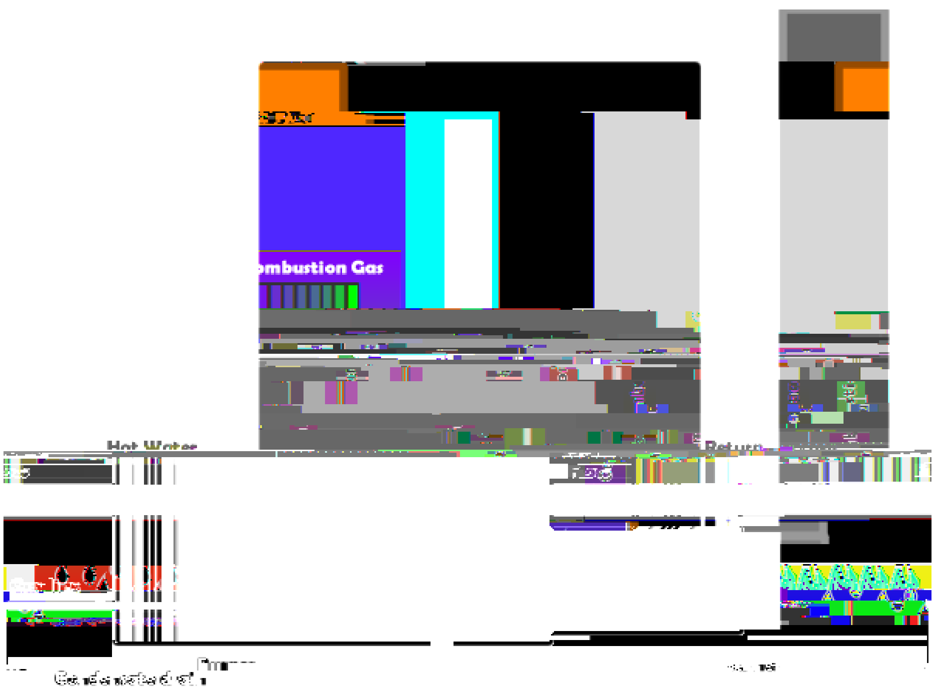


Fig. 1 Diagram of a Condensing Boiler (American Combustion Industries, Inc., 2011).

Fixing a Leaky Building Envelope

Windows

Windows are one of the greatest sources of heat loss in the winter and heat gain in the summer losing and gaining heat by four main mechanisms; conduction, convection, radiation and air leakage (Fisette, 2012). Conduction is the direct transfer of heat (molecule to molecule) through(ou)4(r)vection, rh(ou)4(r4raoi)5(n)4 of the window (National Renewable Energy Laboratory, 2010). Double or triple pane windows are more energy efficient but are considerably more expensive than single-pane windows (National Renewable Energy Laboratory, 2010). Framing also becomes limited with multi-pane windows because of their increased weight (National Renewable Energy Laboratory, 2010).

Window glass may be coated to provide low emissivity (low-E) characteristics. Low-E coatings are thin glazes of metal or metallic oxide layers spread across the panes of windows and skylights, which suggests that replacing existing windows with low-E windows can potentially reduce annual heating demand by 9.1-13.8% and improve energy efficiency of the whole building (Chavez-Galan and Almanza, 2007). There is more to a than just the glass.

Table 1. U-Value, Solar heat transmitted and visible light transmitted for different glass types (Efficient Windows Collaborative, 2012a).

Type of Glass

ACCE currently has around 370 single-paned windows. These windows are also very large, making them a commercial type window. Most of the windows are narrow and tall with dimensions around 38in x 80in. There is also a variety of smaller square windows with dimensions of 35in x 30in. The building faces southeast, which means the front of the building catches the morning sun and the back of the building catches the afternoon sun. This natural sunlight is entering the many classrooms that are in the front of the building during morning school hours and can be beneficial for the learning environment of

in Portland,

health, behavior and achievement (Center for Innovative School Facilities, 2012). They analyzed standardized math and reading scores of students exposed to various lighting conditions and found a 21% increase in performance from students tested under the most amount of daylight compared to students tested under the least (Center for Innovative School Facilities, 2012). Not only will increased natural daylight in ACCE help reduce the amount of artificial light used, it will also create a more beneficial learning environment for students.

Windows are a major gateway for energy gain and loss, and it would be helpful to know how much energy is being gained and lost through the current windows at ACCE; unfortunately it is extremely difficult to do so. As previously explained, there are many details and factors that could affect how much energy is being exchanged, making energy exchange information site specific. This specificity also makes it difficult to estimate a cost for replacing windows without a contractor coming to ACCE and making estimates based on the conditions of the building and windows.

Asbestos, a naturally occurring mineral fiber that is resistant to heat and corrosion, was once widely

Australia and Europe for the last twenty years while the United States is just experimenting with dual-flush toilets on large scales (Huff, 2006). In order for the dual-flush systems to be effective in the United States, society would have to have an increased awareness of water consumption and would require a change in bathroom behavioral patterns. Students and faculty would have to make a conscious decision as to which volume of water is needed to dispose of wastes and choose the valve corresponding to that decision. Updating existing conventional toilets to low consumption, high efficiency, or dual flush systems can dramatically save in water usage.

aced with waterless urinals that require little maintenance. According to the Energy Policy Act of 1992, conventional urinals can use no more than 1 gallon per flush while modern waterless urinals require no water at all (102nd Congress, 1992). Waterless urinals are odorless and hygienic because there is no bacteria-containing water spray from flushing (Kennedy, 2004). Waterless urinals also reduce the need for

sensors guarantee that a faucet cannot be left running and that every toilet or urinal is flushed after use. Sens
reducing human surface contact (NCDENR, 2009). These infrared sensors can be installed for approximately $200 per fixture and are compatible with most modern lavatory fixtures (NCDENR, 2009).

Outdoor Water Use: School athletic fields, gardens, and landscaping also consume water and this water usag
such as rainfall, can reduce the pressure on water resources needed for the landscape. In arid regions throughout the world people know the importance of preserving water resources and one of the most inexpensive methods is to design a rain catching device (Tessman & Gressley, 2011). This device can utilize a gutter system that funnels rainwater through a screen, catching debris, and into a large drum or rain barrel; the water can be either filtered or used as is (Tessman & Gressley, 2011). Impervious surfaces, such as parking lots and roofs, can also provide a platform for capturing rainwater (Environmental Education, 2006). Meadowside Primary School in the United Kingdom recently installed a rain catching system that allows them to generate approximately 75% of their landscape irrigation water use from recycled rainwater from parking lots and the playground (Environmental Education, 2006). The captured water can either be used for landscaping, vehicle washing, boiler or cooling tower use, or can be connected back to the school plumbing and used as gray water (Environmental Education, 2006). Gray water is non-potable water generated from activities such as laundry, bathing, and dishwashing that
i.e., it is not drinkable, it can be recycled for either landscape irrigation, directed to a constructed wet well, or for flush water (NCDENR, 2003). Implementing the use of gray water will drastically reduce the amount of fresh water used by a school and decrease the amount of wastewater sent to the treatment plan5 Tm[( )] TJETBT1 0 0 1 108StTJET BTBsl94y(r)-3(tm)-214(s)-5 atelyir3(a

down when watering would be ineffective (NCDENR, 2009). School facilities can also consider installing artificial turf or drought resistant grass that would require little to no water (NCSBE, 2008). The initial costs of artificial turf or drought resistant grass can be expensive but can vastly reduce water usage over the lifetime of the facility (NCDENR, 2009).

School facilities are dedicated to educating youth and as society becomes more conscious about the importance of water conservation, it is essential to relay this message to the youth. This can be accomplished through practical design around the facility costs, and saved $4,160 from its reduced electrical consumption (Brady, 2012). These are substantial savings.

Implementing a highly effective recycling plan within a school can also save a school money on waste pickup while also reducing the carbon footprint of the institution. Eliminating waste through recycling reduces the net amount of trash collected and transported to landfills; this reduction in waste saves money and energy and, in addition to reducing the waste stream, reduces hauling costs, dumping costs, the need for new landfills and makes materials available for reuse (Tierney, 1996).

A model recycling programs has been developed in one school district in South Carolina with a

SCDHEC, 2012b).

Another South Carolina school district had a documented savings of $18,000 in the 2011 fiscal year as a direct result of its recycling program (SCDHEC, 2012b). Recycling one ton of paper saves 3.5 cubic yards in a landfill, 17 thirty-foot trees, 7,000 gallons of water, 380 gallons of oil and 4100 kwh of energy (Green Waste, 2012). Aluminum cans are another item that many people recycle and for good reason; the energy required to replace the aluminum cans that were wasted in 2001 was equivalent to 16 million barrels of crude oil (Green Waste, 2012). That is enough oil to meet the electricity needs of all homes in Chicago, Dallas, Detroit, San Francisco and Seattle (Green Waste, 2012).

A study focused on the U.S. food system found that an estimated one-quarter, or 96 billion pounds of all food produced in the United States is wasted yearly (Kantor et al., 1997). Food waste accounts for 18% of all waste being sent to land-fills and could be diverted by composting (EPA 2011). By diverting food waste from landfills, emissions of methane gas, a potent greenhouse gas, could be greatly reduced since food waste is the second largest anthropogenic source of methane (EPA 2011 Moreno, 2010). By diverting food waste to food waste co-digestion at wastewater treatment plants, considerable electricity could be generated to power local homes.

In 2002, the students in U.S. public schools were found to waste up to 37% of the food served to them at lunch; the highest waste coming from fresh fruits and vegetables (Buzby and Guthrie, 2002). This wastefulness cost an estimated $600 million (USDA, 2002). Students might discard some of their school lunch because they may not like what was served, too much food was served to them, or because they

what they eat for lunch, they are more inclined to finish what they serve themselves (WRAP UK, 2012). If cafeteria administrators were to issue a survey during school and let students vote on what meals they would like to have each week, there may be a measurable reduction in food waste.

waste. By implementing waste reduction practices in schools, the amount of food waste can be and educating students about the importance of moving food out of the waste stream and into composting operations. Through composting, schools can avoid high costs of food waste going to the landfills, and educate students on the importance of the conservation of natural resources. By helping students learn the importance of reducing and composting food waste, students can create awareness in their homes and community in hopes of changing the community values, by teaching their community about reducing food waste. Currently, food waste and yard trimmings account for 27% of all waste which is sent to landfills (EPA 2012e). Composting leftover fruit and vegetables reduces the volume of waste headed for landfills and can provide families and communities with excellent fertilizer in which they can use in their own gardens.

Mansfield Middle School, in Connecticut, has been composting their own cafeteria-generated food waste regularly for the past 10 years, and over that time estimate they have saved more than 43 tons of compostable material from being sent to landfills and saved the school $3,030 dollars in trash disposal fees (Mansfield Middle School, 2001). Since Mansfield Middle School began recycling and composting, they have diverted 40-45% of their waste from landfills (Mansfield Middle School, 2001).

been shown to be up to 65% more efficient than un-insulated models; this difference leads to an annual savings of $350-$450 (Efficiency Partnership, 2012). The U.S. Department of Energy reports that warming cabinets are frequently left on overnight; an un-insulated holding cabinet left idling during non-operating hours can waste around $1000 per year (Energy Star, 2012).

Refrigeration is another major source of energy use in food services. Perishable food is stored as it is delivered in walk-in refrigerators. There are many opportunities to reduce operating costs when it comes to refrigeration. Strip curtains are inexpensive, easily installed and can be added onto existing walk-in refrigeration units, without having to make extensive changes (Efficiency Partnership, 2012). By some estimates, strip curtains alone can cut outside-air infiltration by 75 % and therefore reduce energy costs of cooling the unit (Efficiency Partnership, 2012). Local utility companies sometimes offer rebates that cover the upfront costs to purchase a strip curtain; with a rebate, the payback on a strip curtain is usually well under one year (Efficiency Partnership, 2012). Refrigeration systems with remote condensers have suction lines that transport refrigerant from the evaporator to the compressor; adding inexpensive insulation to suction lines can help keep them from absorbing heat during the transfer process, ultimately making the entire refrigeration process more efficient (Efficiency Partnership, 2012).

Equipment works most efficiently if it is well maintained and used as it was designed to be used. Maintenance of refrigeration units is just as important as the purchasing or modification of the unit and can have a major impact on the efficiency of the unit (Efficiency Partnership, 2012). The coils on the bottom of a refrigeration unit need to release heat and it is important they are kept free of dust and debris; any restriction of the airflow across coils compromises the efficiency of the unit (Efficiency Partnership, 2012). If the connectionless steamer unit previously mentioned cannot replace a traditional boiler, cutting just one hour each day of a boiler on-time can translate to a savings of around $450 annually (Efficiency Partnership, 2012). Food wells are also utilized for keeping food warm while it is being served at meal times. Because the food is not continuously covered, heat escapes from the food wells; this waste of energy can be restricted by simply lowering the water temperature a few degrees. Gaskets and hinges, while small parts of appliances, are essential to their energy efficiency; proper maintenance or

calculated savings rate, it would take less than five months for a full return on the investment and would continue to save the school money after installation. This software is offered for both PC and Mac operating systems, which would be perfect since ACCE has computers that operate on both.

The second applicable software package is Lightspeed Systems Power Management which is specifically designed for schools (Lightspeed Systems, 2012a). It can be configured simply by scheduling powering off and on times from a single authorized user on the network and can be overridden so that the computer can install updates that are needed (Lightspeed Systems, 2012a). Another benefit that using this software may have over Faronics is that the school using this software may be eligible for green rebates from the local utility company. Lightspeed Systems has documented a few case studies of how much money was saved in schools from using their program (Lightspeed systems, 2012a). By installing this program in the Fremont school district in Wyoming, the entire district saved an average of $5 per computer each month (Lightspeed Systems, 2012a). If this program saved the same amount per computer for ACCE, which has 212 computers, then the school could potentially save $12,720 a year; which is about 1% of its annual electricity cost. The Panama Buena Vista school district in southern California is estimated to have saved $60,000 in the first year after installing the program onto 3,500 computers (Lightspeed systems, 2012b). The estimated cost of installing this program on 212 computers

Management also offers other education oriented services, such as web filters to prevent students from going onto websites they sh   at

Changing School Culture and Habits through Classroom Activities

If ACCE or another institution wishes to engage its student body in changing their energy and natural resources consuming behaviors, it would seem helpful to introduce the concepts behind the activities to the student body. By including some of the following activities in classrooms, students will understand why the requested behavior changes are important and how it is in their long-term best interests as citizens of the world to think before they act. Changing learned behaviors is difficult but these lessons will hopefully help.

Energy Conservation: Sources and Uses

The following activities can be incorporated into the following classes:

Calculations on a daily basis can readily lead to discussions about how much energy is used throughout the entire school year by multiplying the cost of energy by number of school days. All of these numbers are estimates but will be very close to the actual costs. Before students move on to considering how they might conserve energy, it might be valuable for them to consider how the funds used for energy

<u>Energy used by lights:</u> Energy consumption can be reduced in a variety of ways but the simplest one is by reducing the amount of time the lights are on. Teachers can have discussions on turning off the lights when they are not needed as well as the advantages of using natural light in areas that receive adequate sunlight. Using natural light can reduce light costs and save money.

The activity below is an in class activity that provides students with a lesson on the relationship between energy efficiency and the reduction of greenhouse gas emissions and uses a comparison between two products that provide light (EPA, 2012g). Topics include how reducing energy use helps the environment, differences in fluorescent and incandescent light bulbs, and examples of other energy efficient technologies and practices

Materials Needed (The materials below are for this lighting comparison demonstration)

Internet access	Compact fluorescent bulb
Spreadsheet software	Incandescent bulb
Word processing software	Tape
Covered box	Light meter
2 pluge strips	Poster board

Students form into groups and compare a 60 watt incandescent light bulb to a compact fluorescent light bulb with the equivalent light output (TJ4(grou-3(an)4(d cT1 0 0 15ETBT1 0 0 1 457.3 521.11 T] TJETBT1 0 0 1 299.33 5

student body. The students will have a better understanding of how much it costs to light their school, and can think of ideas to save electricity and reduce the amount of energy being used.

Alternative Energy and Why It Is Important

The following activities can be incorporated into the following classes: ***Art, Biology, Earth Science, Environmental Science, Geography,*** *and* ***Physics.***

T

demand (Doran, 2012). Coal is the primary source of electricity in the US supplying 49.61% of all electrical power generated (EPA, 2012f). Although co

demand, coal use has devastating impacts on the environment as well as on human health. Mining coal produces pollutants that contaminate the air, land, and water (Greenpeace, 2010). Coal mining also degrades land, destroys habitats, emits harmful greenhouse gases into the atmosphere, and pollutes groundwater (Clean Air Task Force, 2001) Underground mining results in toxic pollutants seeping into the soil and water which can potentially consumed by people (Greenpeace, 2010). The burning and combustion of coal releases toxic pollutants into the air that can cause severe health hazards such as cancer, impaired reproduction, and respiratory problems (Clean Air Task Force, 2001). The negative impacts of coal on the environment inevitably effects human health.

As ACCE and other Baltimore City Public Schools work to lower their carbon footprint and energy costs, it would be beneficial to implement lessons that help students gain a better understanding of alternative energy sources and how these systems work. Establishing solar and wind power related lesson plans and class activities develop a hands-on and interactive knowledge base about small scale solar and wind projects that can help build a stronger future for alternative energy (DOE, 2012e). This type of activity is especially beneficial to career orientated high schools (DOE, 2012e). Students can discuss renewable energy in a variety of subjects, including social studies and geography (what locations are most promising), math (how are energy savings calculated and converted), and the physical sciences (how do solar panels actually capture energy and how do turbines generate electricity).

Students should start by learning the differences between renewable and nonrenewable energy. This basic understanding is essential before students start to study economic and social effects of using renewable resources. There are also opportunities to conduct mini-experiments and develop models in classrooms. For example, students can easily build small wind turbines and solar water heaters and examine exactly how they work. Since these technologies are new and not seen very often, hands-on learning can be beneficial when trying to understand how these new technologies work. As limited fossil fuel energy resources are depleted, new technologies, such as wind and solar power generation have

natural sources of energy with

no limited supply and their use will reduce the reliance on non-renewable fossil fuel sources and promote cleaner energy production (Clean Energy Ideas, 2012). The rapidly growing popularity of the solar and wind energy are creating new challenges for these alternative energy industries including developing a skilled workforce to operate the technology and explaining it to the public (DOE, 2012e).

Project: Wind Energy: Students will physically construct a windmill, which is an alternative energy source. Constructing an actual windmill model demonstrates to students how electricity is physically generated.

There are many resources available online dedicated to school windmill projects. In particular, Ehow.com (http://www.ehow.com/how_6600557_make-windmill-school-project.html) has many small windmill projects for educators to complete with students (Guy, 2012). Materials are all common househol

10. Suck on one end of the tubing in the control bucket to fill the water pipe with water. Make sure there is no air in the pipe when you insert it back in the water.
11. Leave the solar heater and control bucket out in the sun for 3-4 hours and measure the temperature of the water periodically, as well as the temperature inside the heater.

Lesson plans and inexact increments to demonstrate to the students the amount of water present in the oceans, ground water, rivers, ice caps/glaciers, fresh water lakes, and inland seas/salt lakes. At the end of the activity, students will be able to comprehend how much water is available for human consumption and how much water is unavailable.

Some follow-up q

1. What do you perceive as an issue with this limited amount of fresh water?
2. What do you think could be done to help prevent our water supply from becoming even more limited?
3. Why is frozen water in glaciers and ice caps unavailable for human consumption?

Rain Barrels

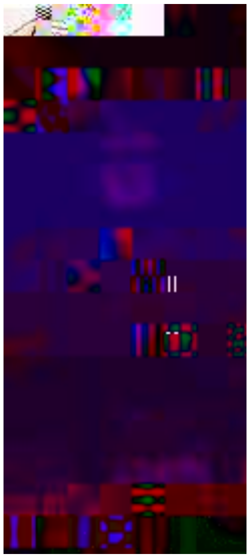
The following activities can be incorporated into the following classes: ***Biology, Chemistry, Mathematics, Physics,*** *and* ***Environmental Science***

Stormwater runoff flowing over impervious surfaces rapidly erodes soils and allows pesticides applied to land surfaces and other pollutants to reach waterways (Chesapeake Bay Foundation, 2007). Reducing runoff as much as possible is very beneficial to waterways because soils remain intact. Rain

Acid rain is the result of air pollutants interacting with rainwater. While students might have heard

people worry about it.

Students can collect rainwater from rain barrels or buckets to test the effects it has on their garden. By



The students can than take the data and use them to calculate how much waste is being generated by the school per year. Afterwards, they can figure out how many schools there are in their district, and how much compostable material would be dumped into landfills from their district for the entire year.

Creating a Composting Program for a School Cafeteria: Students can learn more about composting by being given responsibility for what they do with their food waste in the cafeteria. The cafeteria should have different trash cans for each type of material being used and thrown away; trash, compostable items, recyclables. The choice will be given to the students, after they have learned what materials can be composted, recycled, or sent to a landfill. The students could decorate the containers for each material in an art class to make the cans more appealing in the cafeteria. Twin compost tumbler, tools, and buckets should be acquired to collect food waste (Mansfield Middle School, 2001). The food waste, which will be gathered from the cafeteria using labeled cans, which state they are for compostable material only (Mansfield Middle School, 2001). The cans filled with compostable material should be emptied into the compost tumblers. The compostable foods need to be mixed with certain volumes of

Were your predictions correct?

What kind and how much insulator works the best?

Do you think that composting school wide could help reduce waste produced in the school? Why?

Composting concepts in Biology: A biology lesson could focus on the process of decomposition and its

another one that could be posed and implemented into a lesson plan along with: what effects does the transportation used to move recycled products have on the environment?

(Connecticut, Department of Environmental Protection. 2001). This concept can be applied in art classes by having the students complete a project using recycled materials to form different sculptures (Connecticut, Department of Environmental Protection. 2001). This embraces the idea that reusing materials can be fun and even aesthetically pleasing.

School-

teach the students the importance of recycling; which can be supported by competitions between grades as well as between classes in order to determine which group can recycle the most. Prizes can be distributed to provide incentives for students to recycle.

The implementation of recycling lesson plans is a relatively inexpensive way to reduce a schools carbon footprint while simultaneously reducing disposal costs of the school. Not only would this translate to a cleaner school, but by teaching the students all about recycling and its benefits, it is hoped that those habits would follow the students home thereby helping the community to become more environmentally friendly.

Having a green curriculum is one step to making a green school. Green learning is a way to teach the students how and why the environment is important. The green curriculum helps to illustrate the commitment to environmental education by the faculty, a critical component 4(ta48F0 0 1 i aTm)-20(po)4(ne)4(nt)-7(4(

participation of a teacher, student, administrator, parent, community partner or other facility person and must have the support from the principal or top administrator; this committee structure insures wide support for the initiative (MAEOE, 2012a). The profile summary of the school, a second section of the application, includes information about the school location, the make-up of the student body, the school atmosphere, and introduces the Maryland Green Schools activities already implemented (MAEOE,

y presents and provides

documentation of the activities, projects, and experiences that the school has taken in an effort to achieve Green School status (MAEOE, 2012a). The third section of the formal application includes a summary that outlines the completion of three major objectives including curriculum and instruction, best management practices, and community partnerships (MAEOE, 2012a).

MAEOE makes its decisions known by April 30th of the application year and the schools that are accepted into the Green School Program are publically celebrated at a Maryland Green School Youth Summit (MAEOE, 2011c; MAEOE, 2012a). The Youth Summit, open to the public, provides an opportunity for students, teachers, and parents to be involved in environmental workshops and field experiences, as well as engage in community relations (MAEOE, 2012a). Teachers and educators also have the opportunity to acquire information about classroom activities and curriculum that incorporates Green School fundamentals into the classroom (MAEOE, 2011a).

Schools that achieve the status of Green School will have to apply for recertification after four years (MAEOE, 2011c). For recertification the school needs to document and submit any modifications or new activities directed toward maintaining the three Maryland Green School objectives (MAEOE, 2011c).

What Makes Green Schools Special

Being a Maryland Green School means more than having a special flag; it reflects fundamental activities that are incorporated into the school that

involved.

<u>Objective 1: Curriculum and Instruction</u>. All schools certified as Green schools much meet each of the following criteria (MAEOE, 2012a)

Criteria 1. Use of environment as a context for learning

Students at the school, engaged in a wide variety of course in different disciplines across all grade levels, must have the opportunity to learn about environmental issues both in the classroom and outside of the school classroom. Also they should have the opportunity to learn about environmental issues throughout the community (MAEOE, 2012a).

At the Gorman School, they have developed what they call a green lifestyle program in which green activities are found in all aspects of the school s activities (GCES, 2012). The environment and environmental issues are included in multiple classes (GCES, 2012). Also, they have developed a Green

Team in order to direct student interest and cooperation to addressing and remediating environmental issues in and around the school (GCES, 2012).

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Table 5. Brief Description and examples of Objective 2 (MdAE(r)E2(1Z2a)3(u)/Wefes for Esls, pla

Water Conservation/Water Pollution Prevention
The scope: Indoor and outdoor user behavior: teaching about smarter water use, the energy and resource impacts of producing drinking water and treating wastewater, storm water management, erosion control, the impact of storm water runoff on watersheds and the Bay etc. **Examples:** (but gardens, erosion control measures, storm drain stenciling, parking lot curb cuts, pervious paving for reducing runoff from driveways and parking lots, planting riparian buffers.
Energy Conservation
The scope: Reduce energy demands of the school by updating facilities and user behavior. **Examples:** (but not limited to) Student made reminders to turn off the lights and devices, student energy monitoring, calculat conducting an energy audit, reduce phantom energy loss, tracking and reporting energy savings.
Waste Reduction
The scope: Resource use, waste disposal and waste management. Schools and students examine their resource use, with user education and behavior changes to reduce their waste stream. **Examples:** (but not limited to) Collecting cell phones and ink cartridges for recycling, reducing volume of reduced or recycled.
Habitat Restoration
The scope: Construct, install or enhance the school site with habitat restoration projects, with education on the benefits to the local ecosystem and watershed. Any landscape has the potential to provide some of the benefits provided by natural ecosystems. Other options are to raise native species in the classroom, build reef balls, plant bay grasses etc. **Examples:** Native plant gardens, trees, wetlands, meadows. Remove invasive plants or trees. Raising and releasing trout, eels, terrapins, monarch butterflies, sturgeon, yellow perch etc.
Structures for Environmental Learning **The Scope**

This last objective is to bring the school community and the local community together in their

Benefits / Incentives

There are a variety of reported benefits associated with establishing the Green School Program at a school including increased academic achievement of the students, more engaged students with

Through organizing these events and social media network pages, students will gain communication and leadership skills, which are essential skills to be successful in the working world. The Green Team can use their creativity skills to think of incentives that would help encourage

The value of farm and garden scale urban agriculture is increasingly being recognized. Growing food and non-food crops in and near city schools contributes to healthy communities by engaging students in work and recreation that improves well-being, along with contributing to the local community (Green Heart Education, 2012)

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Appendix A

Survey questions submitted to students in the science class.

Should this item be put into a recycling container?

Plastic Bottle Yes/No	Pizza Yes / No	Soda Can Yes/No
Newspapers Yes/No	Glass Bottle Yes/No	Chip bag Yes/No