B'More Green Schools:
Increasing Efficiency and Enhancing Education

Authors

Holly Burkhardt
Lea Corddry
Eric DiMeo
Tynekia Garrett
Cara Hostetler
Heather Kampe
Brett Kilczewski
Margaret Kozloski
Mary Powell
Matthew Sheils
Lee Single
William J. Smith
Skyla Steele
Ryan Streett

ENVS 491 Fall 2012

Table of Contents

Acknowledgements

We would like to thank the following people and organizations for their assistance in the development and completion of this project:

ACCE Student Survey Participants

ACCE Green Team Students

Jason Mathias, Department of General Services, Baltimore City

Samantha Easter, Department of General Services, Baltimore City

Victoria Mathew, Lead Science Teacher, ACCE, Baltimore City Schools

Susan Carroll, Program Coordinator Baltimore Energy Challenge

Missy Doot, Baltimore Energy Challenge

Renee Goodenow, Baltimore Energy Challenge

Quinhon N. Goodlowe, Principal, ACCE, Baltimore City Schools

William Moeller, ACCE, Baltimore City Schools

Keith Winslow, ACCE, Baltimore City Schools

Steven Kolb, Energy Manager, Towson University

Daniel Davis and Associates

Greenspring Energy

Ashley Traut, Blue Water Baltimore

Jean Mellott, Landscape Architect

Anne Draddy, Department of General Services, Baltimore City

Dr. Jane Wolfson, Director, Environmental Science and Studies, Towson University

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 parts or all of Delaware, Illinois, Indiana, Kentucky, Maryland and other states (PJM Interconnection, 2012), projected that by the year 2011, Maryland would not always be able to import a sufficient amount of energy to keep lights on thereby creating rolling blackouts (Energy Future Coalition, 2008). Rather than address this problem by increasing local production capacity that would lead to increased electrical costs for residents, Maryland chose to address the challenge by requiring reduction in energy consumption by improving efficiency and so passed the EmPOWER Maryland Energy Efficiency Act.

EmPOWER Maryland contains a variety of initiatives and programs designed to reduce energy consumption; one is the Maryland Energy Administration's (MEA) expansion of the State Agency Loan Program (SALP) (Maryland Energy Administration, 2012). MEA is increasing the funds available for commercial loans by 50% reaching $1.5 with a zero interest revolving loan program for projects that enhance energy efficiency (Maryland Energy Administration, 2012). Possible projects eligible for funding are energy efficient lighting, controls, heating, ventilation, and air conditioning (Maryland Energy Administration, 2012). MEA will also expand the funds available through the Community Energy Loan Program (CELP), a low interest revolving loan program available for hospitals, schools, and local governments, to finance energy efficient investments by 33% to $2 million (Maryland Energy Administration, 2012). In addition, the legislation requires local jurisdictions to submit information to StateStat, a performance measurement and management tool (O'Malley, 2012), so that their progress towards energy reduction can be monitored (Maryland Energy Administration, 2012).

Baltimore City is one of many jurisdictions under the EmPOWER Maryland Energy Efficiency Act that is required to reduce its energy consumption. The City and its various agencies are all charged with reducing their energy use. The Baltimore City Public School (BCPS) system presents a substantial challenge to energy reduction, most notably because of the age of many of its school buildings. Many Baltimore City school buildings are stately, traditional school buildings built at a time when energy consumption wasn't a problem and high efficiency technologies were not widely used. Today, this traditional construction is causing high-energy consumption that needs to be reduced to bring the City into compliance with EmPOWER Maryland. Schools are important in helping Baltimore City and the state of Maryland reduce energy consumption because they have the ability to impact future generations, influence other members of the community and can serve as working models of change. School energy and resource use can be reduced through upgrades and retrofits.

New Vista High School in Boulder, Colorado was awarded the 2011 Green Prize in Public Education (National Environmental Education Foundation, 2011). The school received the award after retrofitting toilets from 3.5 gallons per flush to 1.28 gallon low flow models (National Environmental Education Foundation, 2011). They also installed solar panels which eliminated 12,177 pounds of carbon dioxide emissions annually (National Environmental Education Foundation, 2011). The incorporation of environmental content into the school's curriculum has students focusing on real world applications in their lessons; the students proposed and implemented methods to reduce energy (National Environmental Education Foundation, 2011). "Lights out school lunches" is a program implemented through the students' initiatives to cut the energy costs at their high school by using daylight instead of artificial light in their cafeteria (National Environmental Education Foundation, 2011). In addition to science classes, multiple academic subjects such as civics, English, and mathematics have incorporated 'green' projects and examples used in teaching (National Environmental Education Foundation, 2011). In 2012, a civics class project resulted in a successful petition to the Boulder City Council that led to a ban on plastic bags at local grocery stores (National Environmental Education Foundation, 2011). Such projects allow students, teachers, and schools to become the foundation of environmental change.

At New Vista the school's physical changes led to educational awareness and action by the student body. Similar changes can occur in Baltimore City schools. The particular school we have focused on in this report is the Academy for College and Career Exploration (ACCE) that occupies a building constructed in 1923. This school and its building reflect the energy reduction challenges of a historic building but it also, through the educational activities and the initiatives of its administrators, teachers and students, has an opportunity to make a wide-reaching impact on its students and the larger community.

ACCE is currently incorporating energy and environmental awareness in student activities; a "Green Team" has been established; the Green Team is active in the school garden, which is planted and maintained by students, and promotes environmental sustainability at the school. The school has begun the application process to be recognized as a Maryland "Green School." The school's progress is well noted, however, in order to accomplish the goals set forth by the state of Maryland in EmPOWER Maryland, they need to reduce their energy consumption; this would be greatly assisted by physical upgrades to the building. According to the Jacobs Report, an evaluation of the physical conditions of the schools, the building ACCE occupies requires a substantial investment; the report estimates a need for a $14,310,496 investment (Jacobs Report, 2012). The problems noted in the report are substantial; structural concerns consist of missing joint sealants, inappropriate lighting, damaged roof shingles, 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 energy challenge, we realized partial compliance with state mandates could be achieved through energy-efficient behavioral changes by members of the ACCE community. Such changes would not be costly and would enhance student learning by focusing on 'real world' needs. Representatives from the Baltimore Energy Challenge (BEC) presented the results of their work suggesting that behavioral changes among household members can produce significant reduction in household energy consumption and costs. We adopted their platform and began creating learning activities and hands on projects that may be used by teachers at ACCE and other educators. Learning materials are presented on a variety topics covered by our research and are appropriate for different subjects.

Providing ACCE with the tools needed to implement energy efficient changes should reduce the average utility costs. According to the Center for Green Schools; a school that is "green" can save up to $100,000 a year on operating costs (Long, 2011). In addition to energy savings, "green" schools are associated with academic success; evidence indicates that a healthier learning environment improves the overall performance of students and their productivity on tests (American Federation of Teachers, 2008).

What follows are the results of our consideration of the major energy/natural resource expenses associated with ACCE as we viewed it during the fall of 2012. We have evaluated different methods to improve its efficiency although we have not been able to develop financial projections because the retrofits and equipment requirements are site specific; we present guidance as to what to consider as best we can. At the same time, we are mindful of the primary role of ACCE as an educational institution and the role that students can play in improving the energy efficiency of the facility. We are also aware of the impacts of 'applied' problem solving on student achievement and student engagement. Since there are important employment opportunities within the 'green' industry we hope that exposure to the activities proposed lead some ACCE graduates down that pathway. Should the curriculum connections be adopted in whole or in part, it appears as if ACCE is well on its way to becoming a "Green School" and receive certification. We hope our work is of assistance to ACCE and DGS.

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 being wasted. Therefore, the first step that a school, business, or homeowner should take to reduce their energy consumption is to invest in having an energy audit conducted for the entire building. An energy audit is an inspection and analysis of flows of energy throughout a building and its operational systems to identify energy conservation problems and solutions (DOE, 2012a). Energy audits for schools are done by professionals who use their skills and various technologies to identify areas where energy is being lost and suggest measures that can be taken to improve energy efficiency with the resources that are available (DOE, 2012a). Major areas inspected include the building envelope, lighting, HVAC systems, and appliances (DOE, 2012a). Utility bills are also analyzed to identify if energy is being wasted through unnecessary use of electricity and water. Energy audits can be very time intensive depending on the size, age, and condition of the building and range from a few weeks to several months. Professional energy audits can be conducted by private auditing companies and there is the possibility that local or state government agencies could receive a discounted rate (DOE, 2012a).

Energy audits provide several options for improving buildings' energy efficiency when the building is faced with challenges such as high energy bills, poor air and lighting quality, uncomfortable and uneven temperature gradients throughout the building, etc. Energy audits provide the opportunity for schools, homes, and buildings to identify and eliminate systems that are inefficient. An energy audit will diagnose energy consumption problems which, if addressed, will reduce the energy costs of daily operations. Such improvements will also improve the reliability and effectiveness of operations, increase performance and productivity of occupants by making the building more comfortable, and will increase property value (AltaNova, 2009). The energy audit documents the energy efficiency of a building, allowing the owner to make rational decisions about upgrades

There are several types of energy audits including the Home Energy Tune-up and the Diagnostic Home Energy Survey (Regal Services, 2012). The Home Energy Tune-up is an audit in which the physical structure of the building is visually inspected and a diagnostic report is developed to help determine what to do to improve the building's efficiency. The Diagnostic Home Energy Survey is split in to three components in order to produce a more fine-tuned audit of the structure. This Survey uses a Blower Door in which a door is turned into a housing for a large fan that blows air throughout the house allowing the operator to detect the amount of air leaking into the house (Regal Services, 2012). This survey also uses a duct blaster in which a blower is put directly to a vent and forces air through the ventilation system of a structure to check for leaks (Regal Services, 2012). The last part of the survey is the thermal imagery survey which is done by scanning the structure with an infrared gun; this documents 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 overall lighting system's effectiveness and helps control lighting costs 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 from scheduling a routine check of all lighting fixtures in the building, so that lights that are ‘on’ are being used efficiently.

Outdoor security lighting is important for school facilities to protect the building from vandalism and intruders. By putting these outdoor lights on timers, the lights will be in use only during the night when they are needed and not wasting energy at other times (Lighting, 2012). Large programmable timers are available that can be programmed for several different time intervals for each day of the week (Lighting, 2012). These timers would be ideal for an outdoor lighting system on a school building with many lights wired in series. A timer system is an easy way to reduce wasting energy for lights that are on during daylight hours. A photocell system is another option which would be the best system to use outside. A photocell sensor responds to daylight levels and turns lights on and off only as needed, no programming is required and such systems respond to seasonal changes automatically (Lighting, 2012). The outdoor lighting system at ACCE would be greatly improved by being updated to a photocell system. Currently, the lights are coming on during the day and lighting areas when they do not need to be lit. By upgrading the system to a more efficient timer system or a photocell system, energy cost would be reduced and the lights would only come on when needed.

The use of occupancy sensors or motion detectors can reduce classroom and office use of lights, turning them off when no one is in the space. Occupancy sensors or motion detectors will regulate lighting use to periods when people are present (Lighting, 2012). The use of motion sensors works best in areas where lights are necessary but are not used continuously. Occupancy sensors detect a person’s presence in a room, turning on the lights only as needed, and shutting them off when the room is empty again (Lighting, 2012). Motion sensors can be used in the classroom to help cut back on lights being left on when the room is empty. Basements and bathrooms are another place where a need for light is intermittent; these areas are not used constantly and it is easy to forget to turn the lights off when exiting. Motion sensors come in two basic types, a wall mount or a ceiling mounted model. Wall sensors are designed for small rooms and work well for most offices and classrooms (Lighting, 2012). Ceiling sensors are better suited for large open spaces such as hallways (Lighting, 2012). Motion sensors are an easy and efficient way to save energy in a building. Depending on the space and its uses, occupancy sensors have the potential to save a great deal of energy. There are reports of savings from 13%-50% in an office setting, 40%-46% in a classroom setting and 30%-90% in restrooms (Focus on Energy, 2012). The sensor will replace a current light switch, no rewiring of the light system is necessary (Focus on Energy, 2012).

Light switches turn lights on and off, but they give you no control over how much light is being emitted. Light dimmers can circumvent this problem by regulating the amount of light that is emitted by the light fixture. Unfortunately, this technology can only be used with compact fluorescent bulbs and

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 same lumens for less energy (Hozler, 2003). To help cut back on energy consumption retrofitting older T12 bulbs with new T8 or T5 bulbs is an affordable way to solve this problem. Upgrading from T12 to T8 costs about $20 per lamp, including parts and labor and will have a five to seven year payback period (Parpal, 2006). This involves installing a new up-to-date power supply, also known as a ballast, in the fixture as well as the new energy efficient bulb. T12 uses a magnetic ballast that is inefficient compared to new electronic ballasts (Parpal, 2006). Another great feature when upgrading to T8 from T12 is that the fixture remains the same (Parpal, 2006). In order to keep the costs low the school could upgrade sections of the building instead of replacing all the old bulbs at once; it might be best to start the replacements in an area most heavily used. Further reductions in energy use can be had by installing new T5 bulbs. T5 lamps put out up to 100 lumens per watt of energy compared to T8 lamps that put out 80 lumens per watt (LuxAdd, 2012). Currently, ACCE has a variety of different lamps ranging from T12 to T8 bulb systems. Upgrading the current system to all T8 would help save energy and be the most cost effective method. Upgrading the entire system to T5 lamps would produce the greatest energy reduction but is currently a more expensive technology. Using smaller diameter bulbs also means less mercury, a hazard associated with the use of all fluorescent lamps (Parpal, 2006). Mercury is used to help produce the light in the tube, but mercury is a toxin and can be released if a tube is broken (Parpal, 2006).

Light emitting diodes (LEDs) are an up-and-coming way to improve lighting systems (Martin, 2012). LEDs are a solid-state form of lighting that is long lasting and very efficient (Martin, 2012). LEDs are small lenses and have tiny chips placed on a heat-conducting material to produce light using less energy than other sources (Lee, 2012). Since there are no filaments in gas they are less vulnerable to vibrations, making them less prone to break (Lee, 2012). LEDs are small, measuring from 3 to 8 millimeters, and can give off light in one specific direction compared to incandescents that put out light in all directions (Lee, 2012). Installation of LED lights in areas of greatest use such as classrooms, bathrooms and corridors will produce the greatest savings (Lee, 2012). LEDs keep energy bills low, due to their energy saving capacity, which also makes them better for the environment (Martin, 2012). Updating an old lighting system with LED technology can save up to seventy-five percent of current energy consumption and is a great way to save energy (Martin, 2012). LEDs also have a very long life span; a single bulb will last 50,000 hours compared to 2,000 hours for an incandescent bulb and 10,000 hours for a compact fluorescent (Lee, 2012). In the long run this reduction of energy use will save money.

Lighting is a major part of energy consumption in a building and while upgrades to more modern lighting technologies might be the preferred option, they can be costly; there are options for schools and classrooms to reduce energy consumption that do not require upgrades. Basic behavioral changes and energy efficient habits by users of the school building can result in a substantial decrease in the amount of energy being used. Implementing behavior changes at ACCE would be a relatively easy and inexpensive way of reducing energy costs. According to the Baltimore Energy Challenge, a school building can decrease energy costs by 5% through behavioral changes (BEC, 2012). The behavioral changes that can be done in the school are simple and easy to follow as long as everyone in the school is following the rules. The first major way to save energy is by turning off lights when leaving an empty room (Smith, 2011). Oftentimes, people forget to turn off a light switch when they are the last person leaving a room. This results in the light staying on for long periods of time with no one using the light. A simple decal placed over the light switch can help remind the last person in the room to shut off the lights and can help address this problem (Smith, 2011). Another easy way to cut back on light use energy is to take advantage of natural sunlight. Many classrooms have windows that can allow significant amounts of light into the room. This light could be used instead of turning on the lights. These two simple behavioral changes will help cut back on the school's overall energy consumption. Small actions, consistently performed by all people, will add up and cut back on energy consumption (Smith, 2011).

Heating Ventilation & Air Conditioning

Students are in schools to learn, but the physical environment can influence how easy or difficult that is. *Health Reformer Magazine* reports that the neglect of proper ventilation in schools is partly responsible for drowsiness and dullness making teaching ineffective (EPA, 2012a). At the same time, conditioning air is expensive; research indicates that energy use of air conditioning systems falls by 4 to 5 % for every degree that you raise the thermostat setting (Efficiency Partnership, 2012). One inexpensive way to improve comfort is to keep the air moving by using efficient Energy Star qualified ceiling 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 fans may not offer a permanent solution to a school's ventilation needs, the EPA offers software to school 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 City schools, is often found to be the heating, ventilation and air conditioning (HVAC) systems (Efficiency Partnership, 2012). HVAC renovations are typically costly, but can produce a large return on investments in reduced energy use and cost savings in a few years (Efficiency Partnership, 2012). The HVAC system currently in use at ACCE and other schools of similar age presents an opportunity for increased energy efficiency through improvement of these systems. ACCE's HVAC system can be divided between its two main functions of heating and cooling the building's interior space.

The current cooling system utilized at ACCE and many other Baltimore City schools are unitary heat pumps and air conditioners (Trane Heating and Cooling, 2012). These systems, outdated and largely inefficient, provide cooling to individual rooms and consist of limited ductwork (Trane Heating and Cooling, 2012). For a building like ACCE, the lowest cost option would be to replace these heat pumps and air conditioners with more advanced efficient models (Trane Heating and Cooling, 2012). While initially inexpensive to install, this type of unit ultimately becomes more costly and less energy efficient over time. The most common upgrade for a cooling system in a building of ACCE's condition and age would be the use of chillers in order to provide cooling (Trane Heating and Cooling, 2012). The initial installation expense of a chiller system would be relatively high, however the payback time, between five and ten years would represent greater energy savings than other options (McQuay Air Conditioning, 2012).

The different types of cooling systems for HVAC installations include Unitary Heat Pumps and Air Conditioners, Evaporative Cooling Systems, Air Conditioning Systems and Chillers (Efficiency Partnership, 2012). An air-conditioning system consists of more than just the unit itself; it consists of ductwork, ventilation, thermostats, and fans, which control and distribute the conditioned air. To work well, the air conditioning units must be correctly sized and correctly installed (Efficiency Partnership, 2012). The use of individual air conditioners has proved to be less energy efficient than whole building systems 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).

Chillers are large units that use the cooling of water to cool down buildings (APS Business Service, 2012). Much like an evaporative cooling system, warm air is blown over a large ice block but the evaporated water is collected and pumped through coils, at 35 to 45 degrees Fahrenheit. The cold air that is collected off of the chillers is circulated throughout the building. Chiller systems are becoming more popular due to their ease of use and low maintenance costs (APS Business service 2012). These units are frequently used in all types of commercial and industrial buildings that consist of several floors. HVAC units such as chillers and heat pumps, need to be properly maintained on a regularly basis; proper maintenance can avoid the need to purchase a new unit that would be extremely costly for a school (Energy Star 2012). New HVAC units are designed to operate under certain building configurations and uses such as high-rises, schools, residential and commercial use and are more energy efficient than older models; the proliferation of specially engineered units for different situations makes the selection of a proper unit especially difficult (APS Business Service, 2012). A decision should take building size along with quotes and specifications for high-efficiency unit lifecycle costs into consideration. It is always wise to select units that are Energy Star qualified.

The heating system for ACCE and other Baltimore City Schools involves the use of a natural gas steam boiler. The use of a boiler system, which involves heating water in order to distribute heat in a building though a series of pipes and ducts, is a traditional method of heating a building (DOE, 2012b). Due to the low price of natural gas, this method of heating a building represents the most efficient method without incurring substantial installation costs and relatively long payback times (Trane Heating and Cooling, 2012). The current system installed at ACCE and similar Baltimore City Schools has an efficient network of ducts in place to distribute heat from the boiler. Due to the relative efficiencies of boiler systems, continuing to use the current boiler system and distribution network would be the most cost efficient option in terms of energy efficiency (Trane Heating and Cooling, 2012). The current boiler system could benefit from being updated to a new model as improvements have been made in natural gas steam boilers, however, switching to a new overall heating system would not prove to be cost effective (Trane Heating and Cooling, 2012). Such a switch would incur the costs of replacing the existing pipes and ductwork, as well as the costs associated with the purchase and installation of a new system (Trane Heating and Cooling, 2012). Such alternative options as solar or geothermal heat require their own specific distribution system for the heat (Trane Heating and Cooling, 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.

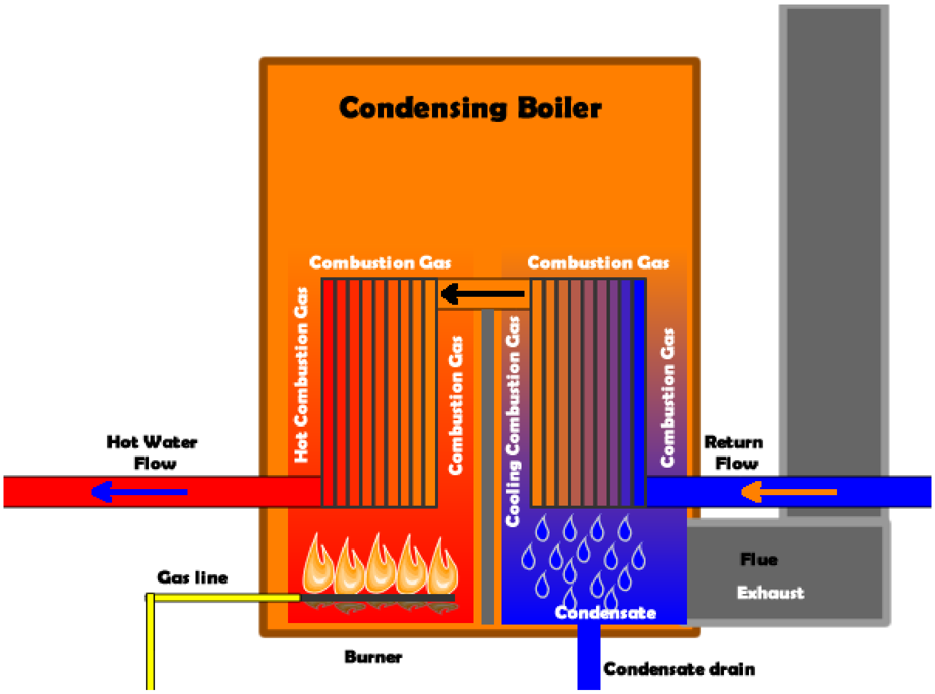


Fig. 1 Diagram of a Condensing Boiler (American Combustion Industries, Inc., 2011).

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 the window to the outdoors (Fisette, 2012). Convection occurs when warm air rising loses its heat as it touches the cooler glass and then sinks to the floor; this sets up currents of warmer air continually flow toward the window, cooling and sinking to the floor, creating a drafty situation (Fisette, 2012). Radiation is the movement of heat in the form of infrared energy through the glass. Air leakage is simply the passage of heated air through cracks and around weather-stripping, that are part of window iinstallation (Fisette, 2012).

The rate of heat loss through a windowpane is indicated by its U-Value; the lower the U-Value, the greater a window's resistance to heat flow and, therefore, the better its insulating qualities (Efficient Window Collaborative, 2012a). State codes and regulations mandate that windows with certain U-Value ratings be installed in a residential setting. Licensing for window installers as well as building inspectors employed by local and state agencies ensures that codes and regulations are observed (Efficient Window Collaborative, 2012a). Each state in the U.S. has an International Energy Conservation Code (IECC) regarding the U-Value of windows and skylights (Efficient Window Collaborative, 2012a). For example, Baltimore, MD falls in a specific zone based on climate; for this specific zone, windows installed in residential buildings cannot have a U-Value more than 0.35 and skylights cannot have a U-Value more than 0.60, based on the 2009 IECC for Maryland (Efficient Window Collaborative, 2012a). Codes for commercial buildings, on the other hand, are not as strict, but many companies offer recommendations for maximum efficiency. For example, the Advanced Energy Guide K-12 School Buildings recommends U-Values of 0.42 or less in a seasonal climate and 0.33 or less in a cold climate (Efficient Windows Collaborative, 2011).

Sunlight also plays a major role in heat loss or gain through windows; when the sun's energy strikes a window, visible light, heat (infrared radiation), and UV are reflected, absorbed, or transmitted affecting the internal environment (Efficient Windows Collaborative, 2012a). The amount of energy that is transferred through a window depends on the number of panes, window glass coatings, and frame materials (Efficient Windows Collaborative, 2012b). Double or triple-pane windows have space between the panes; such a window has a lower U-Value because of its increased ability to resist heat flow (National Renewable Energy Laboratory, 2010). The width of the air spaces between the panes is important; if the air space is too wide (greater than 5/8 in or 1.6 cm) or too narrow (less than ½ in or 1.3 cm), then the window has a higher U-Value because the space allows too much heat transfer (National Renewable Energy Laboratory, 2010). When the space between the panes is filled with an inert gas, like argon or krypton, the window becomes even more resistant to heat transfer and thus, lowers the U-Value 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 reduces radiative heat flow. The reduced radiative heat flow ultimately reduces the U-factor (Efficient Windows Collaborative, 2012a). Treating windows with a low-E coating is not window tinting; tinting only reduces the visual light transmittance, but does not impact the U-Value (Efficient Windows Collaborative, 2012a).

Low-E windows work differently in different natural climates (Efficient Windows Collaborative, 2012a). In a hot climate, low-E windows keep the interior of a building cooler by reflecting the sun's long-wave heat energy, while admitting visible light (Efficient Windows Collaborative, 2012a). In a cold climate, low-E windows reflect long-wave radiant heat back into the interior of the building, also admitting visible light (Fisette, 2012). Low-E windows are a system of double pane windows utilizing a warmer pane and a cooler pane. One of the panes will be low-E treated depending on the type of climate; in a hot climate, the exterior pane, in a cold climate, the interior pane (Efficient Windows Collaborative, 2012a). The treated pane blocks significant amounts of radiant heat, which lowers total heat flow through the untreated pane (Efficient Windows Collaborative, 2012a).

There are three major types of Low-E windows: Double Glazed with High-Solar-Gain, Double Glazed with Moderate-Solar-Gain, and Double Glazed with Low-Solar-Gain. High Solar Gain windows are ideal for a region of yearlong cold climate because it maximizes solar heat gain and reduces heat loss from the interior (Efficient Windows Collaborative, 2012a). Moderate-Solar-Gain windows are ideal for a region of seasonal cold and hot such as Maryland because it reduces solar heat gain, while retaining visible light transmittance allowing the building to gain heat in the winter and keep cool in the summer (Efficient Windows Collaborative, 2012a). Low Solar Gain is ideal for a yearlong hot climate because it further reduces the solar heat gain, while retaining visible light transmittance, thus preventing the building to heat up (Efficient Windows Collaborative, 2012a).

Low-E glass coatings reflect up to 90% of long-wave heat energy, improving the insulation of a window nearly equivalent to adding a third pane (Efficient Window Collaborative, 2012a). Low-E coating can be combined with low-conductance gas fillings to increase energy efficiency by nearly 100% more than clear glass (Efficient Windows Collaborative, 2012a). The cost of low-E coatings and low-conductance gas fillings comprise about 5% of the window's overall cost (Fisette, 2012). One study 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 window's efficiency 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	U-Value	Amount of Solar Heat Transmitted	Amount of Visible Light Transmitted
Double Glazed with High-Solar-Gain	0.30	71%	75%
Double Glazed with Moderate-Heat-Gain	0.25	39%	70%
Double Glazed with Low-Solar-Gain	0.24	27%	64%

Window framing has a critical impact on a window's U-Value (Efficient Windows Collaborative, 2012a). Window framing materials range from wood, composite, vinyl, fiberglass, and aluminum and have different aesthetics as well as different impacts on U-value Efficient Windows Collaborative, 2012a). Wood frames are the most thermally nonconductive, but are also the most expensive and require the most maintenance (Efficient Windows Collaborative, 2012a). Composite frames allow for more flexibility and can be 'custom fit' for specific environments (Efficient Windows Collaborative, 2012a). Vinyl frames, like wood frames, are efficiently nonconductive if a lighter colored vinyl is used (Efficient Windows Collaborative, 2012a). Air leakage is problematic for vinyl frames because temperature changes cause vinyl to contract and expand more than wood, aluminum, and glass, creating air gaps (Efficient Window Collaborative, 2012a). Fiberglass frames, unlike vinyl frames, are extremely strong and can move with the glass as it expands and contracts. Fiberglass is more expensive than vinyl but it is more energy efficient and durable, similar in quality to wood frames (Efficient Windows Collaborative, 2012a). Aluminum frames are low maintenance compared to wood, and more affordable than composite or fiberglass however, aluminum is a metal and therefore a good conductor of heat (Efficient Windows Collaborative, 2012a). Aluminum heats and cools faster than other materials, thus condensation becomes an issue (Efficient Windows Collaborative, 2012a).

Window options such as panes, coatings, and frames are very useful in configuring the most energy efficient window for a given climate. Due to the many different factors that could affect window efficiency, pricing for windows becomes contractor and site-specific. While the expense and scale varies between residential and commercial energy efficient windows, the technology and processes behind them do not.

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 the students at ACCE if heat gain isn't excessive. The Center for Innovative School Facilities in Portland, Oregon has conducted research that shows how quality and quantity of natural light impacts students' 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.

If ACCE were to undergo a physical transformation, including the replacement of windows, especially the windows in the front of the building that catch the morning sunlight, this could be beneficial for the school by reducing heating and cooling costs, as well as creating a better learning environment for the students. Converting from single-pane to double-pane, low-E windows, will create the benefits of natural light in the classrooms, along with lower energy costs.

The window replacements selected will have a large impact on energy efficiency. The University of Minnesota's Center for Sustainable Building Research has created a tool called the Façade Design Tool, which allows any individual to find out how much energy is being used based on window type and other specifics of the building and its location (University of Minnesota, 2011). By simply plugging in this known information, anyone can be given an estimated measurement of energy being used in kBtu/sf per year. For example, a single-pane, clear window with high solar heat gain and high visible transmittance will have a U-value of 1.03 and have an annual energy use of 155.82 kBtu/sf per year (University of Minnesota, 2011). In comparison, a low-E, argon filled, double-pane window with high solar heat gain and high visible transmittance will have a U-value of 0.24 and an annual energy use of 128.88 kBtu/sf per year (University of Minnesota, 2011). If the amount of solar heat gain were to be decreased through that low-E, argon filled, double-pane window, there would still be a U-value of 0.24, but the annual energy use would decrease to 120.45 kBtu/sf per year (University of Minnesota, 2011).

Since Baltimore is known for hot summers and cold winters, this decrease in solar heat gain is more likely to occur in the winter time, when the sun is not as high in the sky. When solar heat gain is high (summer time), the amount of energy used to keep the building temperature regulated will be higher than it would be when solar heat gain is lower (winter time). Therefore, it is more costly to cool a building when solar heat gain is high than to heat it when it is low.

Insulation

Heat naturally flows from warmer to cooler spaces due to conduction, convection and radiation (DOE, 2008). Insulation is used to prevent the transfer of heat from the interior to the exterior of a building and vice versa (DOE, 2008). There are several different kinds of materials that can be used as insulation including foam sprays, blankets or cellulose fill (DOE, 2008). Three factors need to be considered prior to installation of insulation: where the insulation is needed, what type of insulation is optimal, and if the building was built or renovated between 1940 and 1986 whether asbestos is present (EPA, 2012b).

Commercial buildings often confront a struggle to develop sustainable heating and cooling processes due to the use of steel studs during construction, which can conduct energy and heat about 1,000 times faster than wood (Honeywell, 2012). The importance of proper insulation in a commercial building using steel framing is critical because thermal bridging in steel can reduce the effectiveness of insulation systems by 30-50% (Honeywell, 2012). Proper and efficient insulation of a building begins at the foundation and ends at the roof (DOE, 2012g). Foundation insulation helps prevent heat loss through wiring ducts, crawlspaces, and concrete slabs in a basement (DOE, 2012g). Wall insulation provides filler between exterior walls and the drywall to prevent thermal bridging of steel or wood studs (DOE, 2012g). Ceiling and duct insulation help provide even temperature distribution throughout the building by avoiding losses to unconditioned space and transfer of heat between floors (DOE, 2012g). Insulating any region of a building where heat or cooling can easily be lost is ideal for reducing energy costs. The thermal resistance of insulation is measured by an R-Value (EPA, 2012c). The higher the R-Value of the insulation, the more effectively the insulating material prevents heat loss through the walls, floor, and ceiling (DOE, 2012g). The type of insulation best suitable for retrofitting a building depends on the site being insulated and can be broken down into open-cell spray foam, closed-cell spray foam, blankets in the form of batts or rolls, and loose-fill blown-in insulation (DOE, 2012c). Table 2 below presents a summary of each insulation type and its content, application, installation method, and advantages.

Determining the payback of insulation retrofitting can be difficult because energy prices can vary, weather differs year to year, and R-Values can vary throughout a building, as can personal preferences for what consists of a ‘comfortable’ environment . Determining the years to payback insulation retrofits by means of savings of heating and cooling costs can be calculated by the formula:

Years to Payback = (C(i) R(1) R(2) E) (C(e) [R(2) – R(1)] HDD 24), Where:

C(i) = Cost of insulation, expressed in $/square foot
C(e) = Cost of Energy, expressed in $/Btu
E = Efficiency of Heating System, expressed in Annual Fuel Utilization Efficiency values
R(1) = Initial R-Value of Insulation
R(2) = Final R-Value of Insulation
HDD = Heating degree, expressed in days/year
24 = Multiplier to convert heating degree days into heating hours (DOE, 2012h).

For a commercial building such as a school that is likely to have steel framing, the ideal insulation option would depend on site specific recommended R-Values and particular building needs (DOE, 2012d). ACCE is located in the Baltimore, MD region where a recommended retrofitting R-Value for

Table 2. Summary of different types of insulation (DOE, 2012c; DOE, 2012g).

Type	**R-Value (per in^2) and Insulation Materials**	**Where Applicable**	**Installation Method(s)**	**Advantages**
Open-Cell or Closed-Cell Spray Foam	R-2.9 to R-6.2 -Cement materials -Phenolic -Polyisocyanurate -Polyurethane	-Wall cavities -Attic floors	Applied using small spray containers	-Good for retrofitting -Useful in irregular spaces
Blanket: Batts and Rolls	R-2.9 to R-3.8 -Fiberglass -Mineral wool -Plastic fibers -Natural fibers	-Wall cavities -Foundation walls -Floors -Ceilings	Cut and fitted between studs, joists, and beams	-Do-it-yourself -Suited for standard stud and joist spacing -Relatively inexpensive
Loose-fill and Blown-in	R-2.2 to R-4.2 -Cellulose -Fiberglass -Mineral wool	-Wall cavities -Attic floors -Hard to reach places	Blown into place using special equipment, sometimes poured in	-Good for retrofitting -Useful in irregular spaces

attic surfaces is R-38 and floor surfaces are R-25 to R-30 (EPA, 2012c). The use of closed-cell spray foam at ACCE and other Baltimore City Public Schools would likely be the most suitable insulation option because closed-cell spray foam is relatively inexpensive, supplies a high R-Value, and is ideal for retrofitting and irregular spaces. If closed-cell foam is not applicable then open-cell spray foam, loose-fill, or blankets could be used as effective alternatives.

Asbestos, a naturally occurring mineral fiber that is resistant to heat and corrosion, was once widely used as insulation. Asbestos is now well recognized as highly hazardous and is regulated by OSHA and the EPA (DOL, 2012). The EPA has mandated the Asbestos Hazard Emergency Response Act (AHERA) to regulate and manage schools that are contaminated with asbestos (EPA, 2012c). This mandate requires inspections, notifications, and awareness information for parents, teachers, and employees (EPA, 2012c). If a building has asbestos present, the recommendation is to either leave the asbestos insulation undisturbed or to hire professionals to seal or completely remove the asbestos; there is effectively no hazard if asbestos is left undisturbed (EPA, 2012c). When determining if insulation renovations can be implemented, any building built or renovated between 1940 and 1986 should be inspected for asbestos as a pre-condition (EPA, 2012c).

If a school is known to have asbestos throughout the building, then energy saving renovations that involve new insulation can be constrained by difficult and expensive asbestos abatement (EPA, 2012b). In order for the school to implement new and more efficient insulation a certified professional asbestos removal specialist must be hired to safely remove the previously used insulation. Blacksburg Middle School in Montgomery County, MD spent $256,000 to safely abate asbestos from the building (Polantz, 2010). Asbestos abatement requires sufficient funding and time for removal due to the hazards involved, therefore non-removal may be more cost effective.

ACCE is in a building that is known to have asbestos present throughout the building therefore installing new insulation would require asbestos to be abated. If the abatement of asbestos could be funded, then installation of any insulation option would likely increase the R-Values in the building significantly. This would result in decreased heating and cooling costs and lessen the overall carbon footprint of the school. The expenses required to abate a school can be extensive, thus improving the school’s sustainability through adding insulation may be constrained. If funds are insufficient to abate asbestos the best option is to elect to leave the current insulation undisturbed.

Increasing Efficiency in Day to Day Operations

Flushing Dollars: Water Conservation in Public Schools

Water is a finite resource that is quickly becoming scarce throughout the world, including locations inside the United States (World Bank 2007). It is important to conserve our accessible water supplies and to implement water conservation initiatives that include frugal water use and reuse methods (World Bank 2007). Schools can play a critical role in water conservation efforts because of their sheer numbers and the volume of students and teachers that occupy the schools (NCSBE, 2008). The large numbers of students who attend schools throughout the country can be educated about the importance of water conservation through the actions at their schools and educational materials posted in the schools which explain it. Depending on the school facility, a single student is estimated to use approximately 10-15 gallons of water per day (NCDENR, 2003). Some water conservation methods that schools can implement that can potentially reduce water usage expenses are updating lavatory fixtures, installing an efficient landscape watering system that reuses water, the installation of a rain-catching device, and the changing of behavioral patterns. Ultimately education is the critical piece that can help establish a responsible stewardship of water resources.

Indoor Water Usage: School bathrooms account for approximately 45% of daily water usage in schools and if updated, can be the greatest source of water saving (NCDENR, 2009). The installation of efficient toilets, waterless urinals, and intelligent fixtures with infrared sensors is a simple yet effective approach to water conservation (NCDENR, 2009). The Energy Policy Act of 1992 set federal standards for maximum water usage for water fixtures produced after 1992, including toilets, urinals, showerheads, lavatory faucets, and kitchen faucets (102nd Congress, 1992). The maximum water usage standard set for toilets produced after 1992 is 1.6 gallons per flush (102nd Congress, 1992). According to the Maryland Department of the Environment a vintage toilet (Pre-1980's) uses approximately 4 – 6 gallons per flush; a conventional (1977 – early 90's) toilet uses 3.5 gallons per flush; and a low consumption toilet (post 1994) uses 1.6 gallons per flush (Maryland Department of the Environment, 2005). The Environmental Protection Agency has initiated a new WaterSense water efficiency program that rewards manufacturers of high efficiency toilets, which use less than 1.28 gallons per flush, with a water efficiency label (Jahrling, 2007). As the water efficiency increases for a toilet, so does the initial monetary costs for purchase and installation (Jahrling, 2007). Installing high efficiency toilets (HET) toilets can reduce water consumption by as much as 70% of current usage (NCDENR, 2009). HET's have a payback period of approximately three years depending on the efficiency of the existing toilet (Jahrling, 2007). Dual-flush toilet systems use an even lower volume of water, with an option of two flush volumes depending on usage; typically dual-flush toilets use between 0.8 - 1.1 gallons to flush liquid wastes, and a higher volume of water usually 1.6 gallons to flush solid wastes (Kennedy, 2004). Low consumption toilets can be converted to dual-flush toilets by installing an inexpensive valve ranging from $40 – 80, with a payback period of 3 - 4 years and a 20% reduction in water usage (NCDENR, 2009). Dual-flush toilets have been popular in

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.

In a men's bathroom, conventional urinals that are flushed after use can be replaced 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 maintenance from flooding and mechanical failure. The maintenance cost associated with waterless urinals is limited to the replacement of oil filled cartridges that trap odor and are typically replaced every 7000 uses (NCDENR, 2009). Waterless urinals are a rather new concept for school facilities and would require additional pilot programs to determine total cost savings and user acceptance (Kennedy, 2004).

Water faucets in the lavatory also can be upgraded to reduce water consumption (Kennedy, 2004). Conventional lavatory faucets use between 3–7 gallons per minute while new federally mandated faucets use a maximum of 2.5 gallons per minute with some using as little as 1.0 gallon per minute (Kennedy, 2004). The addition of an aerator to a faucet, a screen screwed into the faucet that is inexpensive, at $5 – 10 each, and easy to install, can provide a reduction of water usage to 0.5 – 2 gallons per minute (Maryland Department of the Environment, 2005; NCDENR, 2009). The screen reduces water flow by adding air to the water, giving the sensation of more water. The common ratings for aerators are 0.5, 0.75, and 1.0 gallons per minute and typically have a payback period of a few months (NCSBE, 2008). If an aerator will not fit current faucet situations, a flow restrictor can be installed on the hot and cold water feed lines to the faucet (NCDENR, 2009). A flow restrictor limits or reduces the volume of water that reaches the faucet when turned on (NCDENR, 2009). Flow restrictors are rated at 0.5 – 1.5 gallons per minute and cost approximately $25 each (NCDENR, 2009). A metered shutoff faucet is another faucet option that controls water usage for school facilities; it delivers a water flow for a pre-set time period then shuts off (NCDENR, 2009). According to federal guidelines a metered faucet cannot use more than 0.25 gallons per cycle (NCDENR, 2009).

Installing infrared sensors on toilets, urinals, and faucets can reduce water consumption while decreasing the spread of disease (NCDENR, 2009). Infrared sensors respond to a person's presence and trigger faucets to flow and toilets to flush as needed (Sanders, 2012). The reduction in water consumption with infrared sensor faucets can be as much as 0.5 – 1.5 gallons per minute (Kennedy, 2004). Infrared sensors guarantee that a faucet cannot be left running and that every toilet or urinal is flushed after use. Sensors decrease the possibility of spreading disease because the lavatory fixtures will be “hands free,” 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 usage needs to be integrated into a school’s water conservation program. Utilizing natural resources, 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 contains no human waste; while this water is ‘used,’ 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 plant (NCDENR, 2003).

The construction of a wet well to receive gray water could create an artificial wetland or marsh that supports a habitat for native or migratory wildlife (NCDENR, 2009). The installation of gray water or a wet well system can vary in scale and magnitude depending upon the facilities needs and available funding (NCDENR, 2009). Installing a wet well is an innovative proposal for school facilities because it would provide an educational connection for students. It would lead to a healthy environment with tangible results and visibly demonstrate water conservation.

Designing an intelligent water irrigationr system for athletic fields and other facility landscaping purposes can generate a reduction in water usage (NCDENR, 2009). Timed watering systems allow the school facility to use water responsibility and to set watering schedules that minimize the amount of water needed (EPA, 2012d). School facilities can install flow control nozzles for sprinklers that disperse the appropriate volume of water over a designated area (EPA, 2012d). Sensors that respond to rain, freezing temperatures, soil moisture, and wind can be installed on current sprinkler systems that will shut systems 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, not just through texts and teaching. It is more probable that students will understand the importance of conservation if they are first being introduced to the tangible benefits at their school. School systems must help conserve our water supply, and they can also implement new practices of water use and reuse for the school system.

Reducing Waste

Sustainable waste management is an effective way to reduce the carbon footprint of an institution while providing economic rewards. Schools in Baltimore City can play an important role in educating students about sustainable waste management practices by implementing enhanced recycling programs, diverting food waste for composting and eliminating paper towels for hand drying. All of these changes will help to eliminate excess costs and reduce waste thereby conserving resources.

Switching from paper towels to high efficiency hand dryers can aid in cutting costs and benefit the environment (Brady, 2012). The replacement of traditional paper towel dispensers with high efficiency hand dryers requires an initial financial investment but return savings may be generated in as little as two years (Brady, 2012). The environmental cost of paper towels includes, but is not limited to the price of production, deforestation or destruction of trees, costs of disposal, cost to ship products if not produced locally, time spent ordering paper towels, extra money spent on cleaning and repairing restrooms, time spent restocking dispensers, and chemical pollutants if the towels are bleached (Brady, 2012). A recent study comparing the Dyson Airblade (aluminum and plastic models), Excel Xlerator, a generic warm air hand dryer, reusable cotton paper towels, 100% percent recycled paper towels, and virgin paper towels reports that high efficiency hand dryers' environmental impact is lower than those of other drying systems (Montalbo et al., 2011).

High efficiency hand dryers can also be economically beneficial. The Niles Township High School District 219 located in Chicago, had annual district costs of $35,000 for paper towels, $16,500 in external maintenance costs, and the uncalculated costs of operating warm air dryers for 30 seconds per use (Brady, 2012). Through the replacement of traditional paper towel dispensers and older warm air hand dryers with high efficiency models in appropriate locations, the district had reduced its carbon footprint, eliminated the $35,000 annual cost to purchase paper towels, reduced $16,000 in annual maintenance 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 savings of around $15,000 in “avoided disposal costs” alone in the 2011 fiscal year (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 don’t have enough time to finish eating (Buzby and Guthrie, 2002). When students are able to choose 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.

Schools can play a vital role in the education of future generations' efforts to reduce food waste. By implementing waste reduction practices in schools, the amount of food waste can be decreased by students thus reducing the school's carbon footprint 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).

A new composting facility called Chesapeake Compost Works has opened in Curtis Bay, in Baltimore City (CSS, 2012). Chesapeake Compost Works wishes to work with everyone in the Baltimore region to help reduce organic waste, which would otherwise be sent to landfills (CSS, 2012). Their plan is to create healthier and greener neighborhoods in Baltimore, while reducing harmful methane gases from being emitted into the atmosphere and returning important nutrients back into soils (CSS, 2012). This new facility can recycle any organic waste such as wood chips, yard waste, food scraps, used cardboard and paper and because of their volume of compost, this facility is able to accept foods containing oils, fats, animal byproducts, (CSS, 2012). Baltimore City Public School System could begin to work with this new company, to help to reduce the food waste being sent to landfills. Such a collaboration would send a very positive message about the environmental sensibilities of the Baltimore City Public School System as well as its interest in helping a new green industry.

Composting organic waste not only produces a valuable product, it also addresses the disposal capacity problem; the United States is running out of disposal capacity (NSWMA & WASTEC, 2011). Imagine if every school had a landfill diversion rate of 40-45% due to composting and recycling. Now imagine if every student were to implement these composting and recycling practices within their homes and communities. Under such conditions the expected life of landfills would be extended while simultaneously reducing the amount of greenhouse gas emissions.

The scheduling of lunch periods can also contribute to food waste. On average, Baltimore City Public Schools lunch periods are about 30 minutes long including getting to the cafeteria, obtaining the food, and eating the food (BCPS, 2012). Depending on the student population within the school, such a brief period of time can result in an excess of leftover food (Buzby and Guthrie, 2002). The time at which the lunch periods start could also be an important factor to food waste; if lunch is served too early in the day, students could be less hungry because they more than likely have eaten breakfast a few hours earlier (Buzby and Guthrie, 2002).

Energy costs associated with food service operations as well as food waste can also be reduced by eliminating the use of trays in cafeteria dining (American University, 2011). A survey conducted by American University showed that by removing cafeteria trays, food waste and energy use could be reduced by 30% (American University, 2011). Eliminating trays reduces the need for purchase and use of detergents, which are typically non-biodegradable thereby helping to reduce the carbon footprint of the school (Efficiency Partnership, 2012). An added benefit of eliminating cafeteria trays concerns student health. Without an entire tray to fill with food, students are less likely to overeat and gain excess weight (Komisar, 2011). It is also reported that the removal of trays results in a more “home-like” versus an institutional feel (Komisar, 2011). The option to become tray-less may not be available to all schools and would not apply to students with physical disabilities.

Feed the Students, Not the Utilities

Cafeterias rank among the most energy intensive places within school buildings on a per square foot occupied basis (Efficiency Partnership, 2012). Every student within a Baltimore City school uses the cafeteria daily, whether for breakfast, lunch, or after-school activities. While cooking equipment is assumed to be the greatest consumer of energy, heating, cooling, and sanitation each account for major portions of the average electricity and natural gas consumption associated with food services (Energy Star, 2012). This intensive energy use provides a prime opportunity to begin saving with changes to appliances, maintenance, behavior, proper ventilation and better cooling methods.

When evaluating appliances for purchase, the life-cycle costs, which include purchase price, operational costs and maintenance costs, need to be considered -- not just the purchase price. Whereas one appliance may have a lower purchase price than another, its efficiency may be significantly lower and its useful life shorter; in such a situation a bargain isn’t a bargain. In the case of food heating equipment, an Energy Star qualified connectionless steamer saves considerable amounts of water and energy over a conventional boiler-based steamer; the operational savings could add up to several thousand dollars in just one year (Efficiency Partnership, 2012). A connectionless steamer is consistently more effective than the traditional boilers used in most school cafeterias (Efficiency Partnership, 2012). Warming cabinets are used more than any appliance in the average cafeteria kitchen and well-insulated holding cabinets have 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 replacement of gaskets and hinges can prevent heat and cooling loss. In those cases where gas fuel is used for heating and cooking, pilots lights need to be monitored for proper operation; a pilot light with a tall yellow flame is over firing - the recommended light is bullet shaped blue flame (Efficiency Partnership, 2012). Employee knowledge can also contribute significantly to the reduction of costs in a cafeteria environment. Implementation of a startup and shutdown schedule will help to eliminate idle time, and information is available from many online sources. Energy Star also offers “Smart Decision Making” webinars and online modules for employees to gain a better understanding of their responsibilities and how their actions can impact energy use (Energy Star, 2012). While savings for individual actions may not be staggering, together these energy savings can add up quite quickly.

Energy use in a school cafeteria goes beyond the heating and refrigeration of foods; hot water use for cleaning and hygiene purposes can be a major consumer of a building's hot water supply (US Green Building Council). Solar panels can be installed to provide heated water for a school cafeteria; in Pulaski County Elementary School in Hawkinsville, Georgia, a solar water heating system was designed and installed that offset 65 % of the existing energy demand for heating water in the school's cafeteria (US Green Building Council, 2011). Their system consists of two 120-gallon heat exchange storage tanks that feed into the existing water heater, which will continue to use conventional energy on cloudy days (US Green Building Council, 2011). The heat exchangers wrapped around the water tanks allow the solar water heater to operate on all sunny days, even when the temperature is below freezing (US Green Building Council, 2011). Because this sort of system is able to work with existing electric or gas storage water heaters, they are a viable option for any school looking to reduce the energy demand of their current hot water production system. Although it takes about 10 years for a solar system to pay for itself, the typical life expectancy is 20 years, much longer than a standard gas or electric storage water heater (Energy Star, 2012).

Computers

Today's classroom includes technological advances that are actively deployed during educational activities. Computer labs, classroom projectors and server rooms all contribute to the energy consumption within a school. Therefore changing the standard operating procedures for these common pieces of equipment can lead to significant energy savings.

Computer labs and libraries, where there are multiple computers in a single area, are energy-use intensive areas in schools (Energy Star, 2012). Although an individual computer does not consume a large amount of energy, these areas within schools collectively consume large quantities of energy (Energy Star, 2012). Many of the computers and monitors in many Baltimore City public schools are older models lacking the more recent energy saving elements. Wise decisions can be made about new computer purchases and efforts to modify the behavior of the users can address energy consumption of the older equipment. Energy Star certifies computers, which provides schools with information that can help make informed purchases when looking to replace the older computers (Energy Star, 2012). Energy efficient computer purchases are an investment that can potentially cut energy costs if the district buys Energy Star certified computers in place of less expensive and less efficient models.

Computers and other technologies are considered essential tools for providing students and teachers with a better overall educational environment. Unfortunately, a practice that many schools employ is keeping computers on continuously. Since the typical school day for students is less than 8 hours, it is likely that these computers are left on and unused for at least 16 hours each day during the week and all weekend as well. The same might hold for administrative and staff computers. Computers can go into standby mode when not actively being used, but this still consumes considerable amounts of energy on the scale of an entire school or district.

If purchasing an energy management software program of the type discussed below is not an option, a school which has a Green Team could include nightly shutdown of computers as one of the community service activities this group performs for their school. This is effective although more labor intensive than energy management software. Even without having to make an investment there are still things that can be done to evaluate and reduce energy costs. Energy Star offers free software that can be used to track and assess energy and water consumption in addition to providing guidance of high efficiency equipment (Energy Star, 2012). It provides tools to measure the carbon footprint of buildings, including schools. Energy Star Portfolio can also potentially lead to EPA recognition as a green school and become eligible for possible grants. Energy Star software could be an alternative if the purchase of energy management software is not a viable option.

Installing energy managing software onto the school computers that are on the same network can be a very effective investment to conserve energy and lower costs. Energy management software essentially powers down computers by going into a power saving mode, which uses less energy than standby and back to standby at specific times of the day instead of shutting the computers off completely (Faronics, 2012). These periods of ‘powering down’ can be configured by a single user on one computer and would power down every computer in the network (Faronics, 2012). Scheduling computers to conserve electricity during evenings, weekends, and holidays could save a school thousands of dollars every year. These savings shorten the payback period of the initial investment to several months.

There are two software programs that present viable options for a school to use to reduce electrical use and to promote energy saving. The first software program was designed for an office building but may be a good option if the program is being configured and operated by an IT teacher or IT savvy administrator. Faronics Power Save is designed specifically for users with a background in information technology because it prevents disruptions to a user if the computer is actively being used during atypical hours (Faronics, 2012). The program does this by analyzing activity from the keyboard, mouse, CPU, Disk, and network; this ability also enables the program to save power even when it is not specifically programmed to do so, i.e., the computer is not used by anyone all day (Faronics, 2012). This program also has an energy audit function that measures the amount of energy being used and the energy that is being saved, which can be used to forecast projected savings based on local energy costs (Faronics, 2012). Using information provided from the ACCE energy audit from the Baltimore Department of General Services on total energy use and the savings calculator provided by Faronics’ website, the calculated potential energy savings from using this product on the school is $8,907.39 per year after a single initial investment cost of $3,180 for installing the program on the school’s 212 computers. At the 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 is $2,544, less than what it would cost for Faronics' software. The Lighspeed Systems Power Management also offers other education oriented services, such as web filters to prevent students from going onto websites they shouldn't be using at school, and can provide student email accounts and file storage (Lightspeed systems, 2012a). The lower cost and better educational applications for this program make it a more attractive option for schools such as ACCE.

As the preceding indicates, there are various ways that efficiencies of equipment, energy use, and waste management can be upgraded to reduce energy consumption, energy costs and greenhouse gas emissions. Many of them will require substantial investment of capital but there are often modifications to current systems that are not very costly but which can increase overall efficiency. As decisions are being made about how to proceed to bring the City into compliance with the EmPOWER Maryland requirements, actions can be taken within the school to begin to move the community to increased awareness of the problems of energy and resource waste. ACCE occupies a building but more importantly it is an educational institution; its goals are to educate the students in its care. The need for increased awareness of climate change, alternative energies, how composting benefits soil and communities, can all be incorporated into educational activities and lessons within the school. The next section presents thoughts about how such lessons might be structured, which courses/subjects they could fit within, and how such implementation can help the school become a member of the Green School community.

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: ***Environmental Science, Physics, Mathematics,*** *and* ***Social Studies***

Many high school students may not see the connection between money and energy use even if they have been holding part-time jobs and earning income. The topic of energy conservation and the introduction of various energy saving measures through classroom activities can help establish this connection (EPA, 2012g). These lessons and activities can provide students with habits that will be valuable to them when they are living independently. There are classroom activities that help students understand where the energy for lighting comes from, and how much it costs to light a building (EPA, 2012g). Such lessons would be ideal for environmental science, basic sciences, mathematics, physics and technology.

You and Energy: The Environmental Protection Agency (EPA, 2012e) presents an approach to get students thinking about energy and where things go when we are done with them:

> Think about all things you do each day. You make hundreds, maybe even thousands of choices. Many of these choices affect YOU; others may affect your family and your friends. You may not think so now but many of these choices—even the smallest ones--have an impact on the environment as well. What about that bottle you tossed away? The computer that you recently replaced with a newer, faster model? (EPA, 2012e)

These basic questions can serve to introduce students to thinking about energy consumption and lead to a group discussion. Once the students have become engaged in the topic, thought provoking questions could be asked, such as, "How much work goes into creating energy?" A simple demonstration with a hand cranked power flash light will show that work must be exerted to produce the energy required to light the bulb (EPA, 2012g). The students can determine how much energy is being used by lights in the classroom (counting the number of lamps x the wattage/lamp x the number of hours the lamps are on during a typical day/ 1000 (to convert from watts to kilowatts) = kWh used) and thereby determine the cost of using the lights. Multiplying that number by the cost of electricity in the region gives the student a sense of the cost. It is easy to scale from an individual class room to an entire building if students count the number of classrooms, the lamps in the hallways and public places, etc.

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 could be used for other purposes if this demand on the school budget could be reduced.

In this exercise students visualize a day in society without coal. This connects them with the overall theme of natural resources because it demonstrates human dependency on the Earth. The importance of a healthy environment can also be brought in through the negative health effects created by environmental degradation (these are discussed below under alternative energy). Have students begin by creating a list of the many ways we use coal-based electricity in our everyday life (television, cell-phones, computers, hospital equipment, schools lights, electrical cars, etc. all require electricity to be powered).

Provide students with arts and crafts supplies. They will then create an illustration of a specific aspect of life without electricity. (Example- Have students imagine what a hospital, school, or even their home would resemble without any electricity.)

A longer-term project that could be implemented in the classroom would be to monitor the electrical meters at the school to determine how much energy is being used and whether there are seasonal differences in the use of electricity. The students could monitor the cost of lighting the school building over time and record these values in a journal or on a sign posted in the school. The critical piece that needs to accompany this activity is for the students to develop a plan that could be implemented at the school to reduce energy used by lighting or other electrical systems. The students' journals may be useful to the staff as well to calculate the amount of energy being saved. The reductions in energy consumption statistics could be used as a tool for teaching students the importance of energy conservation by comparing the electrical consumption data from before and after implementing behavioral changes.

The U.S. Department of Energy's website http://www1.eere.energy.gov/education/lessonplans/default.aspx offers lesson plans, labs, projects, and other classroom activities on energy conservation and efficiency (DOE, 2012e). These activities are designed to incorporate the importance of green energy and fitting them into a particular curriculum. If a social studies or technology teacher wanted to incorporate energy uses in modern day society and at the same time develop skills in using the internet to conduct research, s/he would be able to go on DOE website and find several lesson plans that are able to accomplish this.

<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 (13 watts) (EPA, 2012g). This comparison is done through building an apparatus that will power both bulbs and then measuring how much electricity each bulb is using. The apparatus is created by the students, using a cardboard box, plug strips, and a light meter, to demonstrate the light output levels of the two types of bulbs and the amount of energy used to produce the light. Students will then develop a chart showing the potential watts used by both incandescent and CFL bulbs and the cost of energy over their lifetime, as well as the cost of the CFL bulb in comparison to the replacement incandescent bulbs that do not last as long (EPA, 2012g). The student will be able to calculate the savings with the fluorescent bulb by subtracting the cost of using the fluorescent bulb from the cost using the incandescent bulb.

Plans for this lesson can be found at: <u>http://www1.eere.energy.gov/education/lessonplans/default.aspx</u> and are organized in a database by grade range, subject, and national curriculum standards; giving teachers the option of searching for lesson plans most appropriate for their class. By focusing on the power of individuals to 'make a difference' and teaching students about energy consumption, the school's energy expenses might be reduced, but more importantly, the students will have learned that what they do and what they use impacts the amount of energy they consume and what it costs. The school can benefit from these activities both in terms of lower energy costs and an environmentally friendly and energy conscious 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.***

Three fossil fuels, oil, natural gas, and coal, are burned to supply 85% of the world's energy demand (Doran, 2012). Coal is the primary source of electricity in the US supplying 49.61% of all electrical power generated (EPA, 2012f). Although coal satisfies the majority our country's electricity 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 surfaced as "renewable energy" sources. Renewable energy comes from 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 household items that will have the capacity to at least power a standard light bulb (Guy, 2012).

Kidwind.org is another excellent website (http://learn.kidwind.org), which seeks to educate both, students and teachers, on the importance of renewable energy sources (KidWind Project Inc., 2012). On the Kidwind.org site there is a link to WindSenator Educators Network, a group of specialized educators in 22 states dedicated to providing a renewable energy workshop, Kidwind challenges, and other regional events (KidWind Project Inc., 2012). The project goal is to have 400 windsenators, who provide wind energy teacher trainings in their state or region, across 40 states in the next five years (KidWind Project Inc., 2012). The website also sells wind turbine kits for schools with costs ranging from $25 dollars to $400. The more expensive kits are highly advanced and provide practical job training for future generations (KidWind Project Inc., 2012). These projects are best completed during fall and winter when there is sufficient wind to generate electrical power.

Wind energy lessons in classroom are supported by the Department of Energy's Wind for Schools Project from primary education to university levels (Colorado State University, 2012). Wind Powering America and the National Renewable Energy Laboratory launched the Wind Powering Schools pilot project in 2005 (DOE, 2012f). Today the project is supported in 11 states, with over 95 wind systems installed at host schools (DOE, 2012f). The Wind for Schools Project's goals are to equip today's youth with education in wind energy applications, engage communities in the benefits of wind power, and teach wind energy through interactive classroom experiments and data collecting (DOE, 2012f). Regardless of whether a school is a Wind for Schools host school or simply interested in becoming more environmentally friendly the program provides educational opportunities for all ages ranging from K-12 to university level (DOE, 2012f). The National Energy Education Development Project, the KidWind Project, WindWise Education, The Power of the Wind, and Energy for Educators provide free downloadable teaching materials including countless interactive and real application curricula guides and lesson plans on the American Wind Energy Association website: http://www.awea.org/learnabout/education/Wind_Energy_Curriculum_for_K-12.cfm (AWEA, 2012). The provided URL supplies classroom windmill experiments, PowerPoint presentations, and teacher guides.

The implementation of wind programs at schools can motivate our nation's youth and provide a future of skilled workers involved in wind energy engineering, consulting, and education. Challenging the future generations to be innovative and resourceful with alternative energies will help students to be knowledgeable about career based opportunities for future employment. Renewable electricity generation is expected to continue to increase and to grow 60% over the period of 2011-2017 than it was in 2005-2011 (IEA, 2012). This suggests that the alternative energy industry will continue to grow in the future making it necessary to have well trained and educated individuals to provide a skilled workforce as the backbone of this market. Career exploration at primary and secondary schools or college level will open doors for employment in this critical field. Programs such as Wind for Schools or just teaching a wind curriculum in classes will greatly benefit the environment and community on a local to global scale.

Project: Solar Water Heater: The Union of Concerned Scientists has created an activity based curriculum book, which include details on how to construct a solar water heater in 45 minutes. The book is set up similarly to a lab book typically used in a high school or college classroom. The major benefit of this curriculum piece, besides its ability to relay information to students, is the use of inexpensive materials that can be found around the house or school such as cardboard boxes, aluminum, paper clips, paint, buckets, etc. To give an idea of the simplicity of these assignments, a list of procedures to build a solar water heater is given below. This experiment, along with many others has follow-up questions, which allow the students to examine in more detail the task they have just completed. The detailed curriculum can be found at http://www.ucsusa.org/assets/documents/clean_energy/renewablesready_fullreport.pdf

Step-by-step instructions on how to build a simplified solar water heater in the classroom (Union of Concerned Scientists, 2003) are presented below. Note: pictures, diagrams, and materials list are included in the book, not here.

How to Build a Solar Water Heater (Union of Concerned Scientists, 2003)

1. Poke two holes in the box at opposite ends of one side. Make them the size of the tubing you will use. Glue aluminum foil in the inside of the box and paint the foil black.
2. Insert tubing through one hole and curl it around the bottom of the box. Poke the tubing out the hole at the other end. Leave roughly equal amounts of tubing sticking out of both ends of the box.
3. Paint the tubing inside the box completely black.
4. If the tubing does not stay at the bottom of the box, pin it down. Do this by bending a paper clip around the tubing and sticking its ends through the bottom of the box. Bend the clip ends on the other side, clamping the tubing down.
5. Tape a thermometer to the bottom of the box.
6. Cover the box with plastic wrap, glass, or Plexiglas. Tape it on so that it is airtight. If you use plastic wrap, stretch it so that there are no wrinkles.
7. If the buckets you use do not have tops, make tops out of cardboard. Insulate the buckets by taping sheets of newspaper around them. Poke two holes in the top of one of the buckets for the tubing. This is your experimental bucket. The other bucket will be your control.
8. Fill both buckets with water. Insert tubing in your experiment bucket. Make sure that one end of the tubing is near the top, the other at the bottom. You may need to cut off some excess tubing to do this.
9. Prop up the box at a slant so that it is facing the sunlight (its shadow should be directly behind it). Place the experiments bucket on some support (books or another box will work), so that it is completely above the level of the collector. Arrange the control bucket at the same level.

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 in-classroom assignments on solar energy are readily available through government agencies, such as the U.S. Department of Energy, because our nation supports education on alternative energy (http://www1.eere.energy.gov/education/lessonplans/default.aspx). Global development and population growth have increased energy demand around the world; these are projected to double by 2050 (DOE, 2012). The U.S. Department of Energy has called this concern the "energy problem," which is one of the most pressing challenges facing humanity (DOE, 2012). It is crucial that not only universities support education on alternative energy, but also grade schools and high schools because of the seriousness of the problem.

Natural Resources

There are two types of natural resources, renewable and nonrenewable (BrainPOP, 2012). Renewable resources are those that can be replenished on a human timescale (Zen, 2012) and include such things as water, wind power, and crops (BrainPOP, 2012). Nonrenewable resources are those that cannot be replaced or replenished on the scale of thousands to millions of years and includes fossil fuels, such as oil, natural gas, and coal (Doran, 2012). These non-renewable resources were formed deep within the Earth through geologic processes nearly 300 million years ago (Doran, 2012). Humans depend on both types of resources and it is important that these critical resources not be wasted. Technology is being developed to create alternative sources for some resources but some cannot be replaced.

Fresh Water Availability

The following activities can be incorporated into the following classes: ***Chemistry*** *and* ***Environmental Science***

Fresh water is critical for life on earth and humans need at least two and a half quarts of fresh water every day for drinking to remain healthy (James-Enger, 2012). Most of the Earth's water (97%) is in oceans and only 1% of the remaining 3% is available for human consumption (EPA, 2012d). The other 2%, unavailable to humans, is stored in glaciers and ice caps. The amount of water on earth and in the atmosphere remains constant, but with pollution and other human activities we are reducing our water supply through activities that degrade the water quality (EPA, 2012d). An activity on the availability of fresh water can visually demonstrate to students how limited this critical natural resource is and lead to discussions about how it should be protected and consumed conservatively. Details on this activity, which requires a five gallon tank to represent the entire water supply here on earth, can be viewed at http://www.epa.gov/region1/students/pdfs/gndw_712.pdf. In addition, food coloring, a cup of sand, and measuring cups of various sizes are needed. Through the activity, water will be removed from the tank in exact 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 questions for the students after the demonstration could be…

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 barrels collect rainwater from impervious rooftops thereby decreasing stormwater runoff. The collected water can be used to water gardens and indoor plants, which reduces the use of fresh drinking water for these purposes. The best place to put a rain barrel is under an exterior downspout in the shade (Chesapeake Bay Foundation, 2007). A successful rain barrel can be easy and inexpensive to build. The Chesapeake Bay Foundation provides a step-by-step guide to build rain barrels specifically designed for school yards. It also includes a materials list and can be found at http://www.cbf.org/document.doc?id=30. Building rain barrels at schools teaches students proper stormwater management practices and water conservation.

Rain barrels require some upkeep and may be prone to mosquito infestation and leaking if regular maintenance checks are not performed (Steffan, 2012). If funds are available rain barrels can be bought from garden supply centers or home improvement stores. If funds are not available, grant requests can be sent to environmental organizations such as the Chesapeake Bay Trust, Chesapeake Bay Restoration Fund Advisory Committee, and Garden Resources of Washington (GROW) (Chesapeake Bay Foundation, 2007).

Acid Rain

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

Acid rain is the result of air pollutants interacting with rainwater. While students might have heard about acid rain, they don't necessarily understand why it is important and why people worry about it. Students can collect rainwater from rain barrels or buckets to test the effects it has on their garden. By collecting rainwater and other water samples comparisons can be made to determine which source is best to use on plants. The pH of water can be measured using a pH meter, pH paper or, if preferred, it is possible to use red cabbage juice [Clouds R Us 2001; Stanford University, 2009] as a pH indicator (for detailed protocols see http://www.rcn27.dial.pipex.com/cloudsrus/acidrain.html or http://www.stanford.edu/~ajspakow/downloads/outreach/ph-student-9-30-09.pdf).

1. Put cut up red cabbage leaves into a blender with 800mL of water.
2. Blend at high power for 30 seconds.
3. Filter out the leaves with a strainer.
4. Pour 100mL of liquids known to be acid or basic into a cup (acidic control such as white vinegar and a basic control could be 3 tablespoons of baking soda-in to 100mL of water).
5. Pour 50mL of the cabbage juice into each of the solutions.
6. Record the results. The resulting color indicates whether each solution is a strong acid, weak acid, neutral, weak base, or strong base. See Table 3 below for the color code. Acidic solutions turn red and basic solutions turn green.

http://www.rcn27.dial.pipex.com/cloudsrus/acidrain.html

Students can then use their pH indicator to measure the pH of rainwater, tap water, stream water, or water from puddles in the school yard.

To test the possible effects of acid rain on the plants in the garden, students can test a mixture of water and white vinegar, or "acid rain", on sample plants (and compare growth to plants receiving plain water). Students can test the effects of acid rain on other objects, such as stones, coins, chalk, etc. Possible application questions include:

Neutralization: Whenever an acid and a base are mixed, they neutralize each other. If this is the case, why is Alka-Seltzer used to treat stomachaches? (Note: excess stomach acids cause stomachaches)

What is acid rain, where does it come from and how is it a problem for oceans, rivers, lakes, ponds, forests, etc.?

Table 3: Water pH as reflected in cabbage juice (from http://www.stanford.edu/~ajspakow/downloads/outreach/ph-student-9-30-09.pdf).

Color:	Pink	Dark Red	Violet	Blue	Blue-Green	Green-Yellow
Approximate pH:	1-2	3-4	5-7	8	9-10	11-12
Acid/Base	Acid	Acid	Acid/Neutral	Base	Base	Base

Composting in Schools

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

Composting programs in schools can provide educational enrichment to students as well as introduce environmental responsible behaviors by providing students with an alternative method for food waste disposal which will be environmentally beneficial. Many students throw large quantities of compostable organic materials into trashcans because there is no other option at their school (SCDHEC, 2012a). A composting program would be beneficial for schools because these discarded waste materials could be used in a productive way; it would also save funds currently spent on trash disposal (Bradley, 2012). Students will hopefully be able to take what they learn at school through the following activities and apply it at home and possibly change the attitudes and decisions made by their family and community.

Waste Audit: Students could conduct a waste audit in the cafeteria to estimate how much compostable material is being sent to landfills (Sweetman, et al, 2012). During this process, the students can learn the difference between compostable material and non-compostable material. Students participating in the waste audit will learn to separate food items, such as bread, fruit and vegetables leftovers, from meat and dairy products (Sweetman, et al. 2012).

Materials needed

A bucket for the kitchen

Buckets for the cafeteria, by every trash can

Gloves

Spatulas

Steps to follow for Waste Audit (Sweetman et al. 2012)*:*

1. The entire school needs to be notified, included cafeteria staff, that students will be conducting a waste audit ahead of time.
2. A bucket should be placed in the kitchen for the cafeteria staff to throw away left over fruit and vegetables.
3. The buckets for compostable material should be weighed beforehand.
4. Gallon buckets should be placed next to each trash can, labeled, “Fruit, Vegetables, and Napkins” next to where the trashcans are normally located,
5. Student helpers should be by the trash cans to help other students sort their food waste into the appropriate trash can or compostable material bucket.
6. At the end of lunch, the buckets should be weighed. These numbers can give students an estimate of how much waste the school generates a year.
7. Pounds of compostable material x 5 days = compostable material per week
8. Pounds of compostable material x 20 days = compostable material per month

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 'brown' organic material such as coffee grounds, sawdust or wood chips and sources for such materials needs to be arranged. Volunteers, such as students, teachers, and the community members, can help with composting activities such as aerating the compost tumblers by turning it and moistening it. After the compost has been decomposing for a certain time it needs to be moved to a different location to 'finish' without disturbance. If there is a school garden, this new compost would be an excellent source of nutrients for the vegetation. If there is no school garden, the students could sell the newly made soil amendment to the community as a fund raiser.

The final product of composting is a critical component of healthy soil called humus. Humus is produced when organic matter is broken down chemically and physically (Carmen, 2012). Microorganisms, fungi, and bacteria break down organic matter chemically in order to convert elements into bioavailable nutrients. Macro-organisms, such as ants, worms, and spiders break down organic matter physically through decomposition (Trautmann and Krasny, 1997).

Plastic Bottle Bioreactor for Composting: As a class, students can build bioreactors using plastic bottles in order to make their own compost and monitor the process. Through this activity the students will be able to learn the physical and chemical process of making compost. In addition to analyzing the process of composting, students can use the plastic bottle bioreactors in plant growth experiments. Instructions on how to construct plastic bottle bioreactors can be found at http://cwmi.css.cornell.edu/compostingintheclassroom.pdf. The instructions are easy to follow and require materials that are inexpensive and easily accessible. Students begin by selecting types of materials to add and guessing which ones will decompose most quickly

Follow up questions after the bioreactor activities:

Which materials decomposed the quickest? Why?

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 effect on certain plants. Students can compare the growth rate of plants using store bought potting soil, soil collected from outdoors, outdoor soil mixed with compost and just compost. Soils and soil mixtures can be put into flowerpots buried in the ground outside in warm weather. Each type of soil should have several replicate pots. The pots need to be clearly marked as to the soil type they contain. The same number of seeds should be planted in each pot and watered regularly. Watching growth rates and weighing the above ground size of the plants after a certain period of time will allow the students to evaluate these different types of growing media. Students should be encouraged to make additional notes on the pots such as whether they are quick to dry out and other similar observations.

Increasing Recycling

The Following Activities can be used in the following courses: ***Mathematics, Chemistry,*** *and* ***Environmental Science***

ACCE Students and Recycling. A survey intended to probe the understanding of what materials can be recycled and ACCE students' recycling behaviors was developed by the Towson Senior Seminar class and distributed by teachers to students in science classes in October 2012. The survey consisted of eight pictures of items that might or might not be recyclable with instructions that each student check whether the item can or cannot be recycled (see Appendix A). This was followed by questions asking whether the student recycled at school or at home; results for recycling habits at school and at home are below (the instrument and the results are presented in Appendix A). A total of 329 surveys were returned; this represents substantial portion of the student population. The items pictured in the survey were a plastic bottle, a pizza slice, a soda can, a newspaper, a glass bottle, and an empty bag of chips. Most of the students knew that plastic bottles, soda cans, and newspapers were recyclable and that pizza was not. Many students answered the 'can you recycle' question incorrectly for glass bottles and chip bags; glass bottles can be recycled (79% of students got this correct) whereas chip bags cannot be recycled (40% of students got this correct); these results suggest that there is a need to clearly identify recyclable items in any attempt to increase the recycling rate at the school. Similar levels of understanding can be expected to be found at other schools.

Table 4: ACCE student responses, in numbers, to questions about their recycling behavior at school and at home collected October 2012 (percent of responses in parentheses).

Do you recycle at…	Always	Never	Sometimes	No Answer
Home	77 (23 %)	111 (34 %)	101 (31%)	40 (12%)
School	66 (20 %)	136 (42 %)	82 (25 %)	41 (13 %)

The results of this survey suggest that most of the students at ACCE have a strong working knowledge of what materials can be recycled, but many of them do not recycle at all, or do not do so consistently either at home or at school. What is especially interesting is that some students made comments on their surveys that they know they should be recycling or would like to, but cannot because they are not able to find a recycling bin in the school or do not have access to one in their home. These statements along with the survey results suggest that the students would be receptive to a recycling program at their school. A small investment in more recycling bins or boxes marked ‘Recycling only’ and signs in classrooms and cafeterias that remind students to recycle would make a large impact on the amount of waste being put into trash dumpsters.

Recycling is a great activity to engage students’ interests in environmentally friendly behavior because there are many ways to incorporate recycling into a school’s day to day lessons. Lessons such as those presented below can help create awareness about wasteful habits and provide guidance about changing them. Lessons and activities about landfill costs and challenges vs. recycling will help students make their school and homes more environmentally friendly.

Incorporating Recycling into Mathematics: A math class can have students weigh the amount of recycling being collected in the school. Students can track the weekly weight of the school’s recycling and from this data they can calculate the monthly savings per pound of recycling rather than using regular trash disposal. The average tipping fee in Maryland is $52.90 per ton (Waste Business Journal, 2012). The project can become continuous by using previous class’s data to determine the average monthly and annual recycling savings. The results can be shared with the entire school.

Incorporating Recycling into Chemistry: Students can learn about the chemical processes involved in recycling certain materials. For example there can be discussion of what exactly happens to the materials when they are recycled or what chemical processes are used to break down the materials. For example, a recycling lesson that can be used in chemistry class looking at the process of recycling ‘tin’ cans that are really steel cans coated with tin, beginning with a de-tinning solution applied to the cans (http://pages.uoregon.edu/recycle/after_collection.html). There is then a reclaiming process; made up of a series of chemical and electrical steps in which the steel and tin are separated, purified, and recovered. There are several other steps, along with the processes behind many other materials being recycled that can be found on The University of Oregon’s site about recycling (University of Oregon 2012). For more information teachers can go to this site: http://pages.uoregon.edu/recycle/after_collection.html.

Incorporating Recycling into Environmental Science: Environmental Science is another class where lessons and activities about recycling are practical and beneficial to the students. Recycling lesson plans could cover topics such as: “what products can be recycled?” or “what natural resources do recyclables come from?” The question of how much pollution is produced in order to reprocess the materials is 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?

An “inventors fair” could be held challenging the students to build new things out of old materials (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-wide activities can also be utilized in order to raise the student population’s general awareness about recycling. Awareness is essential to promote a “greener” future and it is necessary to 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 of the Maryland Green School Program.

<u>Maryland Green School</u>

The Maryland Green School Program was begun in 1999 and has certified approximately 398 Green schools since its inception (MAEOE, 2012a). It is an award winning program that has the potential to improve environmental sustainability within a school and spread environmental awareness among the youth attending the school (MAEOE, 2012a). Any public or private school in Maryland, pre-K to grade 12, is eligible to apply to the program (MAEOE, 2012a). The program is noncompetitive and recognizes the achievements made by schools for meeting clearly defined environmental education criteria (MAEOE, 2011b). The Maryland Green School Program is a school-wide program in which all class grades are involved in the “green” curriculum (MAEOE, 2012a). Students learn about environmental issues and are involved in actions in reflecting best management practices (MAEOE, 2012a).

The program attempts to incorporate the investigation of local environmental issues with professional development for the staff and life-skills development for the youth with best management practices for the facility, while maintaining a positive relationship with the community (MAEOE, 2012a). The goal of the Maryland Green School Program is to transform education through the use of hands-on, investigative-based curriculum (MAEOE, 2012a). The intellectual tools the students acquire in school from the program are designed to empower them to reduce pollution, decrease waste, increase natural habitat, limit carbon emissions, and create healthy learning and living environments in their communities (MAEOE, 2012a).

Maryland’s Green School Program also assists the 2200 schools and over one million students in the state in achieving the environmental literacy goals and mandates established through the Governor’s Partnership for Children in Nature (MAEOE, 2012a). This Partnership is a program that promotes activities whereby youth spend time discovering and connecting with their natural world, explore wild places close to home, and share nature with a great mentor or teacher (MAEOE, 2012a). Both the programs and initiatives support learning and lessons that can result in continued progress toward a more sustainable future.

The Application Process

Schools interested in becoming a part of the Green School program have to meet program objectives and complete an application process. The Maryland Association for Environmental and Outdoor Education (MAEOE) is charged with evaluating schools and identifying schools that meet the requirements for certification. Following a letter of intent to apply, due to MAEOE by February 1st of the application year, schools must submit its formal application, accompanied by a new school applicant fee of $25 by April 1st of the same year (MAEOE, 2012a).

The cover sheet of the application requires that the committee involved in the application be identified and the appropriate types of participants included. The committee needs to include the 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's location, the make-up of the student body, the school atmosphere, and introduces the Maryland Green Schools activities already implemented (MAEOE, 2012a). The "Top Five" list which accompanies the project summary 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 create a 'special' educational experience for the youth involved.

Objective 1: Curriculum and Instruction. 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).

ACCE is already well on its way to meeting this criterion. Their Green Team, outdoor garden, and teacher cooperation are all commitments that meet criteria one (MAEOE, 2012d). The Green Team demonstrates that the students are interested in learning about the environment and doing more to make their community more environmentally aware. The team and the teachers are involved with the outdoor garden on their own time showing a dedication to becoming a green school.

Criteria 2. Professional development

This criterion ensures that the staff and faculty are actively trying to learn about the environment as well as involving the students (MAEOE, 2012a). In order to educate the students, the faculty must be knowledgeable about all of the issues and problems. Specific criteria states that at least 50% of the educators are actively learning about the environment, while at least 10% have experienced environmental professional development (MAEOE, 2012a). MAEOE suggests bringing in guest speakers as well as participating in teacher workshops (MAEOE, 2012a).

The Magothy School developed their Criteria 2 activity by utilizing their outdoor garden (MAEOE, 2012b). This became a space where students, teachers, and parents could meet and address environmental issues. They also assembled over $2000 in grant money to support their garden (MAEOE, 2012b). They developed a calendar of events and speakers came in to instruct the faculty on becoming more environmentally conscious. They utilized community groups such as the Boy Scouts to come in and give presentations on various subjects, such as how to construct birdfeeders and their importance to local birds (MAEOE, 2012b).

At ACCE, there is clearly already a growing desire for ‘green’ education. Ms. Matthew, the lead science teacher, with the support of the Principal has targeted and focused on the environment and green education, utilizing their outdoor schoolyard. Future possibilities could include workshops and guest speakers. With Ms. Matthew championing the efforts and the MAEOE professional development calendar, other faculty at the school can become actively engaged allowing the school to meet this criterion (MAEOE, 2012a).

Criteria 3. Celebration

The Green School Program notes the importance of commending and recognizing the students, faculty, community, and parents’ achievements associated with their environmental activities. This should be open to the public and should display all of the best management practices at the school (MAEOE, 2012a). The school should report all of its accomplishments and be proud of all they have achieved in order to instill pride in the entire student body, faculty, and parents who participated in the events. This step helps ensure the growth and development of the green school's educational practices (MAEOE, 2012a). This is not limited to a single event, celebration should happen often and publicly.

The Magothy School celebrated their achievements in a variety of different ways: they set up outdoor tables in order to show off what they've done in their gardens; they had community days where the community could come and participate in the Boy Scouts birdfeeder project; on Earth Day, they invited the community to come out and participate in a variety of events (MAEOE, 2012b). Their Earth Day, daylong celebration, is a great way to involve community and family in the environmental practices the school is advocating and promoting. The local paper also published a small article in reference to the Earth Day event (MAEOE, 2012b). This engagement shows the students that the community cares about all the environmental education going on at their school.

ACCE has an opportunity to celebrate on a daily basis. Their community garden is an essential element of their environmental engagement and ACCE is well positioned to hold an Earth Day celebration of its own (MAEOE, 2012d). The local community, friends and family could be invited to the school to see and participate in the planting and harvesting of the garden. Environmental artwork displayed around the school is another way that ACCE can congratulate and celebrate their environmental awareness (MAEOE, 2012d). The Mayor of Baltimore City came to the school to plant a tree and support their greening efforts gaining positive media attention from their environmental activism.

Objective 2. Best Management practices. All schools certified as Green schools much complete two activities in any of these four Criteria areas (MAEOE, 2012a).

There are various best management practices (BMPs) known to have beneficial impacts on our environment; schools declared Green Schools need to use their school grounds and building facilities to demonstrate and teach about the BMPs (MAEOE, 2012a). Not only can books and teachers teach students, but a physical facility can also be a learning tool, especially when discussing environmental issues. Investigating the school site and finding ways to view nature and reduce our environmental impact is another part of a green analysis.

The students will be able to see how their school impacts the environment around them as they learn about the BMPs. There are seven criteria of which four need to be met with at least two activities in each of the four selected criteria (MAEOE, 2012a). MAEOE provides a wide variety of options and ideas in order to fulfill these criteria (see Table 5). Each school will have to find their own way to fulfill these criteria; this list is in no way a comprehensive list but is intended to generate ideas that are locally appropriate. It is noteworthy that ACCE has already accomplished several of these activities.

Table 5. Brief Description and examples of Objective 2 (MAEOE, 2012a**).**

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 not limited to)"Bay Starts Here" stickers on faucets, installation of low flow fixtures, rain 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, calculating the school's carbon footprint, sources of energy, actions to reduce that footprint, 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 printing, implementing a "no waste lunch" day or week, tracking and reporting number of pounds of waste 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: Design, installation, and use of structures for ongoing environmental learning for students. **Examples**: Bluebird houses, trails, signage on gardens and trails, pervious walkways, viewing blinds, green roofs, or outdoor classrooms (mobile or fixed).
Responsible Transportation
The Scope: Examine the transportation options used by students, parents and staff. Design and promote responsible and healthy options. **Examples:** Carpooling programs, no-idle zones, walking, biking, "walking school busses", use of public transportation.
Healthy School Environment
The Scope: Examine the elements of a healthy indoor and outdoor environment, including types of cleaners, chemicals, pesticides used, lighting options, drinking water quality, air quality, purchasing, and maintenance choices. Other options are to implement healthy food and exercise programs. **Examples:** The safe use of chemicals, an Integrated Pest Management plan, improving indoor air quality, the purchase of environmentally friendly products, healthy food, increased physical activity.

Objective 3. Community Partnership All schools certified as Green schools must meet one of the following criteria (MAEOE, 2012a).

This last objective is to bring the school community and the local community together in their learning experience (MAEOE, 2012a). This is thought to help the kids see that their actions and education can have a positive impact on their local community. It also helps students become aware and interested in local environmental issues (MAEOE, 2012a). These partnerships are typically mutually beneficial.

Criteria 1. Your school is active in the community

This criterion reiterates the importance of students, faculty and staff being an active part in the local community. There are many different options and resources containing examples of how the student body and the teaching staff can integrate their resources into the community (MAEOE, 2012a). Some examples include campus cleanups, giving away recycling bins, and explaining to others that such things as cell phones, and printer cartridges can be recycled along with the more common paper and bottles (MAEOE, 2012d).

The Crossroads Center accomplished Criteria One by developing good community-school relationships associated with environmental projects. One example was their partnership with the Back River Restoration Committee (MAEOE, 2012c). In the spring of 2010 and 2011 the committee and the students participated in a tree-planting event (MAEOE, 2012c).

ACCE is well on its way to demonstrating this criterion. The recent tree planting with the Mayor, as well as their selling of homegrown vegetables from the garden to local stores fulfills this criterion and helps connect the students and faculty within the local community.

Criteria 2. The community is active in your school

This criterion encourages the school to invite the local community to become more interested, active, and aware of environmental issues (MAEOE, 2012a). The school should be a center for learning not only for the students, but also for faculty and the surrounding community. This criterion helps support students, faculty and staff working to develop environmental solutions for local problems (MAEOE, 2012a).

The Crossroads Center fulfilled this criterion with a variety of environmental organizations coming to the school to educate the students and faculty about environmental practices (MAEOE, 2012c). One such program was the Maryland Department of Natural Resources coming to the school and giving a presentation about horseshoe crabs (MAEOE, 2012c). Between the years of 2009 and 2011 they had repeat visits to the classroom implementing DNRs horseshoe crab and Sturgeon projects (MAEOE, 2012c).

ACCE can fulfill this requirement by utilizing both government and non-governmental and local programs, which would be happy to come to the school to help educate the students and faculty about environmental practices. One organization already involved in the school is Blue Water Baltimore (MAEOE, 2012d).

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 increased morale, and new resources and partnerships (MAEOE, 2012a). Schools also have reported an increased staff satisfaction from the implementation of the program (MAEOE, 2012a). The community surrounding the school can see a benefit from the schools conservation actions, which can have a positive impact on school-community relationships. Student involvement can result in the development of an ethical stewardship, sense of responsibility and the knowledge of each individual's impacts on the environment that can be shared with the community (MAEOE, 2012a).

Data collected at the national level indicate that the integration of environmental content into the curriculum in schools improves academic performance on standardized tests (MAEOE, 2012a). Some of the subjects that have seen the largest increase in test scores are algebra, biology, and English (MAEOE, 2012a). A study was performed by MAEOE in 2010 that tracked test results at individual schools before and after becoming a Maryland Green School that demonstrates similar improvements at individual schools (MAEOE, 2012a).

Schools that have been certified as a Green school will receive benefits and incentives that set them apart from other schools in the region. A school's association with the program will increase the school's visibility and recognition within the state, county, and city as well as being a model for other schools and for the local neighborhood (MAEOE, 2011a). Every school in the program will be given a Maryland Green school flag that can also help to promote an increased visibility and pride for the school (MAEOE, 2011a).

Every new Green School is also given one Maryland native tree from the Maryland Department of Natural Resources Tree-Mendous MD "Gift of Tree" Program. The Tree-Mendous MD tree program will also match a 1:1 ratio on future tree orders that the school places with the Maryland Department of Natural Resources helping improve their landscape even more (MAEOE, 2011a; MDDNR, 2012).

Becoming a "green school" is the first of many steps for schools like ACCE to begin decreasing their carbon footprint and providing students with activities that are incorporated into the school. This can create a 'special' educational experience for the youth involved. In order to continue the "green" movement schools must incorporate and emphasize green activities and practices. At ACCE these steps have begun to take root but a multitude of further steps are needed in order to continue carbon reduction. ACCE can support changes to the building use, food policy, and invest in infrastructure updates.

Moving Forward

Large and small scale opportunities are available for ACCE to make a transition to become a Green School both academically (join the Maryland Green School Program) and physically (obtain the upgrade and renovations that will reduce its energy use). While many large scale changes require significant financial investment, others can be implemented with the support of students, faculty and staff. Adoption of some of our proposed curricular activities will bolster ACCE's application to become a Maryland Green School; ACCE has the tools necessary to move forward in these areas. The curriculum additions are appropriate for grades 6-12 and will help ACCE fulfill requirements still needed for its Green School certification. With the continued help of the already established Green Team, ACCE is able to use their garden as an outdoor classroom and cultivate food for use in their own cafeteria. The Green Team is also essential for engaging the rest of the school population in an effort to increase sustainability and decrease energy consumption. While retrofits and upgrades are costly, as funds become available, valuable changes could be seen at ACCE.

Upgrades to Increase Efficiency

By initially investing in a detailed energy audit, it will be possible to identify the systems most in need of upgrades. We addressed the systems that we thought most in need of upgrades but we could not develop cost estimates since they require site specific information; once the cost estimates are available decision makers can set priorities. The energy audit will also provide the school with professional suggestions on renovation options that can address the current conditions. During the decision making process for prioritizing renovations, it is important to prioritize them by cost as well as the amount of time taken for a full return on investment and their direct impact on greenhouse gas emissions and the learning environment. While many of the larger upgrades are very costly, some can be done n bit by bit, which lowers the immediate financial outlay

Lighting might be the best place to start. Based on our research and information provided by the energy manager at Towson University, Steven Kolb, changes in lighting can have a major impact of energy use since lighting accounts for about 30% of total energy consumption in a large building (HVAC accounts for another 30%, and the remaining 40% of energy use "plug-loads" such as computers, projectors, televisions, etc.). Mr. Kolb stated that lighting improvements are the most cost effective investment in terms of cost and the payback period. The older the lighting fixtures, the higher the savings when they are replaced. The same principle holds true with most devices and appliances that are considered "plug-loads". Replacing older computers, appliances, and electronics with Energy Star certificated models will result in energy use reduction.

After investing in lighting and "plug-load" improvements within the school, and when funds for larger projects become available, renovations to the structural components of the school, such as windows, HVAC systems, and insulation can be considered. These components require much larger investments and potentially much longer payback periods in terms of energy savings. Before making an investment into HVAC, it would be wise to replace windows despite the faster payback period of a new HVAC system because new windows will maximize energy savings of a new HVAC system through reductions in heating/cooling loss. Once the windows are replaced, the HVAC system should be replaced because of the short time for return of investment and immediate energy savings. To further maximize energy efficiency of a new HVAC system, insulation throughout the building should be installed in areas that are not insulated with asbestos. Replacing asbestos insulation is a very expensive investment and requires a complete asbestos abatement. It is recommended to leave the asbestos undisturbed and to replace insulation in asbestos free areas until it is possible to complete an asbestos abatement.

These upgrades to the physical plant require considerable funds and require time for the pay back benefits to be achieved. These large investments are costly and time consuming, but will result in significant energy use reduction. Therefore, these proposed upgrades should be considered, as they will make the greatest difference in the comfort and functionality of ACCE as a physical learning environment. In the absence of sufficient funding there are still important activities that can be undertaken at the school which have a different but very important return on investment.

Enhancing Education

Engaging the Green Team: Increasing environmental awareness among the members of the ACCE community can also have major impacts on energy consumption. In order for the school to reduce energy use, the entire student body and faculty/staff needs to be aware of the importance of individual behaviors. A good way for the school to raise awareness is through posters and possibly through social media networks around the school, talking about the issues. We recommend the Green Team as the best candidates for raising awareness. The Green Team needs to be aware of all the possible changes that could be made to reduce energy use throughout the school. Once these students are aware, they can begin to spread the word through creating artwork and signs that relay information about energy-reducing projects and fundraising events. Students who participate in art classes have the opportunity to collaborate with the Green Team to contribute to this effort. These posters can be placed on school walls for all students, faculty and staff to see.

The Green Team already has a Facebook page, but constant maintenance of the Facebook page is crucial to keep the student body and faculty up-to-date and involved. Through Facebook and other social media networks, students can create events and invite their friends and families to attend. By holding fundraising events and distributing information about those events over social media networks, the local community will become aware of what the school is doing resulting in a higher attendance at these events; this will also create potential for the Green Team to raise more money to implement energy reducing projects.

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 student body and faculty to become involved. The Green Team can become leaders of their classes and bring a sense of community to the school as they all work together to reduce energy consumption.

***Seed to Fork-Creating a Loop*:** Currently, the students and faculty of the Green Team at ACCE are the leaders and innovators of the school garden. This garden has been up and running for a few years, successfully growing many different types of plants and edible vegetables. The successful yield of vegetables makes it difficult to figure out what to do with the excess. Students of the Green Team have sold some vegetables to local community restaurants raising funds for the team. The school and the Green Team could use the garden as the focal point for the school as a community, bringing students, faculty and staff together to work on energy reduction projects.

A schoolyard garden, in addition to providing specific learning activities, is also valuable to establish a means of incorporating the harvested produce into the school cafeteria, to promote healthy lifestyles and combat prominent health issues such as childhood obesity (PHLP, 2011). The National Policy and Legal Analysis Network to Prevent Childhood Obesity states that the use of produce gathered from school gardens is not regulated by Federal law (PHLP, 2011). The National School Lunch Act however, regulates most school cafeterias through the National School Lunch Program (“NSLP”), and its regulations neither support nor disallow the serving of produce grown on school property (PHLP, 2011). In fact, competitive grants are offered to schools in order for them to initiate farm-to-school and garden programs (PHLP, 2011). These grants are required to be administered by the Secretary of Agriculture, as mandated by the NSLP (PHLP, 2011). Schools may offer the produce gathered from the programs as part of reimbursable school lunch programs as long as state health requirements are followed; such integration is encouraged by the United States Department of Agriculture, which governs the NSLP (PHLP, 2011).

While Federal laws actually encourage the use of fresh produce harvested from local farms or school property, it is important that state regulations are followed, especially when dealing with the health of students. State food codes apply to all Baltimore City Public Schools and the sanitation and health requirements applied to food establishments also apply to school cafeterias making the legality of locally grown produce unclear. The specific question of using produce from a school garden in the cafeteria has not been addressed but nothing appears to exclude a garden to cafeteria program in Baltimore (PHLP, 2011). The current standards enforced by the United States Food and Drug Administration’s Model Food Code (MFC) include preparation of food (including produce), storage and handling (PHLP, 2011). In accordance with these standards, as long as produce collected from a school garden is handled and prepared in the same manner as produce being delivered from a distributor, it is able to be used in school meals (PHLP, 2011).

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). With the introduction of schoolyard gardens, curriculum pertaining to the importance of agriculture and the addition of these foods to the menu of a school cafeteria, students are likely to take knowledge and skills with them to higher education institutions and eventually their future careers.

The garden at ACCE represents one of its tangible efforts to become a Maryland Green School. By consuming the tangible harvest from the garden the entire school community gets a tasty reminder about the benefits of all of the ‘greening’ activities underway.

References Cited

102nd Congress. 24 October 1992. H.R.776 -- Energy Policy Act of 1992. Retrieved from The Library of Congress: Thomas: http://thomas.loc.gov/cgi-bin/query/z?c102:H.R.776.ENR (accessed 2012).

AltaNova. 2009. Energy Audit. http://www.altanova-energy.com/ideas-and-resources (accessed 2012).

American Combustion Industries. 2011. American Combustion Industries, Inc. “Condensing Boilers.” http://www.aciindustries.com/boiler.htm (accessed. 26 Oct. 2012)

American Federation of Teachers. 2008. Building Minds, Minding Buildings: Our union's road map to green and sustainable schools. Washington D.C.

American University. 2011. Trayless Dining. http://www.american.edu/finance/sustainability/Dining.cfm (accessed 19 December 2012).

APS Business Service. 2012. Different types of Air Conditioning systems. https://www.aps.com/main/services/business/WaysToSave/BusWaysToSave_41.html (accessed 27 September 2012).

(AWEA) American Wind Energy Association. 2012. Wind Energy Curriculum for K-12. http://www.awea.org/learnabout/education/Wind_Energy_Curriculum_for_K12.cfm (accessed 6 November 2012).

(BCPS) Baltimore City Public School System. (2012). *School Information/ Breakfast & Lunch*. accessed October 2012, from Baltimore City Schools: http://baltimorecityschools.org/Page/3986

Baltimore Energy Challenge (BEC). Towson, MD. Personnal communication, 25 September 2012.

Bradley, A. 2012. “Composting in the Classroom”. Northeast Recycling Council. http://nerc.org/documents/schools/Resource_Recycling_School_Compost_Article.pdf (accessed 9 October 2012).

Brady, R. C. 2012. Throw in the towel: High-speed, energy-efficient hand dryers. Continuing Education Center. http://continuingeducation.construction.com/article.php?L=199&C=637&P=2 (accessed 8 October 2012).

BrainPOP. 2012. Natural Resources: Background Information & Activities. http://www.brainpopjr.com/science/conservation/naturalresources/grownups.weml (accessed 12 November 2012).

Buzby, Jean C., and Joanne F. Guthrie. March 2002. Plate Waste in School Nutrition Programs. USDA, Economic Research Service. http://webarchives.cdlib.org/sw1s17tt5t/http://ers.usda.gov/publications/efan02009/efan02009.pdf (accessed 2012).

Carmen. 2012. Composting: Practical and Educational. Off the Grid News. 23 January 2012. http://www.offthegridnews.com/2012/01/23/composting-practical-and-educational/ (accessed November 2012).

Center for Innovative Schools Facilities. 2012. School Facilities and Student Achievemen. http://www.cisforegon.org/current/documents/Policy%20Brief%20(8.5x11).pdf (accessed 8 November 2012).

Chavez-Galan, Jesus, and Rafael Almanza. 2007. Solar Filters Based on Iron Oxides Used as Efficient Windows for Energy Savings. Solar Energy: 13-19. *Science Direct*. Accessed 25 September 2012.

Chesapeake Bay Foundation. 2007. Build your own rain barrel. http://www.cbf.org/document.doc?id=30 (accessed 8 November 2012).

Clark, D. 2008. Optimizing Existing Building Energy Efficiency. *Heating/Piping/Air Conditioning Engineering*, 80(1), 36-41. Accessed 2012.

Clean Air Task Force. (2001). Cradle to Grave: The Environmental Impacts from Coal. Accessed 2012.

Clean Energy Ideas. 2012. Renewable Energy Definition. Clean Energy Ideas. http://www.cleanenergyideas.com/energy_definitions/definition_of_renewable_energy.html (accessed 12 November 2012).

Clouds R Us. 2001. Acid rain. http://www.rcn27.dial.pipex.com/cloudsrus/acidrain.html (accessed 8 November 2012).

Colorado State University. 2012. U.S. DOE's Wind for Schools Program. https://sites.google.com/a/rams.colostate.edu/csu-wac/services (accessed 7 November 2012).

Connecticut Department of Environmental Protection. 2001. http://www.ct.gov/dep/lib/dep/reduce_reuse_recycle/schools/schoolfact01.pdf (accessed 2012).

CSS. 2012. Energy Solutions. http://cssenergyservices.com/3-stages.html (accessed 16 December 2012).

(DOE) U.S. Department of Energy. 2008. Insulation Fact Sheet. http://www.ornl.gov/sci/roofs+walls/insulation/ins_01.html (accessed 15 October 2012).

(DOE) Department of Energy. 2012a. Professional Home Energy Audits. http://energy.gov/energysaver/articles/professional-home-energy-audits (accessed 2012).

(DOE). Department of Energy. 2012b. Furnace and Boilers. http://energy.gov/energysaver/articles/furnaces-and-boilers%20 (accessed 15 October 2012).

(DOE) Department of Energy. 2012c. Types of Insulation. http://energy.gov/energysaver/articles/types-insulation (accessed 15 October 2012).

(DOE) Department of Energy..2012d. Insulation Comparison Chart. Home Energy Saver. http://homeenergysaver.lbl.gov/consumer/helppopup/content/~consumer~nrr~insulation-identifying (accessed 7 October 2012).

(DOE) Department of Energy. 2012e. Energy Education & Workforce Development. http://www1.eere.energy.gov/education/lessonplans/default.aspx (accessed 2012).

(DOE) Department of Energy. 2012f. Wind for Schools Project. Wind Powering America. http://www.windpoweringamerica.gov/schools_wfs_project.asp (accessed 7 November 2012).

(DOE) Department of Energy. 2012g. Insulation. http://energy.gov/energysaver/articles/where-insulate-home (accessed 16 October 2012).

(DOE) Department of Energy.. 2012h. Estimating the Payback Period for Additional Insulation. http://energy.gov/energysaver/articles/estimating-payback-period-additional-insulation (accessed 7 October 2012).

(DOL) U.S. Department of Labor. 2012. Safety and Health Topics: Asbestos. Occupational Safety and Health Administration. http://www.osha.gov/SLTC/asbestos/index.html (accessed 15 October 2012).

Doran, K. 2012. List of Fossil Fuels. http://www.ehow.com/about_5445661_list-fossil-fuels.html (accessed 12 November 2012)

Efficiency Partnership. 2012. Building Owners and Managers Association (BOMA) Energy Efficiency Program. Best Practices Guide. http://www.fypower.org/bpg/module.html?b=institutional&m=Education (accessed 2012).

Efficient Windows Collaborative. 2011. Tools for Schools. http://www.efficientwindows.org/ToolsForSchools.pdf (accessed October 2012).

Efficient Windows Collaborative. 2012a. U-Factor. http://www.efficientwindows.org/ufactor.cfm (accessed 27 September 2012).

Efficient Windows Collaborative. 2012b. “Window Technologies: Low-E Coatings". http://www.efficientwindows.org/lowe.cfm (accessed 26 September 2012).

Energy Future Coalition. 2008. http://www.energyfuturecoalition.org/ (accessed 2012).

Energy Star. 2012. EnergyStar for K-12 School Districts. http://www.EnergyStar.gov/index.cfm?c=k12_schools.bus_schoolsk12 (accessed 2012).

EPA. 2011. Turing food waste into energy at the East Bay Utlility District (EBMUD). http://www.epa.gov/region9/waste/features/foodtoenergy/food-waste.html (accessed fall 2012)

EPA. 2012a. IAQ Design Tools for Schools. School Advanced Ventilation Engineering Software. http://www.epa.gov/iaq/schooldesign/saves.html (accessed 2012).

EPA. 2012b. Asbestos in Schools. http://www.epa.gov/asbestos/pubs/asbestos_in_schools.html (accessed 15 October 2012).

EPA. 2012c. Recommended Levels of Insulation. Energy Star. http://www.energystar.gov/index.cfm?c=home_sealing.hm_improvement_insulation_table (accessed 9 October 2012).

EPA. 2012d. Getting up to speed: The water cycle and water conservation. http://www.epa.gov/region1/students/pdfs/gndw_712.pdf (accessed 2012).

EPA. 2012e. Your Environment. Your Choice. http://www.epa.gov/osw/education/teens/think.htm (accessed fall 2012).

EPA. 2012f. Energy and You. http://www.epa.gov/cleanenergy/energy-and-you/index.html (accessed 12 November 2012).

EPA. 2012g. Energy Efficiency and Conservation. http://www1.eere.energy.gov/education/pdfs/efficiency_energyambassadors9-12.pdf (accessed 2012).

Faronics. 2012. Power Save Enterprise. http://www.faronics.com/products/power-save/enterprise/ (accessed 25 September 2012).

Fetters, J. L. 2002. Maximizing Lighting Maintenance. http://www.facilitiesnet.com/lighting/article/Maximizing-Lighting-Maintenance--1699# (accessed 2012).

Fisette, P. 2012. Understanding Energy-Efficient Windows. Fine Homebuilding Article. The Taunton Press, Inc. http://www.finehomebuilding.com/how-to/articles/understanding-energy-efficient-windows.aspx (accessed 26 September 2012).

Focus on Energy. 2012. Occupancy Sensors Save Energy & Money By Controlling Your Lights. http://www.focusonenergy.com/files/document_management_system/business_programs/occupancysensor_factsheet.pdf (accessed 2012).

GCES. 2012. Gorman Crossing Elementary School Going Green! Part II: Summary of Activities. http://gcesgoesgreen.weebly.com/part-ii-summary-of-activities.html (accessed 28 November 2012).

Green Heart Education. 2012. The Value of School Gardens. http://www.greenhearted.org/school-gardens.html (accessed 11 October 2012).

Greenpeace. 15 April 2010. Mining Impacts. http://www.greenpeace.org/international/en/campaigns/climate-change/coal/Mining-impacts/ (accessed 2012).

Green Waste. 2012. Recycling statistics. http://www.greenwaste.com/recycling-stats. (accessed fall 2012).

Guy, Jennifer,. 2012. How to make a windmill for a school project. http://www.ehow.com/how_6600557_make-windmill-school-project.html (accessed 12 November 2012).

Honeywell. 2012. Green Building Insulation: The Environmental Benefits. A Supplement to Building Design and Construction. Accessed 7 October 2012.

Hozler, W. 2003. Light fittings for retrofitting large-diameter inductive fluorescent lamps. http://www.google.com/patents?hl=en&lr=&vid=USPAT6624554&id=ey4OAAAAEBAJ&oi=fnd&dq=t5+lamps&printsec=abstract#v=onepage&q=t5%20lamps&f=false (accessed 2012).

HPAC Engineering. 2012. Maximizing Condensing-Boiler-System Efficiency. Penton Media. http://hpac.com/heating/maximizing_condensingboilersystem_efficiency/ (accessed 2012).

Huff, W. 2006. Dual Flush: A Vote for Water Conservation. Plumbing Systems & Design, 28-30. Accessed 2012.

(IEA) International Energy Agency. 2012. Energy Efficiency. http://iea.org/topics/energyefficiency/ (accessed 28 October 2012).

Jacobs Report. 2012. Facilities Feasibility Study: Robert Poole Building Condition Assessment. http://www.baltimorecityschools.org/cms/lib/MD01001351/Centricity/Domain/6847/JacobsReport2012CitySchoolsStateofSchools.pdf. Accessed 2012.

Jahrling, P. 2007. Water Ways. American School and University, 32-36. http://asumag.com/Washrooms/university_water_ways/ Accessed 2012.

James-Enger, K. 2012. Nutrition Articles: Drink Up. http://bodyforlife.com/library/articles/nutrition/drink-up (accessed 4 December 2012).

Kantor, LS., K. Lipton, A Manchester, L. Oliveria. 2007. Estimating and addressing America's food losses. Food Review http://www1.calrecycle.ca.gov/ReduceWaste/Food/FoodLosses.pdf (accessed fall 2012)

Kennedy, M. 2004. Slowing The Flow. American School and University, 38-40. http://asumag.com/mag/university_slowing_flow/index.html Accessed 2012.

KidWind Project Inc. 2012. Become a wind senator. http://learn.kidwind.org/workshops_events/windsenators/2012 (accessed 12 November 2012).

Komisar, L. 2011. OPINION; How the Food Industry Eats Your Kid's Lunch. 4 December 2011. The New York Times. http://www.nytimes.com/2011/12/04/opinion/sunday/school-lunches-and-the-food-industry.html?pagewanted=all (accessed 19 December 2012).

Lee, L. 2012. The Advantages & Benefits of LED Lighting. National Geographic. http://greenliving.nationalgeographic.com/advantages-benefits-led-lighting-2139.html (accessed 2012).

Lighting. 2012. http://www.greenyour.com/home/home-improvement/ lighting/tips/install-light-timers-and-motion-sensors (accessed 2012).

Lightspeed Systems. 2012a. *Power Management.* http://www.lightspeedsystems.com/products/Power-Management.aspx (accessed 25 September 2012).

Lightspeed Systems. 2012b Panama Buena Vista Saves $60,000 in One Year with Lightspeed Power Manager http://www.lightspeedsystems.com/resources/CaseStudyDetails.aspx?Panama-Buena-Vista-Saves-60K . Accessed 25 September 2012

Long, M. 2011. Center for Green Schools at U.S. Green Building Council Releases. Accessed 2012.

LuxAdd. 2012. Energy Efficiency. http://www.luxadd.com/index.php/energy efficient-use-of-lighting.html (accessed 2012).

MAEOE. 2011a. Benefits of becoming a Maryland Green School. Maryland Association for Environmental & Outdoor Education http://www.maeoe.org/greenschools/benefits/#incentives (accessed 2012).

MAEOE. 2011b. Frequently Asked Questions. Maryland Association for Environmental & Outdoor Education http://www.maeoe.org/greenschools/faq/index.php (accessed 2012).

MAEOE. 2011c. Green School Overview. Maryland Association of Environmental & Outdoor Education http://www.maeoe.org/greenschools/overview/ (accessed 2012).

MAEOE. 2012a. The Maryland Green Schools 2012 Program and Application Guide. Maryland Association for Environmental & Outdoor Education http://www.maeoe.org/greenschools/application/2012%20application/Maryland%20Green%20Schools%20Award%20Program%20Reference%20Guide%202012.pdf (accessed 2012).

MAEOE. 2012b. Magothy Cooperative Preschool Green School Cerfification. Maryland Association for Environmental & Outdoor Education http://www.maeoe.org/greenschools/application/2012%20application/Magothy%20Cooperative%20Preschool%20Application.pdf (accessed 2012).

MAEOE. 2012c. Green School Aplication Crossroads Center. Maryland Association for Environmental & Outdoor Education. http://www.maeoe.org/greenschools/application/2011%20Application/Crossroads%20GSA_April_1_2011.pdf (accessed 2012).

MAEOE. 2012d. Appendix B 2012-13 Program Matrix. Maryland Association for Environmental & Outdoor Education..http://www.maeoe.org/greenschools/application/Qualifying%20Program%20Matrix%202012.pdf (accessed 2012).

Mansfield Middle School. 27 November 2001. Benefits to School Wide Composting. http://www.mansfieldct.org/Schools/MMS/compost/benefits.htm (accessed October 2012).

Martin, M. J. 2012. LED Lights Substitute for Fluorescents. http://greenliving.nationalgeographic.com/led-lights-substitute-fluorescents-20337.html (accessed 2012).

Maryland Department of the Environment. 2005. Conducting a Water Audit. http://www.mde.state.md.us/programs/Water/WaterConservation/WaterAuditing/Documents/www.mde.state.md.us/assets/document/ResAudit.pdf (accessed 2012).

Maryland Energy Administration. 2009. Maryland Energy Outlook. Maryland Energy Administration

Maryland Energy Administration. 2012. EmPOWER maryland. http://energy.maryland.gov/facts/empower.html updated 12 July 2012(accessed 2012).

McQuay Air Conditioning. 2012. Centrifugal Chillers Hotel Case Study. Accessed 28 November 2012.

(MDDNR) Maryland Department of Natural Resources. 2012. TREE-MENDOUS Maryland. Maryland Department of Natural Resources: http://www.dnr.state.md.us/forests/treemendous/ (accessed 2012).

Montalbo, T., Gregory, J., & Kirchain, R. 2011. Life cycle assessment of hand drying systems. Boston: Massachusetts Institute of Technology. http://msl.mit.edu/publications/HandDryingLCA-Report.pdf Accessed 2012.

National Environmental Education Foundation. 2011. Green Prize in Public Education. http://www.neefusa.org/grants/green_prize.htm (accessed 2012).

National Renewable Energy Laboratory. "EREC Fact Sheet: Energy Efficient Windows". Energy Guide. Aclara Technologies, 2010. http://www.energyguide.com/info/heat-05.asp (accessed October 2012).

(NCDENR) North Carolina Department of Environment and Natural Resources. 2003. Baseline Water Consumption Worksheet. http://portal.ncdenr.org/c/document_library/get_file?uuid=e1edb738-7cc3-4d04-85ae-e12cb5e7d57d&groupId=38322 (accessed 2012).

(NCDENR) North Carolina Department of Environment and Natural Resources. 2009. Water Efficiency Manual for Commercial, Industrial and Institutional Facilities. Division of Water Resources. Accessed 2012.

(NCSBE) North Carolina State Board of Education. January 2008. Water Conservation Tips and Information. Public Schools of North Carolina (http://www.schoolclearinghou(se.org/pubs/WaterConservationInformation.pdf (accessed 2012).

NSWMA & WASTEC. 2011. Landfills. http://www.environmentalistseveryday.org/issues-solid-waste-technologies-regulations/landfills-garbage-disposal/index.php Accessed 10 October 2012.

Oldroyd, C. 2012. Dimmer Switches for Energy Efficiency. http://greenliving.nationalgeographic.com/dimmer-switches-energy-efficiency-2245.html (accessed 2012).

O'Malley, Martin. 2012. Maryland StateStat. http://www.statestat.maryland.gov/ (accessed 2012).

Parpal, M. 2006. Fluorescent Lighting: The Benefits of T8 Over T12. http://www.foodservicewarehouse.com/restaurant-equipment-supply-marketing-articles/going-green/ fluorescent-lighting-the-benefits-of-t8-over-t12/c28112.aspx (accessed 2012).

Peterson, J. 2012. Clean Your Light Bulbs for 20% More Light. TLC. http://tlc.howstuffworks.com/home/clean-light-bulbs.htm (accessed 2012).

PHLP. April 2011. Serving School Garden Produce in the Cafeteria. Salad Bars to Schools. National Health, Law and Policy, http://saladbars2schools.org/pdf/SchoolGarden_to_Cafeteria_Liability_May2011 (accessed 11 October 2012).

PJM Interconnection. 2012. http://www.pjm.com/about-pjm/who-we-are.aspx (accessed 2012).

Polantz, Katelyn. 2010. Asbestos Removal at the Old Blacksburg Middle School Could Cost $400,000. http://www.roanoke.com/news/nrv/wb/259290 (accessed 10 October 2012).

Regal Services. 2012. Why an Audit. http://www.myinspectionpro.com/home_energy_inspection_audit_baltimore_county_maryland.php (accessed 2012).

Sanders, A. 2012. How Do Passive Infrared Sensors Work?. http://www.ehow.com/how-does_4613770_passive-infrared-sensors-work.html (accessed 2012).

(SCDHEC) South Carolina Department of Health and Environmental Control. 2012a. Composting: A Guide for South Carolina Schools. http://www.scdhec.gov/environment/lwm/recycle/pubs/composting_guide.pdf (accessed 8 October 2012).

(SCDHEC) South Carolina Department of Health and Environmental Control. 2012b. Recycling: A Guide for South Carolina Schools. http://www.scdhec.gov/environment/lwm/recycle/pubs/recycling_guide.pdf (accessed 2012).

Smith, E. 2011. How to increase lighting efficiency. National Geographic. http://greenliving.nationalgeographic.com/increase-lighting-efficiency-2843.html (accessed 2012).

Stanford University. 2009 Red cabbage lab: Acids and bases. http://www.stanford.edu/~ajspakow/downloads/outreach/ph-student-9-30-09.pdf (accessed 8 November 2012).

Steffan, Rachel. 2012. About Rain Barrels. National Geographic. http://greenliving.nationalgeographic.com/rain-barrels-2156.html (accessed 8 November 2012).

Sweetman, Rosie, Alex Ward and Rachel Sander. 2012. Cafeteria Composting in Schools: Strategies, Systems and Resources for Lane County Schools'. The School Garden Project of Lane County. http://www.myeugene.org/wp-content/uploads/2012/01/Compost-Manual_2012.pdf (accessed 8 November 2012).

Tessman, D., & Gressley, K. 2011. Making Youth Gardens Grow With Captured Rainwater…And Video. Journal of Extension, 196-199.

Tierney. 1996. Recycling is Garbage. New York Times.

Trane Heating and Cooling. 2012. Personal Communication. 27 November 2012.

Trautmann, Nancy M. and Marianne E. Krasny. 1997. "Composting in the Classroom-Scientific Inquiry for High School Students". Cornell University. http://cwmi.css.cornell.edu/compostingintheclassroom.pdf (Accessed November 2012).

Union of Concerned Scientists. 2003. Renewables Are Ready: A Guide to Teaching Renewable Energy in Junior and Senior High School Classrooms. https://bbweb.towson.edu/bbcswebdav/pid-1802147-dt-content rid9412242_2/courses/1124ENVS491101/renewablesready_fullreport.pdf (accessed 12 November 2012).

University of Minnesota. 2011. Façade Design Tool. Windows for High-Performance Commercial Buildings. http://www.commercialwindows.org/ (Accessed 16 November 2012).

University of Oregon. 2012. "The Recycling Process after Collection" http://pages.uoregon.edu/recycle/after_collection.html (Accessed 2012).

US Green Building Council. 2011. Power Partners Solar Collectors Heat Water for Pulaski County Elementary School's Cafeteria and Serve as a Teaching Tool USGBC Georgia. http://www.usgbcga.org/press-room/press-releases/299-power-partners-solar-collectors-heat-water-for-pulaski-county-elementary-schools-cafeteria-and-serve-as-a-teaching-tool [11 May 2011] (accessed December 19 2012).

Waste Business Journal. 2012. Pricing and Volume Index. http://www.wastebusinessjournal.com/wbjpriceindex.htm (accessed 2012).

World Bank. 2007. International Development Association: Managing a Scarce, Shared Resource. http://siteresources.worldbank.org/IDA/Resources/IDA-water-resources.pdf (accessed fall 2012).

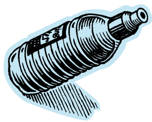
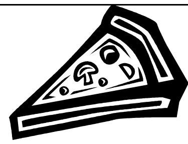
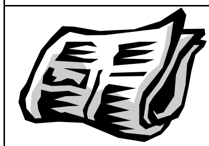
WRAP UK. 2012. http://www.wrap.org.uk/category/sector/construction (accessed 13 December 2012).

Zen, E.-a. 2012. Sustinability and Resources. http://bcn.boulder.co.us/basin/local/sustain4.htm (accessed 12 November 2012).

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**

Do you recycle at home? Yes/No/ Sometimes Do you recycle at school? Yes/No/ Sometimes

Only two items on this list cannot be recycled (Chip Bag, Pizza). Below are the responses from the students attending ACCE who participated in the survey. [N/A=no answer given]

Plastic Bottle	Yes	326
	No	2
	N/A	1
Pizza	Yes	11
	No	309
	N/A	8
Can	Yes	314
	No	9
	N/A	6
Newspaper	Yes	316
	No	12
	N/A	1
Glass Bottle	Yes	226
	No	97
	N/A	6
Chip Bag	Yes	189
	No	132
	N/A	7
Do you recycle at home?	Yes	77
	No	111
	Sometimes	101
	N/A	40
Do you recycle at school?	Yes	66
	No	136
	Sometimes	82
	N/A	41