

ANALYSIS 1 - DEPTH

Green Design in Public Schools

Problem

The new Ambridge Area High School will replace a building over 80 years old and will certainly provide the school district with lower operating costs over the existing building. LEED® certification and inclusion of green design principles were not utilized on this and many other public school projects because of the desire to provide low first costs to satisfy tax-paying citizens and the lack of knowledge and understanding of the LEED® system. Aiming at providing a public school district with a green and efficient building at a minimal additional cost is of major concern, as these buildings tend to have extensive operation and maintenance costs over time.

Goal

The goal of this research is to explore what knowledge school districts have on green building and the LEED® rating system. By speaking to members of industry, public school districts, and people from outside the engineering and construction fields, I hope to develop a method to educate on the benefits that green construction has to offer in terms of reduction of energy and operation costs, indoor air quality and occupant comfort, and reduction in negative effects on the environment. I feel that the incorporation of lessons on green building in high school class situations would marry well with the science and technology class curriculums. By teaching students at this level, hopefully green construction will become more of a topic of discussion outside the design and construction industries.

Methodology

1. Develop a list of interview questions to be asked to public school owners with recent or ongoing school construction projects.
2. Develop a list of interview questions to be asked to design professionals including architects and contractors involved in new school design and construction.
3. Identify and interview various owners, contractors and architects of school construction projects both determining the knowledge of LEED®.
4. Gather information on benefits and advantages of LEED and green construction related to schools
5. Construct a lesson to introduce and educate students on LEED® design and construction.

Tools

The following are tables of questions to be asked to public school owners (Table 1) and designers of public school projects (Table 2) during an interview. The list will be revised and expanded if necessary before conducting research.

1. U.S. Green Building Council Website (www.usgbc.org)
2. Other Green Building Websites
3. LEED® Green Building Rating System for New Construction & Major Renovations (LEED®-NC Version 2.1)
4. Penn State Architectural Engineering Faculty
5. Questionnaires to public school districts and industry professionals
6. Personal conversations with high school science and technology teachers
7. Microsoft PowerPoint

Research

To identify the knowledge of building green and LEED rated schools, questionnaires were distributed to members of industry including architects, engineers, and contractors both who have been involved on a LEED rated project and those who have had no direct involvement in a green building project. Also, questionnaires were distributed to public school districts to gather their opinions and understanding on green construction and LEED. For summaries of the contents of questionnaires please refer to Appendix C. Countless references were collected from both online and print sources on the benefits of green building as well as case study school projects to adapt the green principles better to the intended audience.

Findings

As a result of research into the barriers public school districts have to building LEED rated schools, the primary barrier is lack of information about the LEED rating system, its benefits, and the level of knowledge of industry members who are suggesting LEED to school districts and owners. Industry members indicated that green building and LEED certification are sometimes a hard item to sell to an owner of a project because of the perceived additional costs and lack of knowledge on actual benefits and potential payback periods on investment. Public school districts indicate that projects on already tight budgets leave little funding available to incorporate technologies with added up front costs regardless of their potential cost savings over time. Districts also indicate if they had a better understanding on actual benefits of green building and LEED, they would be more apt to seek more information and possibly seek LEED certification.

*Problem 1**Lack of Knowledge:*

While information about green buildings and LEED is everywhere in publications as well on the internet, there is no one source of information which is directed toward educating the general public and more specifically high school aged students on the benefits of building green and LEED rated schools. In most cases in the Pittsburgh, Pennsylvania area as is the case in the Ambridge Area School District, enrollment in schools has seen a steady decline in past decades leaving many school districts to consolidate schools within their own districts as well as combine with neighboring districts to lower operation costs attributed with their school buildings. Many of the school buildings in this area are nearing their intended

lifespan and need much renovation work to provide students with classrooms with adequate indoor air quality, natural light and technological features. While many school districts opt to renovate to maintain existing structures and locations of schools, others choose to build new buildings in adjacent or new locations to the existing school.

Nine states in the U.S. require LEED certification on public projects while twenty three states have legislation pending or require LEED on projects in certain areas or from specific government agencies. Green building and LEED are catching on as more case studies and analyzes are conducted demonstrating their positive affects with energy efficiency, indoor air quality, and reduction in environmental effects. Educating the public on the benefits of LEED and providing one location for information is the goal of this research.

Problem 2

Cost:

The second barrier to incorporating LEED rated construction and design is the perception or an increased cost associated with Green Construction. Pennsylvania Governor Edward G. Rendell formed the Governor Green Council of Pennsylvania aiming to stimulate green design and construction across Pennsylvania. The council offers grants for school districts that plan to build green. For the 2005-2006 school year, \$200,000 in grants were provided to seven school districts to help offset any additional costs to achieving LEED certification. This funding is offered on a first come first served basis annually with applications being accepted starting July 1. While other means of funding and incentives are available, there have been LEED certified schools constructed with little or no additional cost and short payback periods on additional initial investment.

Tools:

As a result of research, a lesson was developed to serve as an educational tool for use in high schools - either science or technology classes to introduce and discuss the topic of LEED and Green Building. As this is a relatively new topic, it is known that many students have little or no knowledge about Green Building. Green construction has many advantages including, reduced energy use, and reduced maintenance costs, improving indoor air quality, reducing instances of cold and allergies, increasing productivity, reducing the negative effects on the environment. This information can be incorporated into a number of class types including science, technology, and a college like EGEE 101 at Penn state - Energy and the

Environment. I feel the integration and introduction of this material in high schools will allow discussions to occur at home with parents and other adults spreading information about green building like wildfire. Green building has seen slow incorporation in several areas of industry due to lack of knowledge and lack of understanding.

Green school design addresses:

- Classroom acoustics
- Master planning
- Indoor air quality
- Mold prevention
- Energy efficiency
- Water conservation

As high school students are years or even months away from joining the workforce or beginning a college education, what better a time to plant the seed of energy awareness and sustainable building. This course will hope to educate about the advantages of green building in addition to promoting a more energy conscious society in their own homes. With earth day and Arbor Day being large in schools this lecture may also be incorporated on an annual basis in April or taught as an additional lecture in any science or technology based course.

Ideally, this lecture would be contained in a stand alone course promoting topics in the energy and environmental realm. Additional topics may include: Alternative fuel vehicles, geothermal energy, solar energy, hydroelectric power production, straw bale construction, fuel cells, energy efficient homes, and promoting alternative transportation.

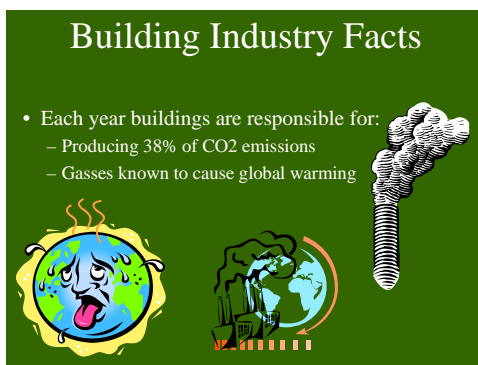
Lecture

The lecture itself is formatted into three main points. The first section includes facts about the building industry, followed by an introduction into green buildings and the LEED rating system, and finally the energy benefits of green schools presented through potential cost savings if the students' school were green.

While the first section of this lecture contains many facts about the true damage the building and construction industry poses to the environment and the users of the building, it is very important that students realize the true extent of this damage should they have any hope in showing interest in a possible solution.

Annually the building industry is responsible for producing over 38% of the CO₂ emissions known to cause global warming. As global warming has become a hot topic in the past few years, it has primarily been blamed on the burning of fossil fuels such as automobile and truck use. Buildings are responsible for consuming 69.7% of all electricity generated and 39.4% of all energy produced each year. As far as waste produced, it was found the average human creates approximately 2.8 pounds of waste per day with the building industry responsible for 136 million tons of waste being sent to landfills each year, as well as consuming 12% of the fresh water on earth.

Facts on the damaging effects buildings pose on their inhabitants are also included in this section. It may come as a surprise to some students but humans spend approximately 90% of their lifetimes in buildings, and indoor air quality may be 2-5 times worse than outdoor air quality. An estimated 14 million school days are missed each year as a result of asthma with indoor air pollutants such as dust and mold triggering asthma attacks. These facts are contained in the lecture slides in a simple format with graphics to reinforce the topic. Two sample slides from this section of the lecture are shown below.

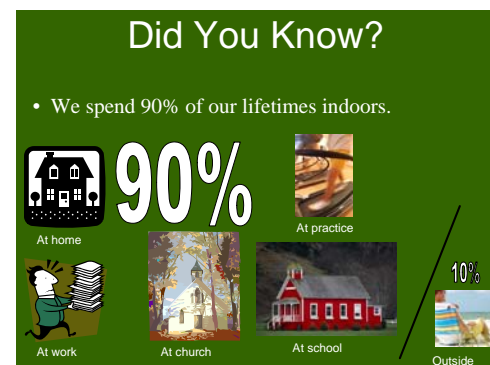


Building Industry Facts

- Each year buildings are responsible for:
 - Producing 38% of CO₂ emissions
 - Gasses known to cause global warming

The slide features a green background with a white lightbulb icon on the right. On the left, there are two illustrations: a sad, sweating Earth with a tongue sticking out, and a globe with a red arrow pointing upwards, symbolizing global warming.

Sample slide from Building Facts



Did You Know?

- We spend 90% of our lifetimes indoors.

The slide features a green background with a large white '90%' in the center. To the left of the percentage is an icon of a house labeled 'At home'. To the right is an icon of a person at a desk labeled 'At practice'. Below the '90%' are three icons: a person at a desk labeled 'At work', a church labeled 'At church', and a school labeled 'At school'. On the far right, a small icon of a person outside is labeled '10%' and 'Outside'.

Sample slide from Building Facts

After concluding the background information session of the lecture, a student led, teacher monitored discussion is conducted requiring students to develop potential solutions to the problems buildings pose, and tasking them to think of potential problems their specific school poses to occupants and the environment.

The next section of the lecture contains information on the principles of green building and an introduction of the LEED rating system for new construction. While this lecture is not meant to provide students with all the knowledge needed to design or evaluate a green building, it does educate on the six main areas to earn points, and the four levels of LEED certification a project can achieve. This information will allow students to have a basic understanding of the LEED system and allow them to look at case study school projects with the background knowledge necessary to understand the benefits.

A short look into what makes a building green is followed by facts on the progression of green building and LEED throughout the country. Included in this section are the U.S. government agencies requiring LEED construction on projects, a look into states across the country who have LEED legislature in place or pending, and some high profile green projects in the Pittsburgh, Pennsylvania area, which students may have seen, heard about or even been into without knowing the background information on green construction and LEED.



LEED® Rating System

- Four levels of certification
 - Certified (26-32 points)
 - Silver (33-38 points)
 - Gold (39-51 points)
 - Platinum (52-69 points)
- 6 categories worth 69 points
 - Sustainable Sites (14 points)
 - Water Efficiency (5)
 - Energy & Atmosphere (17)
 - Materials & Resources (13)
 - Indoor Environmental Quality (15)
 - Innovation & Design Process (5)

The slide features four circular LEED certification logos: Certified, Silver, Gold, and Platinum, arranged horizontally below the text.

Sample slide from LEED Introduction



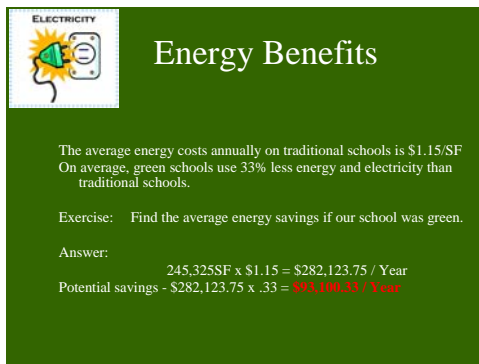
What Makes a Building Green?

- Incorporating elements into design such as:
 - Waterless or low flow plumbing fixtures
 - Certified Wood Products – Eliminates clear cutting
 - High efficiency lighting fixtures
 - Low VOC emitting paints and products
 - Close to public/alternative transportation
 - Day lighting
 - Solar panels – photovoltaic cells

The slide includes several images illustrating green building concepts: a white waterless urinal, a solar panel array, a can of Sherwin-Williams paint, a person walking with a bicycle, and a bicycle rack. Small captions are provided for each image: 'Photovoltaic (Solar) cells', 'Low/ no VOC paints from Sherwin-Williams', 'Waterless Urinal - Waterless CO₂', and 'Bicycle racks to reduce automobile use'.

Sample slide from LEED Introduction

The final section details benefits of green construction and LEED. The information is presented through a potential cost savings study of the students' school if it were green. First is energy and electricity savings, followed by water consumption savings and finally the benefit the students' school would have on reducing air pollution. For the Ambridge Area High School, using approximate figures would have the potential to save \$93,100 annually on electricity, \$4,710 on water use and prevent 585,000 pounds of CO2 and 1,200 pounds of nitrogen dioxide from being emitted annually. Also included from a Carnegie Mellon University study were potential health benefits in the way of reduction of asthma and allergy symptoms and the potential increase in productivity of building occupants. The information was presented in this way to demonstrate to students the difference their individual school could make on the environment and through savings their school district could use toward teachers or textbooks rather than increased energy bills.



ELECTRICITY

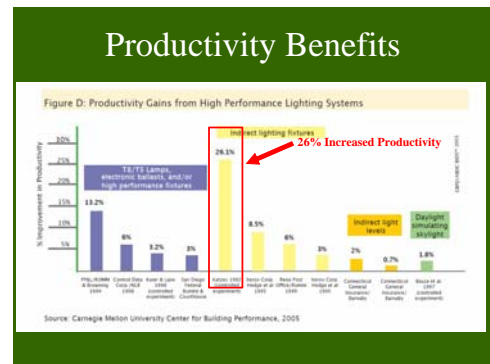
Energy Benefits

The average energy costs annually on traditional schools is \$1.15/SF. On average, green schools use 33% less energy and electricity than traditional schools.

Exercise: Find the average energy savings if our school was green.

Answer:
 $245,325\text{SF} \times \$1.15 = \$282,123.75 / \text{Year}$
 Potential savings - $\$282,123.75 \times .33 = \$93,100.33 / \text{Year}$

Sample slide from Green Benefits



Sample slide from Green Benefits

Following the green benefits section of the lecture, two LEED school case studies are discussed allowing students to see the practical implications of the topics they have just learned. The two schools, Fossil Ridge High School, a LEED Silver project built at no additional cost, and Clearview Elementary School in Hanover, Pennsylvania, a LEED Gold project built at an additional 2.15% initial cost are studied in terms of their environmental benefits as well as their energy saving aspects. Several other case studies may be incorporated, such as those listed on the next page.

USGBC LEED Rated School Case Studies					
Project Name	Owner	City	State	Country	LEED
Third Creek Elementary School	Irdell-Statesville Schools-Admin Offices	Statesville	NC	US	Gold
Clearview Elementary School	Hanover Public School District	Hanover	PA	US	Gold
IslandWood: A School in the Woods	IslandWood	Bainbridge Is.	WA	US	Gold
John M. Langston High School Continuation	Arlington Public Schools, Arlington County	Arlington	VA	US	Silver
Clackamas High School	Clackamas High School	Clackamas	OR	US	Silver
Felician Sisters Convent and School Renovation	Felician Sisters of Pennsylvania	Coraopolis	PA	US	Gold
Baca/Dlo'ay azhi Community School	Baca Community School	Prewitt	NM	US	Certified
Fossile Ridge High School	Poudre School District	Fort Collins	CO	US	Silver

A final discussion allows groups to brainstorm for ideas to spread awareness of the benefits and advantages of LEED schools and construction. This information can be incorporated into the group project portion of the program.

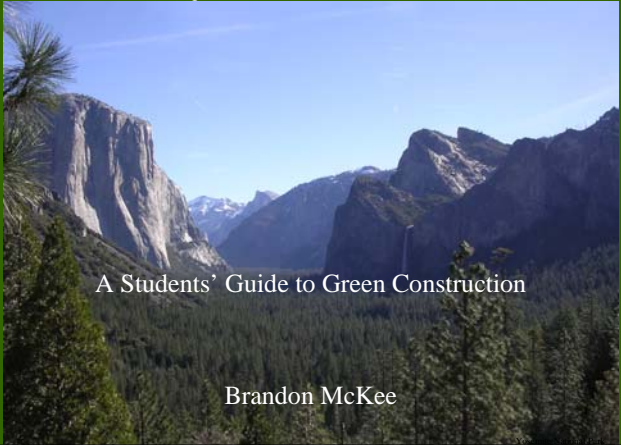
In addition to the lecture with PowerPoint slides, an instructor may utilize the additional tools created as part of this research. A WebQuest type quiz was produced requiring students to show their knowledge on the topics of green construction and LEED. This method requires students to use the websites listed on the quiz to research and complete the questions. This method allows students to gather information on their own from green and LEED websites possibly increasing their interest in the topic and allowing them to read and learn material outside of the classroom lecture setting. This WebQuest quiz can be found on the next page.

A final group project can be utilized to reinforce this topic should interest and time permit. The project developed allows students to form groups and develop a method to spread awareness of the benefits and advantages of green construction and LEED. In groups, students are required to use various methods such as performing a skit, developing a poster or flyer, or producing a short movie to showcase the advantages of building green. The activity allows students to collaborate together and use their own creativity and talents to convey the intended message to the audience.

Conclusion

After conducting research and developing a lesson for use in high school class settings, it is believed that LEED and green building is a concept that is progressing its way through the construction industry. The two main barriers school districts were found to hold to building green were lack of knowledge and understanding and the perceived additional costs to build green. This lecture will hopefully aim to educate school aged students of the benefits and advantages and possibly cultivate discussions at home between parents and relatives or other adult figures in a students' life. It is felt that this age group of students will be most likely to take action and strive to request and require LEED legislation be put in place or at least incorporate some green ideals into construction of school or other building projects should they be in any capacity to do so.

Why Build Green?

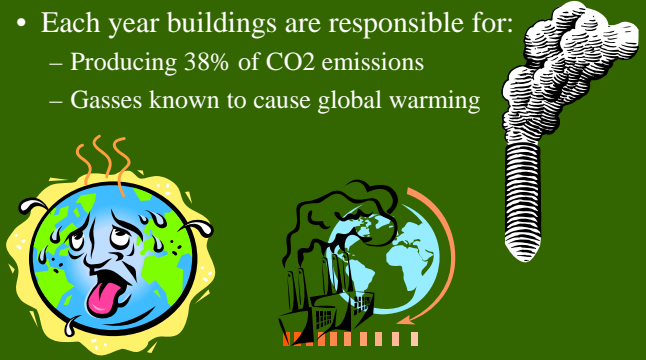


A Students' Guide to Green Construction

Brandon McKee

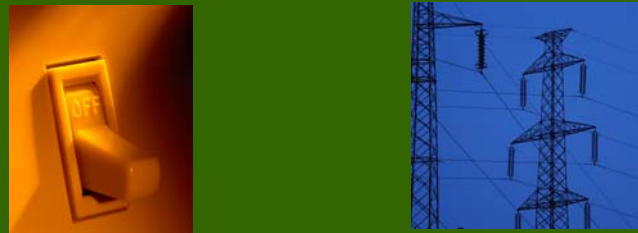
Building Industry Facts

- Each year buildings are responsible for:
 - Producing 38% of CO2 emissions
 - Gasses known to cause global warming



Building Industry Facts

- Each year buildings are responsible for:
 - Consuming 67.9% of electricity
 - & 39.4% of all energy produced



Building Industry Facts

- Each year buildings are responsible for:
 - Draining 12% of fresh water



Building Industry Facts


- Each year buildings are responsible for:
 - Sending 136 million tons of waste to landfills
 - Only 20 – 30% of waste is recycled
 - Average person – 2.8 pounds/day



The diagram illustrates the waste management process: a trash can on the left, an arrow pointing to a garbage truck in the middle, and another arrow pointing to a landfill with a bulldozer on the right.


Did You Know?

- We spend 90% of our lifetimes indoors.




At home


90%




At practice



At work




At church



At school


10%



Outside

Did You Know?

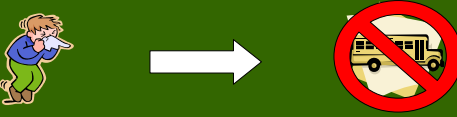
- Indoor air pollution may be 2-5 times higher and sometimes 100 times higher than outdoors.
 - Pollution indoors includes : cleaning products, dust, personal care products, furniture and building materials



The illustration shows a person on the left coughing into a tissue, and a group of colorful cars on the right emitting exhaust, representing indoor and outdoor air pollution.

Did You Know?

- Asthma is the most common childhood chronic disease.
 - Over 6 million children have asthma
 - An estimated 14 million school days are missed because of asthma
 - Indoor pollution can trigger asthma – dust, mold, dander & secondhand smoke



The illustration shows a person on the left coughing, followed by an arrow pointing to a bus on the right with a red prohibition sign over it, indicating that secondhand smoke from a bus is a trigger for asthma.

Discussion #1

- With your group, discuss potential solutions to these problems caused by buildings.
 - Air pollution
 - Energy consumption
 - Draining fresh water
 - Filling landfills
 - Indoor air pollution
- Can you think of any issues this school has with these topics?

Green Building and LEED

- U.S. Green Building Council (USGBC) – non profit, based in Washington D.C.
- Committee based
- Organized to promote:
 - Sustainable site planning
 - Indoor environmental quality
 - Energy efficiency
 - Conservation of materials
 - Safeguarding water
- Created the Leadership in Energy & Environmental Design (LEED) rating system



LEED



- LEED was created to:
 - Define what is "Green"
 - Provide a standard of measurement
 - Prevent false green claims
 - Raise consumer awareness
 - Stimulate competition in the marketplace

LEED® Rating System

- Four levels of certification
 - Certified (26-32 points)
 - Silver (33-38 points)
 - Gold (39-51 points)
 - Platinum (52-69 points)
- 6 categories worth 69 points
 - Sustainable Sites (14 points)
 - Water Efficiency (5)
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 - Indoor Environmental Quality (15)
 - Innovation & Design Process (5)



What Makes a Building Green?

- Incorporating elements into design such as:
 - Waterless or low flow plumbing fixtures
 - Certified Wood Products - Eliminates clear cutting
 - High efficiency lighting fixtures
 - Low VOC emitting paints and products
 - Close to public/alternative transportation
 - Day lighting
 - Solar panels - photovoltaic cells



Yukon™ Waterless Urinal - Waterless CO



Photovoltaic (Solar) cells



Low/ no VOC paints from Sherman-Williams



Bicycle racks to reduce automobile use

States with Green Construction Legislation



(9) - States Requiring Green Construction on State/Public Funded Projects



(23) - States with Legislation Pending or Incentives for Green Construction

Government Required LEED

The following government agencies require LEED construction

- GSA General Services Administration (GSA)
- U.S. Air Force
- U.S. Navy
- U.S. Army Corps of Engineers
- Department of State
- Department of Energy (DOE)
- Environmental Protection Agency (EPA)



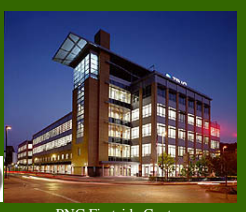
Green Buildings in Our Area



David L. Lawrence Convention Center



Gold



PNC Firstside Center



Silver



Pittsburgh Glass Center



Gold



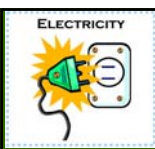
REI - South Side



Silver

Benefits of Green Schools

- Green schools can:
 - Use less energy
 - Use less water
 - Reduce greenhouse gas emissions
 - Provide more natural light and ventilation
 - Improve student and teacher health
 - Improve test scores and productivity
 - Teach you, parents and teachers about a healthier environment



Energy Benefits

The average energy costs annually on traditional schools is \$1.15/SF
 On average, green schools use 33% less energy and electricity than traditional schools.

Exercise: Find the average energy savings if our school was green.

Answer:
 $245,325\text{SF} \times \$1.15 = \$282,123.75 / \text{Year}$
 Potential savings - $\$282,123.75 \times .33 = \$93,100.33 / \text{Year}$



Water Saving Benefits

The average water costs annually on traditional schools is \$0.06 / SF
 On average, green schools use 32% less water and create less waste water than traditional schools.

Exercise: Find the average water savings if our school was green.

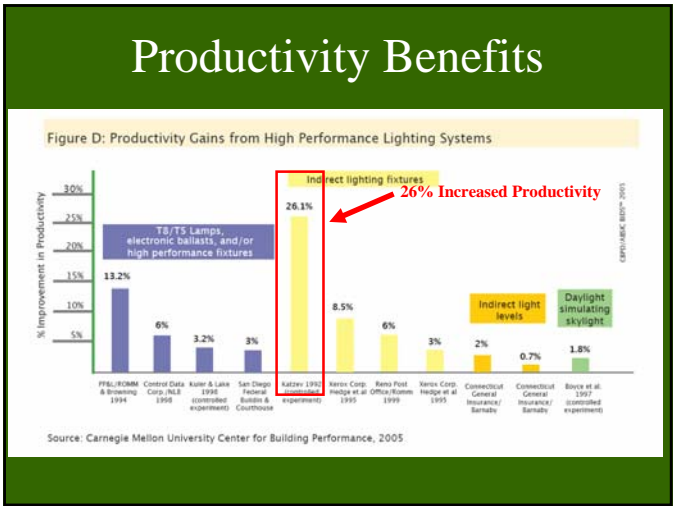
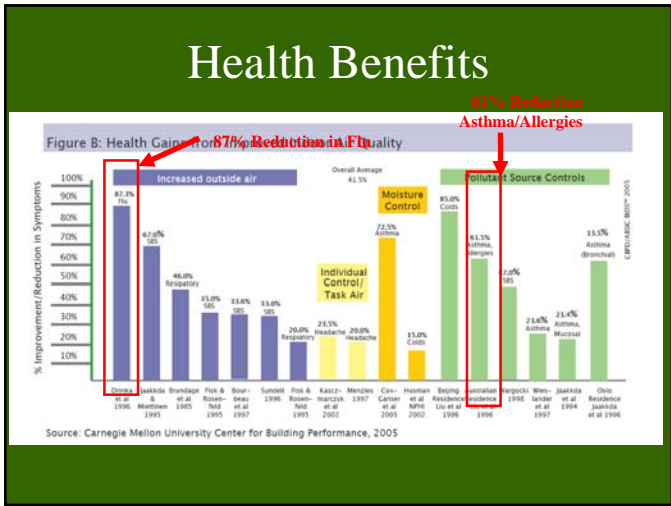
Answer:
 $245,325\text{SF} \times \$0.06 = \$14,719.50 / \text{Year}$
 Potential savings - $\$14,719.50 \times .33 = \$4,710.24 / \text{Year}$



Air Pollution Benefits

It is estimated that a green school could reduce the following emissions annually.

- 585,000 pounds of carbon dioxide (CO2)
- 1,300 pounds of sulfur dioxide (SO2)
- 1,200 pounds of nitrogen dioxide (NO2)



Green Saving Summary

Green schools costs on average 2% more initially than traditional schools.

Let us look at the payback period on this investment from only water and energy savings on our school.

Cost to go green $\$38,846,057 \times 0.02 = \$776,921$

Energy savings $\$93,100 / \text{Year}$
 Water savings $\$4,710 / \text{Year}$
 $\$97,810 / \text{Year total potential savings}$

Payback period $\$776,921 / \$97,810 \text{ annually} = 7.9 \text{ Years}$

Green School Case Studies

- Case Study #1 - Fossil Ridge High School - Fort Collins, Colorado
- Case Study #2 - Clearview Elementary School - Hanover, Pennsylvania

Case Study #1

Fossil Ridge High School Fort Collins, Colorado

State of the art 290,000 SF for 1,800 students


\$0 - Additional cost for LEED


60% - More energy efficient

\$11,500 - Annual water savings

75% - Waste recycled

Low VOC furnishings



LEED Silver 2005 

Case Study #2

Clearview Elementary School Hanover, Pennsylvania


43,600 SF for 350 students


2.15% - Additional cost for LEED

7 Year - Payback period from energy savings alone

Uses 40% less energy than traditional school

50% of building materials recycled



LEED Gold 2002 

Discussion #2

- With your group, discuss how to spread awareness about the benefits and advantages of LEED and building green schools and buildings.

Green Schools Video

- The following video was produced to spread awareness and create interest in high performance green schools.

[Better Places to Learn](#)

Sources

Information contained in the preceding presentation was compiled from the following sources.

- Build It Green www.builditgreen.org
- Governors Green Council www.ggac.state.pa.us
- Green Building Pages www.greenbuildingpages.com
- Greening America's Schools by Gregory Kats www.cap-e.com
- U.S. Environmental Protection Agency www.epa.gov
- U.S. Department of Energy www.energy.gov
- United States Green Building Council (USGBC) www.usgbc.org

LEED® & GREEN BUILDING WEBQUEST

Names: _____

Date: _____

Objective: Alone or with a partner use the websites listed below and information from the in class lecture to complete the following questions about Green Building and LEED®.

Websites:

www.gggc.state.pa.us/gggc

www.usgbc.org

<http://www.cap-e.com/ewebeditpro/items/O59F11233.pdf>

www.energy.gov

www.epa.gov

Questions:

1. Green schools save on average \$_____ per year – That's enough to buy _____ new computers or buy _____ new textbooks for students.
2. Buildings are responsible for producing _____% of CO2 emissions each year, known to cause global warming.
3. The _____rating system is the nationally accepted benchmark for design construction and operation of high performance green buildings.

4. The four levels of LEED certification are _____, _____, _____, and _____.
5. Buildings drain _____% of the fresh water we need to drink and survive each year.
6. We as humans spend about _____% of our lives indoors at school, work, home, practice or church.
7. The average person creates _____pounds of waste in the form of garbage each day, while the building industry is responsible for sending _____ tons of waste to landfills each year.
8. The building industry currently recycles between _____ and _____% of construction waste and demolition debris on average.
9. The LEED rating system allows building projects to earn points in six categories. They are _____, _____, _____, _____, _____, and _____.
10. LEED stands for what? _____
11. List three reasons why the LEED rating system was developed. _____, _____, _____
12. An estimated _____ school days are missed each year as a result of asthma.

13. Currently there are _____ states requiring LEED certification on publicly funded building projects.

14. The average green school uses _____less energy and electricity than traditional schools.

15. Green schools cost on average _____% more initially than traditional ones with an expected payback period of around _____ years.

16. In the Carnegie Mellon University study, green principles were found to reduce asthma and allergies up to _____% and increase productivity by up to _____%.

17. Building one green school could keep _____pounds of CO₂ and _____ pounds of nitrogen dioxide from being emitted annually.

18. The average green school uses _____% less water than traditional schools do.

19. The state of the art Fossil Ridge High School in the case study cost the school district \$_____ additional to go green.

20. The Clearview Elementary School uses _____% less energy than a traditional elementary school of its size.

LEED® & GREEN BUILDING

GROUP PROJECT

Names: _____

Date: _____

Objective: In groups of 2-4 students, create a plan to spread awareness of green building and LEED® to people outside of this class. You may use any of the following formats to spread awareness or create your own. Remember, to be as creative as possible and use your personal interests to adapt the information to your audience.

- Create an article to be printed in the school newspaper
- Perform a short skit to the school or other group of people
- Develop a poster or flyer to educate and list potential places to display it
- Create a short movie starring yourself or others
- Create a board game to teach and entertain
- Create your own!

Potential topics can include but are not limited to:

- LEED® rating system
- Benefits of building green
 - Environmental
 - Health
 - Energy savings
- Ways your audience can help