LEED Design

And the case of the green roof!

A curriculum for after school programs based in the community
Grades 5-8

Green Energy Technologies in the City
http:getcity.org

This material is based upon work supported by the National Science Foundation under Grant No. DRL-0737642

The case of the Green Roof!

Designing a New Green Roof
GET City, Spring/Summer 2009

Driving Question: Should the Club's new roof be green, and what design features might (should?) it contain?

Overarching objectives

- To understand and analyze how the design of a new green roof might address multiple energy, economic, and safety challenges faced by the Club, and to view the problem from the perspective of multiple stakeholders (Club leaders, youth, community members)
- To engage youth in design-based decisions about the Club's roof that affect the club's energy profile, and in ways that leverage core scientific and engineering principles and practices related to energy and climate change

Unit Description

The Boys and Girls Club of Lansing has had a leaking roof for the past couple of years. Each time it rains, and each spring as the snow melts, track buckets are placed all around the club to collect the dripping water. Further, an examination of the Club's electricity bills reveals a much higher than average energy costs in hot summer months of July and August.

In this design-based unit focused on green roofs youth will investigate the reasons for and the design of a green roof that respond to the club's needs (economic, safety, and global climate concerns) situated in the broader context of the pressing global concerns around climate change.

Part 1: Needs Assessment. The unit begins with an exploration of the "problems" the club faces with the current roof, which include the collection and analysis on views of the problems and data to ascertain the level of the problems. Three core problems are explored: leakage (safety), utility costs (economic), and carbon footprint contributions (global climate). During this segment of the unit, youth learn about needs assessments, and conduct one to look at the problems of the current roof from multiple perspectives.

Part 2: Understanding the relationship between the built and green environments. The unit then turns to an examination of the relationship between the "built environment" and the "green environment" by investigating the idea of urban heat islands (and the club's potential contribution to their city as an UHI). Investigate microclimates, and in particular the causes and effects of heat islands in urban areas. Using GIS mapping, youth visualize and compare the built and green environments in their city, and predict how the built environment impacts various local microclimates, including the microclimate of small model homes built of different color materials placed in the grassy and asphalt sun and shade, as well as the real world rock and asphalt rooftop of their club. Using digital thermometers, excel spreadsheets, and heat imagery, youth document temperature gradients of the microclimates investigated. Another core concept covered here is heat transfer (i.e., the transfer of heat through space is affected by the nature of materials, and that energy in the form of heat is almost always one of the products of an energy transformation). Youth discuss potential connections between the microclimate of the club's roof

and the increased summer energy costs of the club and the club potential carbon footprint.

Part 3: Technological solutions. The unit moves towards investigating technological solutions for mitigating UHIs, and using the case of the green roof. Youth investigate both intensive and extensive green roof design as possible energy management systems. Youth visit several intensive, extensive, and white roofs in and around the city, and collect data on ambient and surface air temperature. Youth map and compare data and generate claims about the potential impact of green roofs on both energy costs and microclimates.

Part 4: Youth design for the placement of the skylights. A local firm donated three 4x4 skylights to be included in the club's new roof. Youth will investigate the design, placement and impact of skylights. Following the same design processes used for the larger roof, youth will learn about skylights and their role in energy conservation. They will then conduct a needs assessment among stakeholders at the club, gathered real world data on key aspects of design features (i.e., the need for natural lighting), and created a multimedia proposal to the club's board of directors and engineering firm for the skylight's locations.

Throughout the unit, youth work in collaborative teams, and advance IT skills (digital probes in conjunction with excel spreadsheets and graphing, on-line survey and data analysis, imovie, GIS) are used in support of youth design-based investigations into the new green roof. Also as part of this last segment youth create multimedia artifacts intended to educate Club and Community leaders on why the club should get a green roof and design issues to consider.

Part 5: Job Shadowing. During this cross-cutting segment, youth shadow engineers in their work on the design installation of the green roof. Youth also visit a white roof design and manufacturing company to learn about the different roles played by design and manufacturing engineers, and learn how white roofs are quality tested for a range of safety issues.

Specific science and engineering learning goals

Transfer of Energy (grades 5-8, NSES, p. 155)

- Energy is a property of many substances and is associated with heat, light, electricity, mechanical motion, sound, nuclei, and the nature of a chemical. Energy is transferred in many ways.
- Heat moves in predictable ways, flowing from warmer objects to cooler ones, until both reach the same temperature.
- Light interacts with matter by transmission (including refraction), absorption, or scattering (including reflection). To see an object, light from that object—emitted by or scattered from it—must enter the eye.
- Electrical circuits provide a means of transferring electrical energy when heat, light, sound, and chemical changes are produced.
- In most chemical and nuclear reactions, energy is transferred into or out of a system. Heat, light, mechanical motion, or electricity might all be involved in such transfers.
- The sun is a major source of energy for changes on the earth's surface. The sun loses energy by emitting light. A tiny fraction of that light reaches the earth, transferring energy from the sun to the earth. The sun's energy arrives as light with a range of wavelengths, consisting of visible light, infrared, and ultraviolet radiation.

Science Inquiry (NSES, grades 5-8, pp. 148+)

All students should develop the abilities necessary to do scientific inquiry

- Use appropriate tools to gather analyze and interpret data
- Develop descriptions, explanations, predictions and models using evidence
- Think critically and logically to make the relationships between evidence and explanations

- Communicate scientific procedures and explanations
- Use mathematics in all aspects of scientific inquiry

Technological Design (NSES, grades 5-8, pp. 163-165)
All students should develop the abilities of technological designs
- Identify appropriate problems for technological design
- Design a solution or product
- Implement a proposed design
- Communicate the process of technological design

Climate Change (AAAS, p. 2009)
Climate change & Environment Sustainability
- Humans may be able to mitigate climate change by reducing greenhouse gas emissions
- Strategies for reduce greenhouse gas emissions: renewable and alternative sources & change in how humans use energy.
- Actions taken by individuals, communities, states, & countries all influence climate.

IT Skills
Data gathering and analysis tools: GIS software and databases (ArcView with Excel and ODBC to preprocess GIS attribute data, and chemical/thermal probes for local data generation) to be used in data generation and spatial analysis of energy efficiency and sustainability patterns and its impact on local practices and environmental health, and (b) *Communication Tools:* PowerPoint and web design to share findings with the local/national community.

LEED Design: The case of the green roof!
GET City, Spring/Summer 2009

Part 1 – Lesson Plans

Background

Overarching Driving Question for Green Roof Unit: Should the Club's new roof be green, and what design features might (should?) it contain?

Overarching objectives for Green Roof Unit:

- To understand and analyze how the design of a new green roof might address multiple energy, economic, and safety challenges faced by the Club, and to view the problem from the perspective of multiple stakeholders (Club leaders, youth, community members)
- To engage youth in design-based decisions about the Club's roof that affect the club's energy profile, and in ways that leverage core scientific and engineering principles and practices related to energy and climate change

Green Roof Unit Description
The Boys and Girls Club of Lansing has had a leaking roof for the past couple of years. Each time it rains, and each spring as the snow melts, track buckets are placed all around the club to collect the dripping water. Further, an examination of the Club's electricity bills reveals a much higher than average energy costs in hot summer months of July and August.

In this design-based unit focused on green roofs youth will investigate the reasons for and the design of a green roof that respond to the club's needs (economic, safety, and global climate concerns) situated in the broader context of the pressing global concerns around climate change.

Lesson Plans for Part 1

Part 1: Needs Assessment. The unit begins with an exploration of the "problems" the club faces with the current roof, which include the collection and analysis on views of the problems and data to ascertain the level of the problems. Three core problems are explored: leakage (safety), utility costs (economic), and carbon footprint contributions (global climate). During this segment of the unit, youth learn about needs assessments, and conduct one to look at the problems of the current roof from multiple perspectives.

Lesson 1: Conducting a Needs Assessment

Objectives

- Students will develop an understanding of what a needs assessment is, and how and why it might be useful in determining the problems and possible solutions for the club leaky roof.
- Students will be able to distinguish between different kinds of data collection tools for conducting needs assessments
- Students will conduct a needs assessment using three primary tools (existing data & interviews)
- Students will analyze data and build evidenced claims from the data regarding the problems and possible solutions to the leaky roof

Activities

- What is a needs assessment?
- What kinds of data do we use?
- Conducting a needs assessment for the leaky roof

Activity 1: Discussion - What is a needs assessment?
Share the following ideas with students.

- A needs assessment involves collecting and analyzing information to gain a better understand a community's resources and needs. A community needs assessment permits one to gather specific and reliable information about what members of a community want and need.

- Steps in conducting a needs assessment
    - Determine the problem
    - Determine what might information might be best in getting information about the problem.
    - Decide on procedures for obtaining the data
    - Analyze the data and build evidence-based claims
    - Prepare a report

Discuss: How would you describe the problem of the leaky roof? Have the students come to consensus on: 1 sentence description of the problem; a list of criteria to frame the information they want to find out about others (safety, environment, economic)

Activity 2: What kinds of data do we use?

Share the following table with students.

	Description	Pros	Cons
Existing Data	Electricity Bills Information on program hours & locations	• Data already exists • Quick access • Can chart changes	Lacks people's perceptions of needs
Survey	Asking large number of people to fill out a set of questions related to their concerns.	• Get information from broad range of people •	• Have to build survey which can be tricky
Interviews	Talking with people about their needs and concerns	• Provides detailed information • You can select key people	• Few informants so it might not represent all needs

Put students into 2 groups: Existing data and interviews. In each group have them:

Designing a New Green Roof
GET City, Spring/Summer 2009
http://getcity.org

Lesson Plans – Part 2

Background

Overarching Driving Question for Green Roof Unit: Should the Club's new roof be green, and what design features might (should?) it contain?

Overarching objectives for Green Roof Unit:

- To understand and analyze how the design of a new green roof might address multiple energy, economic, and safety challenges faced by the Club, and to view the problem from the perspective of multiple stakeholders (Club leaders, youth, community members)
- To engage youth in design-based decisions about the Club's roof that affect the club's energy profile, and in ways that leverage core scientific and engineering principles and practices related to energy and climate change

Green Roof Unit Description
The Boys and Girls Club of Lansing has had a leaking roof for the past couple of years. Each time it rains, and each spring as the snow melts, track buckets are placed all around the club to collect the dripping water. Further, an examination of the Club's electricity bills reveals a much higher than average energy costs in hot summer months of July and August.

In this design-based unit focused on green roofs youth will investigate the reasons for and the design of a green roof that respond to the club's needs (economic, safety, and global climate concerns) situated in the broader context of the pressing global concerns around climate change.

Lesson Plans for Part 2

Overview Part 2: Understanding the relationship between the built and green environments.

In part 2, the youth examine the relationship between the "built environment" and the "green environment" by investigating the idea of urban heat islands (and the club's potential contribution to their city as an UHI). Investigate microclimates, and in particular the causes and effects of heat islands in urban areas. Using GIS mapping, youth visualize and compare the built and green environments in their city, and predict how the built environment impacts various local microclimates, including the microclimate of small model homes built of different color materials placed in the grassy and asphalt sun and shade, as well as the real world rock and asphalt rooftop of their club. Using digital thermometers, excel spreadsheets, and heat imagery, youth document temperature gradients of the microclimates investigated. Another core concept covered here is heat transfer (i.e., the transfer of heat through space is affected by the nature of materials, and that energy in the form of heat is almost always one of the products of an energy transformation). Youth discuss potential connections between the microclimate of the club's roof and the increased summer energy costs of the club and the club potential carbon footprint.

Lesson 1: Introduction to urban heat islands and green roofs

Science Objectives:

- To introduce students to the idea of the Club getting a new green roof and why green roods are important
- To introduce the idea of an urban heat island: What it is and what causes them?

Science Standards:

- Energy is a property of many substances and is associated with heat, light, electricity, mechanical motion, sound, nuclei, and the nature of a chemical. Energy is transferred in many ways.
- The sun is a major source of energy for changes on the earth's surface. The sun loses energy by emitting light. A tiny fraction of that light reaches the earth, transferring energy from the sun to the earth. The sun's energy arrives as light with a range of wavelengths, consisting of visible light, infrared, and ultraviolet radiation.

Activities Overview

- Survey Monkey: Green Roofs & Me!
- How *hot* do you feel?
- Pulling it together

Survey Monkey: Green Roofs & Me

In this introduction have students complete the survey, youth answer a series of content questions about energy transfer, urban heat islands, and green roofs, based on NSES content standards. Youth also answer questions related to their concerns about the club's leaking roof.

Investigation #1: How does my bottom feel?

Opening discussion: Green and Built Environments

In this investigation, students split into two groups: "Green environment" and "Built Environment." Tell students that the green environment group will be sitting in the grass while the "Built environment" group will be sitting on the black asphalt. *Discuss, why did we name the groups as we did*?

Data recording activity: How hot do I feel?

Then, hand out the activity sheet, and explain that how youth will sit outside on the asphalt or grass and record their observations upon first sitting down and after 10 minutes. Review procedure:

- Sit down in their assigned spot with a stop watch.
- Before they start the stop watch, they should complete the survey and take the temperature and some pictures.
- Then they should sit for 10 minutes. During those ten minutes they should interview a partner using the questions on the handout. At the end of the 10 minutes, they should complete the survey again.

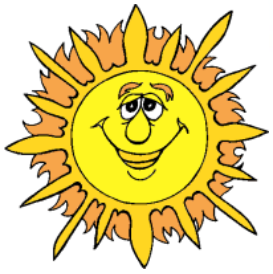
Pulling it together:

Have students write a blog entry on their observations.

Have students look at each other's blog entries and discuss: "How does the natural or built environment matter in terms of how "hot" I feel?"


GET CITY

How do I Feel?



Group: BUILT ENVIRONMENT or GREEN ENVIRONMENT?

Group Roles

- Timer: _____
- Temperature Taker: _____
- Videographer: _____
- Photographer 1: _____
- Photographer 2: _____
- Survey Leaders: _____

YOUR TASK: GO OUTSIDE AND SIT IN THE SUN FOR 10 MINUTES AT YOUR ASSIGNED AREA. DOCUMENT HOW YOU FEEL!

Temperature

To take the temperature, place the thermometer directly on the grass or on the asphalt in the sun. Do not cover or shade the thermometer, and of course, do not sit on it!

Temperature at the start: _____

Temperature after 10 minutes: _____

Survey

Name	At the start		After 10 minutes	
	Sweating? (Yes or No)	How "hot" do you feel on a scale of 1-4?	Sweating? (Yes or No)	How "hot" do you feel on a scale of 1-4?

Photographer: Take pictures of the location you are sitting and people's reaction to it!

Videographer: Interview group members about how they feel. Ask whether it makes it a difference if they are in the grass or the pavement, what clothes they are wearing, and what ever else you can think of!

Everyone: post your reactions at getcity.blogspot.com. Use at least 1 picture and 2 sentences. Sign in using getcity09@gmail.com

Lesson 2: Using GIS to predict microclimates

Objectives:
- To learn what GIS is, and how it used by scientists
- To learn how to use GIS to produce maps and other information
- To locate several locations in Google earth using a range of different means
- To use GIS information to make predictions about microclimates

Activities

GIS Challenge!
Explain to students that we will use Google Earth to try to predict where it might be "hotter" in Lansing based on what the environment looks like – Green or Built. But first, we have to get familiar with Google Earth. We will have the Google Earth Challenge!

Walk students through the Google Earth Challenge Activity Sheet.

Predicting Microclimates
Return to previous lesson discussion: What conjectures can you make about "how hot" the built environment is compared to the green environment? What building conditions (such as color, size, materials) might make a bigger difference?

Have students return to the GIS maps, and mark 3 places where they predict it would cooler than the recorded outdoor temperature 3 places where they predict it might be hotter. Why?

Materials and handouts
20 copies of handouts (How do I feel, Google Earth Challenge)
Computers with internet connection
Pencils or pens

GOOGLE EARTH ACTIVITY

Welcome to GOOGLE EARTH! ☺ With this program, you can have a bird's eye view of buildings, roads and other geographical landscape. Imagine flying over these buildings and looking down on them! Let's get started!

Steps to follow:

1. Click on the Google Earth icon  on your toolbar to open the program.
2. Take 2 minutes to play with the tools on google earth so you figure out how to zoom in and out or to "fly" to a particular location with the panel on the left of the screen.
3. Find at least 8 locations from this given list. Anyone who finishes gets a prize (something yummy to eat!)

- Your School
- The Boys & Girls Club
- A grocery store you go to (Meijer, Kroger, etc.)
- MSU football stadium
- Capitol Building of Michigan
- Capital Airport of Lansing
- Singapore
- Lake Lansing
- Mackinaw Bridge (linking upper and lower peninsulas of Michigan)
- London
- 2 big cities in the USA (e.g. Detroit, New York, Chicago, or Los Angeles)

Part 2:

Lesson 3: Investigating Microclimates

Overview
In this lesson we will investigate: What are microclimates? What causes heat islands in urban areas? What are the effects of heat islands on the environment? What are some ways to prevent or mitigate heat island effects? How can I measure the air temperature above various surface materials to investigate the heat island effect?

Objectives:
- Students will use the scientific process to learn that when various surfaces are exposed to similar environmental conditions, surface temperatures may vary. This variation may be due to differences in thermal properties among the surface types.
- Students will learn the relationship between surface and surrounding-air temperatures.
- Students will learn that the use of light colored roofs and ground surfaces may help reduce urban heat island effects.
- Students will understand that large areas of dark-colored, surfaces increases the temperature of the surrounding air and drives the development of "urban heat islands."
- Students will understand that the "urban heat island" phenomenon increases energy consumption.

Activities
1. **Initial discussion**: What kinds of places in your neighborhood are hotter in the summer?

2. **Experiment #1**: Exploring heat islands – examining the typography around BGC.

3. **Experiment #2**: Causes of Heat Islands #1 - Building Houses: Color and Location (1.5 hours)

Teacher Notes

- Urban centers are often noticeably warmer than the surrounding region. Why? Many of the activities and land uses in urban centers combine to create a "heat island". Various research has indicated that urban centers may be heated by as much as 10 degrees Celsius in the summer as a result of high concentrations of concrete, human activities such as industrial process and cars, and the absence of tree cover. It is also believed that centers as small as 1000 people may generate a heat island.

- Some of the reasons for the heat island are concrete, asphalt, and glass that have replaced natural vegetation. The vertical surfaces of buildings that are added to a normally flat natural rural landscape absorb great amounts of incoming radiation. Furthermore, urban surfaces have a lower albedo and a greater ability to conduct heat. This results in a high capability to store heat. In addition, various human activity in urban areas can add large amounts of heat energy to the local energy balance through transportation, industrial processes, and the heating of buildings. For example, in winter, 2.5 times more heat is generated from the burning of fossil fuels in New York City than the heat absorbed from the sun. Conversely, in rural areas, evaporation and transpiration act to cool the land just as perspiration does for humans.

ACTIVITY 1: Background information on urban heat islands:

Procedures

- Ask students to predict the location of the hottest surface in the schoolyard ~ the area where they would least like to walk barefoot in the summer.
- Tally and record student's predictions to discuss again at the lesson debriefing.
- Then ask students whether they would guess that urban or rural areas are typically warmer. Challenge them to defend their responses, but do not provide any answers yet. Finally, introduce the concept of the heat island effect, using the resources linked below.

ACTIVITY 2: Two Experiments:

Experiment #1: Understanding the mini heat islands at the BGC (worksheet 1 p 1-2):

In this activity, students will measure and compare variations in temperature in various micro-ecosystems in order to identify factors involved in creating the heat island effect. Students will need to have access to most of the school ground and may even need to leave the property briefly.

Procedure

1.Brainstorm with the class a list of sites on the school ground that have a variety of characteristics. They may differ in exposure to UV radiation and shade, surface cover, topography, proximity to a building, human activities (e.g. parking lot versus playing field), etc.

2. As a class, choose 4 different sites around the school ground to investigate the air temperature. Hypothesize as to which sites will have higher and lower temperatures and explain why.

3. Divide the class into 4 groups. Assign a study site to each group.

4. Discuss the objectives and procedures for the investigation.

5. Outdoors, each group will record a detailed description of the physical characteristics of their study site on worksheet 1 p. 1.

6. Each group will measure the temperature 5 to 10 times throughout their study site and calculate the average temperature. Results are recorded on worksheet 1 p. 2.

7. Back in the classroom , share the site data collected by each group. Provide time for the students to respond to the discussion questions.

Discussion and Questions

Invite student groups to discuss their findings as a class. These questions may be discussed as a group and/or presented in student reports or presentations.

1. What places have the highest temperatures? What do you think might be the reasons?

2. What places have the coolest temperatures? What do you think might be the reasons?

4. How do you think these mini heat islands affect kids?

Experiment #2: Causes of Heat Islands #1 - Building Houses: Color and Location:

In this activity, students will build a simple house made out of similar building materials but of different colors. They will measure the surface and surrounding air temperature of their houses in the sun and shade.

Procedures:

Review the scientific process of formulating a question (hypothesis), collecting data through experimentation and observation, and finally explaining the results of the test.

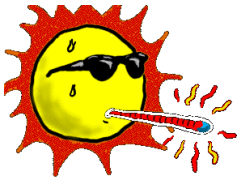
Show the houses with the two different colors of roofing materials (i.e., dark and light). Ask the students to write down a hypothesis as to whether there may be differences in

temperature between the two surfaces when exposed to similar environmental conditions. Also ask whether there may be an effect of the materials on the temperature of the roof, or the inside and outside area of the houses.

Have students build a house using either dark or light colored material. [show a model house, give instructions]

Assist the students in setting up the experiments to test their hypotheses. Students may want to work in small groups or pairs to do this set of experiments. Take the houses outside and place them in direct sun about five feet apart. Put a thermometer near each house and place the attached thermal lead inside the house. Cover the actual thermometer so it is not exposed to direct sun. Allow the houses to remain in direct sun for at least 10 minutes, then have students record (on copies of the sheet provided) the following temperatures: roof surface, inside the houses, and outside the houses. Repeat the experiments above, however, expose the houses to full shade (e.g., behind a building) or dappled light (e.g., under tree with a fairly open canopy). Encourage students to come up with other variables that can be tested (e.g., amount of time in sun or shade).

Discuss the urban heat island effect, why we want to reduce heat island effects, and how to cool our communities. Have students discuss whether surface types found in their neighborhoods contribute to a local heat island effect. If time permits, thermal images for comparison.



Mini Heat Islands at the Boys and Girls Club!

Date: _____

Group Members:_____

In this activity, you will measure and compare temperature variations in different micro-ecosystems in order to identify what factors are involved in creating the "Heat Island" effect.

Location:

Using a picture and words, please describe your site:

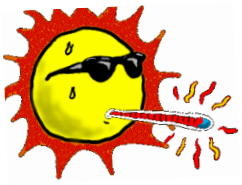
Where is your site? Why did you choose this site? What can you find at this site (e.g. trees, roads, etc.) What do you predict the temperature will be like at this site?

Predicted temperature: _____

The 4 Chosen Sites of LBGC
Let's describe Site Characteristics and Temperature Observations!

Site 1	Site 2
Temperature Observations average: _____	Temperature Observations average: _____
Site 3	**Site 4**
Temperature Observations average: _____	Temperature Observations average: _____

What did you find out? Were you surprised by anything?



Causes of Heat Islands #1 - Building Houses: Color and Location

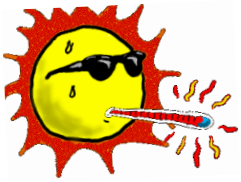
Problem: Why do you think the color of houses matter at all?

Hypothesis: What do you predict will be the coolest house?

Procedures: Build your house with the model plan and instructions below.

Surface Temperature Data sheet				
Surface Temperature			**Surrounding Air temperature**	
Color of House	**Full Sun**	**Shade**	**Full Sun**	**Shade**

What other observations did you make?



Analysis of Different Temperatures:

- Analyze data in Excel.
- Make PowerPoint to Present your results to class.

How to build your model paper house

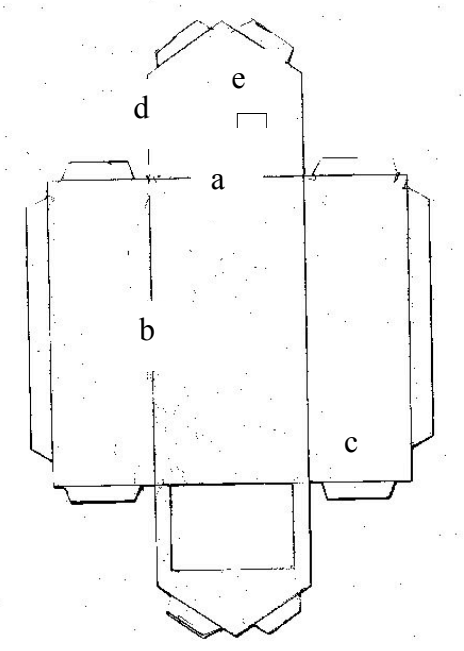
Materials needed:

- Thick construction paper of a color of your choice
- Glue, Ruler, Scissors

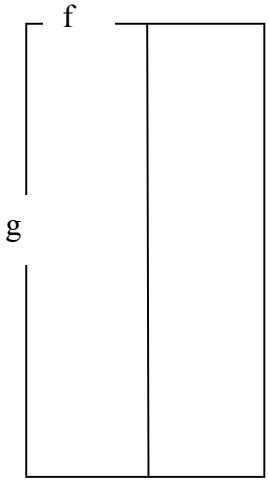
This is what the model house will look like – it will have a door for you to measure the inside temperature.

Here is the blueprint of the house & the roof which you must measure and draw on your construction paper, use the tabs to glue the two parts together.

House



Roof



Key

House
a: 10.5cm
b: 19.5cm
c: 6.6cm
d: 6.6cm
e: 6.6cm

Roof
f: 6.6cm
g: 21cm

Lesson 4: Pulling it together: Microclimates in and around Lansing

Overview
Students will review the concepts of Lessons 1-3 by learning about urban geography and land-cover types in Lansing. Analysis of thermal images will be presented. Students will be introduced to the fact that different land-cover surfaces affect air temperature differently.

Learning Outcomes:
- Students will distinguish the three main types of "urban" environments–urban, suburban, and rural–by learning characteristic land-cover types.
- Students will learn the effects of different land covers on local air temperatures.
- Students will examine and analyze a thermal image of Lansing.
- Students will learn to predict surface and air temperatures from aerial photos showing various land-cover types found in Lansing .

Activities
- Discussion of Geographic Characteristics
- Examining thermal maps & Build conjectures on the relationship between land cover and air temperature

Discussion
Discuss the following geographic characteristics and land-cover surfaces found in the three community environments. Talk about how these characteristics may affect local air temperatures differently.
- Urban = concentrated areas such as the downtown with high rise buildings, commercial and industrial sites, and urban residential spaces including apartments, townhouses, single-family dwellings; wide asphalt roads especially in Utah, parking lots and terraces, urban parks, and nonnative vegetation.
- Suburban = scattered distribution of commercial businesses and residential areas; narrow asphalt and concrete roads; parking lots, parks and recreational facilities, native vegetation in outlying areas, and nonnative vegetation in urban forests; and water bodies such as ponds, streams, and lakes.
- Rural = dry and irrigated farming and widely spaced residential homes; paved, dirt, and gravel roads; native vegetation in mountain forests; and water bodies such as rivers, streams, lakes, reservoirs, and flood plains.

Thermal maps
Explain the overhead showing the infrared map of downtown Lansing. Ask students what geographical features they recognize on the map.
- **Examine** Lansing Thermal Image on computers. Discuss thermal properties of the urban elements labeled on the map.
- **Discuss** thermal properties of major land-cover types that are shown in each image of Lansing. Ask students to predict the effect of these land-cover types on the local air temperature.
- Have students **build conjectures** on the effect of these land-cover types on the local air temperature using the evidence from the thermal images.

Lesson 5: Heat Islands: Making the connections to green roofs

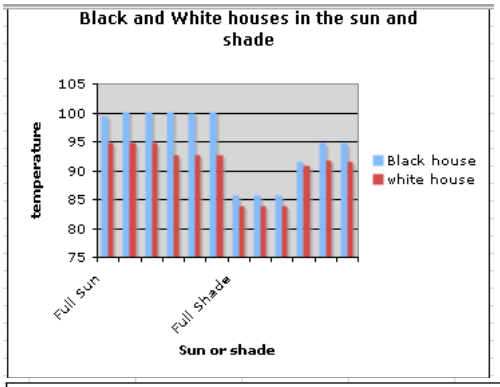
Objectives:

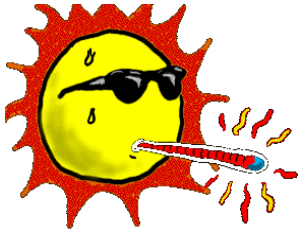
- To help students understand the impact of the built environment on the creation of the urban heat island effect
- For students to hypothesize where in Lansing they might find the urban heat island effect
- For students to begin to see why the design of a roof might matter in the urban heat island effect.
- Preparation for the Dura Last Fieldtrip to Job Shadow Engineers and learn about quality control testing

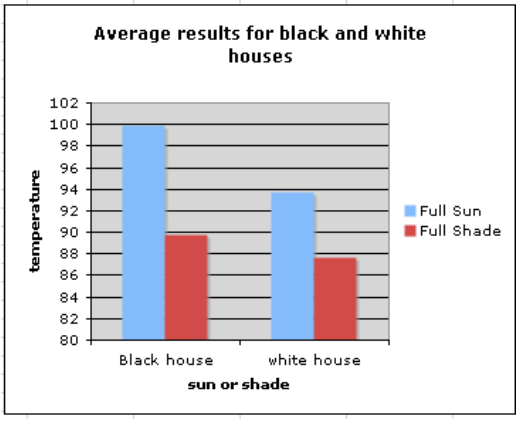
Activities

- Blog Challenge
- Is your roof hotter than your parting lot?
- Google Earth Challenge

Blog Challenge (posted on GETCity.blogspot.com)







We investigated the effect of house color on the indoor and outdoor temperature of the house. What are some of your observations? Look at your graphs and come up with two observations with your team. Are there any differences between the houses? Between being in the shade or in the sun?

Why does it matter:

Show ppt that covers the following points

- Why do hotter temperatures in the built environment matter?
- Because they can contribute to urban heat islands.
- What are urban heat islands?
- Lets find out! Watch youth produce video on UHI's Da Heat!

Does the Club have a problem? (see handout below)

So, does the Club have a problem? Does the built environment around the club contribute to the Urban Heat Island Effect? If so, where and how?

- Have students look at the handout – is your roof hotter than your parking lot.
- Discuss what the picture is telling them.
- Have students investigate whether they think the club and lansing have an UHI problem

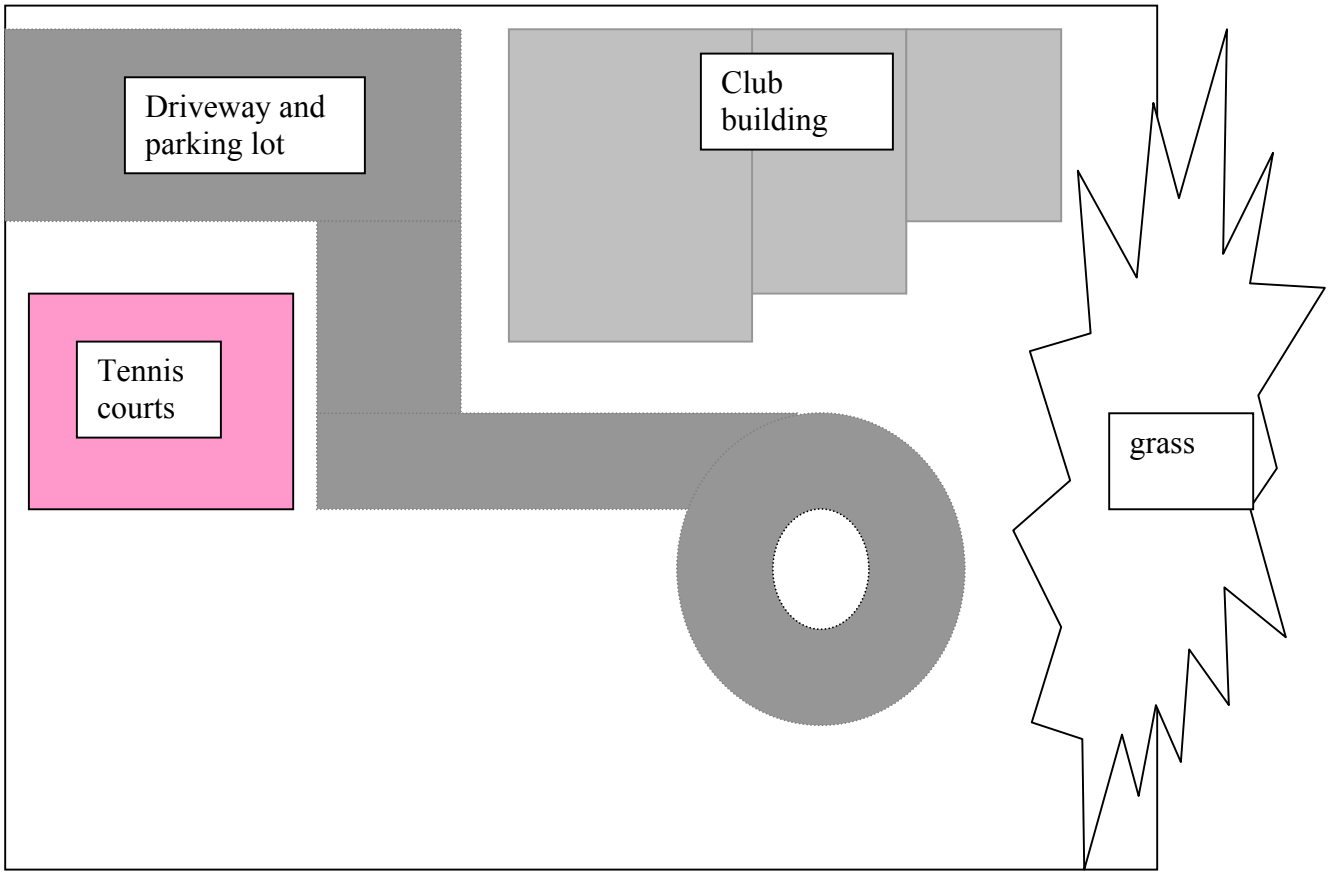
Fieldtrip preparation

Go to Duro Last website

- Take virtual tour
- Look at photogallery
- Look at their blog

In teams develop 3 questions you would like to ask the Duralast Engineers based on: the virtual tour, the photogallery and the blog.

Does the Club have a problem?



Location 1:_____Temperature:_____

Location 2:_____Temperature:_____

Location 3:_____Temperature:_____

Location 4:_____Temperature:_____

Location 5:_____Temperature:_____

LEED Design: The case of the green roof!
GET City, Spring/Summer 2009

Part 3 – Lesson Plans

Background

Overarching Driving Question for Green Roof Unit: Should the Club's new roof be green, and what design features might (should?) it contain?

Overarching objectives for Green Roof Unit:

- To understand and analyze how the design of a new green roof might address multiple energy, economic, and safety challenges faced by the Club, and to view the problem from the perspective of multiple stakeholders (Club leaders, youth, community members)
- To engage youth in design-based decisions about the Club's roof that affect the club's energy profile, and in ways that leverage core scientific and engineering principles and practices related to energy and climate change

Green Roof Unit Description
The Boys and Girls Club of Lansing has had a leaking roof for the past couple of years. Each time it rains, and each spring as the snow melts, track buckets are placed all around the club to collect the dripping water. Further, an examination of the Club's electricity bills reveals a much higher than average energy costs in hot summer months of July and August.

In this design-based unit focused on green roofs youth will investigate the reasons for and the design of a green roof that respond to the club's needs (economic, safety, and global climate concerns) situated in the broader context of the pressing global concerns around climate change.

Lesson Plans for Part 3: Technological solutions. The unit moves towards investigating technological solutions for mitigating UHIs, and using the case of the green roof. Youth investigate both intensive and extensive green roof design as possible energy management systems. Youth visit several intensive, extensive, and white roofs in and around the city, and collect data on ambient and surface air temperature. Youth map and compare data and generate claims about the potential impact of green roofs on both energy costs and microclimates. Lessons in this part include:

- Lesson 1: Green roofs and LEED certified design
- Lesson 2: Extensive and Intensive Green Roofs
- Lesson 3: Green roofs and the UHI effect
- Lesson 4: Hot and cool trends in LEED Design: Green roofs

Lesson 1: Green roofs and LEED-certified design

Objectives

- To introduce youth to LEED certification – what it is and why it is important.
- To have students reflect on the different areas of green certification and to think about how green roofs are important from this framework

Activities

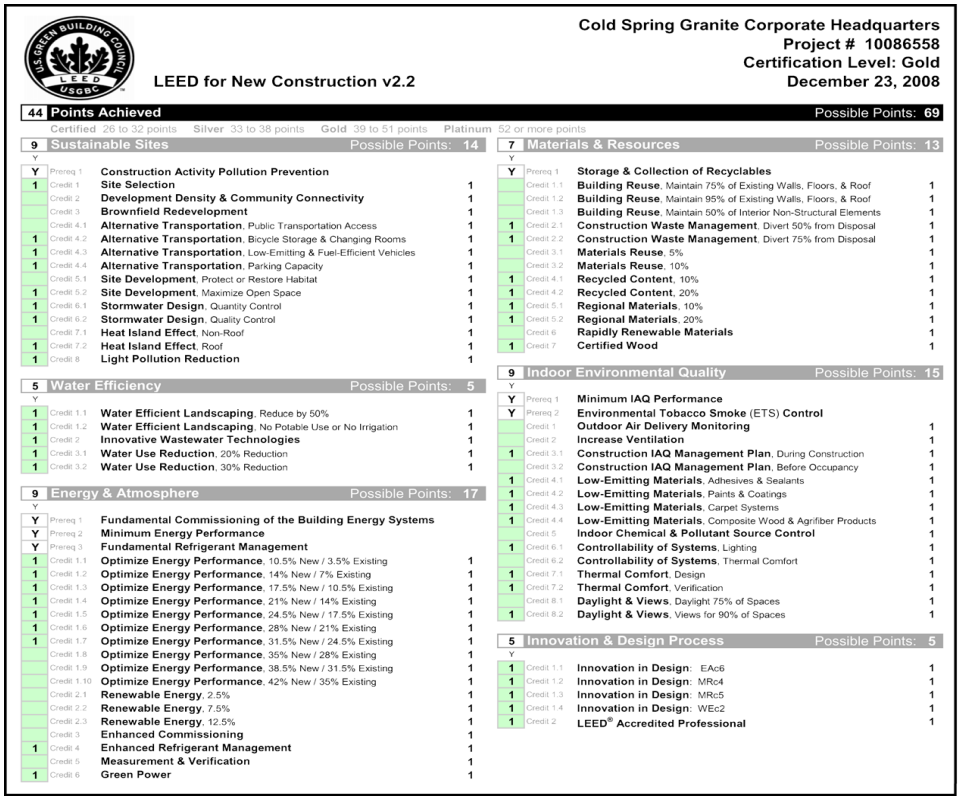
What is LEED?

Activity 1: What is LEED?

From the USGBC, Leadership in Energy and Environmental Design (LEED) is an "internationally recognized green building certification system." The LEED Rating System for existing buildings include the following areas (for new buildings):

- Sustainable Sites
- Energy & Atmosphere
- Indoor environmental air quality
- Water efficiency
- Materials & Resources
- Design and innovation

Have students look at the USGBC worksheet for new buildings:



LEED for New Construction v2.2

Cold Spring Granite Corporate Headquarters
Project # 10086558
Certification Level: Gold
December 23, 2008

44 Points Achieved — Possible Points: 69

Certified 26 to 32 points · Silver 33 to 38 points · Gold 39 to 51 points · Platinum 52 or more points

9 Sustainable Sites — Possible Points: 14

Y	Prereq 1	Construction Activity Pollution Prevention	
1	Credit 1	Site Selection	1
	Credit 2	Development Density & Community Connectivity	1
	Credit 3	Brownfield Redevelopment	1
	Credit 4.1	Alternative Transportation, Public Transportation Access	1
1	Credit 4.2	Alternative Transportation, Bicycle Storage & Changing Rooms	1
1	Credit 4.3	Alternative Transportation, Low-Emitting & Fuel-Efficient Vehicles	1
1	Credit 4.4	Alternative Transportation, Parking Capacity	1
	Credit 5.1	Site Development, Protect or Restore Habitat	1
1	Credit 5.2	Site Development, Maximize Open Space	1
1	Credit 6.1	Stormwater Design, Quantity Control	1
1	Credit 6.2	Stormwater Design, Quality Control	1
	Credit 7.1	Heat Island Effect, Non-Roof	1
1	Credit 7.2	Heat Island Effect, Roof	1
1	Credit 8	Light Pollution Reduction	1

5 Water Efficiency — Possible Points: 5

1	Credit 1.1	Water Efficient Landscaping, Reduce by 50%	1
1	Credit 1.2	Water Efficient Landscaping, No Potable Use or No Irrigation	1
1	Credit 2	Innovative Wastewater Technologies	1
1	Credit 3.1	Water Use Reduction, 20% Reduction	1
1	Credit 3.2	Water Use Reduction, 30% Reduction	1

9 Energy & Atmosphere — Possible Points: 17

Y	Prereq 1	Fundamental Commissioning of the Building Energy Systems	
Y	Prereq 2	Minimum Energy Performance	
Y	Prereq 3	Fundamental Refrigerant Management	
1	Credit 1.1	Optimize Energy Performance, 10.5% New / 3.5% Existing	1
1	Credit 1.2	Optimize Energy Performance, 14% New / 7% Existing	1
1	Credit 1.3	Optimize Energy Performance, 17.5% New / 10.5% Existing	1
1	Credit 1.4	Optimize Energy Performance, 21% New / 14% Existing	1
1	Credit 1.5	Optimize Energy Performance, 24.5% New / 17.5% Existing	1
1	Credit 1.6	Optimize Energy Performance, 28% New / 21% Existing	1
1	Credit 1.7	Optimize Energy Performance, 31.5% New / 24.5% Existing	1
	Credit 1.8	Optimize Energy Performance, 35% New / 28% Existing	1
	Credit 1.9	Optimize Energy Performance, 38.5% New / 31.5% Existing	1
	Credit 1.10	Optimize Energy Performance, 42% New / 35% Existing	1
	Credit 2.1	Renewable Energy, 2.5%	1
	Credit 2.2	Renewable Energy, 7.5%	1
	Credit 2.3	Renewable Energy, 12.5%	1
	Credit 3	Enhanced Commissioning	1
1	Credit 4	Enhanced Refrigerant Management	1
	Credit 5	Measurement & Verification	1
1	Credit 6	Green Power	1

7 Materials & Resources — Possible Points: 13

Y	Prereq 1	Storage & Collection of Recyclables	
	Credit 1.1	Building Reuse, Maintain 75% of Existing Walls, Floors, & Roof	1
	Credit 1.2	Building Reuse, Maintain 95% of Existing Walls, Floors, & Roof	1
	Credit 1.3	Building Reuse, Maintain 50% of Interior Non-Structural Elements	1
1	Credit 2.1	Construction Waste Management, Divert 50% from Disposal	1
1	Credit 2.2	Construction Waste Management, Divert 75% from Disposal	1
	Credit 3.1	Materials Reuse, 5%	1
	Credit 3.2	Materials Reuse, 10%	1
1	Credit 4.1	Recycled Content, 10%	1
1	Credit 4.2	Recycled Content, 20%	1
1	Credit 5.1	Regional Materials, 10%	1
1	Credit 5.2	Regional Materials, 20%	1
	Credit 6	Rapidly Renewable Materials	1
1	Credit 7	Certified Wood	1

9 Indoor Environmental Quality — Possible Points: 15

Y	Prereq 1	Minimum IAQ Performance	
Y	Prereq 2	Environmental Tobacco Smoke (ETS) Control	
	Credit 1	Outdoor Air Delivery Monitoring	1
	Credit 2	Increase Ventilation	1
1	Credit 3.1	Construction IAQ Management Plan, During Construction	1
	Credit 3.2	Construction IAQ Management Plan, Before Occupancy	1
1	Credit 4.1	Low-Emitting Materials, Adhesives & Sealants	1
1	Credit 4.2	Low-Emitting Materials, Paints & Coatings	1
1	Credit 4.3	Low-Emitting Materials, Carpet Systems	1
1	Credit 4.4	Low-Emitting Materials, Composite Wood & Agrifiber Products	1
	Credit 5	Indoor Chemical & Pollutant Source Control	1
1	Credit 6.1	Controllability of Systems, Lighting	1
	Credit 6.2	Controllability of Systems, Thermal Comfort	1
1	Credit 7.1	Thermal Comfort, Design	1
1	Credit 7.2	Thermal Comfort, Verification	1
	Credit 8.1	Daylight & Views, Daylight 75% of Spaces	1
1	Credit 8.2	Daylight & Views, Views for 90% of Spaces	1

5 Innovation & Design Process — Possible Points: 5

1	Credit 1.1	Innovation in Design: EAc6	1
1	Credit 1.2	Innovation in Design: MRc4	1
1	Credit 1.3	Innovation in Design: MRc5	1
1	Credit 1.4	Innovation in Design: WEc2	1
1	Credit 2	LEED® Accredited Professional	1

Discuss:

- What is green about these lists?
- Based on this list, do they think the Club (or school) is green?
- Ask youth to think about how and why a green roof might contribute to LEED certification. What kind of green roof might contribute most to LEED certification & why?

Lesson 2: Types of green roofs

Overview
In this lesson, youth explore different models of green roofs, including intensive, semi-intensive and extensive. They use their explorations to design experiments to determine the green roofs impacts of critical energy and ecological concerns, including the UHI (as previously studied) and air quality and wildlife.

Objectives:
- Students will learn the different types of green roofs in terms of design, purpose and impact
- Students will make connections between the use of green roofs and energy/climate concerns previously discussed in the unit.

Activities
- Roof types Web Safari!
- Discussion of Pros and Cons of roof types

Roof types Web Safari!
Using a web safari, students, in teams, will explore three types of green roofs: Intensive, Extensive, and Energy Efficient. Each team will be assigned a roof type. Students will be asked to gather the following information in teams, for each type of green roof:
- Explanation of the design
- Two different pictures of that type of roof
- A model/figure explaining how the roof is designed
- A list of 3-5 points that explain the benefits of the roof on energy consumption and the environment.
- Cool facts and information

Secondary goals of the web safari include providing youth with detailed information for their design and teaching youth how to adequately site their sources using an internet search.

Have youth use the handout following this lesson plan.

Once youth have finished their safari, have them compile their information into a ppt. Each team of youth, present their ppt on their roof type with the class.

Discussion
Based on the ppt presentations, as a class, discuss the pros and cons of each roof type. Have the class fill out the following chart together during the discussion. As part of the discussion of pros and cons prompt students to include statements that link roof design with energy and the environment. See background information for teachers for key scientific points.

Green Roofs Web Safari

Names:

Roof Type:

What you need to find!	Website URL	Information! (list here, or note file names copied to GET City folder)
Describe main features of your roof type		
Find at least 2 pictures of the roof type		
Find a model that explains the roof type		
Pros of your roof type		
Cons of your roof type		
Cool facts and information		

Background Information

From the US EPA (http://www.epa.gov/heatisld/mitigation/greenroofs.htm)

Green Roofs
A green roof, or rooftop garden, is a vegetative layer grown on a rooftop. Green roofs provide shade and remove heat from the air through evapotranspiration, reducing temperatures of the roof surface and the surrounding air. On hot summer days, the surface temperature of a green roof can be cooler than the air temperature, whereas the surface of a conventional rooftop can be up to 90°F (50°C) warmer.

Green roofs can be installed on a wide range of buildings, from industrial facilities to private residences. They can be as simple as a 2-inch covering of hardy groundcover or as complex as a fully accessible park complete with trees. Green roofs are becoming popular in the United States, with roughly 8.5 million square feet installed or in progress as of June 2008.

Benefits and Costs
In addition to mitigating urban heat islands, the benefits of green roofs include:

- Reduced energy use: Green roofs absorb heat and act as insulators for buildings, reducing energy needed to provide cooling and heating.
- Reduced air pollution and greenhouse gas emissions: By lowering air conditioning demand, green roofs can decrease the production of associated air pollution and greenhouse gas emissions. Vegetation can also remove air pollutants and greenhouse gas emissions through dry deposition and carbon sequestration and storage.
- Improved human health and comfort: Green roofs, by reducing heat transfer through the building roof, can improve indoor comfort and lower heat stress associated with heat waves.
- Enhanced stormwater management and water quality: Green roofs can reduce and slow stormwater runoff in the urban environment; they also filter pollutants from rainfall.
- Improved quality of life: Green roofs can provide aesthetic value and habitat for many species.

For a downloadable pdf authored by the EPA, go here: Green Roof Chapter.

From the pdf:
Extensive green roofs: Light weight and fairly inexpensive roof that contains a shallow, engineered soil (3-6”) and “plant selections suitable for an alpine environment. The concept is to design a rugged green roof that needs little maintenance or human intervention once it is established. Overall, because of their light weight, extensive systems will require the least amount of added structural support, which improves their cost-effectiveness when retrofitting an existing structure.” (p. 4).

Intensive: “An intensive green roof is like a conventional garden, or park, with almost no limit on the type of available plants, including large trees and shrubs. Building owners or managers often install these roofs to save energy and provide a garden environment for the building occupants or the general public to enjoy. Compared to extensive green roofs, intensive green roofs are heavier and require a higher initial investment and more maintenance over the long term than extensive roofs. They generally require more structural support to accommodate the weight of the additional growing medium and public use.” (p. 4)

Lesson 3: Designing & Conducting an Investigation
In this lesson, youth design experiments to determine the green roofs impacts of critical energy and ecological concerns, including the UHI (as previously studied) and air quality and wildlife.

Objectives:

- Students will make connections between the use of green roofs and energy/climate concerns previously discussed in the unit.
- Students will design an investigation to gather empirical data in support of green roofs and for determining potential impact of different green roof types: UHI and local ecology.

Designing an investigation
Tell students that over the next three days we will take three field trips to visit two different intensive green roofs, 1 extensive green roof, and 1 energy efficient green roof. Using the student handout, ask students to design an experiment to determine two key impacts: local UHI effect and local ecology. Note that in each of these cases students or the roof owner will be able to go onto the roof top for data collection.

Brainstorm
Ask students to recall what an urban heat island is from previous sessions. Ask them how they think a "green roof" might mitigate against the heat island effect. Record their ideas on the board. Help them to use their ideas to develop a set of criteria that they might use to design their experiment.

Example: Youth should generate a design that looks at temperature differentials on the different roof types:

UHI Impact

- Roof Type:
- Location:
- Time of day that data is collected
- Weather
    - Temperature in the sun
    - Wind
    - % Sunny/cloudy
- Roof temperate in sun & shade
- Roof temperature at "green" and "nongreen" places on the roof

Note: Students should take the ambient air temperature at least **10 places** each on the green and non green roof top.

Local Ecology

- What evidence is there that birds, bees or butterflies inhabit the roof?
    - Plant types
    - Visual observations

Data Collection Forms

Day#:					
Location					
Time of Day					
Weather					
Local ecology observations					
Temp in shade	Loc 1	Loc 2	Loc 3	Loc 4	Loc 5
Temp in Sun	Loc 1	Loc 2	Loc 3	Loc 4	Loc 5

Day#:					
Location					
Time of Day					
Weather					
Local ecology observations					
Temp in shade	Loc 1	Loc 2	Loc 3	Loc 4	Loc 5
Temp in Sun	Loc 1	Loc 2	Loc 3	Loc 4	Loc 5

Day#:					
Location					
Time of Day					
Weather					
Local ecology observations					
Temp in shade	Loc 1	Loc 2	Loc 3	Loc 4	Loc 5
Temp in Sun	Loc 1	Loc 2	Loc 3	Loc 4	Loc 5

Lesson 4: Hot and Cool Trends

Objectives

- To expand student thinking on the styles and uses of green roofs around the world
- To provide examples of green roofs and their benefits

Activities

- Discussion of Trends
- Building an informational webpage

Activity 1: Hot & Cool Trends in Green Roof Design

Share power point with youth on the Hot & Cool Trends in greenroof design (list taken from http://greenroofs.com). The powerpoint describes each trend and provides fun pictures illustrating each trend.

2010 Hot Trends in GREENROOF & GREENWALL DESIGN

- Client Specific 'Boutique' Greenroofs
- Green Sporting Venues
- A Symbiosis of Ecology & Architecture
- Greenwalls as Public Art
- Daylighting Greenroofs
- The Greening of Latin America
- Building Integrated Greenery for a Cooler Planet
- Biomimicry as Eco-literacy & Holistic Design
- Megacities & Redevelopment Enveloped in Green
- Tower Oases as Skyrise Urban Ag

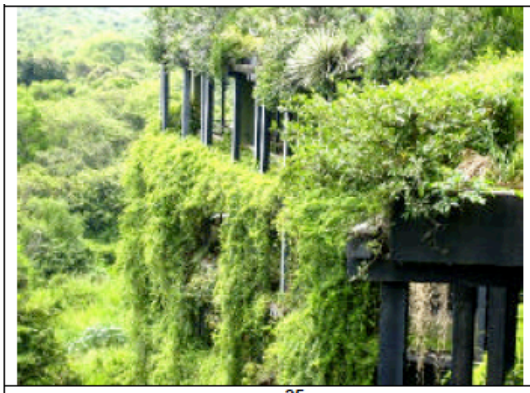
For example:

Client Specific 'Boutique' Greenroofs

Automotive Greenroofs: The Poor Man's Solar Panels? Zhishai, a taxi driver in Beijing, decided to bring the climate solution closer to his local source by planting a mini greenroof atop his cab (Gearlog, 2007). Maybe a potential "Boutique" Greenroof for the Top Ten 2009 Hot Greenroof Design Trends?

How about Green Furniture on a Greenroof? This "Peddy" living table (mindscape, 2008) from a design studio based in Japan gives new meaning to embracing green living on a greenroof…

Greenroofs as public art

	
Kandalama Hotel[25]: Modern hotel designed to blend into the lush jungle landscape with green roofs and planted facades; 1991-1994; Commercial; Architect: Geoffrey Bawa; Dambulla, Sri Lanka.	Post Ranch Inn – Ocean House[26]: Five single standing structures with curved beam roofs covered in wildflowers and overlooking the Pacific Ocean; Commercial; Architect: Mickey Muennig; Big Sur, CA.

Activity 2: Building an informational webpage
Tell students that they will now create an informational webpage on green roofs using i-web, using the following handout.

Green Roof Informational Webpages!

Pick a partner

Decide on topic for your webpage

- Questions: What kind of green roof would you like to cover? What issues or questions will you try to answer?
- List these here:

Develop an overview statement for your page (1-2 sentences):

Conduct research for site
-What do you want to say?

-What pictures do you want to use?

-What other figures, graphs, etc. do you want to use?

-What hyperlinks do you want to have?

-What other features do you want to have? Such as video, podcast, downloadable documents, etc.

Designing a New Green Roof
GET City, Spring/Summer 2009

Part 4 – Lesson Plans

Background

Overarching Driving Question for Green Roof Unit: Should the Club's new roof be green, and what design features might (should?) it contain?

Overarching objectives for Green Roof Unit:

- To understand and analyze how the design of a new green roof might address multiple energy, economic, and safety challenges faced by the Club, and to view the problem from the perspective of multiple stakeholders (Club leaders, youth, community members)
- To engage youth in design-based decisions about the Club's roof that affect the club's energy profile, and in ways that leverage core scientific and engineering principles and practices related to energy and climate change

Green Roof Unit Description
The Boys and Girls Club of Lansing has had a leaking roof for the past couple of years. Each time it rains, and each spring as the snow melts, track buckets are placed all around the club to collect the dripping water. Further, an examination of the Club's electricity bills reveals a much higher than average energy costs in hot summer months of July and August.

In this design-based unit focused on green roofs youth will investigate the reasons for and the design of a green roof that respond to the club's needs (economic, safety, and global climate concerns) situated in the broader context of the pressing global concerns around climate change.

Lesson Plans for Part 4

Part 4: Youth design for the placement of the skylights. A local firm donated three 4x4 skylights to be included in the club's new roof. Youth will investigate the design, placement and impact of skylights. Following the same design processes used for the larger roof, youth will learn about skylights and their role in energy conservation. They will then conduct a needs assessment among stakeholders at the club, gathered real world data on key aspects of design features (i.e., the need for natural lighting), and created a multimedia proposal to the club's board of directors and engineering firm for the skylight's locations.

Lesson 1: Energy conservation & efficiency: What do skylights have to do with it?

Objectives

- .
- Students will
- Students will review concepts of energy conservation and energy efficiency, understand the difference, and how skylights contribute to both.

Activities

- Conservation and Efficiency and patterns in US energy consumption
- How do skylights helps with conservation and efficiency?

Introduction

Energy demands have increased in the US and globally over the last century, and many of the resources to meet those demands are limited and harmful to the environment. As a society we can make technological fixes through new forms of green energy and energy efficient devices, or through behavioral changes, such as energy conservation practices. Skylights involve both technological fixes and behavioral changes.

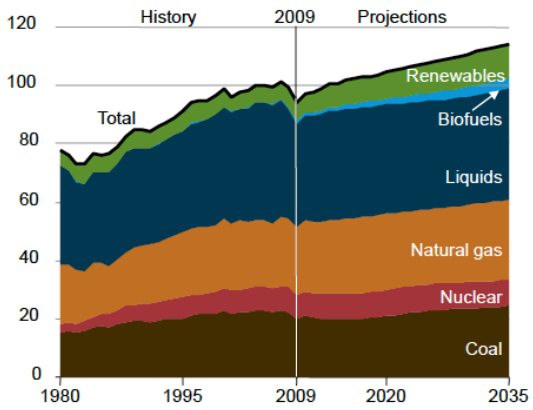
Activity 1: Conservation and Efficiency

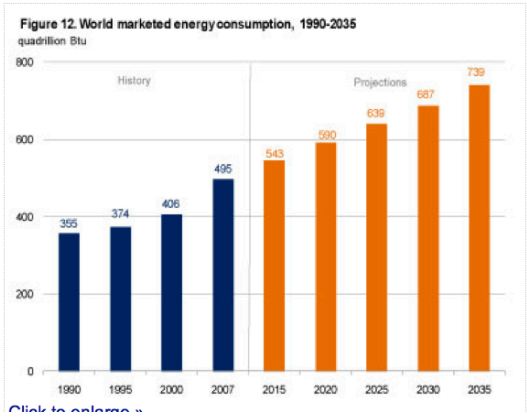
Have students look at the graphs on the blog (from the US Energy Information administration):

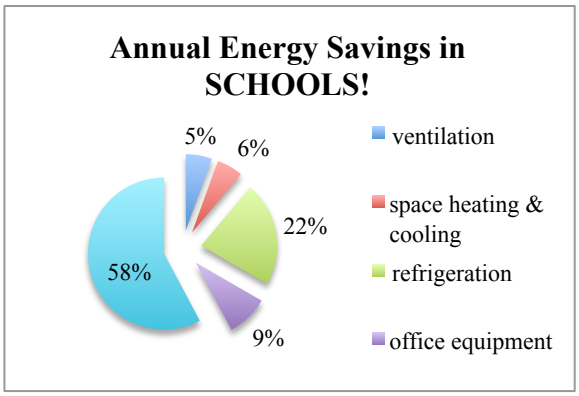
- US energy consumption: renewable and nonrenewable resources
- World energy demand
- Energy Expenditures
- Energy costs in schools and community centers

Renewable sources lead rise in primary energy consumption

Figure 57. Primary energy use by fuel, 1980-2035 (quadrillion Btu)







Use the graphs to discuss:

- Electricity consumption in the United States in comparison to other parts of the world. Have students make claims about patterns in US electricity consumption and use statistics to back up claims.
- Ask students why patterns in US electricity consumption are a problem. Have students generate a list of problems.
  Categorize problems into: Economic, environmental, and other.

Ask students how they might solve these problems. Use the student generated list to talk about "behavioral changes" and "technological fixes."

- *Behavioral changes*: Changes in consumption based on what we do (i.e., turn off lights). These kinds of solutions usually involving saving energy or conservation.

- *Technological fixes*: Changes in consumptions due to inventing new design for energy efficient appliances (i.e., energy star, CFL, more/better windows in buildings). These kinds of design solutions usually involve energy efficiency, or doing MORE with LESS.

Show students a picture of a skylight. Ask them to work in pairs and to generate two explanations (See handout):

- How do skylights save energy (conservation):
- How are skylights energy efficient designs (efficiency):
- What do you see as the connection between energy conservation and efficiency?

Skylights:
Changing behaviors and a Technological Fix!

How do skylights save energy (conservation):

How are skylights energy efficient designs (efficiency):

What do you see as the connection between energy conservation and efficiency?

Lesson 2: Skylights: Designing a Technological Fix

Objectives

- Students will understand the concept of daylighting and its potential positive impact on both energy conservation and efficiency
- Students will understand the three major engineering concerns related to skylights and home energy conservation and efficiency: Design, Placement and Installation.

Activities

- Daylighting
- Designing a technological fix

Daylighting.

- Ask students to predict what daylighting is.
- Write their ideas on the board.
- Explain, using students' ideas (as appropriate) what daylighting is.
- Have students make conjectures on how skylights provide daylighting.

Teacher's notes for daylighting discussion (from http://www.energysavers.gov)

- Daylighting is the use of windows and skylights to bring sunlight into your home.
- Today's highly energy-efficient windows, as well as advances in lighting design, allow efficient use of windows to reduce the need for artificial lighting during daylight hours without causing heating or cooling problems.
- The best way to incorporate daylighting in your home depends on your climate and home's design. The sizes and locations of windows should be based on the cardinal directions rather than their effect on the street-side appearance of the house.
- South-facing windows are most advantageous for daylighting and for moderating seasonal temperatures. They allow most winter sunlight into the home but little direct sun during the summer, especially when properly shaded.
- North-facing windows are also advantageous for daylighting. They admit relatively even, natural light, producing little glare and almost no unwanted summer heat gain.
- Although east- and west-facing windows provide good daylight penetration in the morning and evening, respectively, they should be limited. They may cause glare, admit a lot of heat during the summer when it is usually not wanted, and contribute little to solar heating during the winter.
- If you're constructing a new house, you want to consider daylighting as part of your whole-house design—an approach for building an energy-efficient home.
- A skylight can provide your home with daylighting and warmth. When properly selected and installed, an energy-efficient skylight can help minimize your heating, cooling, and lighting costs.

How does the design of a skylight matter?

- Have students look at the two pictures of the homes with skylights. Ask students to make a list similarities and differences between the two pictures.
- Share lists

Use the lists to generate a list of important design features & considerations

Four Important design features & considerations to review (based on student comparisons)

- Home location: Climate & geography
- Placement of skylight (cardinal direction)
- Size
- Composition

Teacher's notes for skylight design discussion (from http://www.energysavers.gov)

- Skylights on roofs that face north provide fairly constant but cool illumination.
- Those on east-facing roofs provide maximum light and solar heat gain in the morning.
- West-facing skylights provide afternoon sunlight and heat gain.
- South-facing skylights provide the greatest potential for desirable winter passive solar heat gain than any other location, but often allow unwanted heat gain in the summer.
- You can prevent unwanted solar heat gain by installing the skylight in the shade of deciduous (leaf-shedding) trees or adding a movable window covering on the inside or outside of the skylight.
- Some units have special glazing that can help control solar heat gain.

Comparing Skylights!

Your task: Compare the two pictures of the homes with skylights. Ask students to make a list similarities and differences between the two pictures.

House faces south, in northern MI

House faces west, along MI's west coast

Similarities	Differences
• Shape • Location • Direction • Climate, Geography	

Lesson 2 (3 days): Conducting a needs assessment

Objectives

- Students will review what a needs assessment is, and how and why it might be useful in determining the placement of the three donated skylights.
- Students will conduct a needs assessment using three primary tools (existing data, surveys & interviews)
- Students will analyze data and build evidenced claims regarding the placement of the skylights.

Activities

- Review Steps & Data types in Community Needs Assessements (first lessons of unit).
- Selecting Criteria
- Preparation of Materials
- Conducting NA
- Analyzing Data
- Preparing Report

Review Steps & Data Types

BGCL New Green Roof

?

Where do we place the 3 new sky lights?

What are skylights?
A skylight is a special type of window built into the roof of a house in order to allow natural light to come into the house directly. A skylight may be installed for aesthetic purposes, or as part of a general passive-heating strategy. There are many different types of skylight, with differing designs, materials, and added components.

Size: 4feet by 4 feet

Spaces to consider:

1. Office
    a. Office Reception
    b. Office main area
    c. Conference room
2. Entry way
3. Lobby
4. Club Room
5. Kitchen
6. Game Room
7. Computer Room
8. Gym
9. Teen Room
10. Cadet Room
11. Art Room

Skylights!

Location:

Room usage

Day (# hours):

Night (# hours)

Number of People

Reasons:

Natural Lighting….. A lot medium A little

Light Intensity……..Important Not Important

Need for Reliability…….High Low

Does a skylight compromise safety? YES or NO

Will a skylight make this room more beautiful: YES or NO

Is a skylight in this room important for fair and equal distribution? YES or NO

Is it important that a skylight might improve student or staff performance in this room? YES or NO

Other:

Designing a New Green Roof
GET City, Spring/Summer 2009
http:/getcity.org

Part 5 – Lesson Plans

Background

Overarching Driving Question for Green Roof Unit: Should the Club's new roof be green, and what design features might (should?) it contain?

Overarching objectives for Green Roof Unit:

- To understand and analyze how the design of a new green roof might address multiple energy, economic, and safety challenges faced by the Club, and to view the problem from the perspective of multiple stakeholders (Club leaders, youth, community members)
- To engage youth in design-based decisions about the Club's roof that affect the club's energy profile, and in ways that leverage core scientific and engineering principles and practices related to energy and climate change

Green Roof Unit Description
The Boys and Girls Club of Lansing has had a leaking roof for the past couple of years. Each time it rains, and each spring as the snow melts, track buckets are placed all around the club to collect the dripping water. Further, an examination of the Club's electricity bills reveals a much higher than average energy costs in hot summer months of July and August.

In this design-based unit focused on green roofs youth will investigate the reasons for and the design of a green roof that respond to the club's needs (economic, safety, and global climate concerns) situated in the broader context of the pressing global concerns around climate change.

Lesson Plans Part 5

Part 5: Job Shadowing. During this cross-cutting segment, youth shadow engineers in their work on the design installation of the green roof. Youth also visit a white roof design and manufacturing company to learn about the different roles played by design and manufacturing engineers, and learn how white roofs are quality tested for a range of safety issues.

Documenting the New Green Roof
At the Boys and Girls Club of Lansing
Sumer 2009

Tasks

1. Interviews:
    1. Engineers
    2. Club Members (Adults and kids)
    3. Parents
2. Photographs: Process, People, Materials
3. Video

The "Cool" Green Roof at the Boys and Girls Club of Lansing!

DID YOU KNOW?????

- Cool roofs, because they reflect the sunlight, can be 70 degrees cooler or more during hot summer days when compared with traditional roofing materials.
- Cool roof systems save money and energy during peak cooling demand periods - typically mid-days, when electricity demand and costs are highest.
- Cool roof systems help reduce the urban heat-island effect by reflecting solar heat rather than absorbing and transferring it to buildings.
- By keeping moisture out while reflecting ultraviolet (UV) and infrared (IR) radiation, a cool roof can help to protect underlying insulation and keep the roof from breaking down.

Interviews: Kids and Adults

1. Did you know that the Club was getting a new roof? Yes or No
2. Did you know that the roof was a "green roof"?
3. Do you know what a green roof is? Please explain. (*If the person does NOT know what a green roof is, then explain it to them!*).
4. Did you know that the new roof is also a "cool roof"?
5. Read "cool roof facts" to the interviewee:

DID YOU KNOW?????

- Cool roofs, because they reflect the sunlight, can be 70 degrees cooler or more during hot summer days when compared with traditional roofing materials.
- Cool roof systems save money and energy during peak cooling demand periods - typically mid-days, when electricity demand and costs are highest.
- Cool roof systems help reduce the urban heat-island effect by reflecting solar heat rather than absorbing and transferring it to buildings.
- By keeping moisture out while reflecting ultraviolet (UV) and infrared (IR) radiation, a cool roof can help to protect underlying insulation and keep the roof from breaking down.

6. How do you think the Boys and Girls Club should get more involved in Energy Issues?

Interviews: Engineers

1. How many "cool" green roofs do you install every year?

2. What kinds of computer technology were used in designing and preparing the Club's new roof?

3. What are the biggest challenges to designing and installing a new roof?

4. Was there anything special or tricky about installing the new roof at the Boys and Girls Club of Lansing?

5. How will this new roof help the Club?

6. What do you think are the most important things that we should know about this new roof?

7. What are the different jobs involved in putting on the new roof?

Photographers and Videographers

Pictures to take:

1. What people are involved in putting on the new roof?
2. What are their different jobs, and what are they doing?
3. Process
4. What "steps" seem to be involved in putting on the roof?
5. What tools and materials are involved in the new roof?

Videographers

1. Interviews with Engineers
2. Interviews with Kids and Adults
3. Installing the roof.
4. *Note: As you video the installation of the roof, please describe (to the camera) what you see happening. Your observations of the process will be very helpful!