



# **UNIT B**

## ***GREEN BUILDING, ENERGY EFFICIENCY & ENVIRONMENTAL PROTECTION***

### **NM Standards and Benchmarks**

#### **Social Studies**

*Economics Strand, Content Standard IV-B:*

Analyze and evaluate how economic systems impact the way individuals, households, businesses, governments, and societies make decisions about resources and the production and distribution of goods and services.

*Performance Standard #8:*

Evaluate economic systems by their ability to achieve broad societal goals (e.g., efficiency, equity, security, employment, stability, economic growth).

#### **Science**

*Strand III, Science and Society, Content Standard I:*

Examine and analyze how scientific discoveries and their applications affect the world, and explain how societies influence scientific investigations and applications.

*Performance Standard #4:*

Understand the scientific foundations of common technologies (e.g., kitchen appliances, radio, television, aircraft, rockets, computers, medical X-rays, selective breeding, fertilizers and pesticides, agricultural equipment).

#### **Career Readiness, Content Standard III and IV**

Students will demonstrate the technological knowledge and skills required for future careers.

Students will develop and demonstrate responsible and ethical workplace behaviors.

#### **Mathematics**

*Strand: Data Analysis and Probability*

Students will understand how to formulate questions, analyze data, and determine probabilities.

## Content

Buildings are responsible for half of all fossil fuels used in the U.S. Energy efficiency retrofits and green building are needed to reduce energy use of American buildings. The energy efficiency sector provides a significant opportunity to develop climate solutions, create thousands of jobs, and help reduce energy costs for businesses and consumers. Energy efficiency also provides a means to protect vulnerable individuals and communities from the impacts of climate change. In this unit, students will gain an understanding of the fundamentals of building performance and how to improve energy efficiency while not compromising indoor air quality. Students will also learn about common indoor contaminants, such as lead, asbestos, carbon monoxide, mold and some household products. Hands-on field activities will give students real-world experience with green jobs in the energy efficiency sector. Students will also receive information on training and education programs and financial aid availability for these fields.

## Vocabulary

energy efficiency  
building envelope  
energy audit  
heat loss  
blower door  
infrared thermal imaging  
building performance  
building tightness  
air infiltration  
ventilation  
HERS  
base-load  
cost-effective  
HVAC  
indoor air quality  
carbon monoxide  
mold  
lead  
asbestos  
radon  
household chemicals  
pesticides  
off-gas  
green building  
passive solar design  
solar hot water  
retrofit  
repurposing  
construction waste  
building life cycle  
green building materials

## Essential Questions

- In green construction, energy efficiency, and environmental protection, what careers are emerging and what interests me?
- What career paths interest me and suit my talents?
- What are the skill sets needed to be successful in the workplace?

## Focus Questions

- What is energy efficiency?
- How can we retrofit or build our homes and buildings to be more energy efficient and make individuals and communities more resilient to climate change?
- Why is ventilation important for protection of indoor air quality?
- How do we measure building performance?
- What is passive solar design and how can it be used to heat our homes?

## Time Allocation

2.5 weeks

# Introduction

(1 class)

## **Objective:**

Students will demonstrate understanding of the environmental, social, and economic implications of green construction, energy efficiency improvements, and environmental protection through home health and safety.

## **Activities:**

- 1) Students will review their chart, “Rules of a Green Economy” (See Appendix I.5). Make two columns on the board: “Available Renewable Resources: and “Limited Renewable Resources.” Help students to list local resources and to identify the correct category for each. Our indoor living and work spaces consume a great deal of energy, so making sure those spaces are as energy efficient as possible is essential. What constitutes energy efficiency? How does behavior impact energy conservation? What are the social and economic implications of energy efficiency? What about old buildings and those of us who can’t afford to remodel our homes and workplaces? How can we retrofit existing buildings to be more energy efficient and make our communities more resilient from climate change?

*Materials:* “rules” chart, chart paper, markers

*Homework:* Pre-Math Test (Appendix B.1), p. 17-18 from the Home Weatherization Certification Program at:

[http://www.waptac.org/data/files/training\\_resources/corecompetencies12022009.pdf](http://www.waptac.org/data/files/training_resources/corecompetencies12022009.pdf)

*Resources:*

- American Council for an Energy Efficient Economy  
<http://www.aceee.org/sector/residential>
- Energy Efficiency: America’s Greatest Energy Resources  
<http://ase.org/resources/energy-efficiency-americas-greatest-energy-resource>
- The Decade of Energy Efficiency – Video  
<http://ase.org/resources/2010-whats-next-energy-efficiency>

# **Applied Science in Energy Efficiency and Home Health and Safety**

(2 classes)

## **Objective:**

Student will demonstrate basic competency in the applied science involved in energy efficiency and home health and safety

## **Activities:**

Your local Weatherization Assistance Program may have a specialist willing to meet with your class to discuss energy audits and weatherization and walk the students through an energy audit and home safety assessment. Find the weatherization provider that covers your community by visiting: [http://www.nmprc.state.nm.us/energy/low\\_income.htm#agency](http://www.nmprc.state.nm.us/energy/low_income.htm#agency)

## **Conceptual Science Application**

- 1) What are the major energy uses in the home? What is the building envelope and how do air and heat flow in a home? What are the factors that affect building heat loss? What is air infiltration? What are the common indoor air quality concerns and household safety hazards in homes? What is ventilation and why is it important to home health and safety?
- 2) Math: Compute area and volume of conditioned space by assigning dyads to measure classrooms to determine area ( $l \times w$ ) and volume ( $l \times w \times h$ ).
- 3) What is building performance and how is it rated? Why is a Home Energy Rating System used?
- 4) What are the cost-effective measures that can be taken to reduce energy waste and eliminate household hazards and safety concerns?

### *Resources:*

- Weatherization Assistance Program – Introduction to Program - Video  
<http://www.waptac.org/MediaModule/video/216/Weatherization-Works.aspx>
- Home Energy Audit  
<http://tlc.howstuffworks.com/home/home-energy-audit2.htm>
- U.S. Department of Energy: Energy Savers  
<http://www.energysavers.gov/>
- A Healthy Home for Everyone  
[http://www.cdc.gov/nceh/lead/publications/Final\\_Companion\\_Piece.pdf](http://www.cdc.gov/nceh/lead/publications/Final_Companion_Piece.pdf)
- U.S. EPA Indoor Air Quality Program  
<http://www.epa.gov/iaq/>

- Indoor AirPLUS Certification and Labeling Program  
<http://www.epa.gov/indoorairplus/index.html>
- New Mexico Department of Agriculture – Integrated Pest Management  
[www.nmda.nmsu.edu/pesticides/Integrated%20Pest%20Management.html](http://www.nmda.nmsu.edu/pesticides/Integrated%20Pest%20Management.html)

*Materials:* To be discussed with presenter

*Assessment:* To be discussed with presenter

## **Laboratory Activity**

**(1 class)**

### **Activities:**

In collaboration with staff from your local Weatherization Assistance Program, students will participate in a home energy audit at a nearby home, demonstrating how to conduct a blower door test and use of infrared thermal imaging camera if available, common locations for air leakage, and discussion of ventilation considerations. The weatherization specialist will also discuss and demonstrate measures to seal air leaks. Other elements of the home energy audit to be covered include: electrical base-load usage, indoor air quality and combustion safety, and range of measures to improve energy efficiency and mitigate health and safety concerns in the home. Students will need to be bused the short distance between the school and the home or worksite where the audit will be performed.

### **Alternative Activities (if an expert is unavailable):**

- 1) Lesson Plans for Mock Home Energy/CO<sub>2</sub> Audit:  
[http://windows2universe.org/teacher\\_resources/teach\\_co2spew.html](http://windows2universe.org/teacher_resources/teach_co2spew.html)
- 2) CO<sub>2</sub>: How much do you spew? (Appendix B.2)  
[http://www.windows2universe.org/teacher\\_resources/teach\\_co2spew.html](http://www.windows2universe.org/teacher_resources/teach_co2spew.html)
- 3) Plugged in to CO<sub>2</sub>, (Appendix B.3)  
[http://www.windows2universe.org/teacher\\_resources/teach\\_pluggedCO2.html](http://www.windows2universe.org/teacher_resources/teach_pluggedCO2.html)
- 4) DIY Home Energy Audit  
[http://www.energysavers.gov/your\\_home/energy\\_audits/index.cfm/mytopic=11170](http://www.energysavers.gov/your_home/energy_audits/index.cfm/mytopic=11170)
- 5) Take a Tour of the Indoor Air Quality House  
<http://www.epa.gov/iaq/iaqhouse.html>

*Assessment:* Participation in discussion, appropriate questions, and suggestions for cost-effective measures for improving residential energy efficiency and reducing household hazards.

# Applied Science in Green Building

(1 - 3 classes)

## **Objective:**

Student will demonstrate basic competency in the applied science involved in green building.

## **Activities:**

Choose one or more of the following videos and discuss, generating a question that all students will address in their journals:

- 1) PowerPoint: "Green Building," from Oregon Tradeswomen  
<http://www.greenforall.org/green-building/download>
- 2) Video –Michelle Kauffman at Dwell  
<http://www.youtube.com/watch?v=zG1Y-g4qsNY&feature=related>
- 3) Video - Natural Building Construction – Builders Without Borders Strawbale EcoHouse at U.S. Botanical Gardens  
<http://www.youtube.com/watch?v=eQRMAzW0M6g>
- 4) The Powered House, *National Geographic*, March, 2009 (Appendix B.4)
- 5) Video - Earthship Design Principles from Earthship Biotecture  
<http://earthship.com/buildings/356-earthship-design-principles>

## **Conceptual Science Application**

Invite a local green builder to speak to your classroom about the following concepts. (See example PowerPoint in Appendix B.5)

- 1) Passive Solar Orientation Activity – This activity will teach students how to orient the long axis of the house to true south to maximize solar access. Teacher guide and activity worksheet in Appendix B.6.
- 2) Use of local renewable resources - Because the energy and environmental impacts can be so large from using non-renewable resources (e.g., cement) as well as transporting materials to the building site from long distances, use of local renewable resources in green building projects can reduce the overall carbon footprint of the home.
- 3) Leadership in Energy and Environmental Design (LEED). LEED is an internationally recognized green building certification system, providing third-party verification that a building or community was designed and built using strategies aimed at improving performance across all the metrics that matter most: energy savings, water efficiency, CO<sub>2</sub> emission reductions, improved indoor environmental quality, and stewardship of resources and sensitivity to their impacts. Developed by the U.S. Green Building Council (USGBC), LEED provides building owners and operators a concise framework for identifying and

implementing practical and measurable green building design, construction, operations and maintenance solutions. [www.usgbc.org](http://www.usgbc.org)

*Materials:* To be discussed with presenter

*Assessment:* To be discussed with presenter

## **Field Experience in Green Building** (1 class)

### **Activities:**

Students will spend a full day at the site of a green building project. (Hopefully the builder who taught the previous class will be working on an acceptable site.) The builder will give a walking tour describing the project to date, future plans, blue prints, and green materials being used. Students will participate as appropriate in a project that does not require power tools or climbing above ground level.

*Materials:* To be discussed with presenter.

*Assessment:* Teamwork, leadership, thoughtful questions, following directions.

## **Laboratory Science Application in Passive Solar Water Heating** (1 class)

### **Objective:**

Student will demonstrate basic competency in the applied science involved in designing solar water heaters.

### **Activity:**

- 1) Students will work in dyads to build a simple water heater and will time how long it takes to heat one quart of water from tap temperature (cold) to 100 degrees.

*Materials:* sections of black hose, closed glass box, thermometer, quart bottle of water.

- 2) There are a plethora of videos on YouTube between two and seven minutes long which demonstrate building an actual solar water heater. Some use copper tubing, some black hose, some just a simple barrel painted black. Preview some of these for your best option. Most communities have several citizens using a solar water heating system for their household water or for radiant floor heating. Another good plan is to invite such a person to your classroom and have them bring demonstration pictures.

# **Employment and Training Prospects in Green Building, Energy Efficiency and Home Health and Safety**

(1 - 2 classes)

## **Objective:**

The student will identify green jobs in green building and energy efficiency and identify training resources and skill sets necessary for a career in these occupations.

## **Activities:**

1) Share the following information with the class:

### Background:

- Between 1998 and 2007, the energy efficiency sector in New Mexico grew by 184%. According to the New Mexico Department of Workforce Solutions, the short-term outlook (2 - 3 years) for new employees in the energy efficiency sector (green building construction and retrofit) is approximately 2000 new workers.
- Employers needing workers include local home builders and retrofit contractors, the Mortgage Finance Authority and weatherization contractors, and electric utilities/co-ops.
- The American Solar Energy Society Green Collar Jobs report forecasts that hot job areas over the next 10 years include electricians, mechanical engineers, welders, metal workers, construction managers, accountants, analysts, environmental scientists, and chemists.

### Green Jobs in the Energy Efficiency Sector (from NM Green Jobs Guidebook):

Systems Technician  
Green Designer and Architect  
Skilled Energy-Efficient Construction Trade Worker such as Carpenter, Electrician, or Plumber  
Resource Conservation/Efficiency Manager  
Energy and Indoor Air Quality Auditor  
Heating, Ventilation, and Air Conditioning (HVAC) Operation and Maintenance Technician  
Weatherization installer

### Green Jobs in Green Building (from NM Green Jobs Guidebook):

Carpenters  
Electricians  
Cement masons  
Concrete finishers  
Plumbers  
Construction managers  
Civil engineers

Construction and building inspectors

Eco-Broker – real estate agent that understands energy efficiency and green building

2) Watch the following green jobs videos:

- Home Weatherization and Energy Auditor  
<http://careersouthere.com/green-jobs-energy-auditor-home-performance-contractor-careers/>
- Community Action Agency of Southern New Mexico Weatherization training  
<http://www.energyempowers.gov/post/Training-for-Success-in-Las-Cruces.aspx>
- Green Building: Jobs of the Future (Although this was produced for the State of Washington, it is a great overview of green jobs in the construction sector)  
<http://www.youtube.com/watch?v=rr0IAWO9lnk>
- Green building consultant - Watch the Green Building Consultant Careers | LEED AP Careers video  
<http://www.youtube.com/watch?v=9RAoAOs03vI>

*Resources:*

- NM Green Job Portal  
[www.greenjobs.state.nm.us](http://www.greenjobs.state.nm.us)
- Green Jobs Outlook - NM Green Jobs Guidebook  
<http://newenergyeconomy.org/wp-content/uploads/2011/03/nmGreenJobsGuidebook.pdf>
- NM Green Job Career Pathways  
<http://www.greenjobs.state.nm.us/pdf/GreenPathways.pdf>
- NM Green Jobs Educational Opportunities  
<http://www.greenjobs.state.nm.us/education.html>
- NM Green Certifications  
<http://www.greenjobs.state.nm.us/pdf/GreenCertificates.pdf>
- National Center for Construction Education and Research  
<http://www.nccer.org>
- New Mexico Programs in Green Building/Energy Efficiency
  - **Central NM Community College (CNM)** - LEED design and practices
  - **NMSU-Carlsbad** - Green building & energy efficiency
  - **NMSU-Doña Ana Community College** - Green building
  - **Santa Fe Community College** - Green building & Energy efficiency (rating and weatherization)
- Building Performance Institute (BPI)  
<http://www.bpi.org/>
- Weatherization Assistance Program Training Centers  
<http://www.waptac.org/Training-Resources/WAP-Training-Centers.aspx>

3) Invite a carpenter, plumber, electrician, HVAC specialist and/or energy auditor to visit the class to talk about where they received their job training and answer questions about the job.

## **Formal Weekly Assessment**

### **Objective:**

Student will demonstrate with a 70% proficiency or better, his/her understanding of concepts and employment opportunities in this career cluster.

**Assessment:** weekly assessment based on Weekly Grading Rubric (See Appendix I.8)