Designing the School of the Future Today

Achieving Net Zero Energy

Sherman · Carter · Barnhart PSC

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Why is a Zero Energy Building Important?

- Reduces Green House Gases (Carbon Emissions) and Global Warming
- Reduces Dependence on Fossil Fuels
- Reduces Ozone Depletion
- Reduces Climate Change
- Reduces Energy Demands
- Protects Our Environment for Future Generations

The Problem

- Average American School that meets minimum National Energy Code – 73 kBtu of Energy per square foot annually
- Achieving Net Zero Energy from this baseline would require approximately $9 million in solar panels – almost price of a new school building

The Challenge

- To make Net Zero Energy affordable and realistic goal, energy consumption must be drastically reduced
- Every aspect of the design that affects energy consumption is scrutinized for its overall impact

Energy Efficient Schools

Nationwide, the least energy efficient schools use three times as much energy as the most energy efficient schools. The money saved by outstanding energy performance translates directly to more money available for student achievement.

High Performance Features

- Acoustic Comfort
- Commissioning
- Daylighting/Active Daylighting
- Energy Analysis Tools
- Energy Efficient Building Envelope
- Environmentally Preferable Materials
- Environmentally Responsive Site Planning
- High Efficiency HVAC
- High Performance Lighting
- Indoor Air Quality
- Life Cycle Cost Analysis
- Renewable Energy
- Safety and Security
- Thermal Comfort
- Visual Comfort
- Water Efficiency

High Performance Benefits

- Higher Test Scores
- Increased Average Daily Attendance
- Reduced Operation Costs
- Increased Teacher Satisfaction & Retention
- Reduced Liability
- Reduced Environmental Impact

Energy Standards

Energy Star: A Performance Standard

To qualify as an Energy Star school building, a full year of actual energy consumption is used to determine if a building performs in the top 25th percentile of all school buildings in the Energy Star database nationwide.

LEED: Leadership in Energy and Environmental Design

To qualify as a LEED certified school building, points must be earned from various design categories according to the LEED rating system. Such points are allocated to items such as classroom acoustics, master planning, mold prevention, and environmental site assessment.

Energy Standards

LEEP: Leadership in Energy and Environmental PERFORMANCE

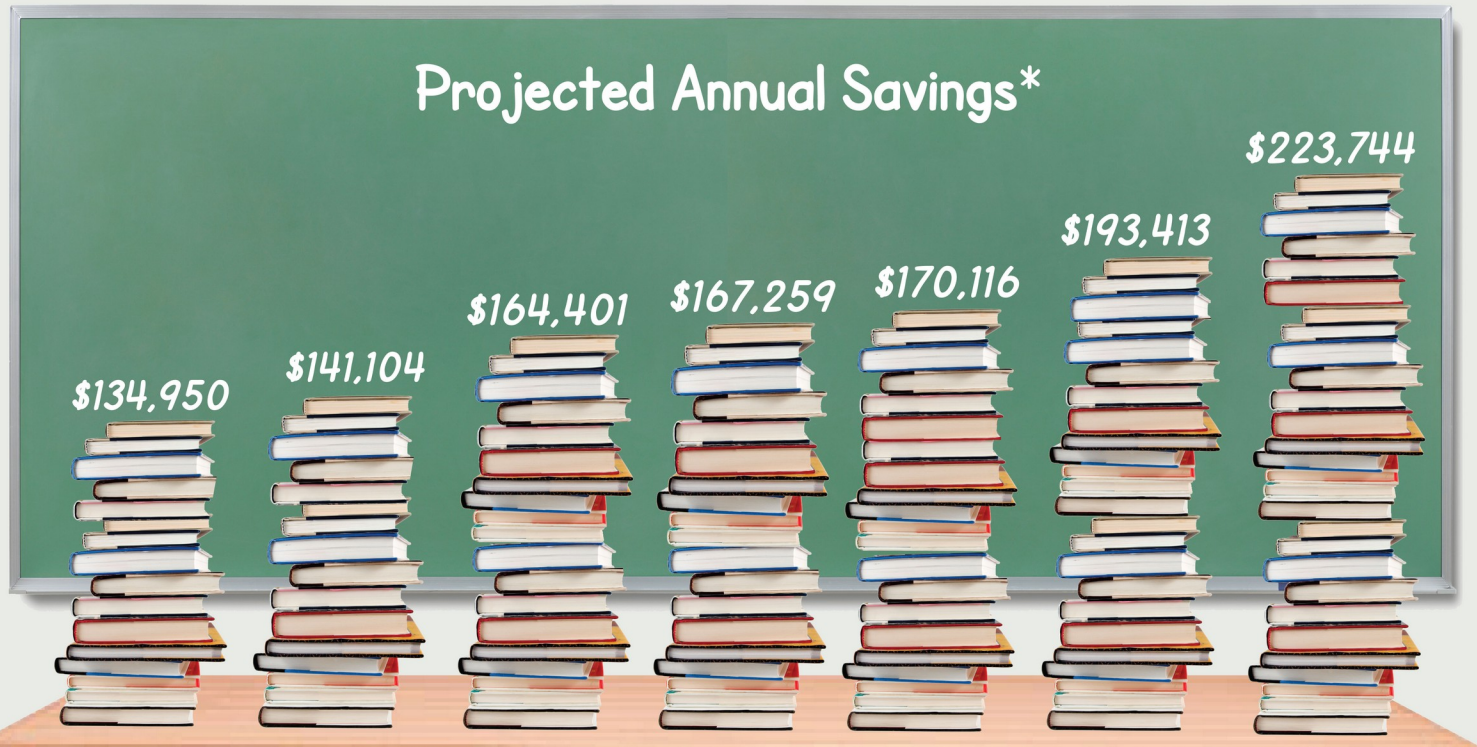
Energy Users

- Buildings are responsible for 39% of our nation’s energy consumption

Where does the Energy go?

* Based on Plano Elementary School performance (2007)

Energy Cost Case Studies



	Warren East Middle	East Jessamine Middle	Hearn Elementary	Alvaton Elementary	North Middle	Plano Elementary	Richardsville Elementary
kBTU/sf/yr 50	43	41	36	35	34	28	18

*Approximate Annual Savings based on U.S. Benchmark (ASHRAE 90.1)

Case Study

Hearn Elementary School - 2008

Franklin County Schools
Frankfort, Kentucky
550 Student Capacity
67,853 sf

<u>High Performance Features:</u>

- ICF Exterior wall construction
- Geothermal heating and cooling
- Automatic building shut-down system
- Daylighting
- Energy efficient glazing at windows
- GREENGUARD certified interior finishes

DESIGNED TO EARN THE ENERGY STAR

36 kBtu/sf/year
$164,401 Savings Annually

Case Study

Alvaton Elementary School - 2006

Warren County Schools
Bowling Green, Kentucky
750 Student Capacity
77,000 sf

High Performance Features:

- ICF Exterior wall construction (First ICF School in the Nation!)
- Geothermal heating and cooling
- Sandwich panel metal roof system R-30 insulation value
- Lighting and HVAC motion sensors
- Daylighting
- Energy efficient glazing at windows
- GREENGUARD certified interior finishes

35 kBtu/sf/year
$167,259 Savings Annually

CHANGE FOR THE BETTER WITH ENERGY STAR

Case Study

Plano Elementary School - 2007

Warren County Schools
Bowling Green, Kentucky
750 Student Capacity
79,000 sf

<u>High Performance Energy Features:</u>

- Geothermal heating and cooling
- De-centralized pumping
- Lighting and HVAC motion sensors
- Daylighting
- Energy efficient glazing at windows
- GREENGUARD certified interior finishes

28 kBtu/sf/year
$193,413 Savings Annually

Most Energy Efficient School in Kentucky

CHANGE FOR THE BETTER WITH ENERGY STAR

The Solution

Richardsville Elementary School in Kentucky is the first Net Zero Energy public school in the nation.

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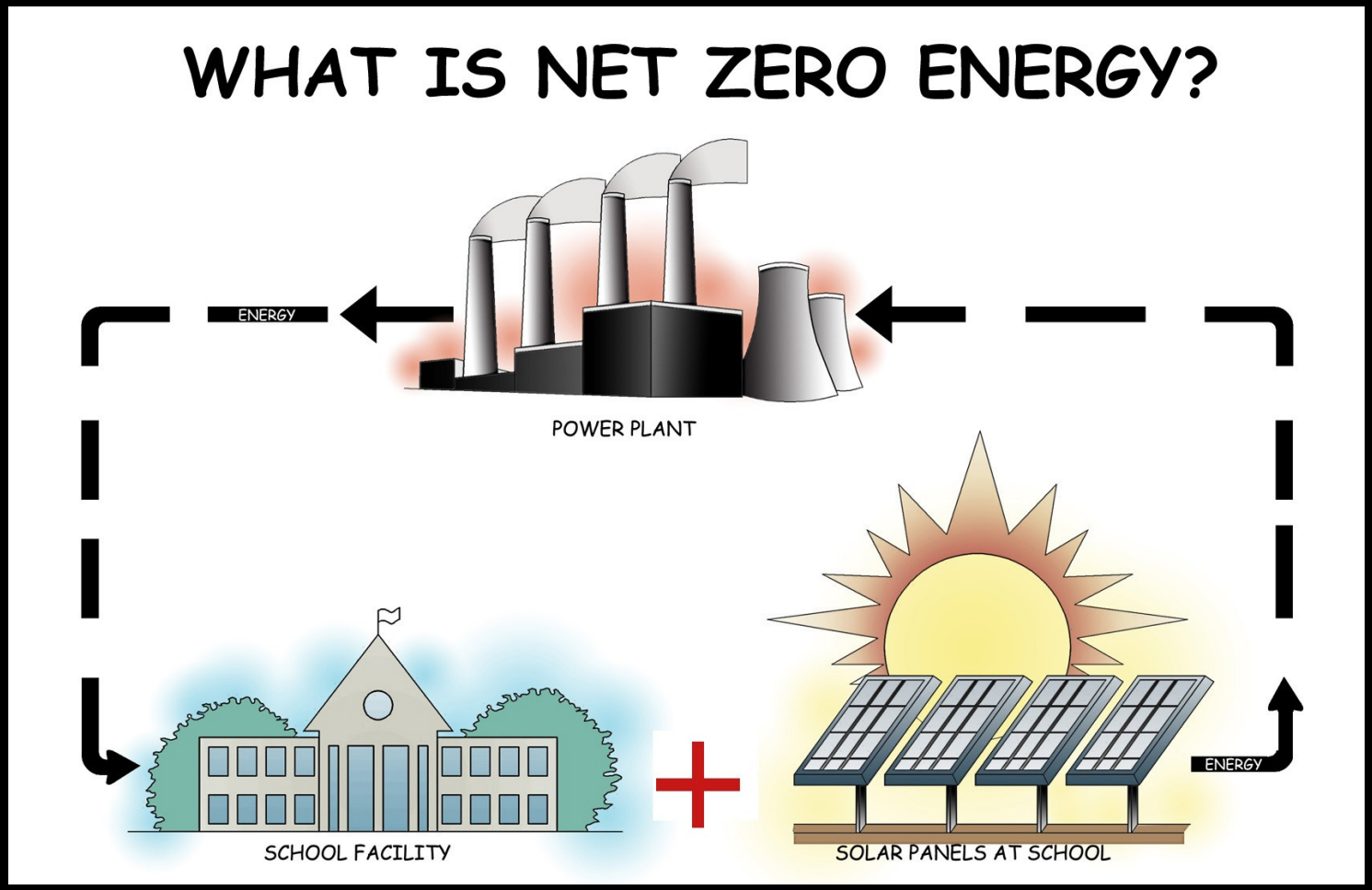
The Solution



Net Zero Energy is a building with a net energy consumption of zero over a typical year of operation.

The Solution

Richardsville Elementary School

Warren County Schools
Bowling Green, Kentucky
550 Student Capacity
72,285 sf

High Performance Features:

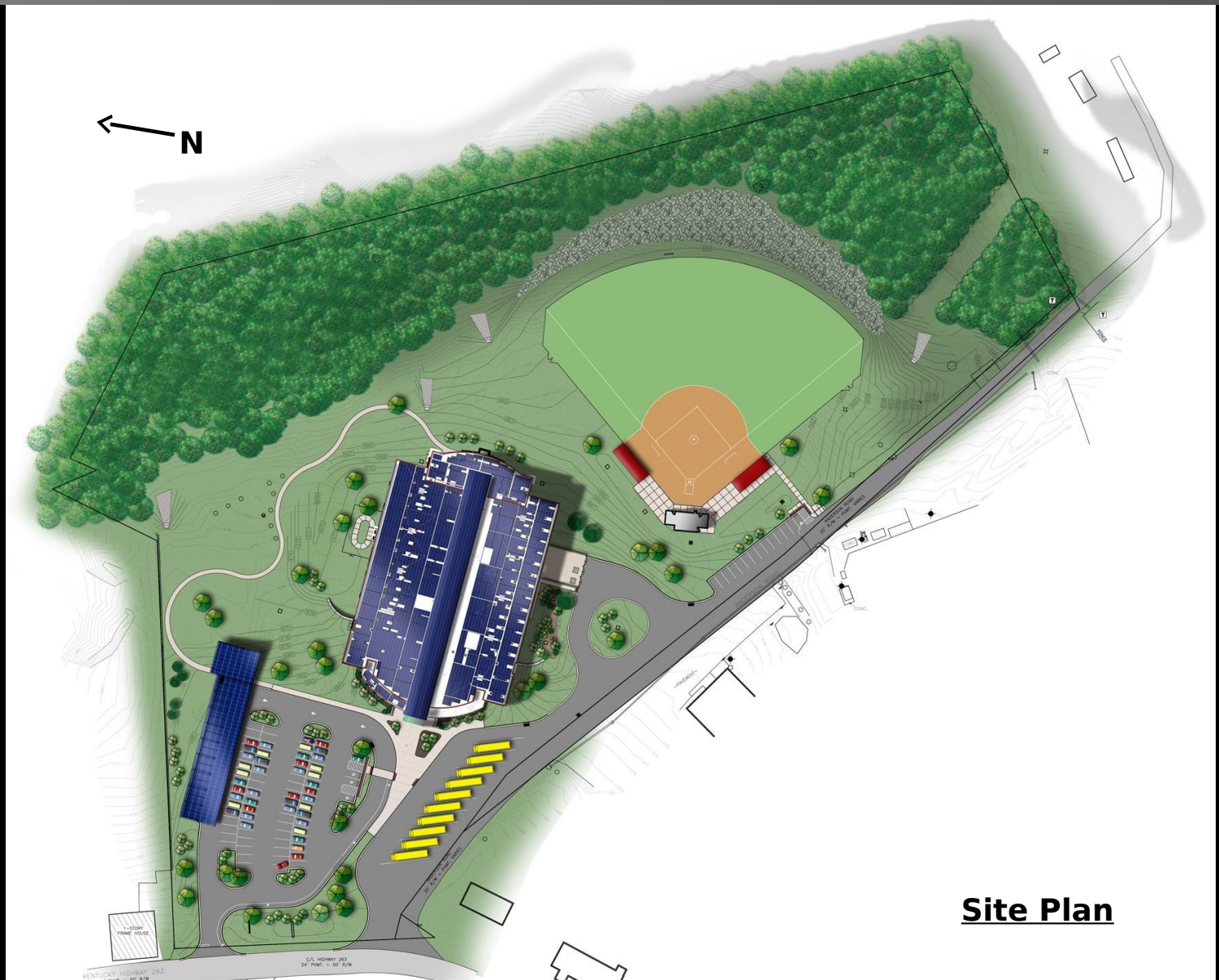
- Photo Voltaic System
- ICF Interior and exterior wall construction
- Geothermal heating and cooling
- De-centralized pumping
- Lighting and HVAC motion sensors
- White reflective membrane roof
- Bio-retention swales
- Active daylighting with light shelves and solar tubes
- “GREEN” Kitchen management
- Wireless technology
- Energy efficient glazing at windows
- GREENGUARD certified interior finishes

Energy Star

U.S. Green Building Council LEED LEADERSHIP IN ENERGY & ENVIRONMENTAL DESIGN

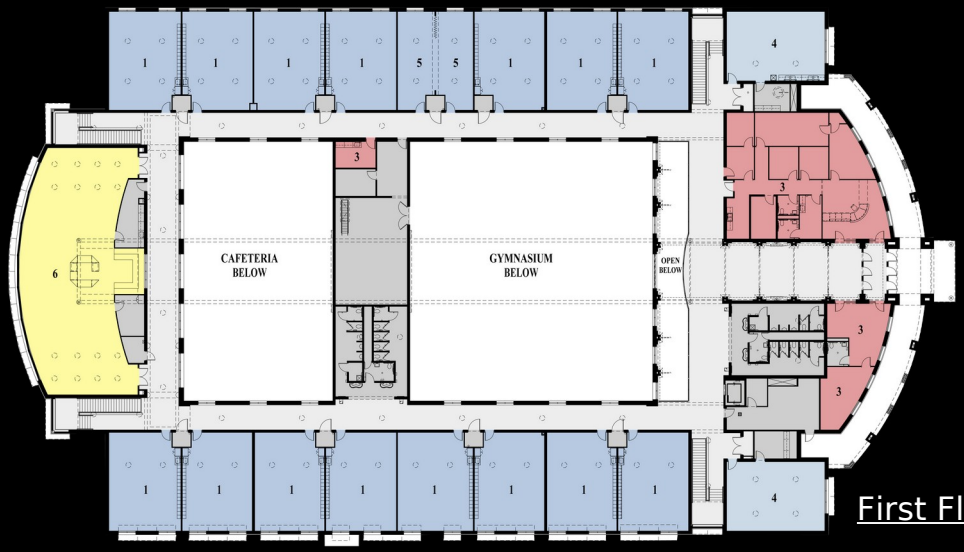
Net Zero Energy

The Solution



Site Plan

The Solution



First Floor Plan

Lower Level Floor Plan

The Solution

The Solution

- 76% Reduction in Energy Consumption Compared to the Average American School
- School Construction Cost (including solar panels) is $203/s.f.

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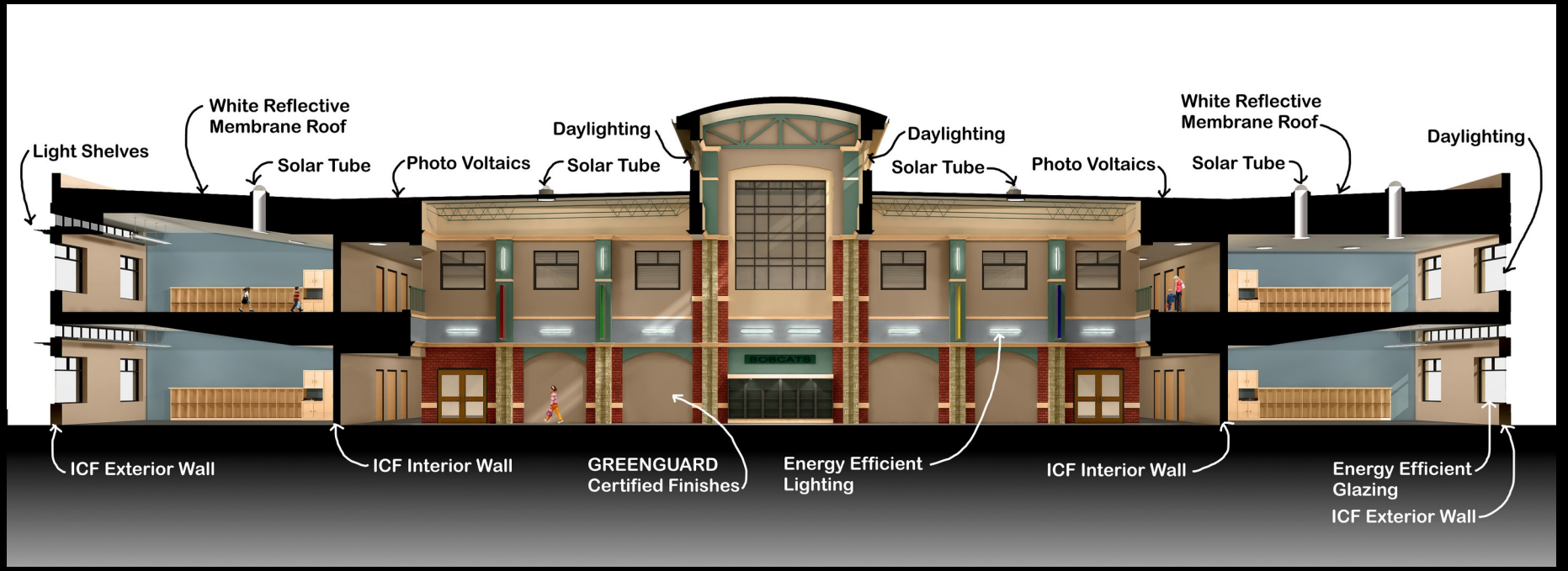
The Solution

Richardsville Elementary School



18 kBtu/sf/year
$223,744 Savings Annually

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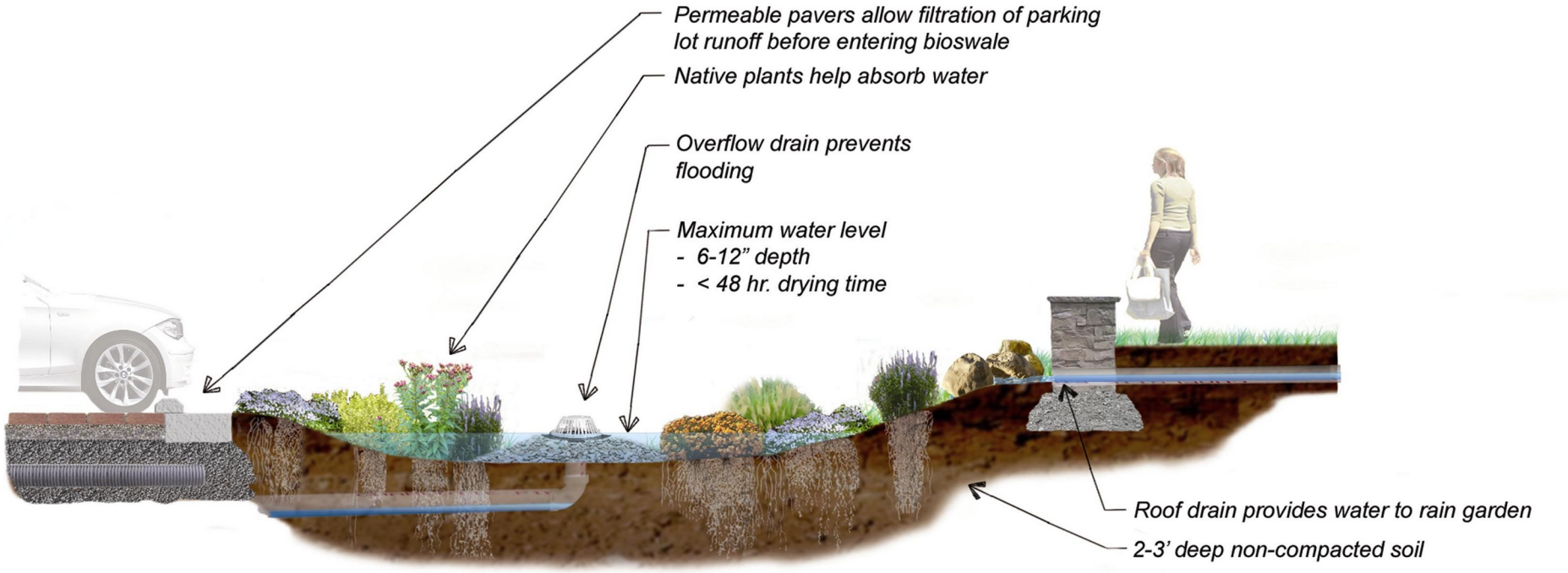
The Solution: Bio-retention Swales

- Creates sustainable sites
- Filters storm water
- Minimizes storm water run-off
- Maintains natural habitat
- Utilizes native plant life



The deep dense roots of native plants help break up heavy soils and increase infiltration. Common grass seed mixtures, used in lawns, have very shallow roots and as a result, cannot absorb excess water.

The Solution: High Performance Building Envelope

Insulated Concrete Forms (ICF)

- Improves speed of construction
- Comprised of greater than 50% recycled material
- Reduces construction waste
- Reduces noise infiltration
- Blocks out allergens and air pollutants
- High strength / storm resistant
- Compact Building Design/Footprint

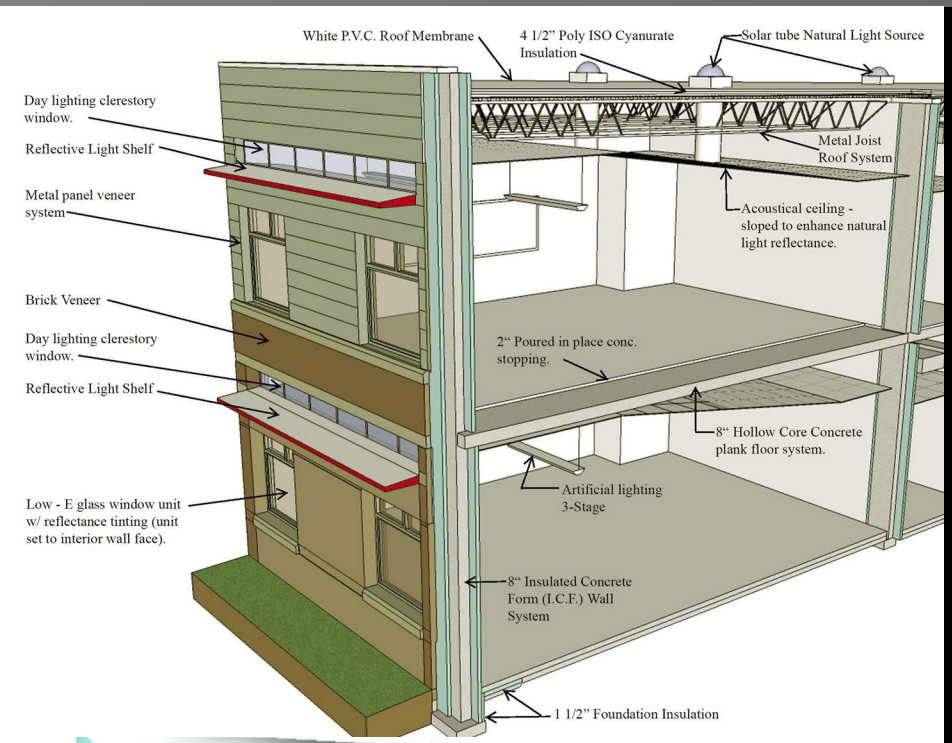
The Solution: Geothermal HVAC / Monitoring Controls

- Distributed Pumping Strategy
- Reduced Mechanical Spaces
- Some units used primarily for hot water generation
- Monitors establish times of “occupied” and “unoccupied” modes for unit operation
- Carbon Dioxide (CO2) Monitoring

The Solution: Photo Voltaic System (PV)

- 300 kW System size
- Grid tied system
- PV System to produce 358,000 kWH annually
- 44,400 square feet of panels on roof
- 5,600 square feet of panels on covered parking structure
- Tennessee Valley Authority program – Energy Purchased at a 4 cent Premium over Fossil Fuel Generation

The Solution: Active Daylighting



- Projects both direct and indirect sunlight into classroom space by light shelves and/or solar tubes while reducing the need for artificial light
- Results in enhanced day lit classroom space and reduced lighting energy consumption.
- Natural light in classrooms creates a pleasant, comfortable visual environment which can increase student and teacher performance
- Critical North/South Building Orientation for Classrooms

The Solution: GREENGUARD Certified Interior Finishes

- Improves Indoor Air Quality
- No Requirements for Harsh Cleaning Chemicals
- Reduction or Elimination of Volatile Organic Compounds (VOCs)
- Ease of Maintenance and Cleaning

The Solution: Efficient Kitchen Cooking Strategies

- Utilizes concepts from DUKE Energy Customer Resource Center
- Specifies Energy Star rated equipment
- Reduces or eliminates Type I hoods by eliminating grease laden vapors from fryers and/or tilting skillets
- Utilizes variable speed hood monitoring for make-up air
- Eliminates gas-fired equipment and replaces with electric equipment

The Solution: Learning Environment

- Engages Students through Interactive Learning
- Building will demonstrate environmental responsibility and stewardship by example
- Engage children and faculty to monitor the performance of the registered LEED Platinum building's conservation and sustainable strategies.
- Not only will facility be energy, water, and resource efficient, but will provide a healthy, comfortable, and safe learning environment for students, staff, and the community

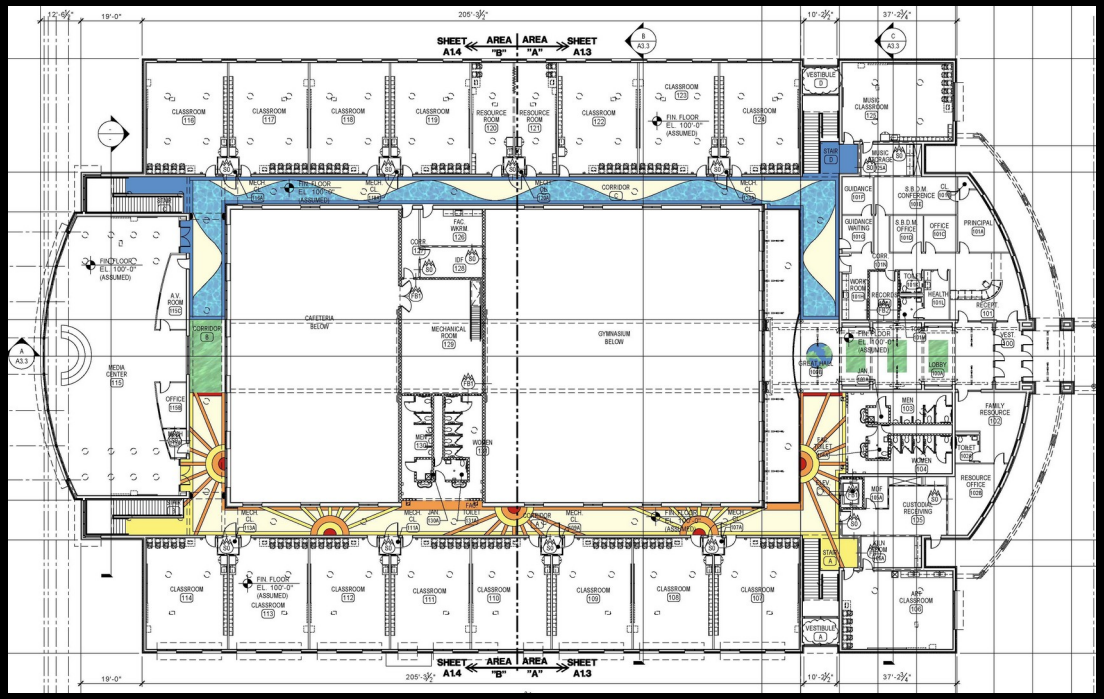
The Solution: Learning Environment

- Engages Students through Interactive Learning
- Color-Coded piping manifolds and temperature gauges monitor the system's performance
- Temperature of water entering building from geothermal ground loop is measured alongside water leaving the building to re-enter the geothermal loop.
- Mathematical and Scientific relationships developed for various age groups
- Students understand concepts relating to the actual systems design and efficiency

The Solution: Learning Environment

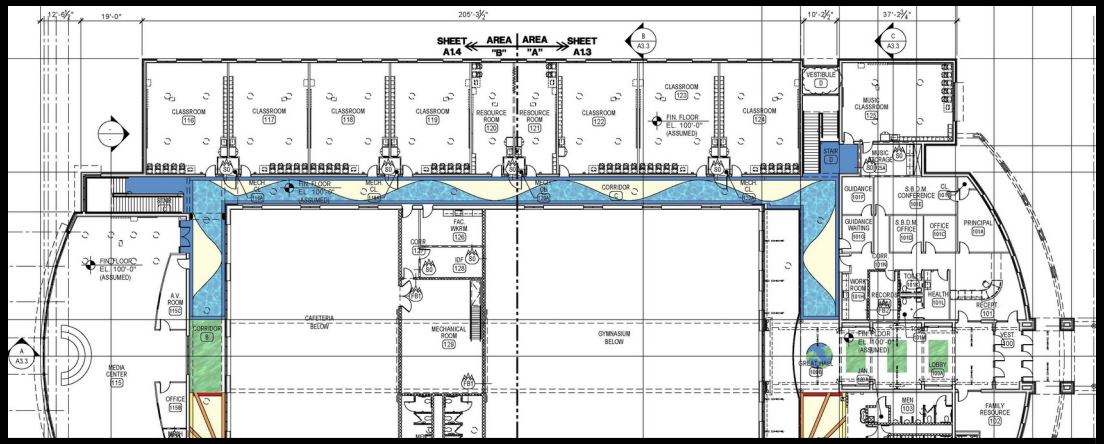
- Engages Students through Interactive Learning
- Wireless technology throughout facility creates flexibility – any space within or outside of building becomes a computer-aided laboratory
- Students monitor current environmental conditions at weather station
- Students track building's Net Zero performance throughout winter, spring, summer, or fall

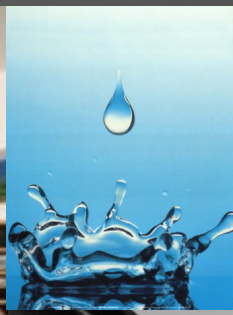
The Solution: Learning Environment



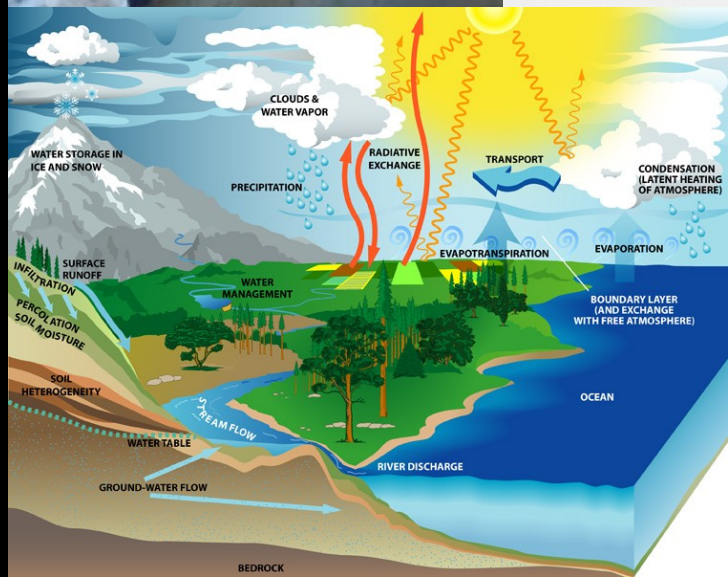
First Floor Plan

The Solution: Learning Environment - Water

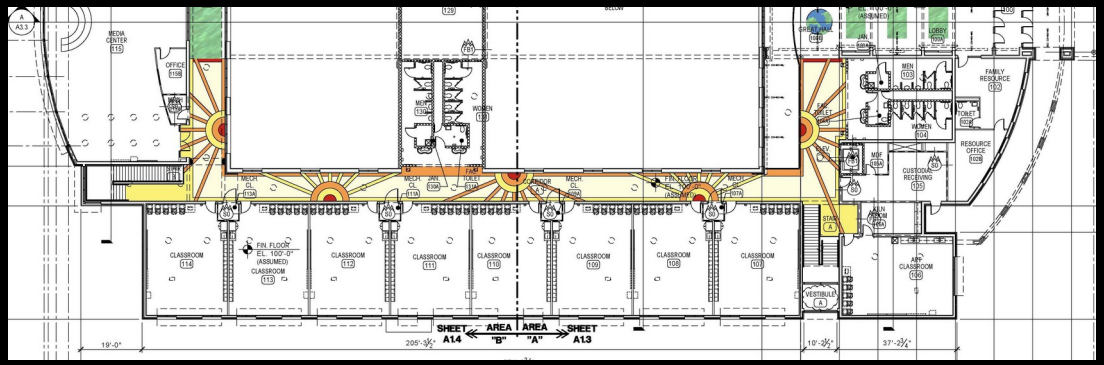




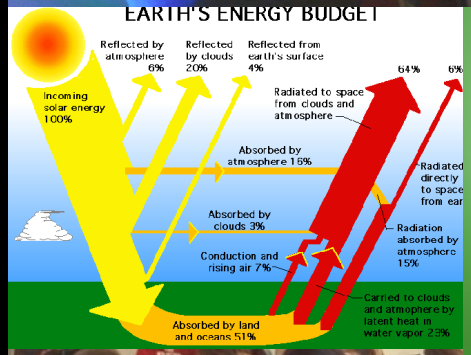
- Engages Students through Interactive Learning
- Measure quantities of roof-collected storm water filtered through the site's organic bio-swales before returning to underground aquifer
- Monitor water consumption by facility users
- Experience effectiveness of water-efficient plumbing fixtures throughout building

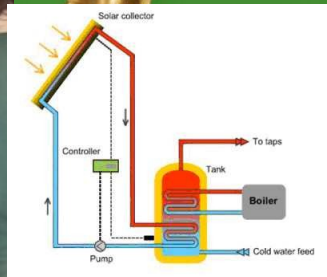


The Solution: Learning Environment - Light

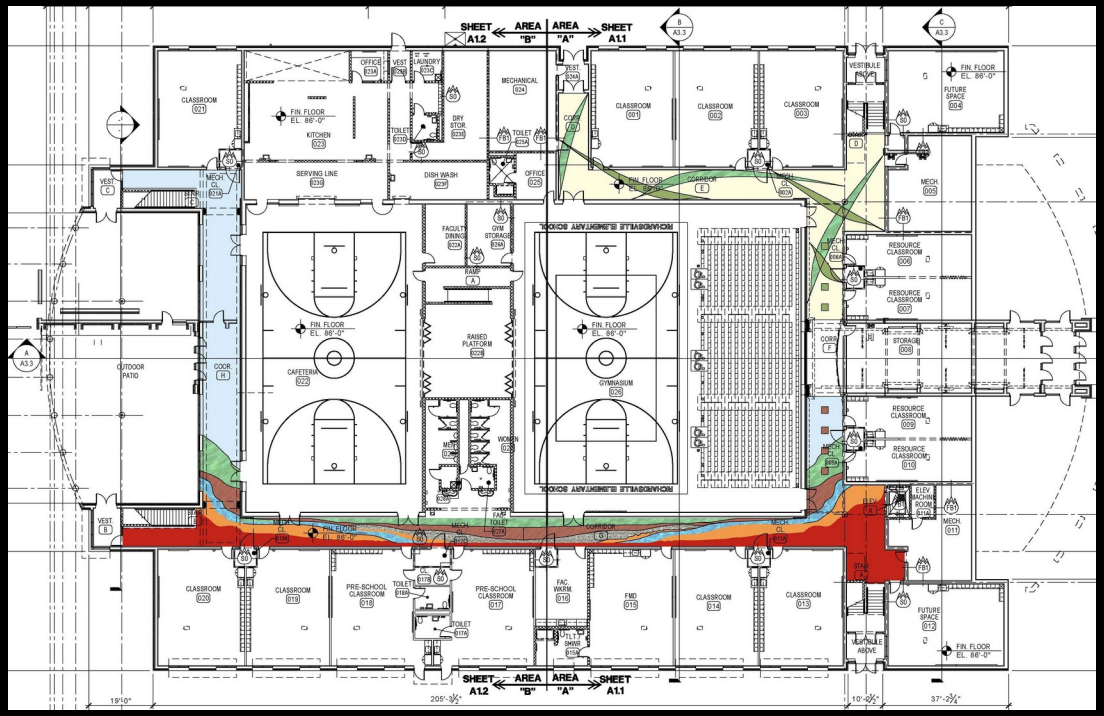


- Engages Students through Interactive Learning
- Laptop computer charging station monitors all energy used by solar panels
- Students understand solar panels, solar tubes, and light-shelves
- Building's energy conservation is maximized



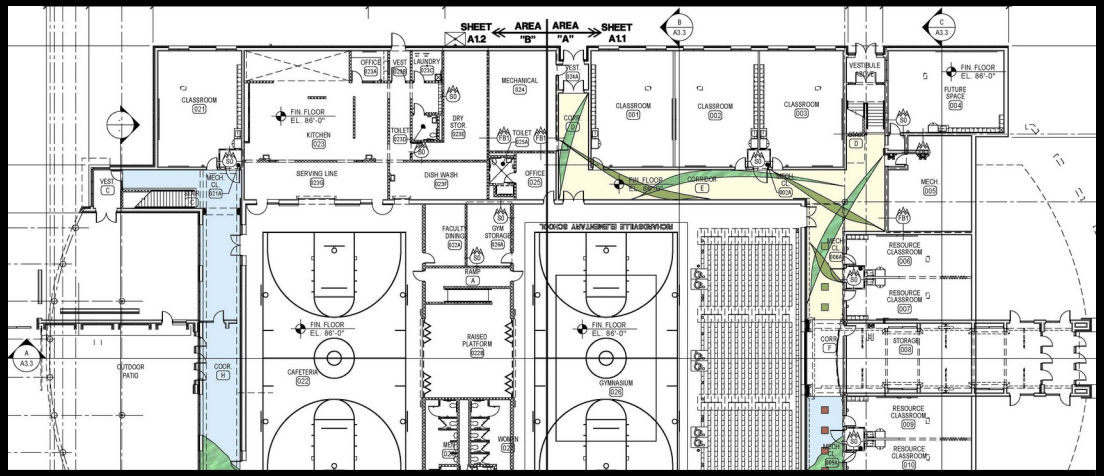


The Solution: Learning Environment



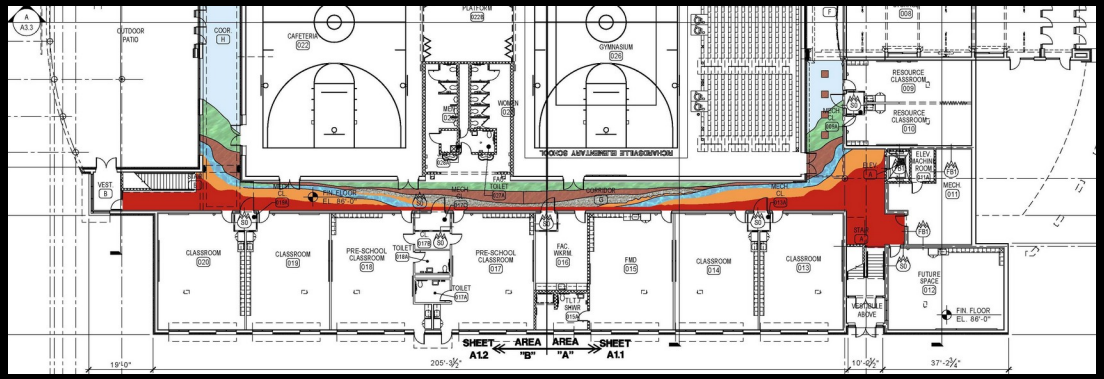
Lower Level Floor Plan

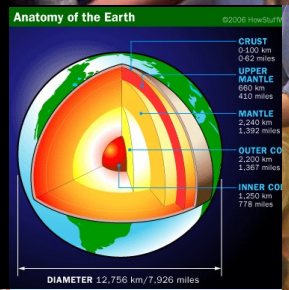
The Solution: Learning Environment - Recycling

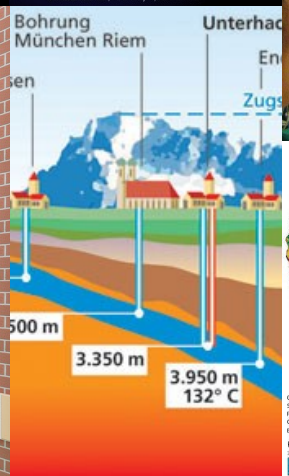


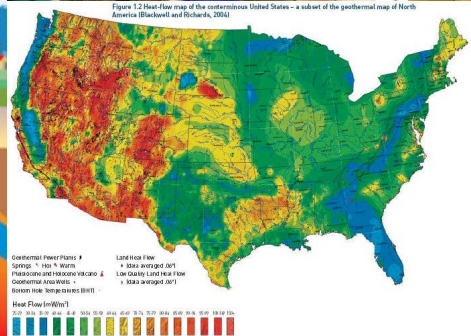
- Engages Students through Interactive Learning
- Collection Bins for various recyclable materials
- Students quantify collected materials
- Understand global impact of recycling

The Solution: Learning Environment - Geothermal





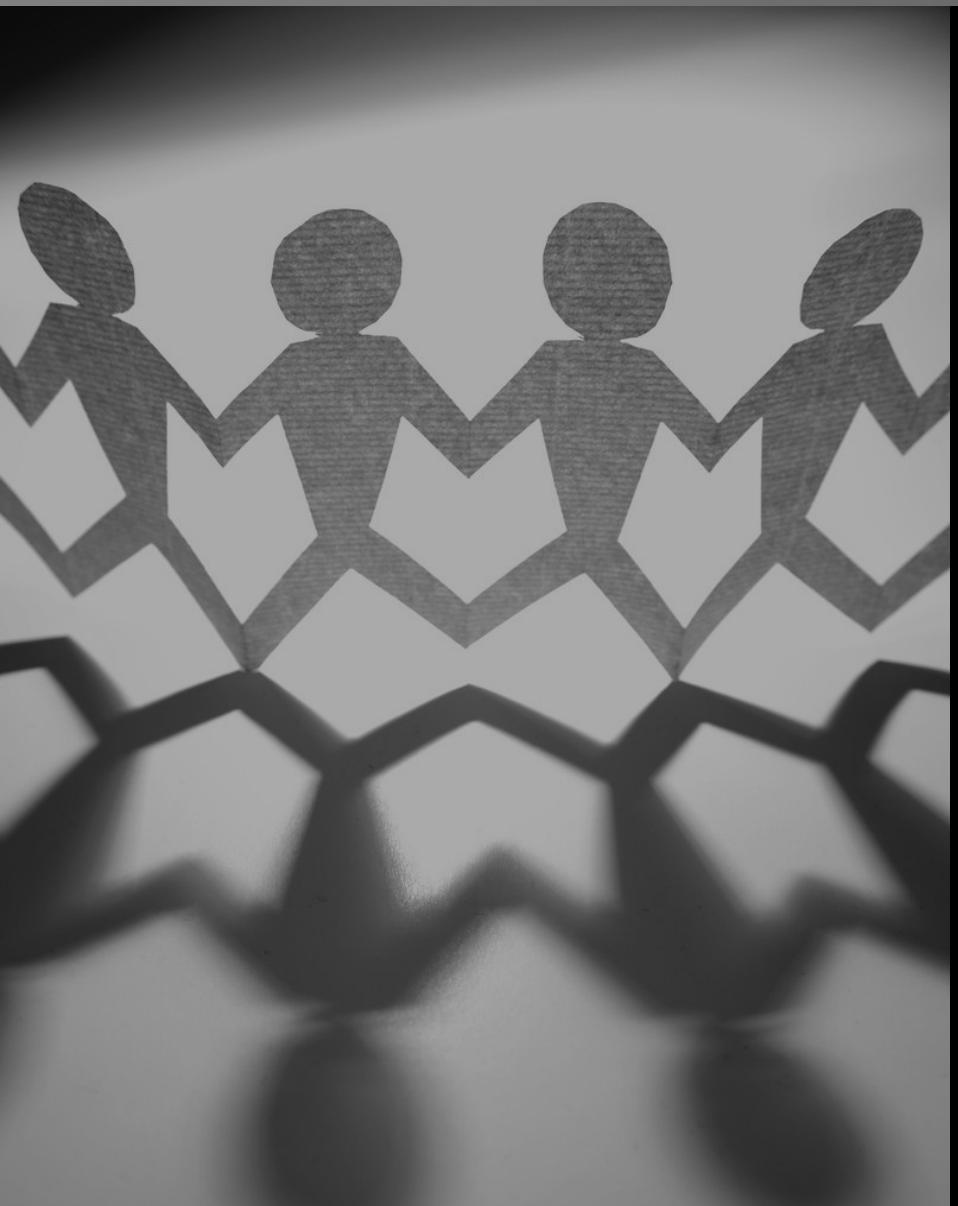




The Solution: Energy Curriculum

Grade Level	Time	Warren County Unit	NEED Unit
P1	Spring	Physical Science: Position/Motion/Light/Sound	**Primary Stories & More** Entertaining stories and hands-on activities to introduce basic energy concepts, energy sources, and electricity to primary students.
P2	Spring	Physical Science: Magnets/Electricity	Exploring Magnets: Background information and hands-on experiments to explore the basics of magnets and magnetism.
P3	Spring	Physical Science: Position/ Motion/Light/Sound	Primary Science of Energy: Explore fundamental concepts of energy, including motion, heat, sound and light with a series of simple activities.
P4	Spring	Physical Science: Magnets/ Electricity	Electro-Works Electricity: Background and hands-on experiments explore the basic concepts of atomic structure and electricity. Included are center-based experiments on static electricity, batteries, magnets, electromagnetism, and circuits.
4th	Weeks 20 – 27	Heat, Sound, Light, Electricity	Energy Works: Explore the basic concepts of energy and the tasks energy performs, including motion, light, sound, heat and growth
5th	Weeks 19 – 24	Unifying Concepts – Energy Transformation (transfer of energy, heat, sound, light)	Science of Energy:
6th	Various times	Economics & Electricity	What Car Will You Drive?: Explore conventional and alternative transportation fuels such as petroleum-based fuels, ethanol, electricity, bio-diesel, compressed

The Solution: Operations and Maintenance Plan



- Everyone involved at the beginning
- Establish Energy Goals
- Verify that Energy Goals are compatible with estimated construction budget
- Determine site orientation/layout, storm water management, building plan, exterior building envelope systems, structural systems, interior finishes and materials
- Determine HVAC system and controls, HVAC controls monitoring system, lighting controls, light fixtures, plumbing fixtures, and kitchen equipment
- Daylight Simulations
- Building Energy Modeling
- Building Energy Management Plan

Responsibility

Next year, California law will require new buildings to make their energy performance visible. Each building will be required to display its energy performance characteristics.

Responsibility

It is our responsibility to create high performance, energy efficient buildings. The dollars required to pay for utilities and maintain the buildings are the same dollars used for teacher salaries, computers, textbooks, and the tools necessary to teach our children.

At Sherman Carter Barnhart, we believe that all green and sustainable goals for school buildings begin with saving energy, reducing maintenance costs, and engaging future generations to conserve energy and protect our environment.

Thank you.

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