GREEN BUILDINGS: BREAKING NEW GROUND WITH SUSTAINABLE DESIGN:

Using "Green For Less" Principles and Technologies To Design High Performance "Green Buildings" on a Conventional Building Budget…

Building GREEN in Pennsylvania

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OVERVIEW

What is a Green Building?

Building "Green for Less"

Green Building Case Studies:

- **PA DEP South Central Regional Office**
- **PA DEP Cambria Office**
- **Others…**

What IS A Green Building?

Five Key Elements:

- Sustainable Site Design
- Water Conservation and Quality
- Energy Conservation and Renewables
- Indoor Environmental Quality
- Materials and Resources

Sustainable Site Design

- Re-use existing buildings and sites wherever possible. Consider developing on brownfield sites vs. clearing greenfield sites.
- Design buildings for flexibility and re-use to curb future development.
- Protect and preserve wetlands and other features that are key elements to existing eco-systems. Remember: Man and nature can co-exist.
- Minimize clearing and disturbance of site. Minimize building footprint.
- Locate building, parking, and driveways to minimize the overall impervious area. Use alternative storm water management technologies such as pervious bituminous asphalt and bio- retention and rain water garden technologies which support on-site or regional ground water/aquifer recharge.
- Select site that optimizes use of passive solar and natural ventilation.
- Use hardy and drought resistant indigenous plants, trees and turf.
- Minimize urban heat island effect by using light colored roofs and paving.

Water Conservation and Quality

- Minimize earthmoving, cut, fill and compaction of soil.
- Preserve and emulate natural hydrological features of the site.
- Design buildings to follow the natural contours of the land instead of carving the land to suit the building.
- Locate buildings and design site to maximize the use of alterative low impact methods of storm water management. Use dry type retention ponds only as a last resource.
- Use water efficient plumbing fixtures, toilets and waterless urinals.
- Establish a water budget for the building and set and monitor performance criteria.
- Use harvested rain water for site irrigation, toilet flushing, etc.

Energy Conservation and Renewables

- Good passive solar design is the fundamental building block of any high performance building.
- Aggressive use of natural daylighting is key to reducing building lighting loads which in turn reduce cooling loads and cooling equipment size and cost.
- High performance low-e thermally broken windows and frames are the single most effective energy conservation technology.
- Design a thermally broken high performance envelope
- Use only high efficiency HVAC, plumbing, lighting and electrical equipment and controls.
- Control humidity, mean radiant temperature, air velocity and air temperature year-round for maximum occupant comfort and highest energy efficiency…don't just control air temperature.

Indoor Environmental Quality

- Maximize use of natural daylighting.
- Use operable windows to maximize use of natural ventilation – design HVAC systems for mixed mode operation.
- Provide dedicated engineered ventilation system that operates independently from heating and cooling system and controls.
- Minimize sources of indoor pollutants. Use only materials, adhesives, finishes, paint, furnishings, etc which do not off-gas VOC’s or other irritants. Provide a smoke free environment.
- Design to control space humidity, mean radiant temperature, air velocity and air temperature year round vs. only controlling air temperature. Provide user accessible zone controls when possible.
- Protect and seal HVAC equipment and ductwork during construction.

Materials and Resources

- Identify ways to reduce and optimize the amount of material used in each building system through efficient design and the use of modern materials. Use resource efficient engineered materials and systems. (trusses, composite design, stress skin structural panels, etc.)
- Use bio-based and recycled content materials where-ever possible.
- Require the use of certified lumber from managed forests.
- Evaluate all materials for ability to be recycled at end of useful life.
- Reduce transportation of materials by placing emphasis on using regionally harvested and manufactured building materials.
- Avoid use of CFC or HCFC based materials, insulation, refrigerants…
- Implement an aggressive construction waste management plan. For most projects, 80 to 90% of construction debris is recyclable.

United States Green Building Council

Leadership in Energy and Environmental Design

USGBC LEED Version 2.0:

A comprehensive system for rating green buildings:

– LEED Certified	26 - 32 Points
– LEED Silver	33 - 38 Points
– LEED Gold	39 - 51 Points
– LEED Platinum	52+ Points

Visit www.usgbc.org to download LEED version 2.0

United States Green Building Council

Leadership in Energy and Environmental Design

- LEED 2.0 – More Intensive Documentation
- LEED 2.1 – Less Intensive Documentation
  Basically Same Elements as 2.0
  Lower Documentation Cost
- LEED EB – Mainly a Re-certification Tool
- LEED C&S – Core and Shell
- LEED CI – Commercial Interiors
- LEED Residential (Proposed)
- LEED User Guides for Building Types

Building Green For Le$$

THE BIG ISSUE:

Those who have limited knowledge and experience with the key principles of sustainable development and high performance resource efficient buildings will tell you that a **"GREEN BUILDING"** will cost more "green" (money) to build.

NOT SO…

Myth # 1: Going Green Costs More

- All green buildings don’t cost more to build.
- All green materials/technologies don’t cost more.
- Costs for green materials and technologies vary widely from region to region based on local contractor experience, and are changing rapidly.
- Many green materials and technologies cost the same or less than traditional technologies, and many green technologies result in significant cost savings or **“trade-offs”** in other parts of the building…

Design and construction professionals not familiar with Integrated Design, Systems Optimization and Green Building Technologies often provide incorrect and misleading information about cost of green technologies:

Many claims that ***"Going Green"*** *costs more are made by civil engineers, architects, MEP engineers, contractors, construction managers, or developers* ***who have limited experience with green building design*** *and the use of "green" materials and technologies…and particularly – those who fail to properly implement a truly integrated design process which fully optimizes all building elements and systems.*

Does it REALLY cost more?

Claims that green building strategies or technologies are often based on un-verifiable random here-say of a single project or technology and not on that individuals **PERSONAL EXPERIENCE**, researched facts, recent or local cost trends, or ***actual bid results*** or direct experience with high performance buildings and green technologies.

Take time to study existing projects that HAVE delivered high performance green buildings – in the LEED Silver and Gold range - without any significant added first costs.

Get <u>REAL</u> NUMBERS (Costs$$)
Don't just say…"OK" when told…
"That will Cost Too Much"

*Claims that "Going Green" costs more are often a cop-out for some other underlying concern or fear – often the **design fee or profit margin**….*

It **DOES COST MORE** to engineer and design a green building, depending upon the firms level of experience with high performance buildings, green materials and technologies, and use of a fully integrated design process. The integrated design process costs more in the design phase but can cost less or the same in construction of done properly. It is possible to recover and justify higher design fees with lower construction costs.

Goal: No increase in net project cost.

Design and Construction Professionals: Verify the Numbers Provided by the A/E

Most resistance to trying a green building or integrating green products or technologies comes from A/E's and contractors who are satisfied with status quo – ***"the way we've always done it",*** *and are not willing to invest time, money, and energy into staff professional development, on-going research into advanced materials and emerging building technologies.*

Going Green means doing research and revising age old standard office specifications and standard engineering, design and installation details and construction practices.

Solving the Problem…

When considering using A/E's with less green experience who have concerns with…

- Fears due to lack of experience with green design
- Fears of meeting design schedules due to green elements
- Fears of design cost over-runs due to green elements
- Fears of liability for green products or technologies
- Lack of experience with integrated design
- Lack of experience with true cost of green technologies

The Solution is…

Hire a different A/E ***OR*** require the A/E to hire consultants who have done the research and who have experience with the technologies that are likely to become part of your project. Eventually these less experienced firms will gain the experience and comfort level to do these projects on their own.

The Facts About The Cost of Green Buildings…

Fact # 1:

Many green building technologies actually cost less, or result in cost trade-offs in other divisions that result in net project cost savings.

Fact # 2:

Many successful green buildings have been built recently which cost the same as "not-so-green" buildings.

The following presentation will hopefully show you how to implement a successful and cost effective green building project using "Green for Less" Principles and Technologies...

Going Green For Less

Understanding how it works:

- Green For Less Strategies
- Green For Less Technologies
- Green For Less Building Case Studies

Green For Less Strategies

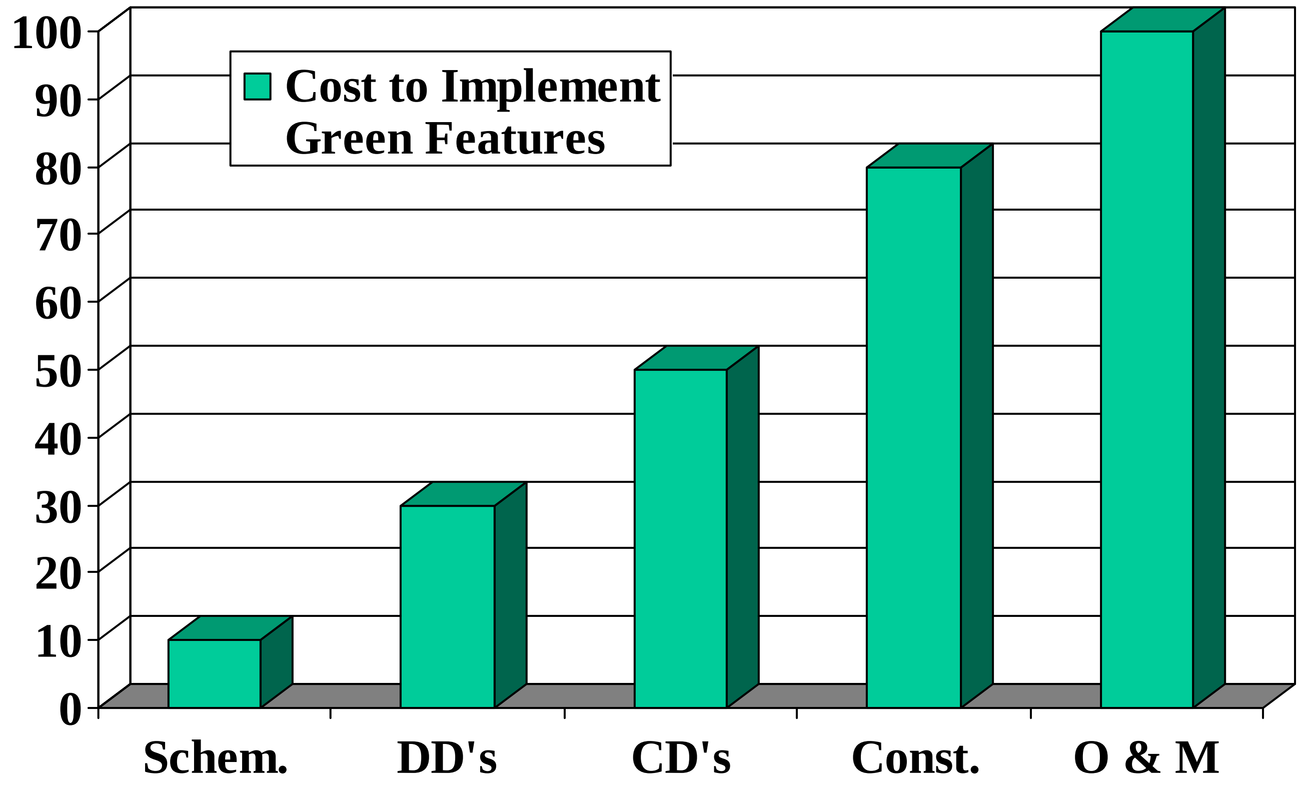
- “Going Green” Early Costs Less
- Building & Land Recycling
- Apply Principles of “Biomimicry”
- Avoid Over-design and Over-sizing
- Use Fully Integrated Design Process
- Optimization of all Systems and Materials
- Apply Less is More and KISS Principles
- Use Computer Modeling to Validate Optimization
- No Line by Line “Value Engineering”
- Apply “Cost Trade Off” Principle
- Careful A/E Selection
- Specialty Consultants
- Contractor & CM Selection
- Environmental Performance Contracting

Green For Less Strategies

"Going Green" Early Costs Less

Establish clear written environmental goals (Site, Water, Energy, Materials, IEQ) early in the project well before site selection has been made and while the inclusion of sustainable site design and alternative storm water management techniques, use of sustainable building orientation (Passive solar and daylighting principles), and implementation of other green strategies are most cost effective. Once site selection has been made and building size and shape and massing have been finalized - options for using many of the most fundamental and cost effective green building principles have been diminished unless additional engineering fees for re-design are to be incurred.

The cost to implement REAL green features increases with time as the more cost effective integrated design opportunities tied to building location, orientation, sustainable site design are lost.



Green For Less Strategies

Land Recycling

- Reuse of previously improved or cleared commercial or industrial sites is not just an environmentally smart thing to do – it can save on development costs if done properly. Brownfield sites may however require creative financing or state funding.

Building Recycling

- Reuse of existing buildings or even a vacated building shell that must be totally rehabilitated again, is not only an environmentally smart thing to do – it can save on development costs if done properly.

Green For Less Strategies

Apply Principles of "Biomimicry"

Refer to book ***Biomimicry*** by Janine M. Benyus. Strive to develop systems and solutions that emulate systems and processes found in nature. This is especially applicable to sustainable site design – but also very useful in both site and building problem solving and in making key building design decisions. When evaluating a particular design or solution – consider this: When Man Solves a single problem – he usually creates a whole host of new problems. (materials used, energy consumed, waste created, chemistry not in water…) When nature solves a problem – it usually solves multiple problems without creating ANY new problems – ie. concept of waste equals food, effective use of renewable resources and energy, low energy processes, nearly all chemistry in water…)

Green For Less Strategies

Avoid Over-Design and Over-Sizing

In many cases building foundations, structures, HVAC systems, and lighting and electrical systems get grossly over-designed when general rules-of-thumb and overly conservative safety factors are used for design in lieu of taking the time to do proper engineering calculations. In some cases there is good reason for over-designing things – but in many cases it is purely due to pressure from developers, building owners, or engineering managers who want to save time and money in the design process. This unfortunately can lead to significant over sizing, it increases first cost, it wastes valuable materials and resources, and often wastes energy over the life of the building. ***Interior and exterior lighting systems*** are one of the most frequently over-designed building systems. Interior and exterior lighting levels in most buildings far exceed recommended standards.

Green For Less Strategies

Fully Integrated Design

***The key to achieving cost effective green design is in the integrated "whole building" design process*…** careful consideration, evaluation, integration and absolute optimization of every major system, element and material in the building with **overall** optimum building performance (site, energy, water, IEQ, materials) and optimum first cost and life cycle cost in mind.

Green For Less Strategies

Integrated Design Example:

Color & Lighting

Until Recently…most architects and interior designers would rarely think to involve the lighting designers from the electrical department in on conversations and decisions about the selection of interior paint colors or finishes. Yet – in several recent school and office projects in Pennsylvania a 25% reduction in the number of light fixtures was achieved simply by selecting a slightly different shade of paint for interior walls. A minor increase in the paint light reflectance value (LRV) from .68 (68%) to .74 (74%) eliminated 25% of the lights in classrooms and open office spaces. This reduced not only the **FIRST COST** of the lighting and electrical system, but also reduced lighting energy use for the life of the building. ***But that is not all…***

Green For Less Strategies

Color Effects Lighting…

Lighting Effects HVAC…

The 25% reduction in the number of light fixtures resulted in a further 25% reduction in the amount of heat given off by lights – which reduced the overall building cooling load. This reduced the HVAC system size and FIRST CO$T, and subsequently reduced the energy used by the HVAC system for the life of the building.

This is just one of many examples of how INTEGRATED DESIGN leads to a better more cost effective green building design.

Integrated Design Process

Goal:

– Highest level of overall performance of the “whole building” with no net increase in project first cost

Process:

– Understanding the ***interrelationships*** of all building systems and materials AND optimizing all elements of the design through complete integration.

Result:

– A cost effective high performance green building…

But how do you get there?…

Green For Less Strategies

Optimization of Building Systems and Envelope

In any building design one of the most challenging roles of the designer is to balance building performance and initial construction cost. Using better windows, more insulation, or high performance insulated wall systems can increase envelope costs but also significantly reduce heating and cooling equipment size and cost. This is an all important but tedious balancing act which is often overlooked, particularly when design fees or schedules are tight. In most cases this optimization is best done through the use of modern computer based energy, lighting and daylighting modeling and simulation software.

Green For Less Strategies

Apply Less is More and KISS Principles

We tend to make our buildings over complicated. New trends are to un-bundle building systems and elements and focus on optimum performance with minimal layers and components. Just a few common examples:

1) **Needless use of suspended ceilings everywhere - when a highly reflective ceiling can be integrated into roof and floor structure**
2) **Careful evaluation of widespread use of un-necessary elements – such as curb and gutter and base and trim.**
3) **Use of Climate Responsive design, high performance envelopes (walls, glass and roof), and dedicated ventilation systems – enable much simpler zone control scenarios as internal climate zones are minimized – ie. 4 primary zones per floor (vs dozens) and under-floor supply system at Cambria. Less equipment, less ductwork – greater flexibility for future changes, minimal impact on zones from external climate changes. We have shown that it can work with care.**

PROFOUND Building NET Cost Reductions Can Be Realized

Green For Less Strategies

Computer Modeling and Simulation

Many different types of sophisticated computer modeling and simulation tools are available to aid the designer in the tedious but essential process of optimizing the building thermal envelope, windows, passive solar design features, daylighting features, and building electrical, lighting, heating and cooling systems. These modern design tools are used to optimize the building orientation, building massing, window size and locations, shading features, and thermal envelope design so as to minimize the size and cost of electrical, lighting, heating and cooling systems. Modeling and simulation software can be used to help evaluate and compare the benefits and cost effectiveness of various energy saving green technologies.

Green For Less Strategies

No Line-by-Line "Value Engineering"

Many cost estimators and construction management firms try to value engineer a project and often see line items that appear to be possibilities for cost savings without realizing the interrelationships between different building systems. In a high performance building – if you eliminate the high performance low-e windows to save money in that category – you may very well cause a 30 to 40% increase in the building heating or cooling load, and a subsequent 30 to 40% increase in the size and cost of the central heating and cooling plant and all associated equipment. A value engineering item which at first may seem like a real cost saver – can actually result in either an increase in project cost, or a significant operational problem if the effected HVAC system is not re-engineered. See examples under "Green For Less Technologies."

Green For Less Strategies

Using "Cost Trade-off" Principles

Use combined savings from "Green for Less" strategies and technologies such as sustainable site design, alternative storm water management or high performance building envelope / daylighting / passive solar strategies which can reduce site/civil, mechanical, lighting and electrical system size and first cost. Net project cost savings in these areas can be used to help pay for newer green technologies that may still cost more (low VOC paints, alternative materials, IAQ monitoring, fuel cells, solar/renewables) for a no-net increase in overall green project cost.

See Following Examples…

Green For Less Strategies

Cost Trade-Off Example #1

Green For Less Sitework

On many sites, the use of alternative site integrated storm water strategies such as pervious paving, bioretention, grassy swales and rain gardens that support a distributed and natural approach to storm water management through on-site infiltration and ground water recharge can significantly reduce the amount of site disturbance and eliminate the need for costly and needless clearing, excavation, and earth moving associated with installation of storm water detention ponds, storm water drain piping, curb and gutter, catch-basins and manholes.

Result: No net increase in project cost, **OR** a net project cost savings from innovative design which can be diverted to cover the cost of other more costly green technologies.

Green For Less Strategies
Cost Trade-Off Example #2

High Performance Envelopes

Use of high performance envelope, high performance glazing, and careful placement and orientation of the building which optimizes use of passive solar and natural daylighting can result in significant reductions in size and cost of lighting, electrical and HVAC systems and equipment.

Result: Net Project Cost Reduction, OR

These savings can be used to offset the first cost of other more costly green features such as daylighting controls or solar/PV, Fuel Cells...

Green For Less Strategies

A/E Selection and Qualifications

- For the owner: Careful selection of the A/E and consultant team with green experience is critical.
- For the A/E: Commitment to the use of qualified specialty consultants OR developing in-house expertise in sustainable site design, storm water management, native landscaping, innovative materials, IEQ, energy and water conservation measures and simulation measures, passive solar design, modeling and simulation; daylighting and lighting design and modeling and simulation, etc
- Careful selection of contractors and construction management teams and ***cost estimators***.

Green For Less Strategies

Role of Specialty Consultants

- Effective use of experienced and qualified specialty consultants is key to cost effective green design: site/civil, alternative storm water specialist, native landscapes, passive solar design, daylighting specialist, lighting specialist, daylighting and lighting computer modeling, acoustics, IEQ specialist, energy specialist, energy modeling, green building/alternative materials specialist, cost estimator and CM with green building and alternative materials experience.
- Using a less experienced A/E is OK if they truly have made a commitment to green design, have budgeted and scheduled for it, have a willingness to do lots of research on advanced materials and technologies, and have agreed to use specialty consultants as needed.

Green For Less Strategies

Contractor and CM Selection

- Careful selection of contractors, construction management teams and ***cost estimators*** is critical.
- Contractors, CM’s and cost estimators must make a commitment to being open minded. They must demonstrate experience with or a willingness to learn about all aspects of green design and construction and must be committed to achieving the environmental goals that have been established for the project.
- Contractors and subs must be willing to learn from other projects and other peers in the construction industry. They must agree to work with materials, technologies and perhaps even specialty sub-contractors or consultants which they may not have worked with previously.

Green For Less Strategies

Environmental Performance Contracting

Establish both cost performance and written environmental performance goals for the project (Site, Water, Energy, Materials, IEQ) early in the project when evaluation and implementation of green strategies is most cost effective. If using USGBC LEED, conduct a LEED targeting session, set individual goals for each category of LEED, and set an overall project goal such as LEED Silver, Gold or Platinum. Make these written environmental goals contractually binding throughout all aspects of the project and use the preliminary LEED target score as a point of reference. ***Environmental and cost objectives should be part of the project scope, and all formal notices, RFP's and contracts for project design and construction services.***

Green For Less Technology

- Sustainable Site Design
- Sustainable Storm Water Management
- Pervious Bituminous Paving
- Sustainable Landscaping
- Climate Responsive Design
- Daylighting
- Lighting System Optimization
- High Performance Lighting
- Light Colored Paints
- High Performance Glazing
- Insulated Concrete Form Systems
- Ground-source Heat Pumps
- Hybrid GSHP Systems
- Waterless Urinals
- Shallow Frost Protected Foundations
- Blended Cements
- BioComposites
- Recycled Content Materials
- Construction Waste Reduction
- Construction Waste Recycling

Green For Less Technology

Sustainable Site Design

Before designing and siting the building, conduct a detailed site survey and identify habitat and key plant, animal and hydrological features which can be used as elements of design instead of spending money to destroy them and then spending more money to re-create them in the landscaping phase of the project. Optimize building and parking size, location and orientation to minimize destruction of key natural features and habitat that exist on the site. Preserve these features and mold the building to the site instead of carving the land to suit the building.

Green For Less Technology

Sustainable Storm Water Management

Use technologies such as open grassy swales, rain gardens, bio retention areas, previous paving, pervious walkways, etc. which allow site to retain and infiltrate it's storm water instead of using "traditional" BMP methods.

Above technologies help to recharge local ground water while off-setting the cost of traditional non-infiltration based storm water technologies such as "dry" storm water detention ponds and buried storm pipe systems resulting in less land clearing, earth moving, excavation and less use of buried concrete pipe and concrete curb and gutter.

Green For Less Technology

Pervious Bituminous Paving

Pervious bituminous paving uses a special blend of bituminous asphalt paving that is porous due to the omission of the fine gravel which makes traditional paving impervious. Much like pervious concrete, this type of paving allows rain water to pass through the paving and enter a gravel storage and infiltration bed located below the paved area. These systems are installed with standard paving equipment but cost the same or in some cases slightly less than conventional impervious paving systems because they include an integral storm water remediation feature which eliminates the need for costly storm water collection systems, catch basins, storm water piping and storm water detention ponds. Most systems also have the capacity to accept run-off from adjoining roofs or paved areas.

Green For Less Technology

Sustainable Landscaping

Use less costly native, hardy, drought resistant landscaping and turf instead of more costly non-indigenous plantings and turf which also require elaborate and costly irrigation systems and on-going maintenance and care including excessive use of water, insecticides, herbicides, fertilizers. Support the sustainable landscape plan by replacing costly modern irrigation systems and costly modern storm water management systems with site integrated sustainable storm water strategies such as rain water gardens, sub-surface irrigation systems, and on-site ground water recharge and infiltration beds.

Green For Less Technology

Climate Responsive Design

Through the use of energy modeling computer programs, it is possible to simulate and optimize the use of passive solar massing and orientation, passive solar heating and cooling techniques, sun-tempering of windows, natural shading, natural ventilation, and natural day-lighting. These simple design elements and strategies cost little or nothing to include in a project, yet they can collectively reduce the lighting/electrical, and heating and cooling loads and equipment size and costs by as much as 30 to 60% or more when compared to buildings and sites that do not incorporate these building and site integrated climate responsive design strategies.

Green For Less Technology

Daylighting

Proper building orientation and massing, careful location, sizing and design of windows, and effective use of light wells, clerestories and shading devices improves daylighting of interior spaces. Daylighting has been shown to improve child performance and learning in schools, it enhances employee productivity, and it can increase retail sales. In some cases, effective use of daylighting actually means cost savings because less light fixtures may be required. Less light fixtures produce less heat – thereby reducing the cooling load and mechanical equipment size and costs. HVAC cost savings can be used to cover optional daylighting features such as light shelves or interior shades. Daylighting features are best optimized using computer based daylight modeling/simulation software.

(See M. Nicklas Handout on Cost of Daylighting In Schools)

Green For Less Technology

Lighting System Optimization

Lighting simulation programs are computer modeling tools that can be used to optimize lighting system design. Most lighting systems in buildings today are designed based on rule of thumb engineering principles. These installations are often way over-designed and provide ambient indoor and outdoor lighting levels that are 25% to 50% higher than Illuminating Engineering Society recommendations. 25% to 30% less light fixtures produce 25% to 30% less heat – thereby reducing the cooling load and mechanical equipment size and costs. Proper lighting design reduces both lighting and HVAC system size and first costs which helps offset the cost of daylighting controls and better quality, more energy efficient light fixtures. Long term lighting and HVAC operational costs are also reduced.

Green For Less Technology

High Performance Lighting

Using high performance light fixtures with polished specular reflectors, energy efficient T-8 and T-5 bulbs in lieu of T-12 bulbs, and high efficiency electronic ballasts in lieu of magnetic ones; and using compact fluorescents in lieu of incandescent bulbs not only saves energy but it can actually reduce the overall cost of a new building. These cooler operating energy efficient ballasts and light bulbs produce the same amount of light but actually generate much less heat than less efficient models. A 25 to 30% increase in light fixture efficiency can transpose to 20 to 25% less heat rejected to the space. This decreases the space cooling load which in turn can reduce the size and cost of the central cooling plant and distribution system.

Green For Less Technology

Light Colored Paints

Lighting simulation programs can also be used to optimize paint color selection and lighting system design. In a recent PA school project, 25% less light fixtures were required while maintaining the same ambient classroom lighting level simply by switching to a slightly lighter paint color for the classroom walls. Similarly, 25% less light fixtures means 25% less heat from lights – thereby reducing the cooling load and mechanical equipment size and cost. Using light colored paints reduces both lighting and HVAC system first costs which helps offset the cost of light shelf technology and better quality - more energy efficient light fixtures. Long term lighting and HVAC operational costs were also noticeably reduced.

Green For Less Technology

High Performance Glazing

Use of high performance low-e glazing and thermally broken window frames can reduce building heating and cooling loads by as much as 30% or more. While high performance glazing costs more than standard glazing, the reduction in the size of building heating and cooling equipment can result in net project savings that can be twice as much as the added cost of upgrading to better windows – resulting in a net project cost savings. This is a prime example using the “Green For Less” cost trade-off strategy – where the cost of using a more expensive “green” technology in one area of the building is offset by resulting savings in a totally different building component.

Green For Less Technology

Insulated Concrete Forms (ICF's)

Insulating foam blocks are filled with steel reinforced concrete to form "high mass", earth coupled, thermally broken super-energy efficient walls for both above and below grade applications. ICF's outperform most traditional wall assemblies in terms of thermal and structural performance while eliminating the time and cost associated with set-up and tear-off of formwork for traditional concrete wall systems. Exceptional thermal performance and high mass results in notable reductions in the size of building heating and cooling systems.

Green For Less Technology

Ground-source Heat Pumps

Despite reports by many that geothermal or “ground-source” heat pump systems cost more due to the “added cost” of drilling the wells and installing pipe loops and manifolds, several recent projects in central PA are disproving this theory. In fact, on three recent elementary school installations the geothermal system provides year round heating or cooling as needed, it uses about 30 to 40% less energy to operate, and the first cost for these systems was less than other traditional HVAC systems for the following reasons…

Green For Less Technology

Ground-source Heat Pump Costs:

Just a few of the Reasons… ground coupled water source heat pump installations actually have a LOWER FIRST COST than traditional HVAC systems, for both new or retrofit situations:

1) There is no large central chiller and cooling tower and associated water treatment system to install. (and operate and maintain)
2) There is no large central boiler or associated hot water piping and water treatment system to install. (and operate and maintain)
3) The heat-pump system uses a two pipe system vs a four pipe system that often requires considerably less piping and pipe insulation and often less pumps, less pump controls and less associated electrical equipment and switch gear.
4) In the case of school construction and many office building installations in PA large underground heating fuel oil tanks are also eliminated from the new construction or retrofit project. (Most schools and larger offices in PA now operate on dual fuel gas/oil boilers in order to provide interruptable gas service in exchange for lower gas rates.) With a GSHP system the large heating system oil tanks and associated leak detection systems are not needed.

Green For Less Technology

Ground-source Heat Pump Costs:

Just a few of the Reasons… ground coupled water source heat pump installations also have a LOWER OPERATING COST than traditional HVAC systems, for both new or many retrofit situations:

1) The elimination of long term operation and maintenance costs for chillers, cooling towers, boilers, and associated pumps and water treatment systems are eliminated. O&M costs for small and medium size water source heat pumps and the central pumping system and ground loop are historically significantly lower than the O&M costs associated with the traditional Chiller/Cooling Towner and Boiler systems that GHPS replaces. (Cost Trade off Principle)

2) In many cases the long term maintenance and inspection costs associated with below grade fuel oil tanks are eliminated. Elimination of the buried oil tanks represents the elimination of a significant potential environmental hazard. The elimination of this liability may even have a positive impact on hazard and liability insurance for the school property.

Green For Less Technology

Hybrid GSHP Systems:

Well field sizing and construction for most GSHP installations today are designed based on the peak heating or cooling load. In Pennsylvania – peak heating load in a building often drives the minimum size of the well field. Significant first cost savings can be realized if the well field is sized for the nominal heating load, while simultaneously being sized for the peak cooling load. In this situation a small gas fired or oil fired boiler or other source of auxiliary heat provides a boost to the condenser water loop system during peak heating days. Well field size and cost can be reduced by up to 30% with this strategy as per the Wattsburg School in Seneca PA (Erie region) The first cost of this small boiler which rarely operates – is about one third to one quarter of the cost of the wells that it offsets. GSHP system payback period is significantly reduced.

Green For Less Technology

Waterless Urinals

Waterless urinals have been proven to be attractive, safe and effective in many installations in PA and across the US. A special patented design eliminates the need for the use of water for flushing. The trap in the waterless urinal contains a special fluid which is lighter than urine – the urine drops though the fluid, passes through the trap, and goes down the drain while the special fluid remains in the urinal. Cost savings are realized because water supply lines and flush valves are not needed. On remote sites, additional significant cost savings are realized due to reductions in drain field size and capacity. Where rain water, storm water or gray water systems are used for toilet/urinal flushing, system capacity, storage and related costs are significantly reduced when waterless urinals are used. Significant long term savings are realized due to a reduction in water use.

See PA Dept. of Health Letter Supporting Use of Waterless Urinals

Green For Less Technology

Shallow Frost Protected Foundations (SFPF)

The SFPF is an age old technology that has been used with great success for both commercial and residential buildings in northern climates across the globe. SFPF's use horizontal and/or vertical insulation to protect the building footing from frost. Insulation is used to raise the frost depth around the building – which enables the depth of footings to be raised. This saves both time and money because less excavation is required and less concrete and masonry is used in the shallow foundation walls. The US Department of Housing and Urban Development recently published a manual which provides architects, engineers and builders with simple guidelines for the design of SFPF's. Model building codes in the US recognize and accept the use of frost protected foundations.

Green For Less Technology

Blended Cements

Fly-ash (bottom ash and top ash) and slag can be used to improve the strength and durability of concrete mixtures while reducing the amount of Portland cement required to achieve the desired strength. Blended cements have been used for hundreds of years with great success – however their use is an often overlooked construction method. Using blended cements such as fly-ash and slag will reduce the cost of the concrete mixture as the ration of Portland is reduced – the cost of the concrete mixture drops.

Green For Less Technology

Blended Cements (continued)

Portland is the most costly element in modern concrete. It is also one of the most environmentally harmful building materials used today. To manufacture Portland cement – lime is fired in a very hot furnace or kiln – at temperatures of over 1000 degrees. This uses an incredible amount of energy – otherwise known as embodied energy. For every ton of Portland cement that is used in a building one ton of carbon (pollution) was created in the manufacture of that ton of Portland cement. Portland can be reduced by as much as 20 to 30 percent when using blended cement technologies. The Parthenon in Rome was built using fly-ash / blended cement. Needless to say – blended cements, when engineered properly, are extremely durable and have proven themselves in the test of time. PENNDOT is now using blended cements in highway construction.

Green For Less Technology

Bio-Composites

Bio-composites are materials that are made from Bio or "earthen" based materials. The most common types of bio-composites are made from agricultural waste products such as wheat straw, soy products, sunflower seed (hulls) and a myriad of other types of agricultural waste that is left over after the food processing. These materials would otherwise be land-filled or in many cases in the western United States – these materials are burned – creating huge environmental problems. Many bio-composites also utilize recycled materials such as recycled newspaper. Bio-composites are very hard and durable – come in many textures and colors.

Green For Less Technology

Bio-Composites (continued)

The most common use for Bio-composites today is for millwork, casework, countertops and work surfaces in modern office work stations, and even in kitchen and dining areas in offices, schools and other institutions. Bio-composites have reached a point in the commercial and residential market-place where the are cost competitive with other solid surface materials such as coated or laminated MDF, Correan, etc. In some cases – bio-composites are actually less costly and more durable than conventional building and casework materials.

Green For Less Technology

Recycled Content Materials

Recycled content materials have been in the market place for many, many years. Many common consumer products are made from post industrial and post-consumer recycled materials such as newspaper, plastic soda bottles, etc. One of the most common recycled content building materials found in modern office buildings today is recycled content carpeting. In some cases both the nylon fibers and the carpet backing are made from high recycled content materials.

Green For Less Technology

Recycled Content Materials (continued)

Other examples of recycled content materials include fiber ceiling tiles and homosote building panels that are used for insulation and for the construction of roof decking assemblies. Recycled content materials have reached a point in the commercial and residential market place where they are cost competitive with other common building materials. In many cases the recycled content materials are actually less costly and as durable if not more durable than the competing products.

Green For Less Technology

Construction Waste Reduction

Many aspects of a construction project are prone to the creation of needless, excessive and costly waste due to poor planning, poor design, over-design, and over-building during construction. More efficient site and building design and detailing, and implementation of a few construction waste reduction strategies can save thousands of dollars on any project. Some examples are: poor building placement on the site and poor site design resulting in needless and excessive site work, site clearing and creation of excess fill; inefficient use of concrete for foundations and footings; and inefficient use of wood and steel framing, drywall, and floor coverings.

Green For Less Technology

Construction Waste Reduction Plan

Implementing and enforcing a written construction waste reduction plan can save the builder and owner through more efficient use of the site and building materials. An effective plan will also reduce costs associated with hauling and disposal of excess site clearing debris, earthen materials and construction waste. Construction waste can be reduced by addressing three key areas of the project:

1) Site Design: Building, roadway and parking configuration and placement on site
2) Landscape and Architecture: Design and detailing,
3) Construction Management: Resource management

Green For Less Technology

Construction Waste Recycling

While economic conditions vary from region to region, in most urban areas where landfill costs are moderate to high, the implementation of an aggressive construction waste management plan can result in 20 to 40% savings construction waste hauling and disposal costs due to the elimination of costly landfill tipping fees. Those willing to do the research will find local and regional users for clean sorted construction waste such as site clearing debris, metals, concrete, masonry, glass, cardboard, dimensional wood, carpet and padding, and asphalt.

Green For Less Projects

PA DEP South Central Regional Office

Harrisburg, PA

Certified: USGBC LEED Bronze

Cost: $ 89.00/SF

PA DEP Southwestern Region Mining Office

Cambria, PA

Target: USGBC LEED Silver

Certified: USGBC LEED Gold

Cost: $ 98.00/SF

Green for Less Projects

PA/DEP South Central Regional Office

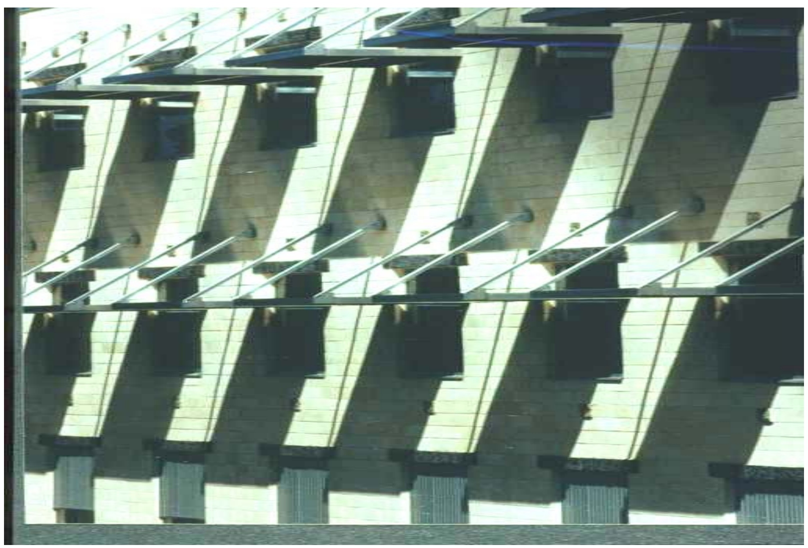
Green for Less Projects

PA/DEP South Central Regional Office

Passive Solar Orientation and envelope features significantly reduce HVAC loads and equipment costs.

Green for Less Projects

PA/DEP South Central Regional Office



Exterior light shelves bounce daylight into the occupied spaces of the building improving indoor ambient lighting levels.

Green for Less Projects

PA/DEP South Central Regional Office

Day-lighting, light shelves, and light colored reflective ceiling reduces the number of light fixtures needed… thereby reducing lighting and electrical system costs. Less lights means less heat which reduces cooling load, equipment size and cost.

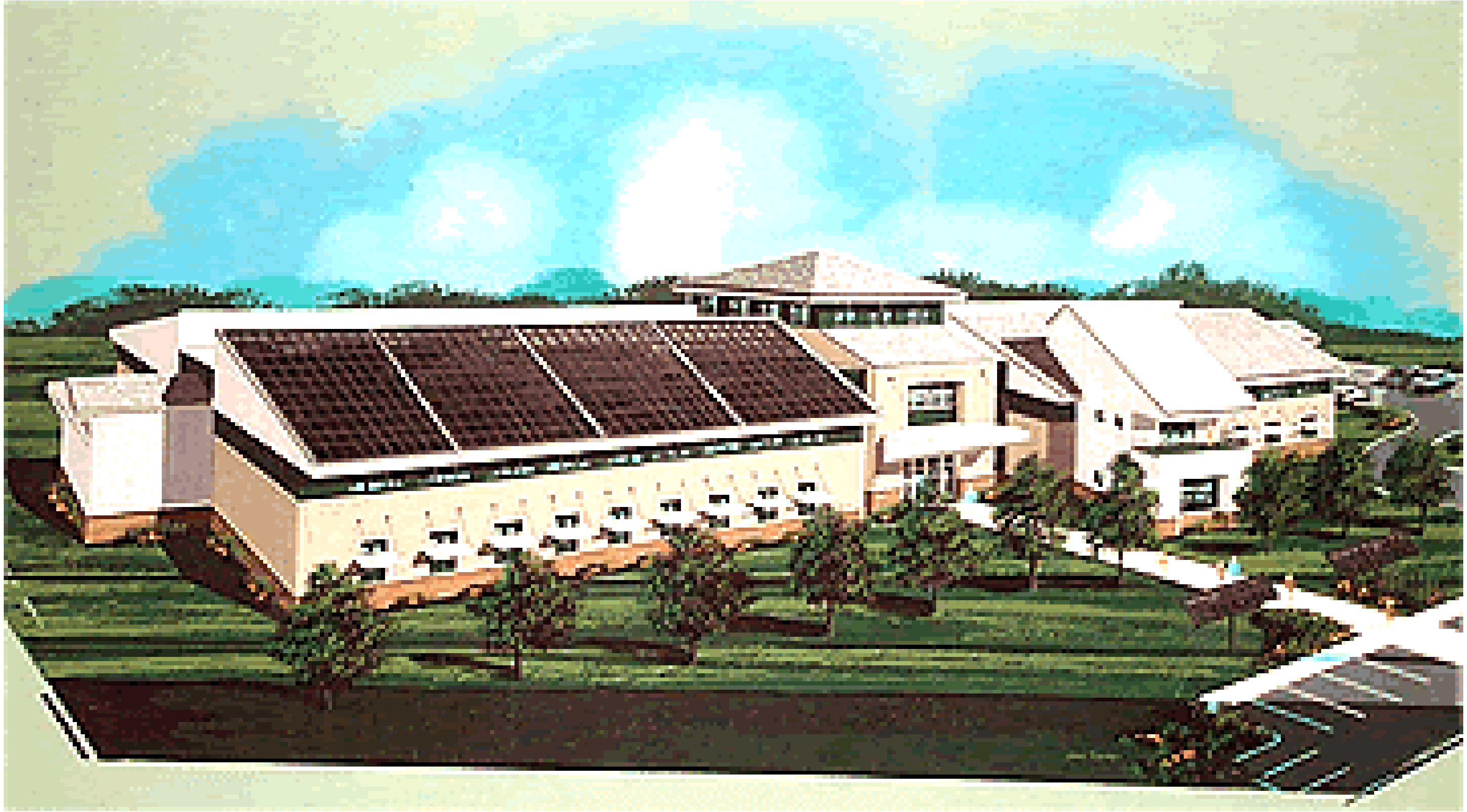
Green for Less Projects

PA/DEP South Central Regional Office

Green for Less strategies and technologies implemented throughout the project enabled the use of some more costly low-VOC finishes, and numerous recycled content and bio-based materials.

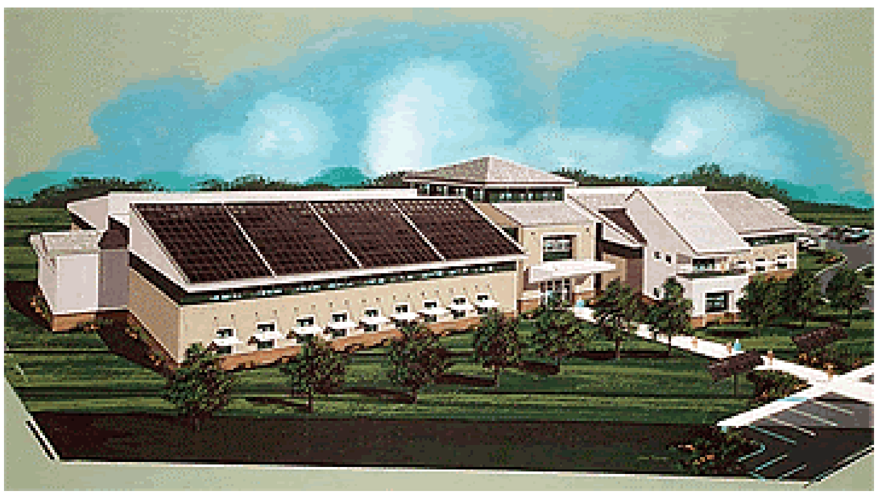
Green for Less Projects

PA/DEP Cambria Regional Mining Office



Green for Less Projects

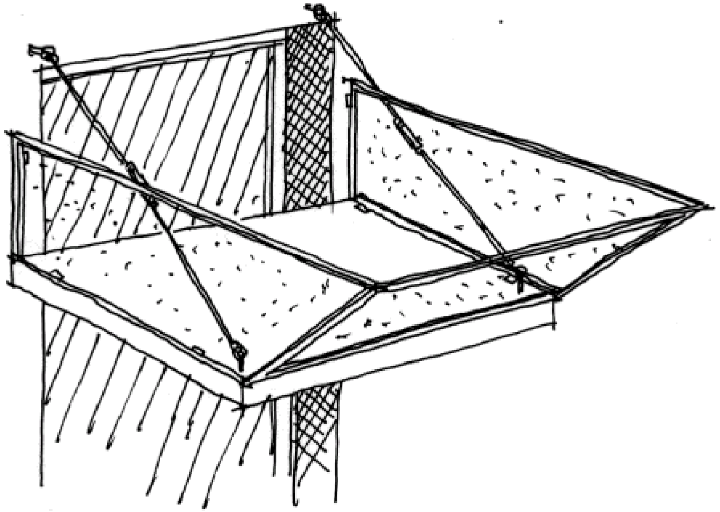
PA/DEP Cambria Regional Mining Office



Aggressive passive solar orientation with east/west axis, roof overhangs, north and south facing windows and clerestories boost natural daylighting while reducing heating and cooling loads, reducing HVAC system cost, and optimizing year-round energy performance.

Green for Less Projects

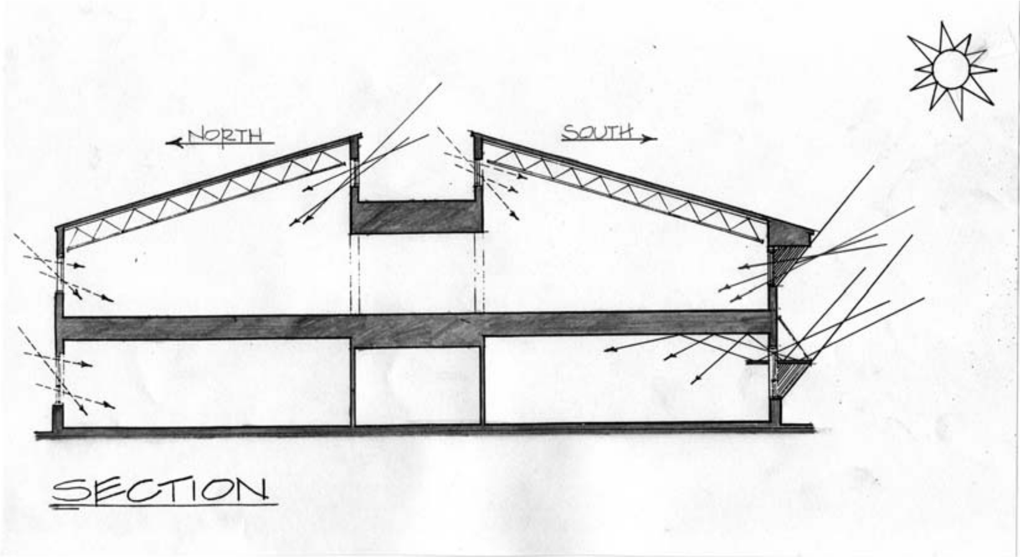
PA/DEP Cambria Regional Mining Office



External light shelves reduce direct solar gain and reduce cooling load while improving penetration of daylighting.

Green for Less Projects

PA/DEP Cambria Regional Mining Office



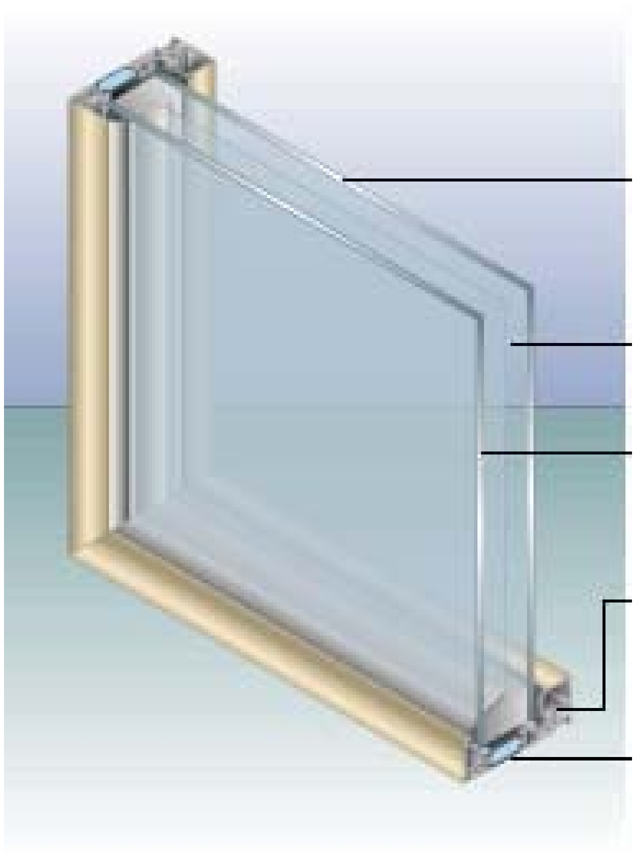
Aggressive use of day-lighting strategies and light colored paints in this building reduced the number of light fixtures and reduced cooling load resulting in both first cost savings and significant operational savings.

Green for Less Projects

PA/DEP Cambria Regional Mining Office

Green for Less Projects

PA/DEP Cambria Regional Mining Office



Use of high performance glazing saved $15,000:

Glazing Upgrade:
$15,000
HVAC System Savings:
$30,000
Net Project Savings:
$15,000

Green for Less Projects

PA/DEP Cambria Regional Mining Office

High performance Insulated Concrete Form (ICF) wall system further contributed to HVAC system downsizing, first cost savings, and significant long term operational savings.

Green for Less Projects

PA/DEP Cambria Regional Mining Office

Waterless urinals are a proven technology with both first cost and long term operational cost savings. Water supply piping and flush valves are eliminated, and no water is used.

Green for Less Projects
PA/DEP Cambria Regional Mining Office

A truly integrated design approach and effective use of various "Green for Less" strategies and technologies enabled PA DEP to install a 14 KW PV array within the modest budget.

Green for Less Projects

PA/DEP Cambria Regional Mining Office

	Cost/ft^2
Structural	$36
Interiors	$25
Mechanical	$15
Electrical	$12
Site	$10
Total	$98

The Bottom Line:

DEP Cambria achieved a LEED Gold Rating for well under $100 per square foot. Year one operating data indicates that the building is using 50% less energy than the standard low rise office building located in our region. Energy modeling predicted energy use of 60-75% less energy than a conventional building.

Just a few of the other recent PA Green projects that have been held to conventional budgets:

- **Clearview Elementary School**
- **PA DEP Norristown, California and Phillipsburg**
- **West Chester University School of Music**
- **West Chester University Student Residence (North)**
- **West Chester University Student Residence (South)**
- **50 Story High Rise in Downtown Philadelphia**
- **Gettysburg Emergency Training Center**
- **Delaware Water Gap Welcome Center**
- **Uniontown County/DEP Office Expansion**
- **Johnstown Goodwill Retail/Office Center**

These projects all have CONVENTIONAL building budgets.

More recent Case Studies of High Performance Buildings with no-net increase in first cost…

- Refer to Mike Nicklas - Innovative Design experience – on hundreds of energy efficient daylit schools – some came in under the standard school budget, most had no-net increase, only a few were in the 1% inrease range.
- Recent survey by California – Supports PA position that LEED Silver and Gold are achievable for many buidling types (low rise offices and schools, etc) for no net increase in first cost.

Conclusion

- It is possible to build a green building on a modest budget by applying “Green for Less” strategies and technologies. Assuring an even balance of “Green for Less” technologies intermixed with green technologies that cost the same and a few green technologies that may cost more, will assure an affordable building project that has superior long term environmental performance.

Building GREEN in Pennsylvania

Action Plan for Cities, Counties & States:

- Encourage the voluntary use of the USGBC – LEED Green Building Rating System. For commercial and institutional development. Develop incentives for those who use it. (ie. Density variance…)
- Set an example for the private sector – Establish energy and environmental goals for all city, county and state projects. Commit to building offices, courts, hospitals, schools, etc., using LEED.
- Develop and promote a residential green builder program for your city/county/state. (see Austin, Denver, Albuquerque, NAHB, others)
- Identify and remove building code and zoning/regulatory barriers that currently present barriers to sustainable development and the use of green building technologies. (parking requirements, road width, etc)
- Construction debris represents 40% or more of land filled material in many areas. Create a city/county/state-wide infrastructure for collecting, storing and handling all recyclable construction and demolition debris. Offer incentives or make construction waste recycling mandatory in city/county/state.