PDHonline Course C759 (3 PDH)

SCROB: Pennsylvania's First Green Building

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SCROB

Pennsylvania's First Green Building

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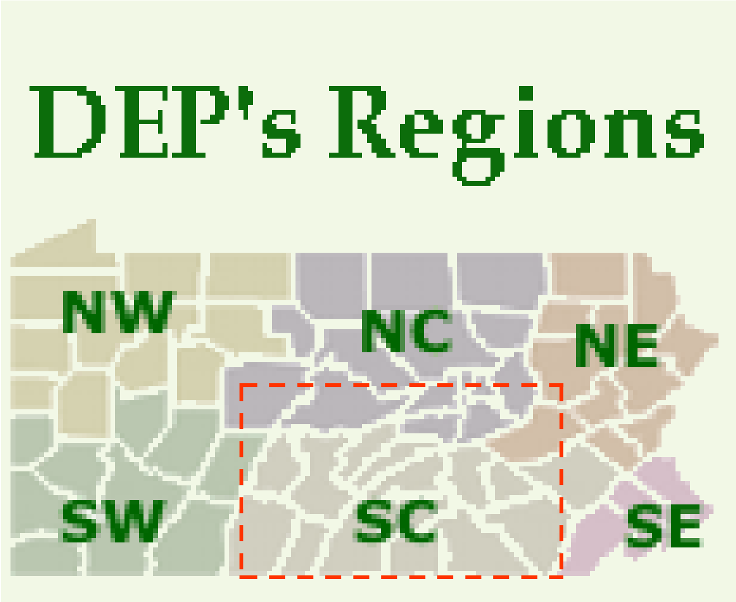
Part 1

Green Team

The Transformation

“The Commonwealth of Pennsylvania, spearheaded by the Governor’s Green Government Council and the Pennsylvania Department of Environmental Protection (DEP), is transforming the way the way its facilities are conceptualized, designed and constructed. Sustainable, high-performance design is integrated in guidelines, specifications, performance standards, lease documents and building operations…”

RE: excerpt from: “Pennsylvania as a National Model for Sustainable Building Practices” (presented in a report to the “Sustainable Building 2000” conference held October 22-25, 2000 at *Maastricht, The Netherlands*)



In October 1996, PA *Department of Environmental Protection* Secretary *James Seif*, in partnership with *The Heinz Endowments*, challenged his staff and *909 Partners*, the project landlord (a joint venture of *Tiger Development* and *Kimbob*) with designing and constructing a green technology model project to house the agency's *South Central Regional Office* (SCRO) and to set a standard for future Commonwealth facilities. Accordingly, a "Green Team" was formed to apply this concept by pursuing an integrated design process for the new facility. The team was comprised of twenty-four representatives from academia, industry and government. Its members consisted of the architectural designer, DEP staff, the developer, selected product manufacturers, design-build mechanical contractors, the PA *Energy Project* and specialized energy consultants including Carnegie Mellon University's *Center for Building Performance and Diagnostics*. Located in *Harrisburg*, the building was the prototype for "Building Green" in the *Commonwealth of Pennsylvania*. The PA DEP selected a 13.4-acre "Brownfield" on which to construct the new headquarters facility for its South-Central region (rather than a virgin "Greenfield"). As well, the project was a finalist for the 1998 *Civil Engineering Research Foundation* award (in the category of "Green Technology in a Model Office Building").

Systems Thinking

"…The initial pursuit of sustainable design recognized four primary objectives within an integrated process or 'systems thinking' approach that differs from the traditional 'linear' process of designing and building disciplines. The integrated process began with these four guiding principles:

- ***Utilization of appropriate high-performance technology to significantly reduce energy consumption and operational costs;***
- ***Maximize the use of sustainable materials throughout the project;***
- ***Minimize negative impacts on interior air quality, and;***
- ***Improve health, motivation and productivity of building users through the creation of an improved, highly flexible environment***

…DEP achieved the four primary objectives for the South Central Regional Office Building by perceiving them as inextricably interrelated issues and as part of the integrated design process that produced a synthesis of all building components…"

RE: excerpt from: "Pennsylvania as a National Model for Sustainable Building Practices" (October 2000)

"…The South Central Regional Office Building design process included site issues of Brownfield utilization, sustainability, improved energy efficiency, sustainable materials and resource conservation, enhanced indoor air quality and reduced water consumption. The outcomes of the design and process considerations resulted in a coordinated and planned application of various categories of technology for sustainable development…"

RE: excerpt from: "Pennsylvania as a National Model for Sustainable Building Practices" (October 2000)

SCROB was/is a privately owned, 73,101 square-foot, three-story office building leased by the *Commonwealth of Pennsylvania* for the PA DEP (the building was sold in 2013, but the DEP remained as tenant under a long-term lease). In many respects, the creation of this building – the first “green” building in the state – was/is remarkable. Perhaps most note-worthy is the extent to which the state government has gone to make this building a learning tool since its completion in the spring of 1998. The integrated planning and design process used in creating the building - a process that became the model for how the Commonwealth intended to do business henceforth (according to *Jim Toothaker*, *Director of Office Systems and Services* for the PA DEP). The twenty-four member “Green Team” participated in the design process. One of these Green Team members was energy expert *Stephen Lee* (AIA) of *Carnegie Mellon University*, whose day-lighting and energy modeling helped generate a design in which annual energy costs were dropped from $1.54 per square foot (for the base-case building) to $0.74 per square-foot, realizing a projected annual energy savings of $50K (as compared with a base-case building modeled on the standard state office building specifications, at the time).

The project's Green Team had four primary objectives:

- **to utilize appropriate high-performance technology for significantly reducing energy consumption and operational costs;**
- **to maximize the use of sustainable materials throughout the project;**
- **to minimize negative impacts on interior air quality, and;**
- **to improve health, motivation and productivity of building users through the creation of an improved, highly flexible environment**

Some green features of SCROB include:

- **thirteen-acre Brownfield site requiring remediation, methane recovery, leachate collection and methane barrier;**
- **energy-efficient building envelope, including argon-filled, low-e windows;**
- **raised access floors used for conditioned air distribution;**
- **highly reflective ceiling tiles, coupled with light shelves for daylight penetration and high-efficiency indirect lighting;**
- **gas-fired absorption chillers;**
- **removable carpet tiles;**
- **recycled-content workstation fabric and natural-fiber upholstery fabric;**
- **occupancy-sensing power strips and lighting controls;**
- **recycled-content entry floor tiles (from window glass) and wall panels (from straw and *Environ*);**
- **indigenous landscaping and "Xeriscaping" (planned by a committee of employees)**

The Site

<u>Left</u>: in 2015, the 20th anniversary of Pennsylvania's historic "Land Recycling Act" will be celebrated. The Commonwealth's voluntary cleanup program was established by legislation enacted in 1995. Commonly known as the "Land Recycling Program," it encourages the voluntary cleanup and reuse of contaminated commercial and/or industrial sites (a.k.a. "Brownfield") such as the SCROB site represented (in 1996).


The Story of a Flood, in Pictures - Pages 23, 25

Pottstown Mercury

Vol. 41, No. 228 — Pottstown, Pa. (19464) Friday Morning, June 23, 1972 — 40 Pages — 15¢ A COPY 75¢ A WEEK

Record Flood Devastates Area

'Dying' Hurricane Gives Sunday Punch

Industry in Pottstown Crippled By Schuylkill

Story Effort

Power Delay

'Disaster' Clause Insures Flood Loss

The Weather

FLIGHT FROM THE FLOOD—The waters of the Schuylkill still were rising rapidly Thursday afternoon when rescue workers got this South Pottstown family out of its home on South Hanover Street.

Union Pickets Walk 3½ Miles To Protest Court Injunction

By DOLLIE SMITH

Hurricane at a Glance

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The project's sustainability began with site selection. After serving as a rock quarry and shale mine, the property devolved into a landfill (for the refuse from *Hurricane Agnes* in 1972, above & left). As a result, the building was sited on the only available non-filled location and oriented to maximize solar design. Also, underground leachate collection and methane collection systems alleviated below-grade toxic substances from the landfill. The site is located near a surface bus line. In addition, bike racks, showering facilities and preferred parking for carpools encourage the two-hundred and sixty-two occupants to conserve fuel.

Comprising a lot size of 13.40 acres (and a building footprint of 29,200 square-feet), a significant portion of the site was left undisturbed. Habitat was restored with new wetlands and indigenous plants. The building used low-flow showerheads, faucets and urinals. The landscaping required no permanent irrigation system since it used hardy breeds of native plants and grasses. Overall, a 20% reduction in water use (based on the 1992 *Energy Policy Act*) was realized.

A Model Project

THE HEINZ ENDOWMENTS

HOWARD HEINZ ENDOWMENT • VIRA I. HEINZ ENDOWMENT

PennEnergy

LEED

LEADERSHIP IN ENERGY & ENVIRONMENTAL DESIGN

"At its March 30 Federal Government Summit, the U.S. Green Building Council presented the first twelve buildings to receive LEED™ certification. These buildings are certified under the standards of the pilot program - also known as LEED 1.0…"

Environmental Building News **(EBN), April 2000**

RE: from the outset, the PA DEP determined to make SCROB a "Green Technology Model Project." With support from *The Heinz Endowments*, *Alan Barak* (of the *Penn Energy Project*) assembled the "Green Team" to assist with the design of the building. The building would earn a "Bronze" rating under the U.S. Green Building Council's (USGBC) LEED (*Leadership in Energy & Environ-mental Design*) pilot (a.k.a. "Pioneer") program.

Energy

HVAC Absorption Chiller

Electric Chiller (Compression Chiller)

A gas-fired absorption chiller (with no compressors and no ozone-depleting refrigerants) was used for SCROB. Though natural gas HVAC absorption chillers (left) have been in service for some time, there has been a drastic decline in the use of this technology (sales dropped by up to 75% percent in the U.S. (from approximately 2006 to 2010) and are in decline worldwide. Most gas-fired chillers sold in the U.S. are being used to replace existing gas systems, not for new installations. In addition, gas-fired absorption chillers are no longer manufactured in the U.S. Gas-fired chillers were able to overcome their higher first-cost (as compared to electric chillers, at right) because gas-fired systems produce lower electrical demands. However, the steady increase in efficiency of electric chillers has narrowed the operating cost differential with gas chillers. Even with the decline in gas prices since the peak (in 2008), gas-fired chillers have not seen a resurgence in sales. Most probably, new gas-fired chiller installations will be relegated to niche applications, such as where alternative energy sources are available (i.e. landfill gas). Another niche market is where waste heat is available, such as from an industrial process, that could be used with a hybrid direct/indirect-fired absorption chiller to offset the cost of natural gas.

Comparison of Absorption Chillers vs. Electric (Compression) Chillers:

• absorption chillers have a COP (Coefficient of Performance) of only 0.54–1.1 which competes poorly with electric chillers (rotary compressor chillers). On the other hand, electric chillers have a COP from 1.0 ~ 8.0;

• absorption HVAC chillers occupy approximately 50% more floor area than the equivalent electric chillers (vapor compression chillers). Additionally, due to height of absorption chillers, mechanical equipment rooms must be six to ten-feet higher than rooms housing electric chillers. As well, because the liquid solution is contained in long, shallow trays within an absorption chiller, the floor must be as close to absolutely level as possible;

• for an HVAC system, an absorption chiller will weigh at least twice as much as an equivalent electric chiller;

• due to their greater size, absorption chillers are sometimes shipped in several sections, requiring field welding for final assembly. This is not the case with comparable electric chillers;

• most electric water chillers are shipped from the factory with their refrigerant charge installed. For absorption chillers, the refrigerant and absorbent (including additives) must be field installed;

• absorption chillers (unless direct-fired) are quiet and essentially vibration-free (as compared to electric chillers). Noise and vibrations in an HVAC system are considered more disturbing than anything else;

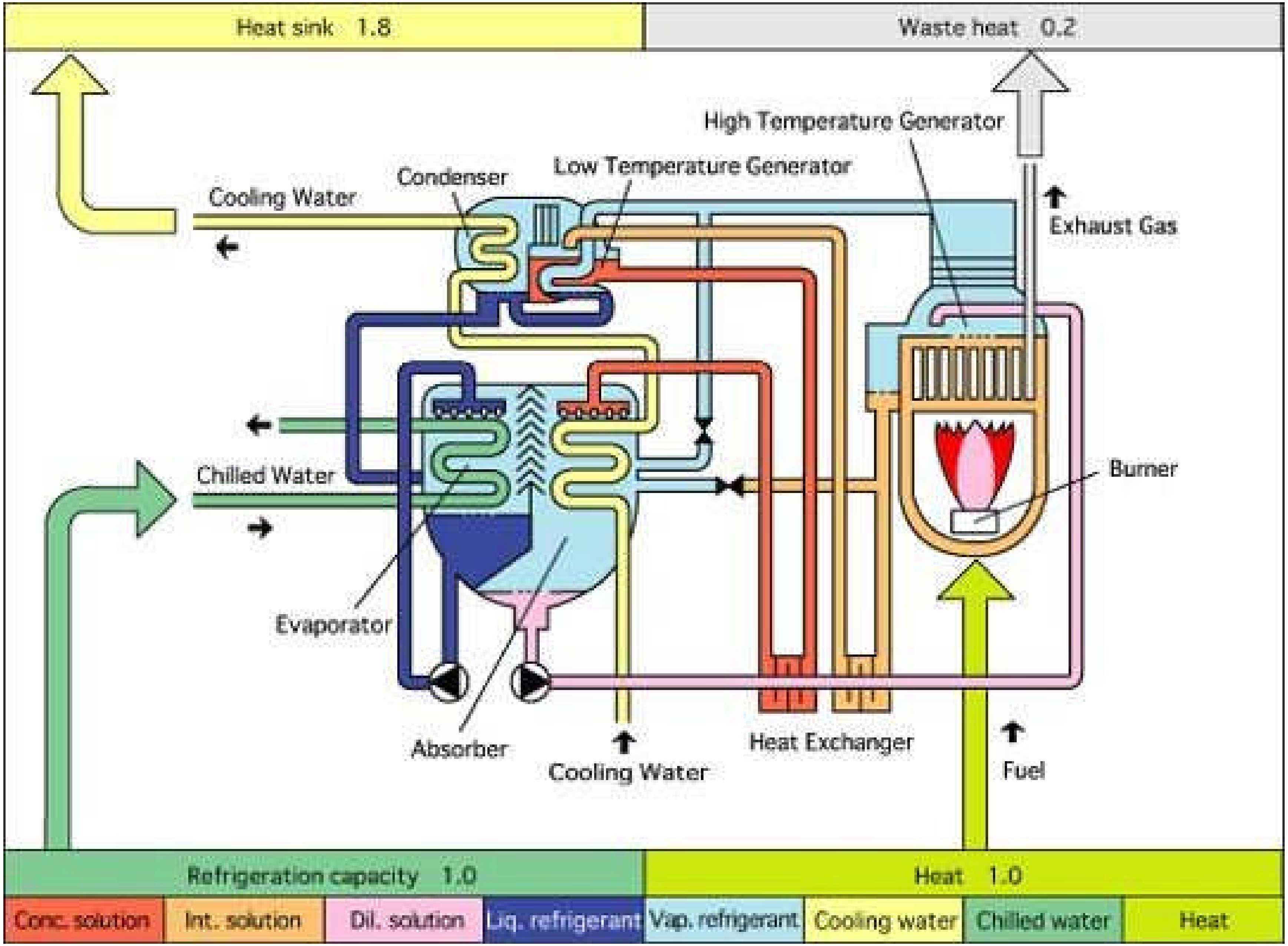
• due to the potential for crystallization of the lithium bromide in the chiller (if it becomes too cool), the condenser water temperature must be kept above 75-degrees (F). There is no problem of crystallization in electric chillers;

• absorption chillers sometimes require an emergency power source if lengthy power outages are expected. Without power and heat input, the chiller begins to cool and the lithium bromide solution may crystallize. However, as absorption chillers consume very little electric energy, a small, dedicated back-up generator is suitable;

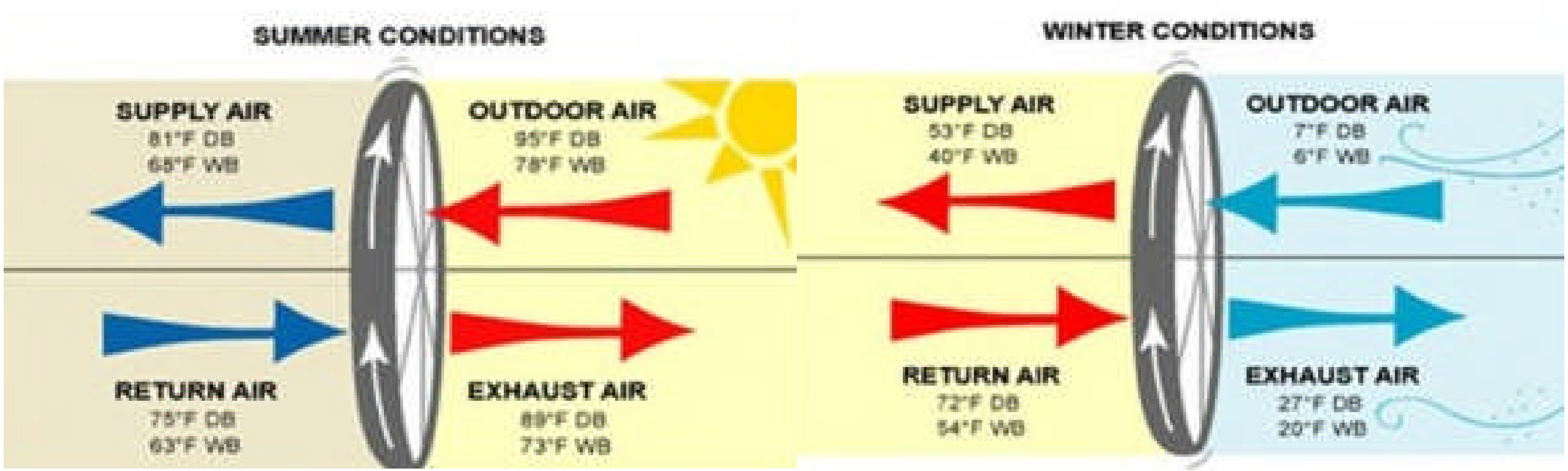
• in an HVAC system, the amount of heat to be rejected in the condenser (by water cooling or air-cooling media) is important. The heat rejection rate from the condenser of a lithium bromide chiller is 20–50% greater than for the equivalent electric chiller, requiring higher condenser water flow rates and larger cooling towers and condenser water pumps;

• direct-fired absorption chillers cost nearly twice as much as electric chillers and have the added costs associated with providing combustion air and venting (stack), and;

• absorption water chiller or lithium bromide chiller uses natural refrigerants such as water, eliminating the need of CFC and/or HCFC refrigerants which have negative environmental impacts



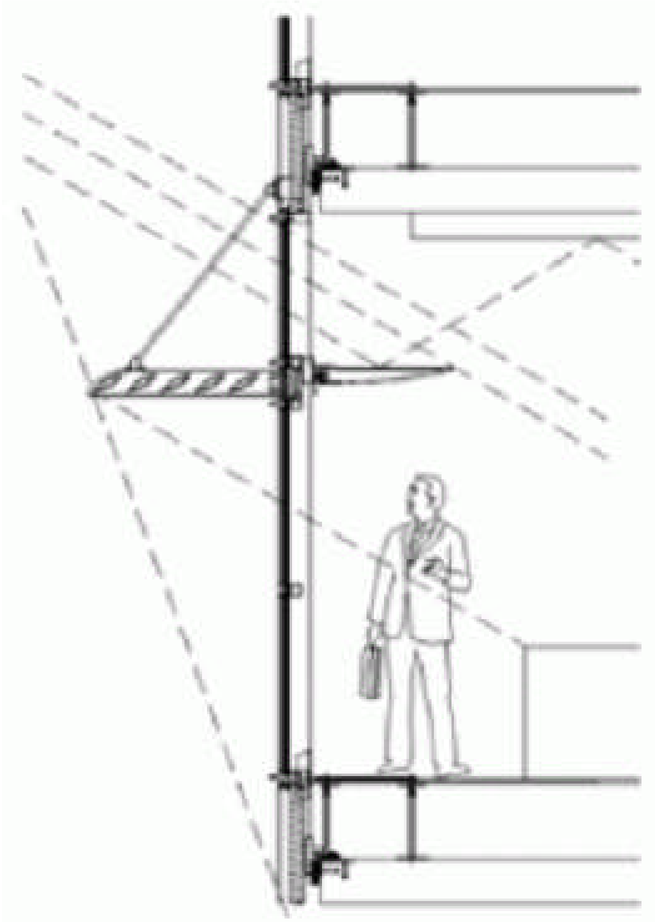
Above: direct (gas)-fired absorption chiller flow diagram



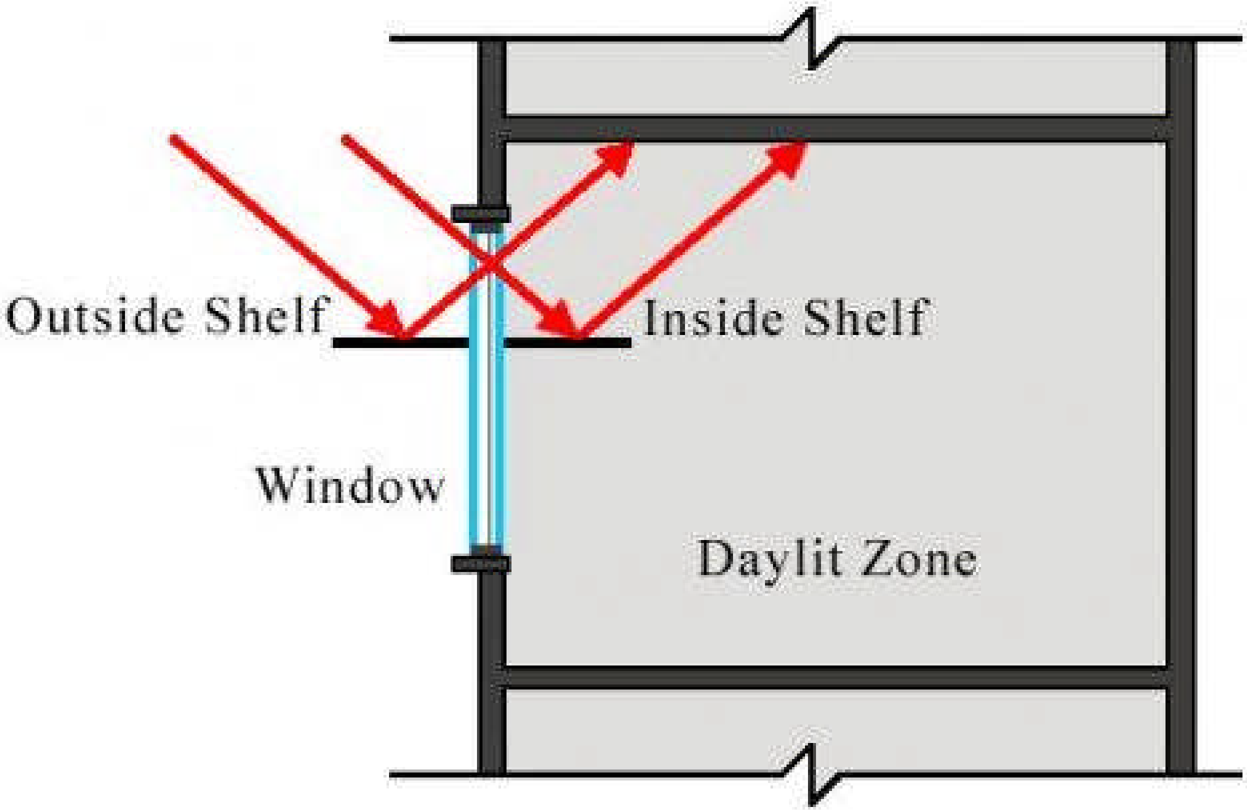
Desiccant (moisture absorbing) wheels were installed at the air handlers for dehumidification and/or humidification recovery, eliminating the need for energy-inefficient humidification control systems as well as displacing twenty-five tons of latent cooling load. Commercial buildings require substantial amounts of outside air to be brought in through their ventilation systems. Exhausting expensive conditioned indoor air and replacing it with outdoor air is both expensive and inefficient. Energy recovery devises, like the "Enthalpy Wheel" (above) can be incorporated to transfer outgoing temperature and humidity (energy) to the incoming outdoor air. Most energy recovery devices transfer heat (sensible) energy only. An Enthalpy Wheel allows both heat (sensible) energy and moisture (latent) energy to be exchanged. The Enthalpy Wheels are usually made of porous materials to increase surface area which aids in energy transfer. In most cases, a matrix core material is coated with a desiccant such as Silica Gel or other molecular sieves to increase latent transfer. The Enthalpy Wheel, coated with a desiccant material, is rotated between the incoming fresh air and the exhaust air. Heat and moisture are given up to the wheel. When the space is in the heating mode, the heat and desirable humidity is used to pre-condition the incoming, cold, dry air. In the cooling mode, the incoming air is pre-cooled and dehumidified. Because the cost to remove moisture can represent 30 to 50% of the cost to condition air, substantial additional savings are available with enthalpy wheels over conventional air-to-air exchangers.

<u>Above</u>: caption: "Typical of energy exchanged through an enthalpy wheel"

Lighting



T-8 fluorescent lamps with electronic ballasts and motion sensors in conference rooms, toilet rooms and all workstations helped reduce electrical power consumption. Careful attention to the building's solar orientation helped reduced heat gain and augmented natural illumination of interior spaces. This was further enhanced by a combination of solar shades and south facing "light shelves" (left) which shade summer sun and bounce natural light across the ceiling plane much deeper into open office spaces. High-reflectance (90%) ceiling tiles (10% more reflective than conventional ceiling tiles) enhanced indirect illumination and natural day-lighting from the light shelves, while providing improved acoustical qualities through greater sound absorption and attenuation properties.


Outside Shelf
Inside Shelf
Window
Daylit Zone

Above: interior view of light shelves and highly reflective acoustic ceiling tiles

Left: orientation of the building reduces heat gain and augments day-lighting. The light shelves provide shade from the hot summer sun and, simultaneously, bounce natural light through the top of the window, across the highly reflective ceiling plane and deep into office spaces.

Annual Purchased Energy Use

Fuel	Quantity	Cost ($)	MMBtu	kBtu/ft2	$/ft2
Electricity	631,000 kWh		2,150	29.5	
Natural Gas	3,470,000 MJ		3,290	45.1	

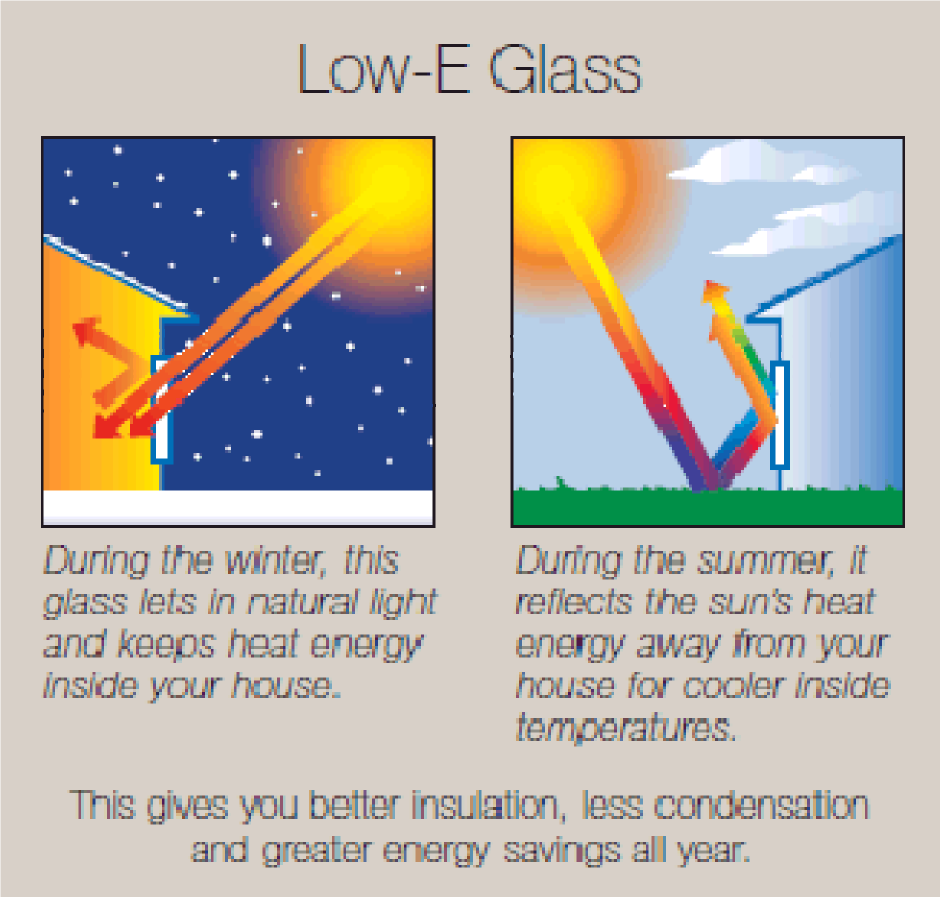
Total Annual Building Energy Consumption

Fuel	Cost	MMBtu	kBtu/ft2	$/ft2
Total Purchased		5,440	74.5	
Grand Total		**5,440**	**74.5**	

Annual End-Use Breakdown

End Use	Quantity	MMBtu	kBtu/ft2
Heating	1,220,000 MJ	1,160	15.9
Cooling	624,000 kWh	2,130	29.2
Lighting	237,000 kWh	809	11.1
Fans/Pumps	144,000 kWh	490	6.71
Plug Loads and Equipment	249,000 kWh	850	11.6
Vertical Transport			
Domestic Hot Water			
Other			

The split task/ambient lighting scheme in combination with natural day-lighting reduced the electrical lighting load by over 50%, to a target of 0.85 W/ft2.



Argon-filled, low-emissivity glass was utilized at all exterior windows to augment insulating capacity. By filling the space between the glass panes with gas (such as krypton or argon), the natural convection currents generated within the space are minimized. Thus, the overall transfer of heat between the interior and exterior is significantly reduced. The union of gas and glass combine to block harmful ultraviolet sunlight and heat transfer; major causes of high-energy costs, faded flooring and condensation buildup.

Materials

The Green Team focused on maximizing the use of high-performance sustainable building materials for SCROB. Selection criteria was based on recycled content and/or the recyclability of the material itself. In the case of virgin materials, the product's renewability (as a recoverable resource) was considered. However, global concerns were also considered in terms of limiting the environmental impact of the materials' production process and/or transportation requirements (38% of all material/s were manufactured within five-hundred miles of the site). Many green materials were integrated into the building's lobby design (left). As a result, the building itself became a living example of high-performance, green building technology. Fully 25% of all materials used in the project contain a significant amount of recycled content. SCROB has a centralized storage area (in the basement) for recyclable materials based on type.

Left: recycled-content tile flooring in the main entry hall

Several innovative green building products used in the SCROB project included:

- **modular system partitions made from 100% post-consumer recycled PET soda bottles;**
- **recycled-content and recyclable chair fabric;**
- **recycled structural steel;**
- **Mechanically fastened, single-ply TPO white roofing membrane (minimizing solvent-based adhesives and solar heat gain);**
- **solvent-free, water-based, non-VOC-emitting paint;**
- **window blinds that offer both solar protection and/or natural light;**
- **acrylic concrete sealer;**
- **recycled asphalt, and;**
- **mulch made from 100% recycled construction material**

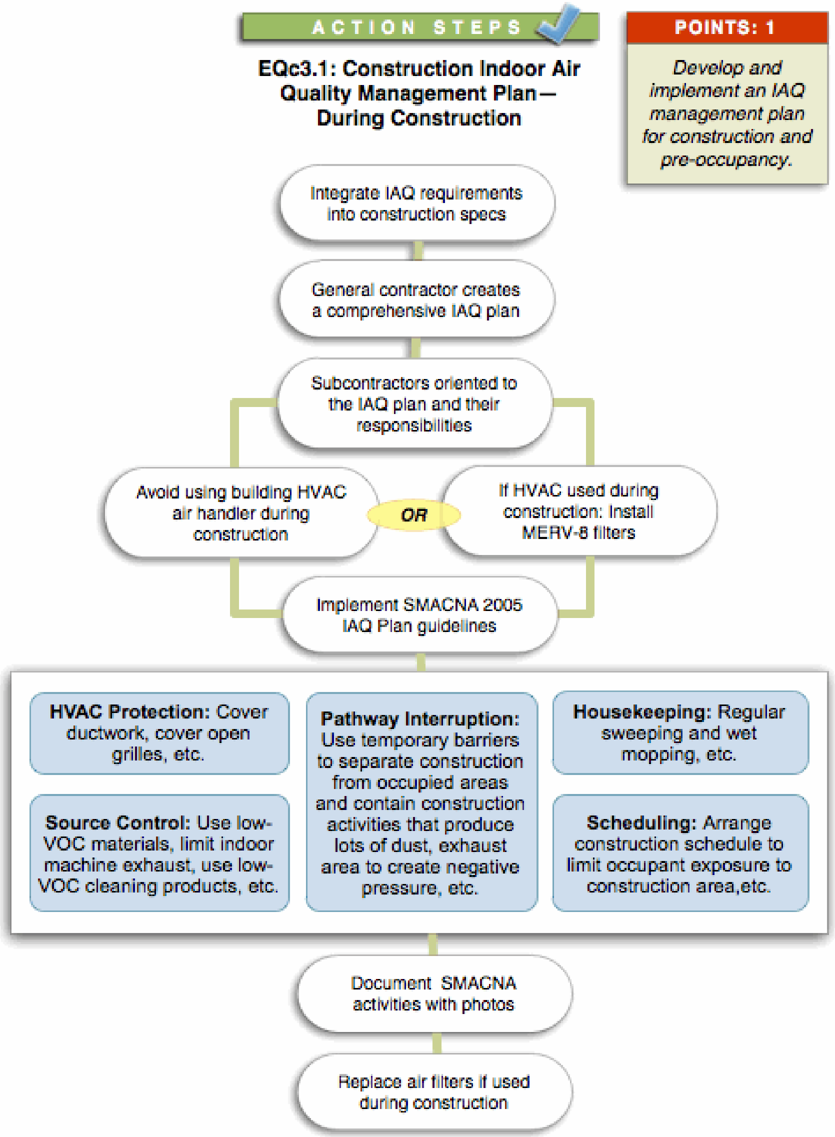
Construction materials and furniture components emphasized sustainable sources such as wheat straw, soybean, cork, wood, recycled glass and steel. The carpeting is 100% recyclable and manufactured with anti-microbials that destroy *V<u>olatile</u>* *Organic* *Compounds* (VOCs)

IEQ

SCROB's Green Team scrutinized the *Indoor Environmental Quality* (IEQ) of the project carefully. According to extensive studies, improvements in lighting, thermal comfort, acoustics and *Indoor Air Quality* (IAQ) can provide measurable increases in employee satisfaction and productivity. In fact, just a 2% increase in worker productivity will amortize the additional costs of green building technology within the first year of occupancy. As such, the Green Team focused on integrating IEQ issues, such as:

- **higher ceilings;**
- **quality glare-free lighting;**
- **individual temperature control;**
- **maximization of natural illumination;**
- **minimization of VOCs, and;**
- **high level of flexibility (i.e. office space reconfiguration)**

All of these played a key role in project decision making. To ensure high levels of IAQ, a housekeeping and maintenance plan was adopted to utilize non-toxic chemicals and/or cleaning solutions. Also, a construction IAQ management plan was implemented. Low-VOC paints, coatings, sealants and adhesives were specified and an air monitoring system constantly measures CO_2, temperature and humidity level/s within the building.



"Managing indoor air quality (IAQ) systematically during construction is becoming more and more common as contractors gain more experience with LEED. It benefits the health of everyone who works on the site, not just the eventual occupants of the building. Earning this credit can be fairly easy, but it does require careful coordination and buy-in from all the subcontractors and field personnel involved in the project. It's important to remember that IAQ management is not a one-time compliance event that can be checked off a list - it must be an ongoing effort for the duration of the construction process. The contractor should create the IAQ management plan before construction even begins, and check on compliance at various times throughout the process - including collecting photos for credit documentation."

USGBC LEED Program

Left: flow diagram for achieving IAQ credit under LEED NC-v.2.2 EQc3.1 (Construction IAQ Management Plan – During Construction)

The SCROB project's high IEQ is demonstrated by the performance of the floor diffusers, which provide 100% stack ventilation efficiency; a significant factor in reducing the potential for *Sick Building Syndrome* (SBS) due to airborne contaminants. As well, the raised-floor air plenum reduced ceiling cavity depth by eliminating duct/piping conflicts with structural components, thereby allowing for a more comfortable nine-feet of clearance to the underside of the suspended acoustical ceiling (typical throughout the office spaces).

<u>Left T&B</u>: mock-up of an access floor with under-floor air plenum. Raised access floors also reduce the cost of reconfiguring office space (a.k.a. "Churn") by up to 90% (in the U.S., about 30% of office space is reconfigured annually. The photograph/s demonstrate a section of the access floor, complete with electrical outlets and ventilation.

"…The incorporation of integrated design, inclusion of academic resources (The Center for Building Performance and Diagnostics in the School of Architecture at Carnegie Mellon University) and teaming with manufacturers, contractors, material suppliers and building owners and occupants resulted in innovative and groundbreaking creative concepts in state government functions. The South Central Regional Office Building was occupied in May 1998. The actual hard construction costs, excluding site costs, totaled just over $78 per square foot. The energy costs are expected to exceed ASHRAE 90.1-1989 by 20%. Also, the building is one of the first twelve ever to earn the United States Green Building Council's LEED certification for sustainable design and construction…"

RE: excerpt from: "Pennsylvania as a National Model for Sustainable Building Practices" (October 2000)

Part 2

Lessons Learned

Educational Value

"…The commonwealth's first green building introduced integrated sustainable design and high-performance technology to Commonwealth projects. There were successes and also lessons learned. In future design and construction projects Green Team consultants will be more closely involved in the decision-making process and systems detail associated with the construction of a high-performance building. Additional active involvement will assure that chillers are optionally sized, and HVAC systems will avoid operation and maintenance problems adversely impacting the building population. Criteria associated with the thermal envelope, indoor air quality and building performance will be emphasized. Permanent energy and air quality monitoring systems have been installed to analyze the interactions between comfort, air quality, energy use and HVAC operations. One of the greatest benefits to come from South Central Regional Office Building is its educational value…"

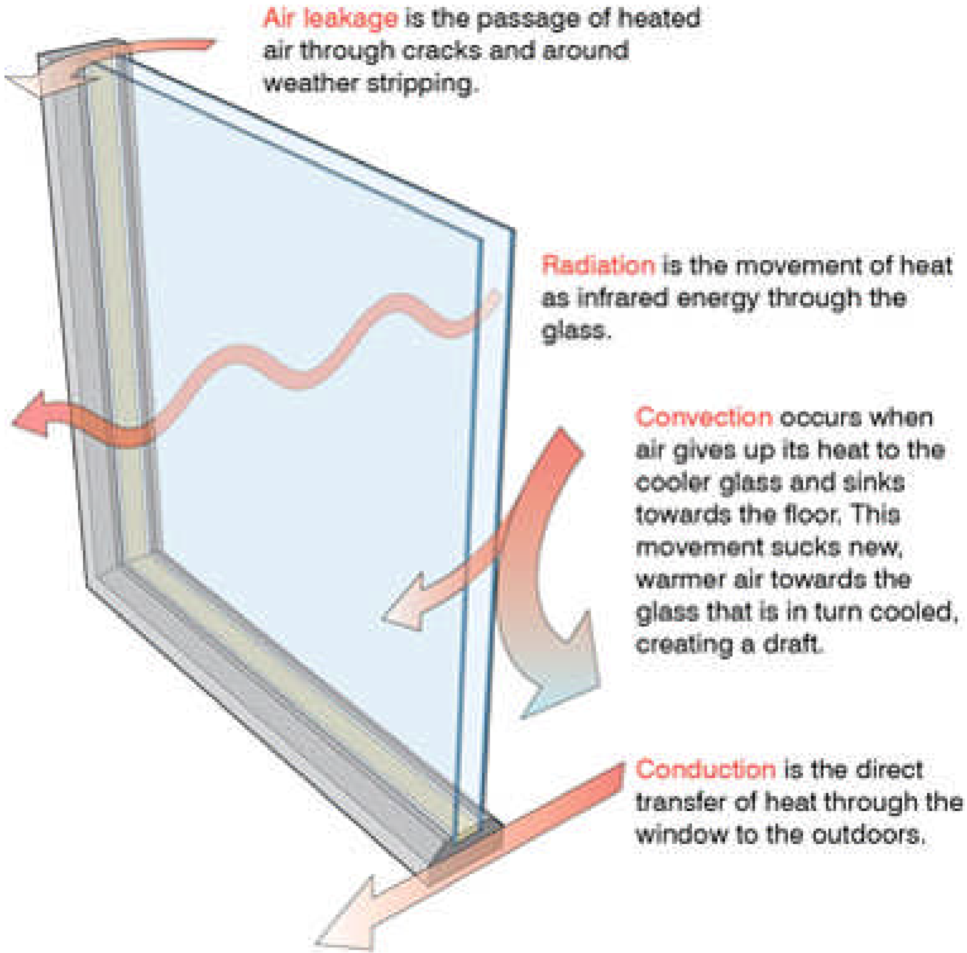
RE: excerpt from: "Pennsylvania as a National Model for Sustainable Building Practices" (October 2000)

Actual performance of SCROB (after it was occupied in May 1998) did, however, not live up to expectations. The engineer was concerned about sizing the chiller too tightly to the projected load and, since absorption chillers are only available in limited sizes, ended up specifying one twice as large as was necessary. This caused inefficiencies in operation (absorption chillers are particularly sensitive to performance losses from frequent on-off cycling) and freezing of the salts. Only cavity-fill insulation was used in the steel-framed exterior walls, resulting in thermal bridging and lower performance and the light-shelves were not modeled properly, which led to glare problems from direct sunlight reaching workstations. The required retrofit resulted in a less-than-optimal solution to the problem. While many of these shortcomings were addressed by building management, they were indicative of a sub-optimal process in which the Green Team provided direction to the design-build firm but was not involved closely enough during implementation of those ideas. For its next building, the PA DEP persisted in recommending a sustainable design approach and SCROB architect *John Boecker* and energy consultant *Marcus Sheffer* got another opportunity to “get it right.”

Getting it Right

For the design of the 36K square-foot *Cambria Office Building* in *Ebensburgh, Pennsylvania*, the entire team worked together much more closely than they did for SCROB. However, even with everyone in the same room old habits die-hard and there was a tendency for discussions to become fragmented. According to architect *John Boecker*, this fragmentation was evident during one particular meeting concerning locating mechanical systems (which consist of ground-source heat pumps and under-floor air distribution). One group was struggling with locating duct runs to/from the proposed penthouse air-handling systems, while others were working on other issues with the system. Both Boecker and energy consultant *Marcus Sheffer* realized that the process had broken down, so they asked the mechanical engineer directly where the optimal location for the air handlers should be. Momentarily shocked at being asked such a question by the architect, mechanical engineer *John Manning* proposed that they be on the first floor, with one in each wing. The Green Team then studied this idea long enough to overcome the conventional wisdom that first-floor space is too valuable for air handlers, discovering that they could enlarge the floor plate slightly to acc-ommodate them with a net savings of $40K in construction costs. This solution not only greatly increased air distribution efficiency but also improved the day-lighting design, which had been hampered by the penthouse.

<u>Above</u>: air handling units like the one in this photograph provide ventilation make-up air separate from conditioned air, allowing air conditioning equipment to be shut off when not needed. Ground-source heat pumps are linked to a closed-loop, ground-source heat pump well field that provides HVAC heating and cooling supply as well as domestic hot water heating. Raised-access flooring provides an under-floor supply air plenum for displacement heating and cooling air distribution through floor-mounted air diffusers (similar to SCROB).



When the architect first proposed an upgrade to triple-glazed, double "Low-E" windows (manufactured by *Visionwall*), the developer balked at the $15K cost increase. However, he was won over when it was demonstrated that this upgrade allowed elimination of the perimeter heating zone for a savings of $15K, downsizing of the heat pumps for another $10K savings and a $5K gain in leasable space due to the smaller equipment and ducts.

<u>Left</u>: fenestration dynamics

"…This high-performance building is designed with a 14 KW photovoltaic array (the second largest in Pennsylvania), under floor supply air plenum distribution and coupled with a ground-source heat pump supply (this may be the first project nationwide to integrate these systems). PowerDOE modeling indicates annual energy consumption will be under 25,000 BTU/sq. ft., or 45% better than ASHRAE standard 90.1. Ebensburg is highly energy efficient with lighting power density of 0.7 watts per sq. ft. per ton…"

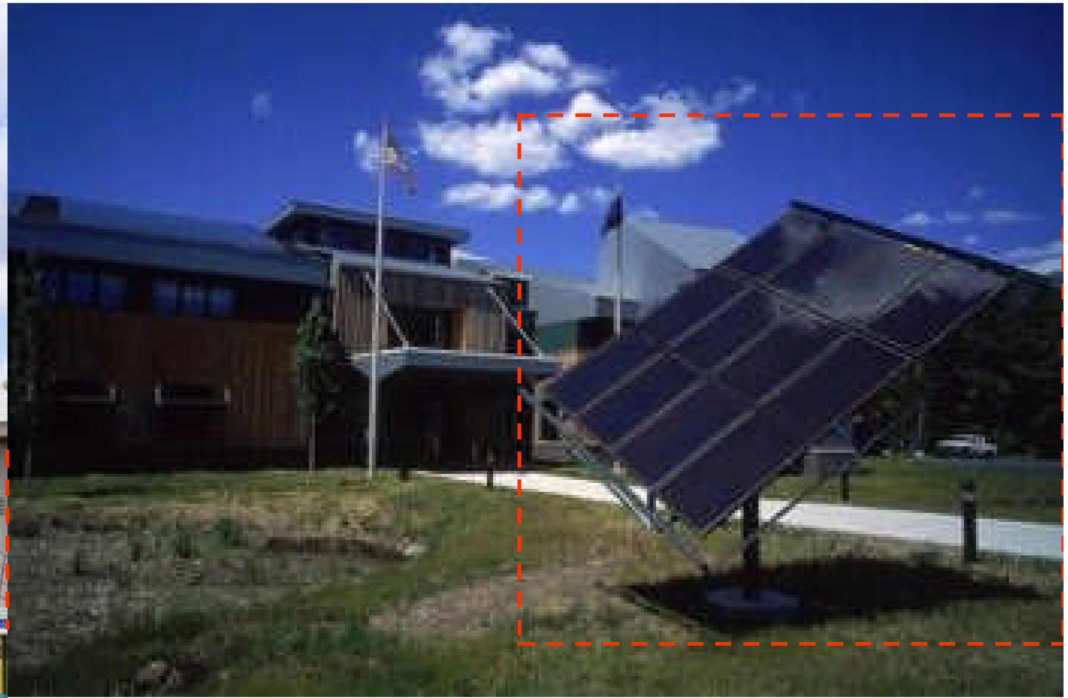
RE: excerpt from: "Pennsylvania as a National Model for Sustainable Building Practices" (October 2000)

With an improved lighting design and day-lighting, the connected lighting load at DEP-Cambria is 0.65 W/SF.

<u>Top Left</u>: south-facing light shelves attached to the windows allow more indirect daylight in and reduce the need for artificial lighting

<u>Top Right</u>: photograph shows how the fourth-generation design of light shelves on south-facing windows increases indirect lighting levels

<u>Left</u>: the north-facing clerestory floods the interior with natural daylight



<u>Above & Left</u>: 14.3 kW PV solar panels on the roof and a pair of 1 kW thin-film PV trackers (highlighted) flanking the entrance walkway. Second-floor south-facing windows are shaded via integral roof overhangs. Combined, they offset the energy use of the building.


Cambria's site selection, building placement, and parking layouts were integrated with existing site conditions in order to eliminate negative impacts on existing wetlands and to minimize the removal of existing trees. The parking areas utilize grass planting pervious parking surfacing in order to minimize storm-water runoff (impervious paving was limited to circulation aisles). Exterior lighting design reduces light pollution. Required clearing of existing vegetation was limited to a maximum of 25-feet from the building perimeter. The building is oriented along an east-west axis in order to maximize south and north solar exposure/s. High-albedo roofing materials and strategic planting of deciduous trees help reduce "heat island" effects. A significant portion of the site was left undisturbed. Indigenous plantings and other measures resulted in no net increase in the rate of storm-water leaving the site.

<u>Left T&B</u>: rooftop PV panels

<u>Top Left</u>: this skylight table in *Cambria* receives abundant daylight from above and passes some to the first floor lobby through its glass top
<u>Top Right</u>: exposed roof trusses add visual interest in Cambria's second floor office area, where daylight is provided by clerestory windows
<u>Left</u>: photograph shows site-specific reverse-baffle solar shading devices that were designed to shade south-facing windows from summer sun while allowing winter solar radiation to penetrate interior spaces. Second-floor south-facing windows are shaded via integral roof overhangs.

“Almost everything we did at Cambria is at a higher level.”

***John Boecker*, Architect**

RE: since it was occupied in September 2000, DEP-Cambria began using energy at the very low rate of 62,300 kWh per year, or less than $0.18/ft2 – exclusive of any contribution from the PV system (trackers and roof panels). This performance is about 90% better than a typical base-case. The 14.3kW-PV system offsets by about 30% the annual electrical energy cost of the building. The facility’s electricity supplier; *Green Mountain Energy* (GME), buys all of the output from the PV system (at a premium rate since solar power is a small but critical part of its green electricity mix) thus technically, none is used by the facility itself. The DEP, in turn, buys its electricity from GME, which includes PV-generated power from this and other facilities in its mix of suppliers. Even though, contractually, the PV system’s output is delivered to GME and other power is purchased, DEP does not pay distribution fees on this power (in Pennsylvania’s deregulated market, users pay for distribution separately from supply). Taken together, the revenue from electricity sales and the avoided distribution charges add up to +$8K per year (at initial occupancy in the fall of 2000). Ultimately, energy consumption of only 22.340 BTU/SF per year was achieved, equating to 66% energy savings (or $25K annually).

	Typical[1]	SCROB modeled	Cambria modeled	Cambria actual[2]
TOTAL ENERGY (site)				
Btu/ft^2	87,400	83,700	23,500	6,162
MJ/m^2	993	951	274	70
ELECTRICITY				
kWh/ft^2	14.20	14.88	6.05	1.80
kWh/m^2	152.69	160.00	65.00	19.35
NATURAL GAS				
Btu/ft^2	35,000	33,088	1,232	0
MJ/m^2	398	376	14	0
COST				
\$/ft^2	\$1.71	\$1.18	\$0.54	\$0.18
\$/m^2	\$18.39	\$12.69	\$5.81	\$1.94

1. Based on Energy Information Administration data for Commercial Office Buildings in the Northeastern U.S.
2. Annual projections based on utility bills for the first five months of operation (November 2000 through March 2001)—low data reliability! Occupancy at about 50% of design level (65 people vs. 130).

The impact and source of building materials used for the project were given special consideration:

- **74% of building materials contain high-recycled content;**
- **25% were manufactured locally (i.e. locally harvested hemlock wood siding was selected)**
- **insulated concrete forms eliminated thermal bridging in the exterior walls (a serious problem at SCROB), and;**
- **material selection criteria resulted in specifying +30% of building materials be manufactured within three-hundred miles of the project site (*Ebensburg, PA*)**

Cambria's construction cost came in at $88/SF (with an additional $10/SF for site-work). The project demonstrated the value and power of material modeling software (used for materials life-cycle cost analysis comparisons – a.k.a. "LCA"). The Building would become the first LEED-NC v2.0 Gold project certified in the *United States* (the original goal of the project was a Silver LEED-NC rating). As well, in 2000 the *American Institute of Architects* (AIA) selected the Ebensburg/Cambria project as one of their "Earth Day Top Ten" (examples of viable architectural design solutions that protect and enhance the environment). It was selected as one of five U.S. buildings to participate in the "2000 Green Building Challenge" (in *Maastricht, The Netherlands*) and one of the U.S. Department of Energy's (USDOE) "Buildings for the 21st Century."

<u>Above</u>: the extremely economical "push-rod" automatic faucet controls (highlighted) reduced water consumption by over 40% and minimized piping redundancies by mixing hot and cold water into single pipe supply lines. Thus, a single automatic mixing valve (for a gang of lavatories) allowed just a single supply line to each, saving on installation and maintenance expense. Water conservation measures for the one-hundred and twenty-five building occupants also included the use of water-less urinals.

Some green products used at *Cambria* included:

- **permanent concrete forms (recycled-content, formaldehyde-free cellulose insulation was utilized where EPS concrete forms were not used);**
- **recycled-content structural high-density fiberboard panels;**
- **recycled-rubber flooring;**
- **zero-VOC interior paints;**
- **wheat-board and another bio-fiber hardboard were used for wainscoting;**
- **recycled structural steel;**
- **recycled steel roofing shingles;**
- **high-density fiberboard roof decking (made from waste paper);**
- **fly-ash concrete access flooring panels (integrated with high-density, solution-dyed, recyclable nylon carpet tiles);**
- **systems furniture partitions fabric was made from 100% post-consumer recycled plastic (also 100% recyclable);**
- **flooring tiles were comprised of 100% recycled rubber;**
- **engineered, acrylic-impregnated hardwood flooring only 3/8 in. thick. (consisting of maple harvested from certified (FSC) sustainable forests);**
- **toilet partitions and exterior light shelves were made from 50% recycled polypropylene plastic;**
- **the acrylic concrete sealer used is one of only a few available products that is non-petrochemical based. Utilizing this product eliminates off-gassing in the under-floor supply air plenum;**
- **TJI floor-joists and exposed open-web roof trusses were fabricated utilizing waste wood products, low energy consumption, minimal waste production and recycled steel pipe webbing, and;**
- **high-reflectivity (90%) ceiling tiles (consisting of 75% post-consumer recycled material)**

Preferred carpool parking, a bicycle rack and shower facilities for employees encourage alternative transportation programs and physical fitness activities while a natural-gas fueling facility services alternative-fuel maintenance vehicles. The building is also located near a bus line. A centralized storage area for materials separation and recycling was provided and the design of building and materials systems utilized modular dimensioning in order to minimize construction waste. A *Construction Waste Management Plan* monitored recycling of cardboard, metals, concrete, wood, masonry, plastic, glass, gypsum board, insulation, beverage containers, carpet and other materials during construction.

Future Vision

“Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs. ‘Building Green in Pennsylvania’ has evolved as the tactical means to incorporate high-performance green and sustainable development in our built environment as we pursue our objective of environmentally neutral impact buildings.”

Governor’s Green Government Council **(GGGC), Fall 2000**

Pennsylvania Department of Environmental Protection