Description

The benefits of vegetation can be extended to surfaces above ground. By shading a building's roof, a green roof will reduce radiant heat transfer into a building by replacing highly-absorbent roofing materials
(e.g. asphalt/ bitumen) with a layer of vegetation. (Typical summer air temperatures can increase the surface temperature of a gravel roof to 140-175 degrees F).

The temperature of an equivalent green roof will be 10 to 20 degrees F cooler, resulting in significant energy cost savings. By reducing annual temperature swings, degradation of the roof structure is slowed in comparison to a conventional roof. Maintenance and replacement costs are also reduced.

Analysis

Heat absorbed by the vegetation is used in the process of photosynthesis, reducing maximum summer air temperatures within the microclimate of the building. In addition the vegetation filters air moving across the surface of the roof. 10 sq.ft. of grass roof can remove approximately 0.4 lb of airborne particulates from the air every year.

Use of native plants on the green roof could reduce the use of irrigation required and also reflect seasonal changes.

Strategy

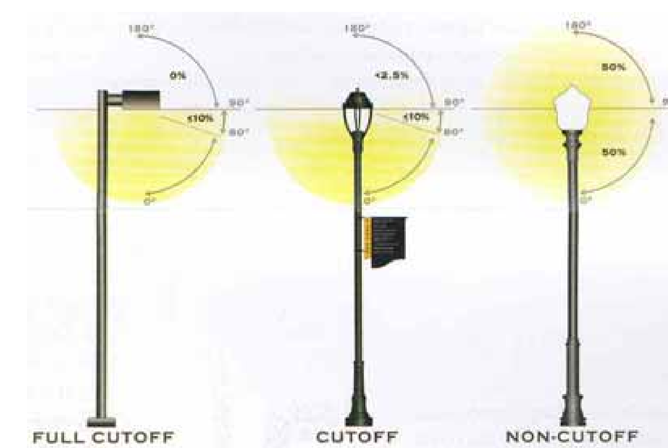
Green Roof

Light Pollution Reduction

Effective and efficient site lighting improves aesthetics, reduces energy use and maintenance, reduces light pollution to adjacent sites, and preserves the night sky.

Provide site lighting appropriate for the security needs of the site while maintaining an overall "low-lighting profile" for the complex. Use high efficiency lighting (metal halide or high pressure sodium lamps) with low cut off angles and down lighting for landscaping. Utilize reflective-type lighting fixtures to reduce or eliminate glare and provide safer, more human-scaled nightscapes. To reduce dependence on high-wattage electrical lighting at night, use light colored or reflective edges along driveways or walkways.

Shielded Fixtures



Design Strategies – Site Design & Planning

Exhibit S-01

Description	Analysis	Strategy
Water Use Reduction		
Reduce the use of potable water that is suitable for drinking and is supplied from the municipal systems.	Use only captured rain water or recycled site water to eliminate all potable water use for site irrigation. Maximize water efficiency within buildings to reduce the burden on municipal water supply and wastewater systems. Effective methods to reduce potable water use include reusing roof runoff for non-potable applications, installing sensors and flow restrictors on water fixtures, and installing dry fixtures such as waterless urinals.	**Potable Systems** 
Reduce the use of potable water that is supplied from the municipal systems. Install high-efficiency fixtures such as low-flow toilets and automated fixtures to minimize the demand for potable water. Specify water-conserving plumbing fixtures that exceed the fixture requirements stated in the Energy Policy Act of 1992.	Water efficiency measures in commercial buildings can easily reduce water usage by 25% or more. In a typical 100,000-square-foot building, low-flow fixtures coupled with sensors and automatic controls can save one million gallons of water per year or more. Consider ultra high efficiency fixtures and control technologies, including toilets, faucets, showers, dishwashers, and cooling towers. A variety of low-flow plumbing fixtures and appliances are currently available in the marketplace and could also be used to educate users about system operation and purposes. Restroom signage is a good way to educate students, signs could include instructions and brief descriptions of how the system functions.	**High Efficiency/ Low Flow Fixtures** 
Motion sensors help to modulate the flow of water and reduce waste.	Installation of motion sensors in fixtures aids in determining a set percentage of water flow per use. This avoids the waste of potable water.	**Motion Sensors** 

Design Strategies – Water Efficiency

Exhibit S-02

Description	Analysis	Strategy
Reduce generation of wastewater and potable water demand.	Use high-efficiency fixtures such as waterless urinals to reduce wastewater volumes.	Waterless Urinals 

Waste Water Systems

Gray water is wastewater from wash basins, showers, bathtubs, washing machines and sinks that is not used for disposal of hazardous or toxic ingredients or wastes from food preparation.	Check with the local health department for regulations governing the use of a gray water system and the permits required. Gray water can be used for the flushing of toilets, landscape irrigation and other functions that do not require potable water. If it is likely that a graywater source will be used in the future, install dual plumbing lines during the initial construction to avoid the substantial costs and difficulty associated with adding them later.	Use Of Gray Water 
Water reuse involves taking domestic wastewater, giving it a high degree of treatment, and using the resulting high-quality reclaimed water for a new, beneficial purpose. The resulting water is called reclaimed water. Extensive treatment and disinfection ensure that public health and environmental quality are protected. Reclaimed water is water that has been treated (typically by a local municipal or state agency) and released for non-potable uses (irrigation, sewage conveyance, etc.) Reclaimed water also reduces discharges to surface waters, recharges ground water, and postpones costly investment for development of new water sources and supplies. Water reuse has allowed some communities to continue to grow where the availability of historically used freshwater sources has become extremely limited.	Las Positas currently uses locally available reclaimed water and intends to explore the possibilities of using reclaimed water for sewage conveyance within buildings. Reclaimed water can be used for many purposes including: • Irrigation of landscaped areas • Urban uses such as toilet flushing, car washing, dust control, and aesthetic purposes (i.e. decorative lakes, ponds, and fountains) • Agricultural uses such as irrigation of edible food crops such as, citrus, corn, and soybeans; other crops such as, pasture lands, grasslands, and other feed and fodder crops; and irrigation at nurseries • Industrial uses including plant wash down, processing water, and cooling water purposes	Reclaimed Water 

Design Strategies – Water Efficiency

Exhibit S-02

Description

Solar Aquatic Waste Treatment systems use bacteria, plants, snails and fish that feed on waste to break down and digest organic pollutants. Typical systems consist of a series of cylindrical tanks and planted beds accommodating distinct ecologies that break down organic waste.

After passing through the system, water is discharged into either a constructed wetland or a series of fluidized beds for final polishing, and then to a storage tank to be held until needed. In university settings, these systems have been established at Oberlin College and Penn State University.

Analysis

Works faster and has more control than a constructed wetland on its own.

Easily expanded to meet future needs. Costs less to operate than conventional systems. Aesthetically pleasing; no odor. Great teaching tool, high visibility of ecological intent. Can adapt to dramatic changes in waste stream with low to no chemical usage.

Strategy

On Site Waste- Water Treatment

Landscape

Water efficient irrigation helps to conserve local and regional potable water resources. High efficiency irrigation strategies include micro-irrigation systems, moisture sensors, clock timers and weather database controllers.

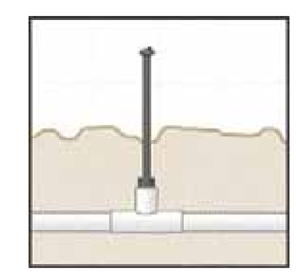
A typical permanent underground sprinkler system with raised sprinkler heads is approximately 70% efficient at applying water. Sprinkler systems are wasteful as they water both the plants and the soil. Solar radiation and winds as low as 5mph cause evaporation of the water, and leaves that remain wet overnight render a plant more susceptible to disease.

Drip irrigation is the most efficient method. Water flowing under low pressure through tubes (either laid directly on/under the ground) is slowly applied to the soil, minimizing the risk of evaporation or runoff. By laying the tubes so water is applied directly to the plant's root zone, waste from applying water to unplanted or weedy areas is avoided. Irrigation requirements vary according to plant species, soil type, rainfall, and temperature.

Water Efficient Irrigation

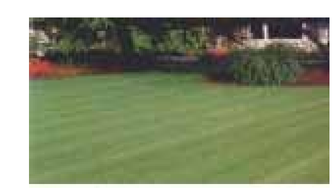
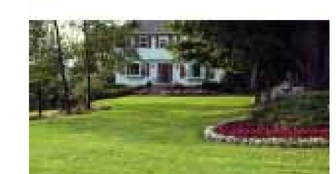
Design Strategies – Water Efficiency

Exhibit S-02

Description	Analysis	Strategy
One of the most effective ways to save water is to regulate an irrigation system with a controller. The top of the line controllers use a phone jack to connect the controller to the internet, or satellite based system. In doing so, the controller can receive local evapotranspiration rates (ET) and water accordingly.	An ET controller: • Monitors the duration and frequency of operation for each irrigation 'station' or valve • Receives updated evapotranspiration rates daily by satellite or through an internet connection. With an internet connection, the maintenance person can change or update the system from any computer • Can be connected to an onsite mini-weather station and used as a teaching aid • Saves an average of seven percent (7%) more water per day than a standard irrigation controller. On a large campus this can equate to hundreds of thousands of gallons of water saved annually	**ET Controller** 
Low precipitation rotors were designed to be used on hillsides where too heavy an application of water can cause erosion. They can also be used in heavy clay soils where frequent but brief irrigation can minimize soil saturation.	A low precipitation rotor is a gear-driven irrigation head that typically applies water in a range from 20-60 feet. It has the same radius as a standard rotor, but uses 1/3 to 1/2 of the amount of water.	**Low Precipitation Rotors**  
Irrigation bubblers are used in narrow planters, or can be located directly adjacent to shrubs to provide an exact amount of water and minimize run-off or growth of unwanted weeds.	The main advantage of bubblers is that they can be easily retrofitted to existing systems and they are not prone to damage by rodents and/ or students.	**Irrigation Bubblers**   

Design Strategies – Water Efficiency

Exhibit S-02

Description	Analysis	Strategy
Xeriscaping is a strategy of sustainable landscaping based on reducing dependence on irrigation and protecting the environment via the use of move appropriate plant species for climatic region. It is a complete system combining soils and appropriate drought tolerant and/ or native plant materials that require little or no supplemental water.	Xeriscaping Incorporates seven basic principles that lead to water savings: • Planning and design – addressing plant associations such that areas have plant groupings with the same water requirements • Soil analysis and improvement – improved soil quality reduces compaction, improves the absorption and performance of plants • Appropriate plant selection – native and drought tolerant plants that withstand periods of low rainfall, and are adapted to Livermoore's regional weather pattern • Minimize use of turf areas, and maximize your return water used for turf • Efficient irrigation – ideally implement temporary irrigation systems just until the new plantings take hold, or weather station based high-efficiency systems to deliver water to plants on a demand basis • Use of mulches – a two to three inch layer of mulch, either organic or inorganic, will keep soil cool, minimize evaporation and help control weeds • Appropriate maintenance – regular fertilizing, pruning and weeding, along with irrigation system checks, are essential elements of maintenance	**Xeriscaping** 
The most widely used type of permeable paving is cellular paving with turf planting. This method consists of interlocking "cell" pavers laid on a prepared bedding layer over a sub-base. The cells are then filled with soil and seed/ sod of a variety to meet the requirements for pedestrian/ vehicular traffic. Low to moderate maintenance is required, as this system was designed such that the grass will grow within and between the paver cells.	The Pervious surface allows for stormwater percolation. Las Positas College may consider the use of grass infill at pavers in those areas where fire access requires increased bearing capacity but a paved area is not required or desired.	**Permeable Turf Pavers**  
Synthetic turf is typically used in areas where fields that receive regular use are difficult or costly to maintain. Since synthetic turf uses no water and requires much less maintenance it can be a cost effective alternative in areas that need to minimize water use, risk groundwater or surface water contamination, or wish to reduce maintenance costs.	Synthetic turf has two major advantages: • The field can be extensively used, moving from one sport or activity to another, with a minimum chance of reducing its useful life over a 5- to 7-year period. • Annual maintenance costs are lower, and it requires a less technically trained management team.	**Synthetic Turfs**  

Design Strategies – Water Efficiency

Exhibit S-02

Description	Analysis	Strategy

Building System Efficiency

Description: Reduce internal loads and gains through window and lighting improvements. Installing energy-efficient equipment reduces annual maintenance costs, conserves finite resources and improves indoor air quality. Savings from these systems are proven to typically reduce annual utility costs by an average of 20 percent.

Analysis: Demand Reduction is the first step to optimize building energy performance. Reduce demand through design strategies such as reducing the overall building footprint to decrease the total space requiring conditioning, relaxing temperature design criteria to allow for a wider acceptable range of indoor temperatures, and utilizing occupancy sensors to automatically turn off equipment when building occupants are not present.

Key factors include:
- Replace inefficient and obsolete equipment
- Replace incandescent bulbs with compact fluorescent lamps
- Add photocell controls to exterior lights
- Provide programmable thermostats, switching from a demand rate to a time of use rate, and HVAC upgrades

Strategy:

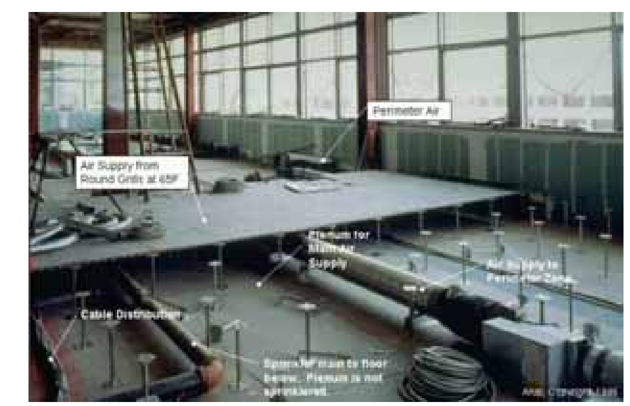
Reduction Of Peak Load Demand

Description: Displacement Ventilation can optimize ventilation rates and energy efficiency.

Analysis: Displacement ventilation systems significantly reduce building life cycle costs associated with reconfiguration of building floor plans and reduced ductwork costs. It improves occupant satisfaction and productivity (via improved thermal comfort, control, and indoor air quality). It also reduces energy use and cost.

Strategy:

Displacement Ventilation



Description: In a typical commercial lighting installation, 30%-50% of the energy is wasted by obsolete equipment, inadequate maintenance, or inefficient use. Saving lighting energy requires either reducing electricity consumed by the light source or reducing the length of time the light source is on.

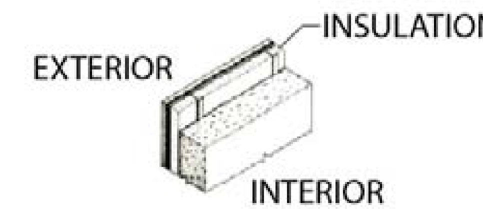
Analysis: Energy efficiency is achieved through:
- Lowering wattage, which involves replacing lamps or entire fixtures
- Reducing the light source's on-time, which means improving lighting controls and educating users to turn off unneeded lights
- Using day lighting, which reduces energy consumption by replacing electric lights with natural light
- Performing simple maintenance, which preserves illumination and light quality and allows lower initial illumination levels

Strategy:

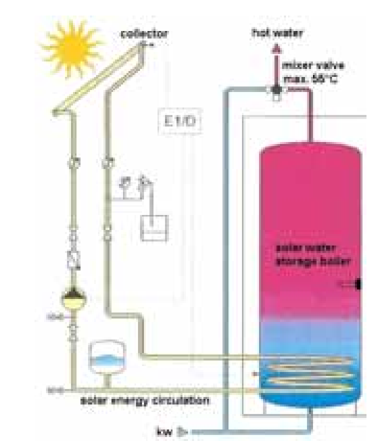
Energy Efficient Lighting

Design Strategies – Energy & Climate

Exhibit S-03

Description	Analysis	Strategy
Thermal mass strategies entail the use of materials that have good thermal conductivity and storage capacity which serve to slow down the building's response to changes in external conditions and reduce internal temperature swings. Materials such as masonry, concrete, and stone or ceramic tiling are conducive to these strategies, and often only need to be an inch or two thick. Mechanical systems use thermal mass by drawing air through buried pipes, rock stores or labyrinths of concrete blocks. On summer nights, cool air is pulled across the mass to produce a cold store, which in turn is used to pre-cool warm outside air during the day. During winter, the mass is warmed by solar radiation during the day, or through the use of a solar air heater that forces warm air across the mass. At night, the mass radiates warmth to the interior as well as warms air blown across it.	Temperature mitigation reduces loads on HVAC systems, and results in lower energy consumption. Thermal mass is useful for cooling if the mass is on the inside of the building, exposed to the occupied areas, and cool night air is drawn through the building. During the heat of the day, windows and doors should be closed to avoid heating the high mass surfaces through radiation. In winter, the opposite strategy is required - warm solar heated daytime air should be drawn into the building, and windows and doors should be closed at night to prevent heat loss through infiltration and radiation.	Thermal Mass 
Measurement and Verification of a building's ongoing energy and water consumption allows for optimization of related systems over the lifetime of the building. As a result, the cost and the environmental impacts associated with energy and water use can be minimized.	The College may provide for the ongoing accountability and optimization of building's energy and water consumption performance over time. Install continuous metering equipment and develop a measurement and verification plan that incorporates the monitoring information for end uses and is consistent with the International Performance Measurement and Verification Protocol (IPMVP) Volume 1. Concepts and Options for determining Energy and Water Savings. Examples of end uses that could be metered: Lighting systems and controls, cooling loads, boiler efficiencies, indoor water risers, outdoor irrigation systems and building related process energy systems and equipment.	Measurement And Verification 

Renewable Energy

Description	Analysis	Strategy
Solar water heaters come in two types: "passive" systems are designed so that the heated fluid moves through the collector naturally (heat rises, while cold tends to sink), without requiring a pump or outside power. In contrast, "active" systems use pumps to move the fluid through the collectors, resulting in increased system efficiency. Solar systems can also provide indoor space heating by running the heated water though hydronic baseboards or radiant floor-heating pipes. These systems can provide heat and hot water with very little energy use.	The College could easily incorporate solar hot water heaters as a supplement to domestic and heating hot water for new buildings, but it will likely be most cost effective when the demand can best be matched by the load. As a result, the optimal use is likely as a primary or supplemental heating source for the campus swimming pool.	Solar Panels: Water Heating 

Design Strategies – Energy & Climate

Exhibit S-03

Description	Analysis	Strategy
Photovoltaics (PV's) convert sunlight directly into electrical power. There are several ways of incorporating PV's on site, as standalone structures on parking spaces and as building integrated assemblies.	On site renewable energy is superior to conventional energy sources, because of its negligible transportation costs and impacts. In addition to preventing environmental degradation, on site use of renewable power can improve power reliability and reduce reliance on the local distribution grid. The conversion process also affords net metering, where the college could put power back into the utility grid when the local demand is less than the capacity of the PV system. Current incentives for PV's are in the range of $2.50-$3.50 per Watt. This equates to a little less than the entire system cost for most installations.	**Photovoltaics – On Site** 
Building integrated PV's are increasingly incorporated into building elements such as the roof, cladding or window systems.	Use of on-site renewable energy technologies can result in energy cost savings, particularly if peak hour demand charges are high. Current incentives for PV's are in the range of $2.50-$3.50 per Watt. This equates to a little less than the entire system cost for most installations. With building integrated PV's, the cost should also include the marginal savings on the replaced elements of the building such as roofing and cladding. The realized cost for these systems is typically $0.10 to $0.50 per kWh, however this can change markedly based on the offset material costs	**Building Integrate PV** 
Wind Energy Systems convert wind into electricity. It is a clean, relatively low cost and reliable source of obtaining electricity that is increasingly competitive with conventional sources.	The college could benefit from using this as an alternative source of electricity generation. However, adequate research must be done to study the impact on the local avian population and undesirable noise generation. According to the American Wind Energy Association, the l realized cost for commercial wind energy generation is $0.04 to $0.06 per kWh.	**Wind Power** 

Design Strategies – Energy & Climate

Exhibit S-03

Description	Analysis	Strategy
Encourage the development and use of grid-source, renewable energy technologies on a net zero pollution basis. Provide at least 50% of the building's electricity from a renewable source. Grid Power that qualifies for this credit originates from solar, wind, geothermal, biomass or low impact hydro sources.	Wind Energy Systems convert wind into electricity. It is a clean, low cost and reliable source of obtaining electricity. The college could benefit from using this as an alternative source of electricity generation. However, adequate research must be done to study the impact on the local avian population and undesirable noise generation. According to the American Wind Energy Association, the realized cost for commercial wind energy generation is $0.04 to $0.06 per kWh.	Green Power

Alternative Building Systems

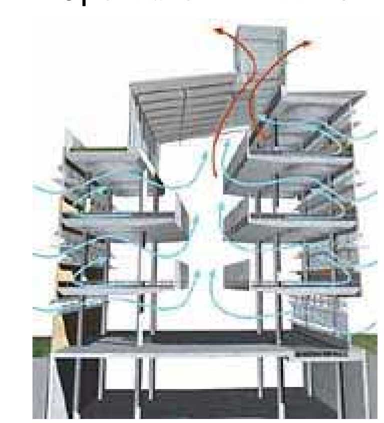
Cogeneration systems simultaneously produce electricity, heating and cooling in a single process. Operational costs are reduced when heat generated by electrical generators is used for applications ranging from the scale of individual buildings to district heating and cooling systems. Cogeneration is a highly efficient means of generating electricity and heat on-site and achieves a 15-35% reduction in the primary energy use of typical power stations, and 30-50% reduction in CO2 emissions. Overall efficiencies exceed 70% provided that systems are sized to meet the stable heat demand.	Cogeneration is a secure and highly efficient mode of producing electricity and heat with significantly reduced greenhouse gas emissions. Potential for good energy payback due to a reduction in transmission losses. Can lead to better rates with utility companies due to reducing peak loads. In some instances cogeneration may be a viable strategy for coupling with a centralized condenser water loop serving heat pumps, as a supplemental heat source for a swimming pool, or as a heat source for absorption chillers.	Cogeneration System 
Microturbines are small turbine engines which burn natural gas and produce 30 KW-75kW of 3 phase power that is synchronous with an incoming utility power feed. (If the grid goes down, they can operate in a stand-alone mode.) A heat exchanger can be provided to capture a continuous stream of waste heat from the unit and heat domestic or space heating water.	Same as cogeneration, but easier to phase and expand due to its decentralized nature.	Microturbines 

Design Strategies – Energy & Climate

Exhibit S-03

Description	Analysis	Strategy
For stand-alone cogeneration needs, the best current technology fuel cell to use is the phosphoric acid cells (although molten carbonate and PEM cells are rapidly making inroads). These fuel cells are the most commercially developed and are used in office buildings. Electricity generation efficiencies are in the order of 40%, and 85% of the steam produced can be used for cogeneration. This compares to 35% efficiency for the power grid.	Reduced emissions; when hydrogen is commercially available, emissions from fuel cells will consist of water vapor. Fuel cells displace the need for backup generators, thus offsetting some initial cost. Fuel cell installations are eligible for the CEC incentives; for systems ranging from 30 kW to 1 MW, the Self-Generation Program offers either 50% of the project cost, or $4.50/W.	**Fuel Cells** 
Assuring future technology flexibility is a sure way to allow for future operational improvements in efficiency.	Provide room for expansion whenever possible, install additional sleeves and access to crawl spaces to make future expansion more cost effective.	**Flexibility For Future Technology** 

Building Envelope

Mixed mode systems incorporate both a mechanically driven air conditioning mode and a naturally ventilated mode.	By providing individual controls such as operable windows, occupants can customize the indoor environment according to their preference. Educate occupants on individual control of their office space environment. A monitoring system should be implemented to maintain proper system operation. Effective signage could be implemented to remind occupants of their responsibilities (closing the window when HVAC system is ON).	**Mixed Mode Buildings- Operable Windows** 

Design Strategies – Energy & Climate

Exhibit S-03

Description

Thermal performance is an important consideration when selecting window glazing. To date the most reliable strategies have been to use either multiple layers of glazing or spectrally-selective, low-emissivity coatings. Multiple layers of glazing create insulating air pockets between each pane. The gap between layers varies from 1/4 inch to 1 inch and can be a vacuum or filled with air or an inert gas like argon or krypton. Argon has been shown to improve the thermal performance by 10-30%, while krypton offers a 40-50% improvement. For multilayered systems, thermal performance is effected by spacers used to create spaces between panes. Using plastic rather than aluminum spacers has been shown to improve a glazing system's thermal performance by 20%.

Spectrally-selective low-emissivity ("Low E") glazing is coated with a metal or metal oxide layer that limits long-wave infrared radiation. Depending on which pane surface the Low E coating is applied to, it can serve to reduce heat gain in summer or minimize heat loss in winter.

Low-E coatings maintain a clear appearance and transmit up to 75% of visible light. Compared to standard clear insulated glass, a high performance glazing system is estimated to have a 10-25% cost premium. However, operational savings in artificial lighting and cooling requirements for applications with effective day lighting have been shown to be 20- 40%.

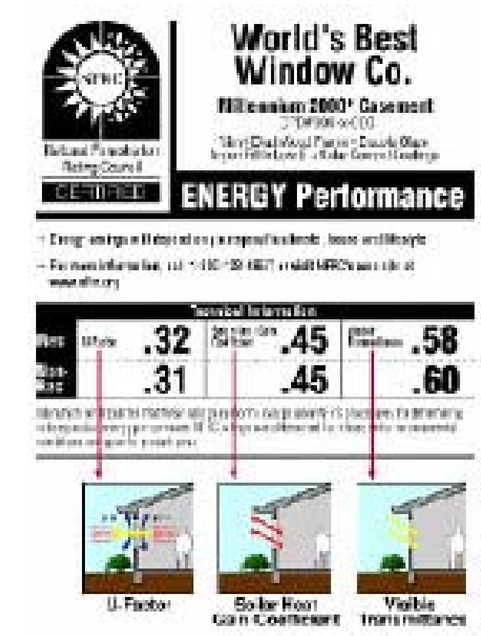
Analysis

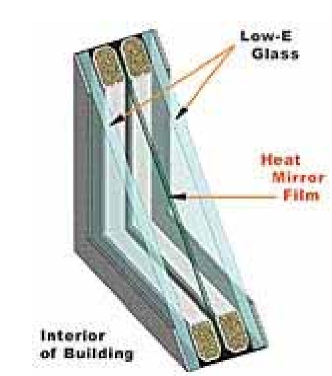
High performance glazing reduces heat gain, thereby reducing cooling loads/energy requirements and the corresponding CO2 emissions. Increased glazing, without heat gain, encourages day lighting strategies which reduce the need for artificial lighting and therefore reduces heat loads and energy consumption.

The college should establish a baseline target of performance glazing required on all buildings according to NFRC rating categories of the glazing requirements. This would help in achieving energy efficiency by heat load reduction. Existing fenestration could also be replaced with little cost to High Performance glazing to aid in optimized energy performance.

Strategy

Performance Glazing





Design Strategies – Energy & Climate

Exhibit S-03