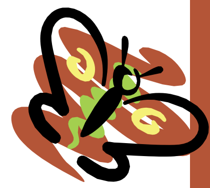
9.0 Facility Systems

In this chapter we present the building systems that support the FirstSchool facility. Included are: LEED®/Sustainability ; Mechanical; Electrical; Data Communications; Food Service; and Interiors.



FACILITY SYSTEMS

The following sections outline options and recommendations for building systems and features. These recommendations are provided with the understanding they might conflict with local standards. We believe if implemented, measurable improvement in indoor air quality (IAQ), building systems performance, and energy efficiency will be realized.

As with earlier sections of this document, every feature of the building is seen as a learning opportunity for children and as a possible mechanism for making the school an integral part of the community. Our emphasis on energy efficiency is seen not only as an end in itself, but also as an opportunity to act as an educational facility, promoting stewardship of the environment, and teaching children that taking care of their community is important and that their actions have an impact on the world in which they live.

9.1 LEED®/Sustainability
9.2 Mechanical
9.3 Electrical
9.4 Data/Telecommunications
9.5 Food Service
9.6 Interiors

LEED® - a third party certification program and the nationally accepted benchmark for the design, construction and operation of high performance green buildings. LEED® gives building owners and operators the tools they need to have an immediate and measurable impact on their buildings' performance. LEED® promotes a whole-building approach to sustainability by recognizing performance in five key areas of human and environmental health: sustainable site development, water savings, energy efficiency, materials selection and indoor environmental quality.

~ USGBC

9.1 LEED®/Sustainability

FirstSchool is dedicated to developing high-performance and sustainable buildings that minimize impact on the environment. The design should rely on daylighting, solar power, stormwater storage and use, and environmentally-friendly building materials. FirstSchool is dedicated to preserving and utilizing outdoor space, as well as educating its inhabitants about protecting and safeguarding the environment. Every effort is made to make the design features that accomplish the goals of sustainability transparent to users of the space, with particular emphasis on student access to these environmentally-friendly considerations.

The United States Green Building Council (USGBC) offers Leadership in Energy and Environmental Design (LEED®) certification, The LEED® Green Building Rating System serves as a voluntary United States standard for developing high-performance and sustainable buildings which consume less energy and water and contribute less to landfills and to global warming, while promoting a healthier environment. We recommend that schools that are designed according to FirstSchool principles meet or exceed LEED® Silver certification. We have included in this Design Guide a copy of the LEED® Project Checklist. LEED® promotes a whole-building approach to sustainability by recognizing performance in five key areas of human and environmental health: sustainable site development, water savings, energy efficiency, materials selection, and indoor environmental quality. It is possible to obtain a LEED® Silver certification by adhering to a number of the credits listed on the Checklist. The attached LEED® Checklist has been filled out listing possible credits that would be a minimum of all FirstSchool facilities.

Many building elements can make use of a high percentage of recycled content: carpet, ceramic tile, drywall, structural steel, concrete, and acoustical ceiling tile. All finish selections should avoid the use of formaldehyde and minimize or eliminate Volitile Organic Compounds (VOCs). An achievement of more than a 30 percent reduction in energy consumption, compared against a baseline model, would include heat recovery from air and kitchen exhausts; individual controls in each classroom; landscaped plantings which shade the south and west facades; and recycled roof water used in the evaporative cooler. Large openings in the classrooms, along with high-reflectant paint and shades, could provide plenty of controllable natural light.

Features of high-performance and sustainable designs are as follows:

1. Utilize rainwater management strategies that target "capture and reuse" approaches, and/or approaches that promote infiltration and vegetative uptake. Look for opportunities to bring water into the learning environment through use of visible features such as scuppers, weirs, water wheels, runnels, etc.
2. Collect, store, and use rainwater for beneficial uses including supplemental plumbing and irrigation of native landscapes or vegetated gardens.
3. Limit turf grass areas and instead focus on native vegetation requiring minimal maintenance by students and faculty.
4. Integrate stormwater management with bioswales, vegetative filters, and filter strips throughout parking areas, and promote sheet flow to these areas and recharge groundwater systems.
5. The use of green roofs will help with both the cost of heating and cooling the building and the treatment of rainwater.
6. Rain gardens can help to treat rainwater and runoff from parking lots, preventing untreated water from entering local streams.
7. The use of renewable energies such as sunlight, solar harvesting, wind harvesting, animal waste, and rainwater harvesting will reduce energy cost and greenhouse gas emissions.
8. Other principles, such as use of gray water for irrigation or building sanitary systems, should be considered.
9. Using high energy-efficient windows and skylights and direct/indirect lighting fixtures allows for a healthy and economical mix of natural and electric illumination in new and renovated schools.
10. Provide a high performance building envelope, exceeding minimal thermal requirements with special attention to the use of continuous air barriers to reduce air infiltration.
11. Daylighting requires attention to location, placement, and shading of windows and skylights relative to the building's solar orientation. This design concept can provide:
    - Balanced, diffused, and glare free daylight from two or more directions;
    - Sufficient light levels for tasks in the space;
    - Operable shading devices to reduce light intensity for audio-visual programs and computer work;
    - Windows for interest, relaxation, and communication with the outdoors; and
    - Exterior shading devices as needed to minimize solar heat gain during cooling season.

Daylighting -

The practice of placing windows, or other transparent media, and reflective surfaces so that, during the day, natural light provides effective internal illumination.

Within the overall architectural design of a building, particular attention is given to daylighting when the aim is to maximize visual comfort, productivity, or to reduce energy use. Energy savings from daylighting are achieved in two ways — either from the reduced use of electric lighting, or from passive solar heating or cooling.

Byram Hills School District | Wampus Campus
Photo courtesy of Perkins Eastman | Photographer: Chuck Choi

Byram Hills School District | Wampus Campus
Photo courtesy of Perkins Eastman | Photographer: Chuck Choi

The following are daylighting design considerations for architects:

- Building orientation for cost effective solar access;
- Roofing material and reflective factor and lightwells;
- Lightshelves and skylights;
- Collaboration with the electrical engineer to balance day lighting control;
- Interior finishes; and
- Windows: glazing, location, and orientation.

The following are daylighting design considerations for electrical engineers:

- Selecting suitable light source for application;
- Use of efficient luminaries and ones with high coefficient of utilization;
- Designs based on recommendations from IES and Ashrae; and
- Using modern technology to balance day lighting controls.

A balance control system integrates dimming controls, daylight sensors, and occupancy sensors with a network of digitally-addressable dimming ballasts.

9.1.1 Passive Solar Guidelines and Building Envelope

Passive solar buildings aim to maintain interior thermal comfort throughout the sun's daily and annual cycles, while reducing the requirement for active mechanical heating and cooling systems that require an energy source. The basic processes that are used in passive solar energy include the thermal energy flows associated with radiation, conduction, and natural convection. When sunlight strikes a building, the building materials can reflect, transmit, or absorb the solar radiation. Additionally, the heat produced by the sun causes air movement that can be predictable in designed spaces. These basic responses to solar heat lead to design elements, material choice, and material placement that can provide optimal heating and cooling for the FirstSchool building.

The FirstSchool building will focus on passive solar building design. These elements revolve around a set of core physical environmental and scientific principles. Specific attention is directed to the site and location of the dwelling, the prevailing climate, design and construction, solar orientation, placement of glazing and shading elements, and incorporation of thermal mass based on careful consideration of latitude, altitude, climatic conditions, and heating/cooling requirements.

There are basic passive solar building design elements required to optimize the use of natural elements and to minimize mechanical systems which heat and cool the building. These include:

- Orientating the building to face the equator, or a few degrees to the East to capture the morning sun, and a South face to receive sunlight into the building throughout the day during the winter-heating season;
- Elongating the building dimension along the east/west axis;

- Adequately sizing windows that face the midday winter sun;
- Adequately shading windows in the summer;
- Minimizing windows on other sides, especially west facing windows;
- Erecting correctly-sized, latitude-specific overhangs, or shading elements (shrubbery, trees, trellises, fences, shutters, etc.) to reduce cooling loads during the cooling season;
- Using the appropriate amount and type of insulation, including radiant barriers and bulk insulation, and the use of green roofs to minimize seasonal excessive heat gain or loss;
- Using thermal mass to store excess solar energy during winter days (which is then re-radiated during the night).

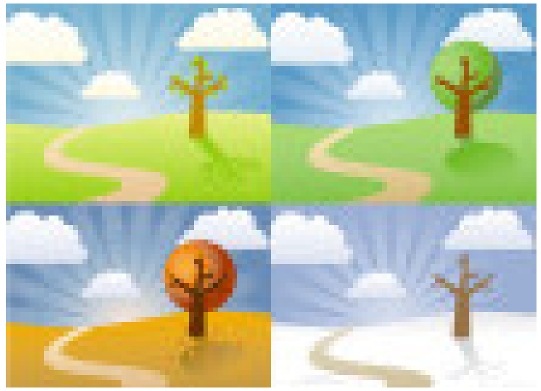
We recommend wall massing and insulation and a cool or green roof to provide a radiant barrier, that will significantly reduce the roof solar cooling load for the building. Overall, the combination of the building configuration and orientation, in conjunction with providing strategic overhang elements and natural shading components, will reduce the heating and cooling loads for the building significantly. If we assume a one-to-two story building that is long and narrow with a high proportion of exterior skin to interior area, we estimate that approximately 40% to 55% of the heating and cooling load for the building (excluding ventilation) will be produce from the exterior skin and roof.

Achieving an ideal solution requires careful integration of these principles. Modern refinements through computer modeling and application of other technologies can achieve significant energy savings without necessarily sacrificing functionality or creative aesthetics. Commissioning offers a quality-oriented process for achieving, verifying, and documenting that the performance of the facility, systems, and assemblies meet the defined objectives and criteria. This independent third party professional will help ensure that the strategies and recommendations required by the owner are achieved.

9.1.2 Human Behavior

The staff, faculty, and students all take an active role in reducing energy and incorporating a sustainable environment for the new building. Some of these actions include:

- Eliminating the number of printers in individual spaces. These printers are normally older and have a higher heat gain to the space than larger units that have a much lower efficiency. Designing space for central printer and copying areas in lieu of printers in individual offices;
- Eliminating old equipment that is inefficient;
- Turning off or unplugging power sources at night or that are not being used; and
- Promoting a paperless classroom and instituting policies that maintain paper records electronically, minimizing the need for individual printers, copiers, and other equipment that generates heat and consumes energy to operate.



Concordia International School | Elementary School
Photo courtesy of Perkins Eastman | Photographer: Tim Griffeth

40% to 55% of the heating and cooling load for the building (excluding ventilation) will be produced from the exterior skin and roof.

9.2 Mechanical

Overview

A vital aspect of the system design is promoting energy efficiency and maintainability of the systems. As rising energy costs and diminishing operating budgets become frequent issues at school districts across the country, providing energy efficient and sensible systems should be a priority for any new facility.

Energy costs typically account for 16% of a school district's "controllable" costs. New guidelines for schools are being developed in collaboration with The American Institute of Architects (AIA), the American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE), Illuminating Engineering Society of North America (IESNA), the United States Green Building Council (USGBC), and the United States Department of Energy (DOE) to achieve energy savings over the minimum code requirements of ANSI/ASHRAE/IESNA Standard 90.1-1999.

The initial energy saving target is 30% which is the first step in the process towards achieving a net zero building – defined as a building that, on an annual basis, draws from outside resources using on-site renewable energy sources. Heating, cooling and refrigeration equipment, lighting controls, and appliances are all being studied to maximize energy efficiency within the modern school. .

The optimum mechanical and electrical designs for school buildings aim to improve the environment for students and staff. This is accomplished by designing and constructing systems that promote exceptional indoor air quality (IAQ), reduce airborne noise, and increase occupant comfort.

The system should be transparent to the staff and students of the school to allow for learning opportunities. For example, meters that track air quality, energy consumption, or water use should be accessible to staff and students for use in math and science instruction.

9.2.1 Building Envelope

The building technologies being proposed advances the research and development in the next generation of energy-efficient components, materials, and equipment to reduce energy along with the architectural impact of site location, site orientation, and building form/geometry (massing) of the building.

Energy modeling of each building is crucial to saving energy. The building envelope and building orientation are critical components for the use of passive solar systems that reduce energy consumption through orientation of the building, daylighting, and location of overhangs, shading, and glazing locations.

9.2.2 Mechanical Systems

More than half the total energy used for heating, cooling, ventilation, refrigeration, and water heating is electrical. Air conditioning is the single leading cause of peak demand of electricity. The electrical loads need to be reduced to achieve the net-zero energy schools of the future. Practices that are being used to reduce energy consumption and reduce the carbon dioxide footprint include:

1. Energy Plant Systems

   Research has contributed to the development of energy efficiency in mechanical equipment. Large refrigeration equipment (chillers) and heat pump systems can substantially reduce energy consumption and cost. Today, most school designers specify gas-fired hot water boilers for heating and air-cooled chillers for cooling the building.

   New technology:

a. High efficiency non-condensing hot water boilers requiring lower temperature hot water and less energy. Larger boiler systems may have air-side economizers that can heat outside air required for combustion or pre-heat domestic hot water. Providing variable speed drives on pumps will also save pumping energy.
b. Water cooled refrigeration systems with high efficient compressors in lieu of air-cooled equipment. These systems can reduce overall refrigeration cost by 20 percent. In addition, thermal storage can be used in conjunction with the plant whereby chilled water is made on off-peak hours and stored for daytime use.
c. Geothermal water source heat pumps have shown excellent energy savings using underground water as a heat sink versus air.

2. HVAC Delivery Systems

   Most schools are designed with variable air volume systems which distribute air from main air-handling units. The main units heat and cool the air, mix with ventilation air, and distribute to the rooms depending on need. The amount of air varies depending on what temperature the thermostat is set. If the air is too cold, hot water coils heat the air for that specific room.

   New technology:

a. Individual heat pump systems as explained above;
b. Radiant convection panel systems where hot and cold water is distributed to panels located in the ceiling to heat and cool the space;
c. Underfloor displacement systems where air conditioning and heating is distributed from below the floor in lieu of through ceiling diffusers. This system allows for the air to be delivered directly to the occupants and there is no need to condition the entire volume of the room.

The initial energy saving target is 30% which is the first step in the process towards achieving a net zero building – defined as a building that, on an annual basis, draws from outside resources using on-site renewable energy sources.

Felician Sisters Convent and Our Lady of the Sacred Heart High School
Photo courtesy of Perkins Eastman

d. Water is a much more efficient way to transport energy than air. The smaller air handling units for ventilation also use heat recovery wheels or glycol loops in the units. Active chilled beam systems introduce ventilation air to units in the ceiling that also have a cooling coil. Chilled water is pumped around to the ceiling units and the cooler air is induced down in the space. Main air handling units are not required except for ventilation air (approximately 20 percent of the size), and large fans are not required. Heating is through finned tube radiation.

f. Demand control ventilation is becoming a common practice to minimize the amount of outside air that is needed in the building. Carbon dioxide sensors maintain specified levels and as those levels increase, more outside air is introduced.

3. Renewable Energy Sources

Renewable energy sources are being used in some schools today, including solar domestic hot water systems that heat domestic water for the school.

New technology:

a. DOE is investigating the development of a new system for calculating heat loss and gain through the building envelope. Advanced wall systems are being developed with air tightness, thermal mass, and durability.

b. Photovoltaics will be a major energy producer in future schools. New materials and systems are being developed for both residential and larger institutional use. System types will include stand alone, battery, and generator type systems where energy can be used instantaneously or stored for future demand. Photovoltaics with roof shingles will generate electricity and be incorporated into the building structure.

c. Solar hot water and pool heaters are now being used but only to achieve the net-zero energy building, active solar space heating will need to be developed further through researching building materials and fluids for both space heating and cooling.

d. Fuel cells will also be a viable source of energy in the future, but at this point, they do not reduce the carbon footprint for the environment.

4. Controls/Commissioning

Diagnostic and real-time monitoring tools will be incorporated in new school buildings. These tools will be used by school administrators, maintenance staff, and students to gain an understanding of what the impact of energy consumption has on budgets and the environment.

9.2.3 Water Conservation

The goal for the FirstSchool facility is to maximize water efficiency within the building by reducing the amount of water used and reducing the amount of waste water treated by the local municipal treatment plant. Multiple options will be evaluated to reduce water use. Specifying low flow and waterless type plumbing fixtures, flow restrictors, along with occupant sensors will achieve less water used in the building. In addition, the reuse of grey water, and stormwater retention for non-potable water applications, will enhance water conservation for the building and the surrounding site.

We estimated that the building is being designed to house 450 staff and students. We have also estimated that the building will use approximately 480,000 gallons a year of water for plumbing fixtures based on current codes. If we specify high efficient dual flow plumbing fixtures, we can reduce the water usage by 57 percent or 276,000 gallons annually. These design features incorporated into the building today will increase the water savings over the life of the building as the population of the facility grows.

This reduction in water usage is for the internal water usage of the building and does not include site water retainage or the reclamation of process/non-regulated water such as condensate return from HVAC equipment that will also enhance the water saving potential of the overall building and site.

New Technology:

1. Low Flow Plumping Fixtures

   In 1995, the National Energy Policy Act mandated that toilets use no more than 1.6 gallons of water per flush. Since then, low-flow plumbing fixtures, including toilets, faucet aerators, and shower heads have been developed that save substantial amounts of water compared to conventional fixtures providing the same utility.

   Low-flow toilets use a maximum of 1.6 gallons of water per flush compared with about 3.5 gallons of water used by a standard toilet. The initial introduction of low flow toilets generated complaints that the low-flow toilets had trouble clearing the bowl and frequently clogged. Flushing performance has improved in recent years but some models may still not perform as well as older high flow toilets. Some toilets have large drain passages, and redesigned bowls and tanks for easier wash down. Others supplement the gravity system with water supply line pressure, compressed air, or a vacuum pump.

2. High Efficiency Toilets

   Designed for water conservation, high efficiency toilets (HETs) have been defined by the plumbing industry and the Environmental Protection Agency (EPA) as those that use an average of 20 percent less water per flush than the industry standard of 1.6 gallons. Using a high efficiency unit (1.28 gallons per flush) can save up to 8,760 gallons of water each year for a family of four with average daily flushes of six each.

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Harvey Milk Middle School
Photo courtesy of Perkins Eastman | Photographer: Seth Boyd

Children's Museum of Pittsburgh
Photo courtesy of Perkins Eastman

3. **Gravity Fed Single Flush Toilets**
   Gravity fed single flush toilets operate the same way as any standard toilet, however, they use less total capacity per flush. Typical flush capacities that are available for these models are 1.1 and 1.28 gallons.

4. **Dual-Flush Toilets**
   Designed for light and heavy flushes, dual-flush toilets tend to average less than 1.2 gallons per flush. They meet HET criteria of 1.28 gallons per flush or less (HET criteria for dual flush toilets identify the effective flush volume as the average of one high flush and two low flushes). Dual flush models are available from many well-known manufacturers with light flush capacities from 0.8 to 1.1 gallons and heavy flush capacities from 1.3 to 1.6 gallons per flush. These toilets typically operate with a handle that can move up or down, or have a two button system. One direction or button will activate the lower flow flush, while the other will activate the higher flow flush.

5. **Pressure Assist Toilets**
   Pressure assist, or pressurized tank toilets are another high performance, low consumption alternative. These toilets use either water line pressure or a device in the tank to create additional force from air pressure to flush the toilet. The device in the tank could either be a storage device with compressed air that would require replacement, or a tank that creates pressure when the tank is being filled. These toilets typically average 1.1 to 1.2 gallons per flush. Some pressure assist systems move a greater volume of water at a significantly lesser volume of sound.

6. **Power Assist Toilets**
   Power assist toilets operate using a pump to force water down at a higher velocity than gravity toilets. Power assist toilets require a 120V power source to operate the small fractional horsepower pump. Typical flush volumes are between 1 and 1.3 gallons per flush, and dual-flush models are also available.

7. **Waterless Urinals**
   Before 1993, the standard flush rate for urinals was 3 gallons per flush (gpf). After that date, however, any urinal manufactured for use in the United States must have a flush rate of 1.0 gallons per flush or less. Waterless urinals require no water to flush and no flush valves or other control hardware to operate. Instead, they use replaceable cartridges that contain a liquid sealant. The difference in specific gravity between the trap solution and urine creates a liquid seal. The lighter specific gravity of the seal enables liquid to float to the top of the urinal while sealing the discharge line and preventing sewer odors from backing up into the bathroom.

   The chief benefit of waterless urinals is their lack of water use. No water piping is connected to the unit, which keeps down installation and maintenance costs, as well as water and sewer bills.

9.2.4 Greywater Reuse

Greywater is wastewater from bathtubs, shower drains, sinks, washing machines, and dishwashers. Greywater accounts for 60% of the outflow produced in homes and to a lesser degree, in institutional and commercial buildings. It contains little or no pathogens and 90 percent less nitrogen than black water (toilet water). Because of this, it does not require the same treatment process. Greywater can be recycled for irrigation, toilets, and exterior washing, resulting in water conservation.

9.2.5 Process and Non-Regulated Reuse

There will be opportunities to reclaim water from both storm-water and HVAC equipment. In parts of the country, during many months of the year the humidity in the air is condensed when introduced into the HVAC air conditioning units for buildings. This condensate is normally collected and discharged into the sanitary drain system and eventually to the utilities water treatment facility.

9.2.6 Interior Environment

During the early phases of design, the development of energy strategies will be incorporated into the First-School building. The reduction of overall energy consumption will depend on optimizing on-site resources, including: daylighting, which reduces energy loads both internally and externally; sizing of HVAC systems properly to operate at peak efficiency; and having a comprehensive maintenance plan to maintain the building once construction is completed. In addition, a plan is required to educate the staff and students on how to incorporate energy efficient habits in the workplace and create a sustainable "life style" during the operation of the building's life.

Reducing the internal loads of the building will be a major focus for reducing the overall energy consumption of the building. As stated above, optimizing on-site resources such as daylighting, energy efficient lighting systems and controls, and specifying energy efficient equipment for both the mechanical systems and office equipment is also needed.

9.2.7 Daylighting

Daylighting is essential for the most energy-efficient and sustainable building design. Effective daylighting uses sunlight to offset electrical lighting loads. When properly designed, daylighting saves energy and reduces cooling loads. In addition to energy benefits, a number of studies have shown that daylight can also help improve learning. From a student and teacher productivity standpoint, classrooms are the most beneficial spaces to daylight.

If carefully designed, vertical fenestration and skylights can provide interior illumination without excessive solar heat gain. Electric lighting systems can then be extinguished or dimmed for most school hours, saving significant energy and maintenance costs. The key to daylighting is an integrated design in which HVAC and electric lighting controls are optimized to take full advantage of and harvest energy savings. Added first

Clerestories, skylights, and light shelves will offer opportunities to provide top lighted and side lighted daylighting, in conjunction with integrated lighting systems.

Brunswick County Academy
Photo courtesy of Perkins Eastman | Photographer: Paul Rivera/ArchPhoto

Byram Hills School District | Crittenden Campus
Photo courtesy of Perkins Eastman | Photographer: Paul Rivera/ArchPhoto

costs of fenestration are offset by reduced costs in HVAC equipment. Daylighting must provide controlled, quality lighting. For daylighting to save energy, it must be "superior" to the electrical lighting. Lighting and daylighting design can provide predicable and consistent lighting energy savings of up to 40 percent.

As the FirstSchool building is designed with an elongated East-West orientation and an expansive North-South facade, it will offer many opportunities for daylighting. Clerestories, skylights, and light shelves will offer opportunities to provide top lighted and side lighted daylighting, in conjunction with integrated lighting systems.

9.2.8 Humidity Control

There are many different types of air conditioning systems that can be used in schools. Typically, chilled water or direct expansion type systems are used. In a typical DX application, the compressor cycles off regularly to avoid over cooling. As the compressor operates for a smaller percentage of the hour, dehumidification capacity decreases significantly. In a typical chilled water application, a modulating valve reduces system capacity by throttling the water flow rate through the cooling coil. As the water throttles down, less moisture is removed from the air.

The spaces relative humidity will increase under part load conditions and can present conditions where mold will form with relative humidity levels above 60 percent using either chilled water or DX system. Depending on the air conditioning system selected (single-zone and packaged DX systems, heat pumps, or fan-coil units) this equipment can be designed to minimize higher humidity at part-load conditions mainly through control modifications. The use of dedicated outside air units can also help minimize higher humidity levels.

9.3 Electrical

Energy consumption for all lighting in the United States is estimated to be about 22 percent of the total electricity generated. More than 50 percent is consumed in the commercial sector where lighting coincides with peak electrical demand and contributes to a building's internal heat generation, which also increases air-conditioning load.

The DOE technical objective is to develop and demonstrate energy efficient, high quality, long lasting lighting technologies to illuminate buildings with 50 percent less electricity than in 2005.

The focus of decreasing energy consumption from lighting is as follows;

a. For conventional lighting, decreased energy consumption is due to the improvement in the quality and performance of fluorescent and high intensity discharge (HID) light sources, advances in fixtures, controls, and distribution systems; along with optimizing lighting quality.

b. Solid state lighting is also targeting improvements in efficiency, performance, lifetime, and quality of light from both organic and inorganic light emitting diodes. LED type fixtures are being developed and used in more facilities each day.

In addition, green school lighting design typically emphasizes providing views and managing daylight. It specifically focuses on increasing daylight, reducing glare and minimizing energy. Using high energy efficient windows and skylights and direct/indirect lighting fixtures allows a healthy and economical mix of natural and electric illumination in new and renovated schools.

Compared to electric lighting, daylighting has a better light quality that is more appropriate for human visual tasks. Lighting system design can improve attributes of the "Light Quality". The controllable attributes of light quality are: better distribution of light throughout the space, and absence of flicker and noise associated with electric light fixtures and ballasts.

Lighting controls are also being investigated in more detail for monitor and control efficiency. Balance Daylighting Control uses modern technology to integrate dimming control, daylight sensing, and occupancy sensing with a network of digitally addressable dimming ballasts.

The development of highly efficient, cost-effective, solid-state lighting technologies, along with advanced windows and space heating and cooling technologies, can help reduce total building energy use by 60-70 percent. This improvement in component and system energy efficiency, coupled with on site renewable energy supply systems, can result in marketable net zero energy buildings.

All of these features offer opportunities for teachers and students to observe the environmentally friendly components and monitor and assess energy and cost saving measures.

9.3.1 Lighting

Lighting systems that use the most current, energy-efficient lamps, ballasts, and integrated controls should be included in the FirstSchool building design. Because lighting energy savings also produce cooling savings, HVAC energy savings of 10 to 15 percent are possible in cooling–dominated climates. Moreover, even though the cost of the high-performance system may be about the same or more than a basic solution, the cost of HVAC capacity can also be reduced.

For daylighting and electrical lighting to be used efficiently, spaces must have light-colored finishes. Ceiling reflectance should be at least 70 percent (preferably 80 percent to 90 percent). The average reflectance of the walls should be at least 50 percent. Floor surfaces should be a minimum of 20 percent.

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Byram Hills School District | Crittenden Campus
Photo courtesy of Perkins Eastman | Photographer: Paul Rivera/ArchPhoto

For each Energy Star certified computer and LCD monitor, approximately 860kWh of energy are saved in one year.

T8 lamps and electronic ballasts are the standard commercial fluorescent lighting system in the United States. To achieve the highest energy savings, the more efficient lamps and ballast are required. T5 lamps, an alternate to T8 lamps, can be used since they have a higher output and offer superior overall performance in several key applications. The key difference between T8 and T5 lamps involves performance at rated temperatures. T5 lamps reach peak efficiency when the surrounding air is 95 degrees, while T8 lamps peak at 77 degrees. Specific applications will need to be evaluated.

We will use occupancy sensors, either passive infrared or ultrasonic, in most areas of the building. The greatest energy savings are achieved with manual on/automatic/off sensors when daylighting is used.

9.3.2 Equipment

Plug loads contribute up to 25 percent of the electrical load in the school. A large contributor to this load is equipment and appliances left on after use and equipment that has a phantom load when not in use. The use of occupancy sensors and unplugging fixtures is a way to control these loads and reduce energy.

Purchase of technology equipment with the Energy Star certification can significantly cut down on power consumption and the building's carbon footprint. For each Energy Star certified computer and LCD monitor, approximately 860kWh of energy are saved in one year. By using certified equipment, each machine can save an additional $5-$10 in office cooling loads annually. Certified copiers and fax machines are on average 25 percent more efficient than their non-certified counterparts. We will make recommendations and provide a list of Energy Star certified equipment to assist in purchasing.

9.4 Data/Telecommunications

Integrated Technology

For students to thrive in a world enabled by information technology, we must give them the skills to make sense of and use the available information. Many students already use computers and surf the Web on their own, but there's more to educational technology than desktop computers. Teachers and students need access to wireless laptops, and handhelds, digital cameras, microscopes, web-based video equipment, graphing calculators, and even cellular devices. They need to become responsible and savvy users and purveyors of information so that they may successfully collaborate across miles and cultures.

Switches, routers, firewalls and other equipment, both wired and wireless, are required to make technology integration seamless. Commercial grade structured cabling systems are a must. Integrating support for technology into the building design is critical.

As the demand for technology in education grows, so does the space required to support that technology. Independently cooled telecom/equipment rooms are required for approximately every 10,000 square feet of learning space. Separate space will be needed to house cellular repeaters and third party network equipment. Smaller localized closets will be necessary to support A/V equipment for teacherless two-way conference classrooms.

In terms of port density, each office will be provided with two standard telecom outlets. All other spaces including lounge areas, computer labs, and classrooms will be provided with data drops to accommodate expected computer usage. Each standard outlet will consist of one voice port and two data ports. All telecom rooms will be interconnected with fiber optic and copper riser cabling to support maximum bandwidth and flexibility for whatever the future holds. The telephone system will be designed to support Voice over Internet Protocol (VoIP). Wireless access points will be located throughout the building to allow WiFi connectivity both inside and outside the classroom.

As a result of integrating technology into the building design, the student receives the technologically advanced education required to survive and thrive in the fast paced tech-driven world in which we live.

9.5 Food Service

The facility will provide for the preparation of food for service to a maximum of 450 students pre-kindergarten through third grade. The building will have two dining areas for students. One larger area will be for the older students (kindergarten through third grade) and one smaller dining area will be for pre-kindergarten students (and possibly kindergarten students depending on the configuration of the school).

Food deliveries will arrive at the loading dock and be stored in dry food storage and walk-in cold storage assemblies. Because many food items are pre-cooked and/or frozen, the walk-in cold storage assembly will be larger than dry storage and the freezer will be larger than the cooler.

Prep areas will include (but not be limited to) prep sinks, slicers, food processors, and small mixers.

All equipment will be heavy duty commercial grade. The cooking equipment will include a convection oven, convection steamer, range, and a tilting braising pan. The exhaust hood's automatic fire suppression system will include cooking equipment fuel shut-off.

The kindergarten through third grade dining room will have one serving line. This line will include hot and cold food, plain top, milk cabinet, ice cream dispenser, cashier counter, and tray/silver cart. Heated cabinets and refrigerators will store prepared food for serving areas. The pre-kindergarten dining room will serve family style meals. Children will serve themselves from community bowls and platters.

Byram Hills School District | Crittenden Campus
Photo courtesy of Perkins Eastman | Photographer: Paul Rivera/ArchPhoto

This kitchen is designed to prepare and transport food to dining areas (pre-kindergarten and kindergarten through third grade). There will be parking for food transport carts, both hot and ambient.

Trays will be reusable and returned to the dish room. Compartmented trays which hold dishes and flatware would reduce the amount of trash, but would increase labor and the amount of space needed for cleaning/drying and storage. Another option is that all dishes and flatware be disposable.

The can wash will be outside the rear door on the loading dock, on the same level as the kitchen floor. A janitor's closet will include a mop sink and chemical storage. An office will be in the vicinity of the back door and there will also be an employee restroom, locker area, and washer/dryer.

Trays and/or flatware/dishes are to be washed by machine in a conventional dishwashing arrangement. Hose reels will be provided for cleaning of the floor and equipment. Pots will be washed in a three-compartment sink.

To enhance worker safety and comfort, all aisles will be a minimum of 42" wide. The kitchen floor will have a non-slip finish. Kitchen walls will be a smooth, easily cleanable surface. All kitchen and cafeteria equipment will be NSF and UL approved and will be of a commercial, heavy-duty quality. These items will be installed per all national and local codes.

9.6 Interiors

The principals that serve as the basis for the FirstSchool Model for optimum interiors should be a seamless transition between comfort and scale; accessibility; materials; finishes; and visual transitions, such as light, color and texture. All of these elements serve a vital role in the overall development of the learning process at the earliest age of a student. The spaces need to be designed to organize, control, transition, and interplay all of these elements. Considerations include open and flexible environments; durable, flexible and low maintenance materials and finishes; environments to support playful exploration; and use of natural light.

Comfort and Scale

Each student should feel that he or she has "a home away from home." Child comfort is most critical in those areas within the building where children spend most of the day. To create such a comfort level, the scale of the building and interior inhabitant space must be based on the respective ages of the student population. It is important that the students do not feel overwhelmed or out of place. This must take into consideration the size of the spaces, width of corridors, height of ceilings and furnishings relative to the scale of the children.

Accessibility
Provisions for handicapped access and wheelchair clearances to meet the Americans with Disabilities (ADA) height regulations, which tend to be higher than necessary for general students, must be balanced with the lower heights required for younger student populations.

Materials
School buildings are among the public structures that are called upon to last for a long time and endure decades of accommodating schoolchildren and various educational programs. These factors should be a major factor in the selection of finish materials. The materials should be durable and maintainable and withstand years of use and abuse while continuing to provide an atmosphere conductive to learning.

The following are the general material selection criteria used for the major spaces:

- Walls
  For durability, high impact gypsum products, painted concrete masonry blocks, ground-face or textured block, and brick are common alternative. For warmer materials wood and vinyl wall coverings are used.
- Floors
  Carpet materials for classrooms and large play areas should be given consideration to both enhance acoustic quality and reduce injuries associated with slippery, harder surfaces. Solution-dyed products with integral moisture backing should be specified to ensure color retention and easy cleanup of soils and spills.
  In areas used for artwork, toilet rooms, and wet or messy activities, the use of VCT or sheet-vinyl products, which provide long-term durability and maintainability as well as many aesthetic options, should be considered.
- Ceilings
  Acoustics should be addressed for each area designed. Acoustic ceiling tile is a good material to use when addressing acoustics in certain rooms. In areas with harder surfaces such as large expanses of glass wall or hard tile flooring, acoustic tile ceilings may not be adequate. Consideration should be given to the use of acoustic wall treatments such as fabric-wrapped panels.
- Wall Protection
  The protection of openings and corners, always a consideration, will ultimately help the facility maintain its appearance. The use of corner guards at key impact areas is recommended, and consideration should be given to recessed guards with carefully coordinated coloring.
- Trim and Casework
  The use of natural wood to enhance the quality of a space is often desirable and can provide a very durable low-maintenance alternative to painted trim and cabinets. Among the common woods used for their durability and affordability are maple and oak. If painted cabinets are desired, factory polyester or vinyl paint coatings offer good durability as well as easy cleanup. Countertops of plastic laminate

are quite functional, but may peel and delaminate over time. Melamine materials should be used on concealed surfaces only.

The following list contains considerations in material selection for interior materials within a school building project:

- Administration: Soft flooring; acoustical walls; appropriate lighting; cleanable surfaces; ventilation for copying areas
- Offices: Acoustical walls; durability; proper air change and ventilation
- Nurse's area: sanitary conditions; germ-resistant environment; hard and non porous flooring; smooth surfaces; proper ventilation; humidity; and temperature levels
- Library: Quiet environment; non-glare surfaces for computer use; indirect lighting; controlled moisture and humidity levels
- Classrooms: Easily cleaned flooring; hard flooring; environment conducive to concentration; water-resistant walls, floors around sink areas
- Kitchen: Hard non-slip flooring; ability to withstand heavy daily cleaning with chemicals; seamless surfaces for food prep and cooking; splash-guard surfaces at sink area; floor and wall surfaces resistant to oil and cooking residues; smooth surfaces to resist the growth of bacteria
- Dining: Hard flooring; smooth surfaces; finishes that can be cleaned with disinfectants; hard and smooth wall surfaces for cleaning
- Gymnasium: Resilient floor surface that allows true bounce and spring action; hard wall surfaces for ball play; padded wall sections; noise reduction treatments; durability of all products used; vandal-resistant materials
- Locker rooms: nonporous and nonslip flooring; water and humidity resistant materials; mildew resistant curtains; vandal resistant materials; ventilation; moisture resistant wall surfaces
- Science: Chemical and acid resistant materials; hard and cleanable floor finish; proper ventilation for chemical and gas use; water resistant work surfaces; chemical storage
- Art: Cleanable walls, floors and ceilings; hard and smooth flooring; natural light; heavy duty storage shelving; water resistant work surfaces, walls and floors

Finishes

The choice of interior finish materials can have the most profound effect on the physical environment and its familiarity to children. Finishes can also have an impact upon behavior and attendance. Many finishes consisting of endless vinyl tile, painted block walls, seas of carpeted floors are often associated with the most institutional settings and convey a stronger sense of factory than home.

A combination of finishes that create a strong design statement can provide a visually interesting environment for the students. Color, graphic patterns, texture, and special materials on walls, floor and ceilings can be strategically applied throughout the spaces to create a warm and interesting sense of place.

Textures friendly to a child's skin and body adds another aspect to a child's experience with the physical environment. A number of textures can be considered such as wood, ceramic tile, various plaster surfaces, metal or wire screens, fabric, rubber, various metal surfaces, safety mirror and glass.

Visual Transition

The wide use of light, color and texture can be very desirable.

Light, both natural and artificial, must be carefully planned. Varied lighting not only adds to the interest of the environment, but also provides options for creating moods, supporting different activities, and learning. Day-lighting may be a significant part of the education curriculum. Daylight should be allowed to enter the building from different orientations and locations. Large windows, skylights, and outdoor sundials will help to connect sunlight with the children's daily lives.

Color can be vibrant or subdued, but there is no need to limit environments designed for children to the ubiquitous primary colors. Research has suggested that bright red hues create excitement, and deep purples and greens are stabilizing and soothing. Yellow, as well as being restful, is the first color that can be perceived by small infants. Color that is very simple that provide a neutral backdrop allows the environment to be personalized and animated by its inhabitants. The neutral backdrop would not compete with the artwork and projects of the children.