April, 2009

Green Healthcare Facilities

Steps Toward Sustainability

Healthcare facilities account for 9% of all commercial energy consumption in America, according to the DOE.[1] As shown in Figure 1, inpatient healthcare facilities are the second largest energy consumer and use on average 250,000 Btu per sq ft.[2]

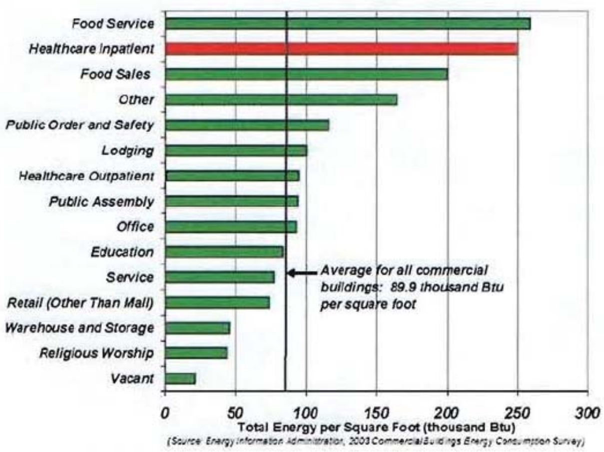

Figure 1. Energy Usage by Building Type.

Motivation to Go Green

The motivation for healthcare facilities to incorporate sustainable *green* design, construction and operating practices is that improved indoor environmental quality improves the health of patients, professionals, staff and visitors.

More than 20 healthcare facilities have achieved the U.S. Green Building Council's LEED for New Construction (LEED-NC) certification; however, it is acknowledged that the LEED-NC rating system was designed for commercial buildings and presents challenges to healthcare facilities.

1. Joyce Hackenbrach, *Healthcare Facilities Account for 9% of Energy Consumption*, Managed Healthcare Executive, December 1, 2008
2. Carol Fem, *Champion Both Infection Control and Energy Conservation*, Healthcare Building Ideas, April 5, 2008, pp 68-74

Green Guide for Health Care (GGHC)

The Green Guide for Health Care (GGHC)[3] is a voluntary, self-certifying tool for sustainable design, construction, and operations. Modeled, with permission, on the U.S. Green Building Council's Leadership in Energy and Environmental Design (LEED®) building rating systems and tailored to address specific healthcare regulatory requirements that control many aspects of acute care hospitals' physical environment and facility operations.

The GGHC was developed with guidance from the Green Healthcare Construction Statement written by the American Society of Healthcare Engineers (ASHE).

USGBC and GGHC

U.S. Green Building Council (USGBC) and the Green Guide for Health Care (GGHC) signed a memorandum of understanding in September of 2007.

The LEED for Healthcare rating system was developed as a collaborative effort between the Green Guide for Health Care (GGHC) and USGBC. GGHC helped streamline development by aligning the organizational structure, conducting public comment periods and a pilot program that included more than 100 healthcare facilities.

LEED for Healthcare will be released in 2009.

3. For more information, see the Green Guide for Health Care (GGHC) Web site at: www.gghc.org

Innovation and Design Process

The GGHC created the Innovation and Design Process (ID) to provide design teams and projects with the opportunity to achieve additional points for exceptional performance above credit goals set by the GGHC and innovation for green building goals or strategies.

Sustainable Sites

Hospitals store and manage chemicals in both underground tanks and other outdoor facilities. By minimizing potential leaks and spills, hospitals can protect the surrounding community.

Leaks and Spills

Hospitals are required to have an Emergency Power System (EPS) that will be the source of electrical power for the healthcare facility during an extreme event. Level 1 system(s) are installed when failure of the equipment to perform can result in the loss of human life or serious injuries. NFPA 99 Healthcare Facilities further identifies the criteria for EPSS used in hospitals. Generators set must restore power within 10 seconds following loss of normal power and be able to provide power for the time period (for example: 96 hours[4]) as required by local code.

Typically fuel storage tanks associated with storage of fuel for emergency or backup generators are installed with a fuel storage tank monitoring system that allows fuel tank levels, delivery information, and leak sensing alarms to be monitored by the building automation system. These systems usually provide leak sensing for underground storage tanks, containment sumps, dispenser pans, and monitoring wells, in addition to line leak detection and inventory control/management.

GGHC (SS10.2) Community Contamination Prevention: Leaks & Spills: requires underground fuel-oil storage tank to comply with U.S. EPA Title 40, Code of Federal Regulations, Part 112, or local regulations, whichever is more stringent.

Hospitals with an above ground storage tank (AST) capacity of **greater than 1,320 gallons** or total underground storage tank capacity **greater than 42,000 gallons** must prepare and implement a SPCC plan to prevent any discharge of oil per 40 CFR Part112.3.

Underground Storage Tanks (USTs) are regulated by Federal regulations 40 CFR Part 280 or 40 CFR 281 (State UST regulations). All USTs installed after December 2, 1988 are required to provide a method for monitoring the release leak detection as identified in 40 CFR Part 280.43.

Figure 2 shows an UST Detection system.

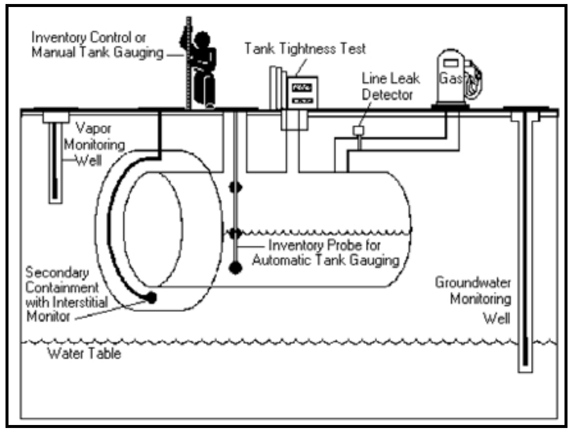

Figure 2. Underground Storage Tank Monitoring System.[5]

To learn more about the Clean Water Act and other environmental regulations that apply to hospitals, see the *Healthcare Environmental Resource Center* website at: http://www.hercenter.org/regsandstandards/cwa.cfm

Water Efficiency

Typical water use per capita in hospitals ranges from 40 gallons per day to 350 gallons per day. The allocation of water at a facility varies depending on the services provided, in-patient versus out-patient visits, staff attendance, equipment used, age of the facility, and periodic maintenance practices followed.

4. *Design Guide for Improving Hospital Safety in Earthquakes, Floods and High Winds*, U.S. Federal Emergency Management Agency (FEMA), publication FEMA 577, June 2007, pp 4-105

5. *Inside ASHE*, Sept/Oct 2005

A water use study, published in 2002, showed that hospitals typically have the following broad breakdown of water use as shown in Figure 3.[6]

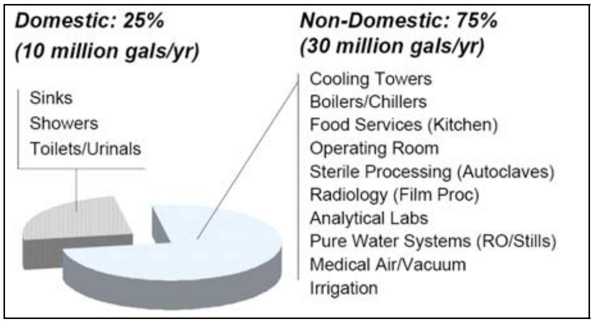

Figure 3. Water Usage in Healthcare Facilities.

Rain Water Usage

The GGHC, WE1 requires using captured rainwater, recycled water, recycled greywater for non-potable uses for irrigation. Rainwater systems have significantly fewer code requirements than greywater systems. Using rainwater reduces the load on municipal water utilities. The system may be as simple as a collecting tank that uses gravity to irrigate landscaping. or a rainwater collection system that include specific functions such as automatic pumping, water treatment and performance monitoring. Pre-engineered rainwater catchment systems are beginning to emerge, saving designers from reinventing the entire package.

Figure 4 illustrates a typical design. Rainwater is collected from the roof gutters and flows down to a cistern for storage. In addition to straining and filtering, treatment may include ultraviolet irradiation or chemical disinfection. Even for non-potable applications, it’s important to prevent biological growth in the tank.

6. *Water Conservation*, PracticeGreenhealth.org Web article at: http://cms.h2e-online.org/ee/facilities/waterconserve/

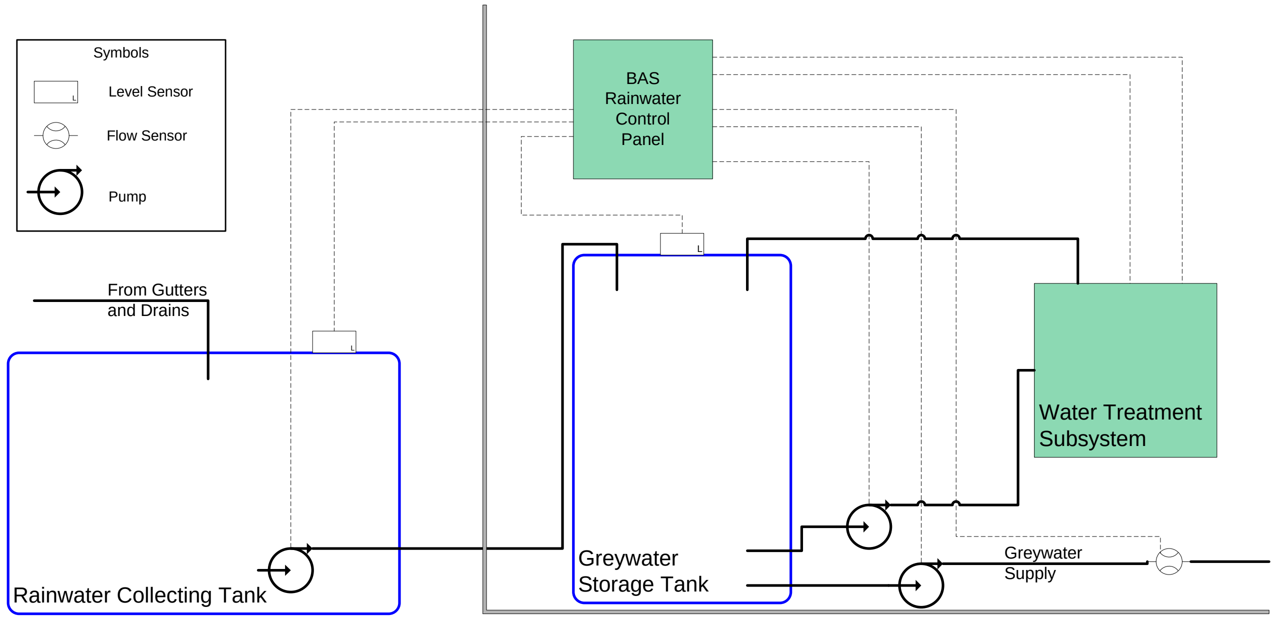

Figure 4. Rain Water Collection Processes are Coordinated by the Building Automation System.

Pumps deliver the greywater for such uses as landscape irrigation and cooling towers. The BAS monitors water meters, pressure sensors and level sensors to correctly operate the pumps and treatment system, and to inform the building operators. It's important to integrate the rain water system into the building automation system.

M&V Potable Water Use Reduction

In the long run, water efficiency depends on effective management and that requires information. The GGHC, WE2.1 requires meters on the facility's water sources and submeters for various identified uses (for example, cooling tower makeup, boiler water make-up, outdoor irrigation systems, purified water systems, laundry, etc.).

The data can support maintenance and troubleshooting tasks. In some cases, measured data can affect billing arrangements with the water and sewer utilities. It also sets a baseline for evaluating improvements in this facility or a new one.

Pure Water Systems

Hospital laboratory processes demands a grade of water more pure than municipal tap water. Tap water typically contains particles, dissolved organics and dissolved inorganics that can disrupt laboratory research or analyses. Water treatment systems remove these contaminants through a combination of technologies, including reverse osmosis, deionization, UV photo-oxidation, ultrafiltration (UF), and microfiltration.

Today, these treatment technologies are replacing distillation because of the enormous energy savings. To purify the same amount of distillation water, it still may consume twenty-times as much energy as reverse osmosis system. This fact eliminates distillation as an option for sustainable facility.

In order to produce purified water for the lab, these processes convert some of the tap water to wastewater that flushes away the contaminants. This *reject rate* can affect the overall water consumption for facilities that require large volumes of high-purity water. In the proposed standard,[7] ASHRAE limits the reject rate for laboratory treatment systems to 60% or less. This target affects equipment selection and system design.

Facilities that use large volumes of purified water have the strongest reason to minimize the reject rate. They often apply centralized, engineered water treatment systems that can be optimized for low water reject rate. Compared to systems that serve a

7. ASHRAE, *BSR/ASHRAE//USGBC/IESNA Standard 189P*

single room, central systems are more complex to design, install and operate. Long term water efficiency depends on regular maintenance by specialists trained on the equipment. This is a good approach for organizations that can realistically commit to maintaining performance.

For smaller users, a trade-off in efficiency is often made so that a simpler system can be installed. Small reverse osmosis systems, sized for a single laboratory, are designed with high reject rates to eliminate the need for pre-treatment of the tap water.

Between the largest and smallest systems, there is an intermediate class of equipment sized for multiple labs (200 liters/hour) that can be applied with reject rates below 50%. Designers can choose a modular, scalable approach, rather than a fully centralized system. This combination of efficiency and flexibility expands the possibilities for designers.

Energy and Atmosphere

A recent study that modeled energy usage in a typical hospital, found that, for all climates evaluated, the major energy usage averaged across all climates was:

- Ventilation Fan Energy
- Ventilation Air Cooling
- Reheating and Space Heating
- OA Heating and Cooling
- Dehumidification and Humidification

These systems consumers accounted for 59% to 64% of the annual energy cost in a typical hospital facility, regardless of the facilities location.[8]

Commissioning of Building Energy Systems

The Joint Commission EC7.10 identifies *Utility Systems*[9] as being essential to the proper operation of the environment of care. In the *2006 Edition: Guidelines for the Design and Construction of Hospital and Health Care Facilities*, the commissioning process must be done by an independent Commissioning Agent (CxA).[10]

Commissioning is prerequisite to achieving a LEED or GGHC rating.

Fundamental Commissioning (EA P1) emphasizes installation and acceptance tests to verify that the systems operate as intended. At a minimum, commissioning requirements are incorporated into the contract documents and a Commissioning Plan is developed and implemented. The tests are preferably executed by third party Commissioning Agents (CxA). The results will be compiled in the commissioning report along with any necessary corrective actions. The mechanical contractor, the BAS contractor and the Testing Adjusting and Balancing (TAB) agent need to coordinate their activities with the CxA.

Enhanced Commissioning (EA Credit 3) extends the scope in both directions, back to the design phase and forward to occupancy and verification. This is consistent with the commissioning concepts defined in the ASHRAE Guidelines.[11] This credit requires that the commissioning design review is conducted prior to the construction; contractor submittals applicable to the systems being commissioned is reviewed; a system manual of operation is developed; training is completed; a commissioning summary report is issued; and operation of the building is reviewed within ten months after substantial completion.

To successfully obtain this credit with this approach you need partners who have thorough understanding of systems, not just parts suppliers. If the building operation staff also participates in the acceptance test program, it gives them a tangible feel for how the systems are supposed to perform. They draw on this experience when they need to analyze, troubleshoot, and maintain the building in years to come.

Table 1 lists specific commissioning tasks particularly relevant to pressurization within healthcare facilities.

8. ASHRAE Short Course: *Healthcare Facilities: Design Considerations*
9. *Utility Systems* may include electrical distribution, emergency power, vertical and horizontal transport; heating, ventilating, and air-conditioning; plumbing, boiler, and steam; piped gases; vacuum systems; or communication systems including data-exchange systems.
10. *AIA Guidelines*, 2006 Section 1.5.4, A4 p 29
11. ASHRAE, Guideline 1.1-2007, *HVAC&R Technical Requirements for the Commissioning Process*

Table 1. Commissioning Tasks for Pressurization in Healthcare Facilities.

	Fundamental Commissioning (Prerequisite 1)	Enhanced Commissioning (EA Credit 3)
General	Describe acceptance tests in the contract documents.	Include commissioning team members during all phases.
Patient Rooms	Verify airflow rates at high and low values of cooling and ventilation rate. Verify pressurization throughout operating range.	Commissioning team reviews design, include voice of user and safety.
Protective Environment Room (PE)	Verify airflow rates at high and low values of cooling, exhaust and ventilation rate. Verify pressurization throughout operating range.	Commissioning team reviews design, include voice of user and safety. Train personnel to use containment.
Airborne Infectious Isolation Room (AIIR)	Verify airflow rates at high and low values of cooling, exhaust and ventilation rate. Verify pressurization throughout operating range.	Commissioning team reviews design, include voice of user and safety. Train personnel to use containment.
Supply Air Handler	Verify supply air temperature control in all conditioning modes (for example, heating, cooling, heat recovery). Verify flow, pressure and power levels at high and low loads.	Train building operators intended sequence of heating and cooling functions.
Exhaust Fan System	Record exhaust system operation at high and low load to verify that the system turns down as intended.	Commissioning team reviews design. Train building operators to recognize exhaust capacity adjustments.
High-Purity Water Supply	Verify water reject rates.	Train users to use energy and water saving settings of water systems.

Optimize Energy Performance

Minimum Energy Performance (EA P2) establishes the minimum level of energy performance for healthcare building and systems. The energy code to establish energy performance is ASHRAE/IESNA 90.1-2004 (without amendments).

Compliance for GGHC may be attained from one of the following:

- Obtain an EPA energy start rating of 75 or higher for estimated energy use.
- Demonstrate proposed building performance meets ASHRAE 90.1-2004 Energy Cost Budget.
- Design building to comply with both mandatory provisions and prescriptive provisions of ASHRAE/IESNA 90.1-2004 (without amendments).

More information about the EPA's Energy Star Program for Healthcare can be found at: http://www.energystar.gov/index.cfm?c=healthcare.bus_healthcare

Optimize Energy Performance (EA1) establishes increasing levels of energy performance above minimum energy performance levels established by GGHC prerequisite EAP2 baseline and compared to ASHRAE Standard 90.1-2004. Compliance requires building energy performance to be modeled using DOE2.1, BLAST or Energy Plus in accordance with the Building Performance Rating Method in Appendix G of ASHRAE Standard 90.1-2004.

Controls–Mandatory Provisions

ASHRAE 90.1-2004 documents mandatory automatic control provisions in section 6.4.3 of the standard. Application Specific Controllers (ASCs) are oriented towards a single piece of equipment (VAV box, Unit Ventilator, Fan Coil, etc.) and contain a fixed program optimized to control equipment and the following mandatory provisions of ASHRAE 90.1-2004:

- Deadband (6.4.3.1.2)
- Setpoint Overlap Restriction (6.4.3.2)
- Setback Controls(6.4.3.2.2)

Typically, the following mandatory provisions of ASHRAE 90.1-2004 are found in either Custom Application Controllers or Building Controllers that facilitate global control strategies, such as:

- Automatic Shutdown (6.4.3.2.1)
- Optimum Start Controls(6.4.3.2.3)

The following mandatory controls are required for HVAC system energy efficiency:

- Zone isolation (6.4.3.2.4)
- Shutoff Damper Control (6.4.3.3.3)
- Low-leakage Dampers (6.4.3.3.4)
- Ventilation Fan Shutoff (6.4.3.3.5)
- Humidifier Preheat (6.4.3.5)
- Freeze Protection (6.4.3.7)
- Demand Control Ventilation (6.4.3.8)

Duct Leakage–Mandatory Provisions

HVAC systems are large, custom, sheet metal structures built under tight cost constraints. Typically, they leak. Leakage wastes energy. When the supply ducts leak, conditioned air gets lost on its way to the rooms. It adds to the total energy load, without accomplishing a result. When exhaust ducts leak, air is drawn from interstitial spaces or other areas without improving air quality in the zones.

ASHRAE 90.1-2004 documents mandatory HVAC system duct leakage provisions in section 6.4.4.2 of the standard. Duct leakage tests should be written into the contract documents to communicate to the mechanical contractors so they can select the appropriate materials and construction processes.

It is important that air stream surfaces comply with section 6.2 of *ASHRAE/ASHE/ANSI Standard 170-2008, Ventilation of Health Care Facilities* to resist mold growth on air stream surfaces.

Factory-fabrication of terminal units provides a turnkey solution that provides terminal unit, controls and hydronics preassembled and leak-tested in a complete package. These ultra-low terminals pass less than 1 cfm at a static pressure of 1 in. WC, compared to 3 cfm leakage from terminals with *standard* construction. Sealed terminal units are available from manufacturer upon on request. All box seams and joints are sealed with an environmental friendly water based adhesive. This sealing essentially eliminates all box air leakage to the plenum air space. This means all conditioned primary air makes it to the zone being controlled, and will not leak to the return air plenum. The incremental cost of tighter terminal pays for itself in three to five years, early in the useful life of the building.

Controls–Prescriptive Provisions

ASHRAE 90.1-2004 documents prescriptive automatic control provisions in section 6.5 of the standard.

Eliminate Simultaneous Heating and Cooling

Elimination of simultaneous heating and cooling (section 6.5.2) requires controls that serve zones, hydronic systems and dehumidification process to be sequenced to *prevent reheating, recooling or mixing* of mechanically cooled or heated fluids or air.

Reduce Ventilation Fan Energy and Cooling

In healthcare facilities, ventilation systems are designed to:

- Maintain the indoor environment at comfortable levels for healthcare workers, patients and visitors.
- Control odors.
- Remove contaminated air.
- Minimize risk of transmission of airborne pathogens.

The primary way in which the ventilation system assists in the infection control process is through Ventilation (for example, dilution of contaminants), Pressurization (for example, containment of contaminants), and Filtration (removal of airborne infectious agents).

Reducing energy usage can be conserved by reducing ventilation air during unoccupied periods and moving the air more efficiently. The FGI 2006 guidelines include the provision for reducing the number of air changes when the room is unoccupied, provided that the room pressurization is maintained.[12]

Reducing the number of air changes per hour during unoccupied hours in operating rooms has significant impact on energy costs. A recent hospital design review study found that five of the ten operating rooms examined, could have reduced supply air flows by 20% to 56% of the occupied flows to

12. Guidelines for Design and Construction of Hospital and Health Care Facilities, 2006. Washington, DC, The Facility Guidelines Institute., p. 121, section 10.2.2.4(3)(b)

conserve energy while still maintaining the desired room pressurization.[13] FGI 2006 guidelines do not specify an unoccupied air change rate, but does require pressurization to be maintained at all times.

The following ASHRAE 90.1-2004 prescriptive provisions are recommended for healthcare facility ventilations systems:

- (6.5.1) Air handling units that provide cooling must provide either an air or water economizer. Air Economizer options are based on ASHRAE climate zones.
- (6.5.3.2) VAV fan with motors 10 hp or larger have one of the following: variable-speed drive, vane-axial fan with variable-pitch blades or other controls and devices that will reduce fan motor demand.
- (6.5.3.2.3) VAV systems where DDC controls zone terminal boxes reporting to a central control panel, the static pressure shall be reset based on zone requiring the most pressure. That is, the set point is reset lower until one zone damper is nearly wide open.
- (6.5.6) Exhaust air energy recovery is required for air systems that have a supply air capacity of 5000 cfm or greater and have minimum outdoor air supply of 70% or greater of the design supply air quantity must have an energy recovery system with at least 50% recovery effectiveness.

High-Efficiency Central Plants

(6.5.4) Energy consumption for central plants may be reduced by the use of high-efficiency hydronic system design and control strategies to reduce plant energy consumption at full and part-loads (for example, chillers with variable speed-drives, primary-only variable flow pumping designs, series-counter flow chiller design arrangements, etc.).

On-site Renewable Energy

The GGHC rating system awards a maximum of three points (EA2) for On-Site Renewable Energy. The U.S. Environmental Protection Agency (EPA) website provides a complete listing of resources for renewable energy programs at:

http://www.epa.gov/oaintrnt/energy/renewtech.htm

13. Richard Hermans, Martha Hewett, Chad Colsh; *Strategies to Reduce the Spread of Airborne Infections in Hospitals: Review of Hospital Designs*, National Institute of Standards and Technology, NIST GCR 06-887, October 2006, p. 10

A comprehensive source of information on state, local, utility, and federal incentives that promote renewable energy and energy efficiency can be found at the following Web site:

http://www.dsireusa.org/Index.cfm?EE=1&RE=1

Solar Hot Water Systems

Solar hot water systems are a good renewable energy source for healthcare facilities, due to their high thermal loads. The use of heat-exchangers to pre-heat domestic hot water, re-heat systems and steam systems are all important strategies to energy conservation. The solar hot water system can provide hot water to power a small absorption chiller, during the high-solar summer months.

Combined Heat and Power Systems

Combined heat and power (CHP) systems operate on the heat generated from the facility and produce electricity. These systems provide a source of energy savings, but do not reduce the facility energy consumption.

Measurement and Verification

The GGHC rating system awards a separate point (EA 5) for Measurement and Verification (M&V). An M&V Plan must be developed and implemented that is consistent with the International Measurement & Verification Protocol (IPMVP). This means that a minimum of three years energy use in hospital must be continuously measured. Metering must be provided for electrical and mechanical systems such as: Lighting Power Loads, Chillers, Data Centers, Critical Electrical Distribution Systems, Air Distribution Systems, and Motor Loads.

An open BAS provides the platform for integrating data from different facility systems. Installation of power meters and sub-meters allow energy usage to be recorded, as well as equipment operational data (flows, temperatures, etc.) to be logged, routine analysis of data allows facility manager to accomplish M&V goals.

Figure 5 shows an example energy dashboard that provides healthcare facility and the public information on the healthcare facilities sustainable operations and programs.

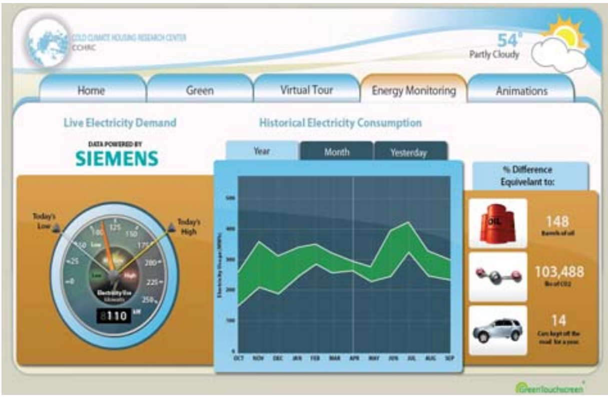

Figure 5. A Energy Dashboard Indicates Progress to Everyone in the Building.

Improve Equipment Efficiency

The GGHC rating system awards a separate point (EA 7) for Equipment Efficiency. This GGHC credit focuses on improving energy usage through the purchase of energy efficient equipment as part of the EPA's Energy Star® Program.[14]

Medical Equipment

When Energy Star qualified products are not available, compile a market survey identifying the top 25th percentile of lowest energy consumers for different classes of equipment. Focus on high load medical equipment such as Diagnostic Imaging Equipment (x-rays, MRIs, etc.), Sterilization, and Physiological monitoring.

Environmental Quality

Monitoring OA Delivery

The GGHC rating system awards one point (EQ1) for Monitoring Outdoor Air Delivery. Outdoor air ventilation air change rates are identified by patient areas in the FGI 2006 Guidelines, Table 2.1-2. Maintaining minimum required OA ventilation rates is a key component to infection control in a healthcare environment. Monitoring the OA Delivery for mechanically ventilated spaces ensures adequate ventilation rates are maintained.

CO_2 sensors should be installed in all densely populated occupied spaces (occupant density is greater than 25 people per 1,000 sq ft) such as: conference rooms, patient waiting areas, etc. CO_2 monitoring locations should be located three feet to six feet above the floor. CO_2 and airflow measurements should be monitored, controlled and trended by the Building Automation System (BAS).

Controllability of Systems: Thermal Comfort

The GGHC rating system awards one point (EQ6.2) for Controllability Thermal Comfort. Studies have shown that occupant control over the patient's thermal environment has positive impact on patient's and healthcare facility staff satisfaction.

To provide the patient easy access to thermal comfort controls requires that the building automation system be integrated with one of the following systems: patient bed control systems or patient entertainment system.

The Patient Portal enables patients to adjust the temperature, humidity, and lighting in their room using a computer touch screen monitor from their bedside (Figure 6). The Patient Portal resides on the Patient Infotainment system. The infotainment system allows patients to access a diverse range of applications including TV, internet access, food ordering, patient room controls; and clinicians to access patient records from the patient's bed side system.

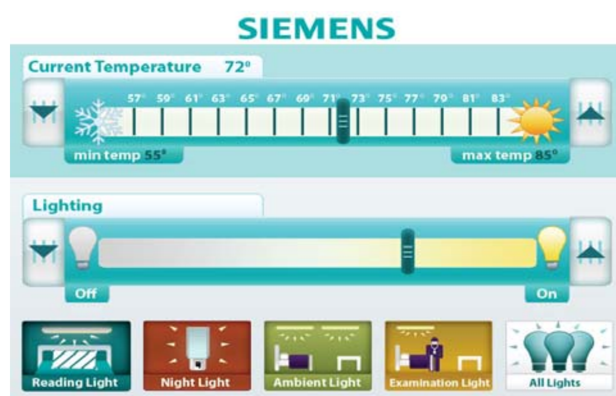

Figure 6. Patient Room Touch Panel.

14. EPA Energy Star Commercial Heating & Cooling Products: www.energystar.gov/index.cfm?c=bulk_purchasing.bus_purchasing#comhvac

Existing Healthcare Facilities

Operations and maintenance protocols are critical to ensuring the health and environmental performance of healthcare facilities. The Green Guide for Health Care (GGHC) developed a specific set of credits to support a healthcare facilities continuous improvement program for sustainable operations.

Many of the Facility Management credits found in the GGHC mirror those found in the LEED for Existing Buildings: Operations & Maintenance.

Facilities Management

Best Management Practices: Planning, Documentation and Opportunity Assessment

(FM Prerequisite 1) The GGHC Operations rating systems requires that the following best management practices be implemented. Fulfilling these best practices requires the following:

- **Develop a Building Operating Plan** and annually revise to provide details how the building is operated and maintained. The operating plan must include, at a minimum, an occupancy schedule, equipment run-time schedule, design setpoints for all HVAC equipment, and design lighting levels throughout the building. Identify any changes in schedules or for different seasons, days of the week, and times of day. Validate that the operating plan has been met for a minimum twelve-month period.
- **Develop a Systems Narrative** that briefly describes the mechanical, electrical systems, equipment and envelope system of the building that correspond to the written preventative maintenance plan. The systems narrative must include all the systems used to meet the operating conditions stated in the Building Operating Plan, including, but not limited to heating, cooling, ventilation, lighting, and any building controls systems.

  Systems Manuals created as part of the Enhanced Commissioning process identified in EA Credit 3.

- **Document the Sequence of Operations** for the building and review annually. The sequence of operation for building HVAC systems is typically found in the Systems Manual. Sequence of Operation for the building needs to be up to date (as-built) based on any changes made to how the systems operate.
- **Create Narrative of Preventive Maintenance Plan** for equipment described in the Systems Narrative and documents the preventive maintenance schedule over a minimum twelve-month period.

  The Joint Commission, Environment of Care, E7.10.7 requires that a hospital develops and maintains a written management plan describing the processes it implements to manage the effective, safe and reliable operation of utility systems.

- **Conduct an annual energy audit** that meets the requirements of the ASHRAE Level 1: Walk-Through Assessment. The assessment analyzing the building's energy cost and efficiency by analyzing energy bills and briefly surveying the building, accompanied by the building operator. Level-1 analysis identifies and provides the savings and cost analysis for low-cost/no-cost energy conservation measures. It also lists potential capital improvements that merit further consideration, along with initial judgment of potential costs and savings. The level of detail depends on the experience of the auditor or on the client's specifications. The results can be used to develop a priority list of building that are candidates for a Level II or Level III audit.

Outdoor Air Introduction and Exhaust System

(FM Prerequisite 5) The GGHC Operations rating systems requires that the following items be documented.

An annual compliance letter must be provided by an mechanical engineer or other qualified NSF testing or certified contractor demonstrating the general dilution ventilation and specialty local exhaust systems serving the building are operating as designed (for example, laminar airflow hoods, biosafety cabinets, and barrier isolators found in laboratories and pharmacies) and that the existing outdoor-air (OA) ventilation distribution systems supplies at least the outdoor air ventilation rate and air quality required by ANSIASHRAE 62.1-2007 or the minimum requirements of relevant to local licensing requirement for ventilation.

Ongoing Commissioning

The GGHC Operations rating systems awards a separate point (FM3.3) provided that the following items are implemented.

- **Implement ongoing commissioning program** that includes planning, system testing, performance verification, corrective action response, ongoing measurement and documentation to proactively address operating problems.
- **Create written plan** that summarizes the commissioning cycle for the building by equipment or building system group. The ongoing commissioning cycle shall not exceed 24 months. Plan includes a building equipment list, performance measurement frequency for each piece of equipment and steps to respond to deviation from expected performance parameters.
- **Update the Building Operating Plan** and Systems Narrative as necessary to reflect any changes in the occupancy schedule, equipment runtime schedule, design setpoints, lighting levels, or system specifications.
- **Track progress** of ongoing commissioning program against a baseline of two years to the current year.

Staff Education

The GGHC Operations rating systems awards a separate point (FM4.1) provided that a continuing education program has been created for facilities maintenance and operations staff. Each staff member, whose primary job responsibilities is building maintenance shall be provides with a minimum of eight hours per year of continuing education courses above and beyond licensure requirements on topics covered in the GGHC Facilities Management section such as building systems operations, continuous commissioning, maintenance, energy and water efficient building operations and practices. The continuing education courses will meet the quality standards for continuing education set by the staff member's licensing board.

Building Systems Maintenance

The GGHC Operations rating systems awards a separate point (FM4.2) provided that the following items have been documented.

Preventative Maintenance Program is required for GGHC Operations, FM Prerequisite 1.

- Document ongoing building systems maintenance in accordance with FM Prerequisite 1 for a minimum of one-year. Provide documentation of in-house resources and/or contractual services to deliver post-warranty equipment maintenance.
- Compile and annually review documentation associated with the Computerized Maintenance Management System, including actions triggered by CMMS.

Building Systems Monitoring

The GGHC Operations rating systems awards a separate point (FM4.3) provided that the ventilation systems have permanent, continuous monitoring systems (for example, building automation system) that provide feedback on ventilation system performance.

Annually document alarms that occurred, as well as responses, and corrective actions taken. Include analysis of the root cause and short-term and long-term actions. Alarm Issue Management features of the building automation system provide the means to document corrective action taken for building system alarms.

Documenting annually the percentage of time desired conditions are delivered in the building on a floor-area weighted basis can be accomplished by using a historical report. Figure 7 shows an example report indicating when percentage of time operating conditions were delivered. This type of report can be generated using historical building operating data logged by the building automation system.

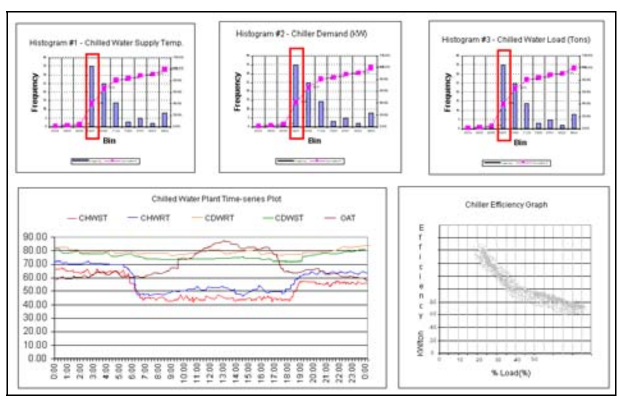

Figure 7. Example Historical Report.

Emission Reduction Reporting

The GGHC Operations rating systems awards a separate point (FM5.4) provided that the following items have been documented. Emissions reductions must be tracked and recorded, including those obtained for energy efficiency improvements, renewable energy and other building emission reduction actions. Figure 8 shows an example of a Emissions Summary Report generated from historical building operating data by the building automation system.

Emissions Summary Report SIEMENS

Development Campus

StartDate: 1/1/2006 12:00:00 AM
EndDate: 1/1/2007 12:00:00 AM
PortionOfDay: All Day

Point Name	Energy	CO2	SOx	NOx	Methane	Mercury	Particulates
	KWH	lbs	lbs	lbs	lbs	lbs	lbs
Building 1A	3,252,323.00	4,878,484.50	24,522.52	11,187.99	63.42	0.07	1,736.74
Building 1B	5,583,423.00	8,375,134.50	42,099.01	19,206.98	108.88	0.12	2,961.55
Building 1C	1,231,232.00	1,846,848.00	9,283.49	4,235.44	24.01	0.03	657.48
Building E1	4,100,325.00	6,150,487.50	30,916.45	14,105.12	79.96	0.09	2,189.57
Building E3	989,602.00	1,484,403.00	7,461.60	3,404.23	19.30	0.02	528.45
Totals	**15,156,905.00**	**22,735,357.50**	**114,283.07**	**52,139.76**	**295.57**	**0.33**	**8,093.79**

Figure 8. Example Emissions Report.

Steps to Green Healthcare

- **Register as LEED for healthcare project**. Registered projects identify their institutions as a leader in the healthcare industry committed to environmental excellence and high-performance healing environment. Projects may qualify for state, local, utility, and federal incentives that promote renewable energy and energy efficiency.
- **Align facilities mission and strategic plans**. Align GGHC operations with your healthcare facilities mission and strategic plans. Identify prerequisites that are common practice. Then, identify credits for future inclusion into operations best practices to become a leader in environmental excellence.
- **Establish a multi-disciplinary, inter-departmental integrated process**. An integrated operations team is an essential element to developing and maintaining green operational practices.

Adopt one or two new goals per year. To reach long-term goals, develop a continuous improvement plan that identifies long-term green operational goals. On a yearly basis, identify one or two new goals per year to be incorporated.

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