Managing Energy Costs in Museums

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When considering how to make budgets go further, cutting energy costs is a goal everyone can get behind. Depending on the measures you choose, your paybacks can be quick, and your museum can continue to accrue those savings over time. Most of these described energy-saving measures can help you save money while enhancing museum aesthetics and staff productivity. To get started, perform an energy audit to identify opportunities for energy savings. Your utility may provide audits and financial incentives, such as rebates or low-cost financing, to help you implement energy-saving strategies.

How Museums Use Energy

Museums serve two separate indoor climate needs: (1) maintaining optimal conditions for artifact and artwork preservation, and (2) providing a comfortable and healthy environment for visitors and staff. The main characteristics of museums that uniquely define their energy use are high-ceiling gallery spaces, often complex lighting needs, and intermittent occupancy levels. Each of these can contribute to increased energy consumption, especially in older buildings with aging HVAC systems. More than 75 percent of museum energy use is consumed by space heating and cooling, ventilation, and lighting (**Figure 1**).

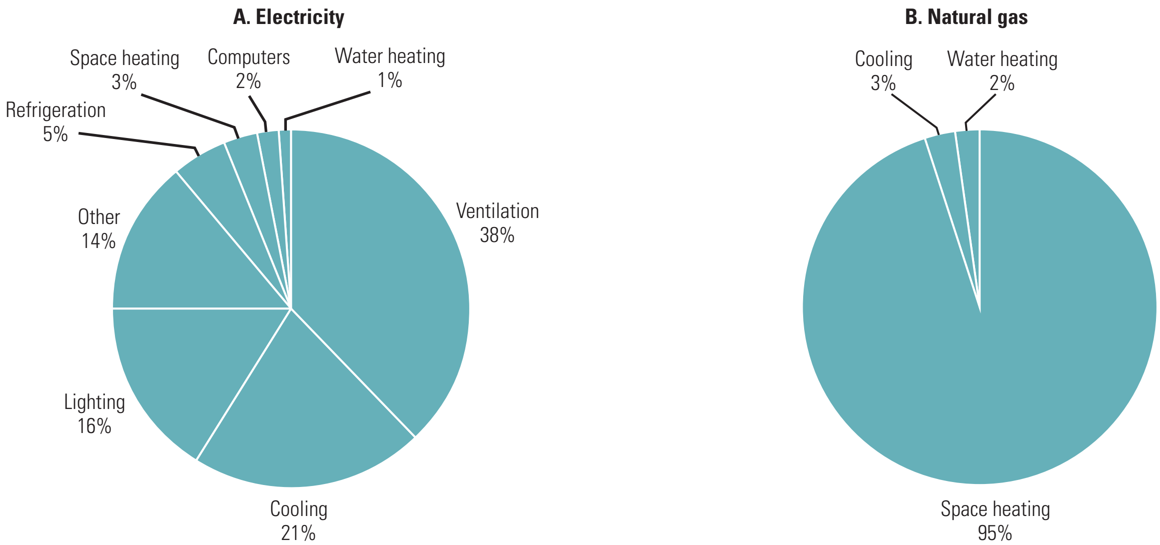
Museum buildings are as varied as their contents and come in a variety of shapes, sizes, and ages. Acting as multiuse cultural centers, museums often include cafeterias, gift shops, kids' zones, educational meeting rooms, and even theaters, in addition to gallery space and staff offices. Although building ages and layouts may vary, the energy-saving measures described below can offer most museum facility managers effective efficiency opportunities, many with a quick payback.

Quick Fixes

Many museums can benefit from quick low-cost or no-cost energy-saving solutions. Often these solutions can be as small an action as turning things off or turning things down.

FIGURE 1: Museum energy consumption by end use

In museums, large, open gallery spaces drive the demand for ventilation, which is the biggest electricity user (A), and space heating, which is the biggest natural gas user (B).



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Turning Things Off

Turning equipment off might seem like too small an action to make a significant difference, but it does. It's important to remember that if you save 1,000 kilowatt-hours (kWh) per year by turning something off, you can take $100.00 off your utility bill annually, assuming electricity costs of $0.10 per kWh.

Lighting. Turn lights off when they're not in use. Training museum staff to turn lights off when they leave employee-only areas is a simple no-cost solution.

Computers and office equipment. Museum operations are often supported behind the scenes by a large office staff working with a full suite of energy-consuming equipment. Turning that equipment off when no one is using it is a critical energy-saving strategy. A typical desktop computer and monitor, for example, can draw about 110 watts of power when idle. If left on overnight or over weekends, a single liquid crystal display (LCD) monitor that draws 35 watts of power could add $25 or more to your annual energy bill. One way to start saving on computing costs is to use smart power strips with built-in occupancy sensors that shut off plugged-in devices like printers and monitors when no one is using them.

Additionally, most consumer electronics sold today can be set to go into a low-power sleep mode after a specified period of inactivity. Asking the IT manager to enable these settings on users' computers can produce significant energy savings. Get more tips and tools for computer power management from the Energy Star website (www.energystar.gov/index.cfm?c=power_mgt.pr_power_mgt_low_carbon_join).

Electronic displays. Museums using electronic displays in their exhibits often leave the illumination on after hours. Consider shutting off the displays at the end of the day either manually or with simple timers.

Escalators. Turning escalators off during unoccupied hours is the best way to reduce their energy use. It would be even more beneficial to shift escalators to low-speed operation or shut them down entirely when they're not in use, and enable them to restart automatically when a passenger approaches. However, current code requirements in the U.S. prevent this type of automation.

Turning Things Down

Some equipment cannot be turned off entirely, but turning it down to minimum levels where possible can save energy.

HVAC temperature setbacks. During closed hours, turn temperature settings down in heating seasons and up in cooling seasons in all galleries and exhibits that are not temperature sensitive. You can automate these settings with programmable thermostats.

HVAC settings in peripheral spaces and back rooms. Rarely used areas don't require the same comfort settings as public spaces. You may be able to cut energy expenses by keeping HVAC levels in stockrooms, unstaffed offices, and other peripheral spaces at their minimum settings.

Water temperature settings. Many museum facility managers find that they can achieve energy savings by turning down the temperature a few degrees on water heaters that supply restrooms.

Longer-Term Solutions

Some energy-saving actions require more time and investment, but they can dramatically increase the efficiency of your museum without compromising artifact and artwork preservation or visitor and staff comfort. Ask your utility's representative for more information about initiating such projects and about options for technical and financial assistance.

Commissioning

Commissioning is a process by which engineers check and tune building systems to ensure that they're operating appropriately and efficiently. A 2009 study by the Lawrence Berkeley National Laboratory indicates that commissioning existing buildings yields average energy-use reductions of 16 percent. The Indianapolis Museum of Art (IMA) (http://www.aam-us.org/pubs/mn/chronicleenergy.cfm) used this approach to reduce its energy consumption. The museum hired consultants to analyze its boilers, HVAC equipment, and nonexhibit lighting systems. After testing different equipment settings while carefully monitoring temperature and humidity conditions, modifications were implemented, including reduced boiler temperature setpoints, increased preventive maintenance strategies, and economizer controls to decrease the excess amount of outside air that needs to be conditioned. The museum also replaced incandescent bulbs with more-energy-efficient, longer-lasting compact fluorescent lamps (CFLs) in areas where artwork isn't displayed or stored. As a result, IMA reduced its natural gas consumption by 48 percent and its electricity consumption by 19 percent.

Lighting Measures

The evaluation of museum lighting-efficiency measures must consider the gallery spaces separately from the areas used by visitors and staff.

Exhibit spaces. Museums face a unique challenge when it comes to lighting: they must illuminate art objects for public view while conserving them for posterity. Light is necessary to display art objects to the best advantage of viewers, but at the same time, it can cause deterioration of the artwork—primarily in the form of discoloration and increased material fragility. Halogen is the primary light source used in museums today because it offers excellent color qualities. But halogen lighting is very inefficient, and there are alternatives that can save energy and better serve a museum's mission of preservation. These include light-emitting diodes (LEDs), CFLs, and ceramic metal halide (CMH) lamps.

To select among these alternatives, it's helpful to identify the desired characteristics of an exhibit-quality light source:

- *Directional rather than diffuse output.* The majority of the light should illuminate the displayed object.
- *High color rendering index (CRI).* The art object should be viewed in as close to natural light as possible.
- *Minimal to no ultraviolet (UV) radiation.* UV radiation should be minimized because it can damage paintings and art objects.
- *Minimal to no infrared (IR) radiation.* Because heat also causes deterioration, IR radiation should be avoided.
- *Dimmability.* Without having to change lamps or fixtures, museum staff should be able to adjust light intensity in galleries where exhibits change throughout the year.

LEDs achieve a high ranking for each of these characteristics. They are directional, have a very good CRI, emit no UV radiation and very little IR radiation, and have excellent dimming capability when installed as a package with lamps and a dimming circuit. When LED lamps are installed as a retrofit into dimming circuits originally designed for incandescent or halogen lamps, the dimming capability can be compromised. Notably, not all LED products are dimmable, and not all of them share the same quality standard. For integral LEDs, the Energy Star list (**www.energystar.gov/indexcfm?fuseaction=iledl.display_products_pdf**) is a good source of reliable products.

If time and budget allow, it's best if multiple LED lamps from different manufacturers can be compared in a side-by-side test for such qualities as smoothness of light pattern, appropriate warmth and coolness of light for the art, color rendering, visual clarity, and suitability of the lighting for the type of artwork displayed. A case study of the Jordan Schnitzer Museum of Art (**http://apps1.eere.energy.gov/buildings/publications/pdfs/ssl/2011_gateway_schnitzer.pdf**) in Eugene, Oregon, describes how the museum used such comparison testing to choose the most appropriate energy-efficient light source to replace its existing halogen parabolic aluminized reflector (PAR) 38 lamps for a new exhibit of photographs. This demonstration showed that carefully chosen LED replacement lamps can provide an equivalent or even preferred appearance of art in comparison to halogen lamps, while consuming only a fraction (14 percent, in this case) of the energy that halogen lamps use.

CFLs are less versatile in museum exhibit applications. They can have a very high CRI, but they provide a diffuse rather than directional output. Depending on the fixture, they also emit some UV radiation, and they emit more IR radiation than LEDs—but about half as much as incandescent bulbs. CFLs may also be dimmable, but with a wide range of results.

CMH lamps are also a good choice for exhibit lighting. They have a high CRI, provide a directional output, consume about one-third as much energy as comparable incandescent lamps, and can be filtered to minimize UV emittance. A General Electric case study (**www.bettermuseumlighting.com/case_study.htm**) describes how the Tacoma Art Museum took advantage of these characteristics to upgrade lighting in its gallery spaces from 150-watt PAR 38 incandescent lamps to 20- and 39-watt CMH lamps. The lighting retrofit reduced the number of fixtures installed in the ceiling by about 19 percent, cut annual energy consumption by nearly 85 percent, reduced UV exposure by approximately 60 percent, and improved the visual clarity of the artwork.

Public and staff spaces. In addition to gallery spaces, there is likely opportunity for lighting-efficiency measures in hallways, offices, restrooms, and parking lots. Replacing older T8 fluorescent lamps with high-performance T8 lamps (super T8s) and electronic ballasts can reduce lighting-energy consumption by 30 percent. And replacing old T12 lamps and ballasts can increase savings by 70 to 80 percent! Areas that are not consistently occupied—such as storage rooms, restrooms, and back offices—are ideal places for occupancy sensors. They can save 30 to 75 percent in lighting-energy consumption, and they typically yield simple payback periods of one to three years.

Most parking lots are designed with far more lighting than is necessary, so a retrofit with lower-wattage bulbs can be a big energy saver. When designing lighting for a new parking lot, instead of using high-pressure sodium lamps, consider using lower-wattage metal halide lamps in fixtures that limit light trespass and light pollution. Metal halide lamps are less efficient than high-pressure sodium lamps in conventional terms, but because they project more light in the blue part of the spectrum, they make it easier for our eyes to see under low-light conditions, allowing for lower-wattage, energy-saving bulbs. LEDs are also becoming a viable alternative for parking lot lighting. They offer long life, high efficiency, and the ability to precisely direct the light stream, which minimizes light pollution. However, products must be selected carefully because manufacturers often exaggerate LED product performance. For more information, see the U.S. Department of Energy's LED Application Series: Outdoor Area Lighting (**http://apps1.eere.energy.gov/buildings/publications/pdfs/alliances/outdoor_area_lighting.pdf**).

HVAC Systems

On average, HVAC systems account for 52 percent of annual energy consumption in commercial buildings. The most cost-effective way to enhance HVAC performance is through controls and systems upgrades.

Programmable thermostats and building automation systems. Programmable thermostats automatically adjust temperature to preset levels. Installation is simple, and the investment can quickly pay for itself in a space that doesn't require 24/7 heating or cooling. A programmable thermostat costs about $19 more than a standard model, saves an estimated $150 per year, and has a payback period of about one month. For larger or more-complex buildings, consider using a building automation system, a centralized control system that automates the operation of HVAC and lighting. These systems can save an average of 5 to 15 percent of total building energy consumption—in older or poorly maintained buildings, they can yield savings of 30 percent or more.

Demand-controlled ventilation (DCV). Spaces with variable occupancy, such as auditoriums or theaters, can see big energy savings with DVC, which adjusts ventilation rates based on occupancy. Sensors are used to determine occupancy by measuring the concentration of carbon dioxide (CO_2) in the return airstream—the more people there are in the area, the higher the CO_2 level. When CO_2 levels are low, the system decreases outdoor air intake, reducing the energy that would have been used to heat and cool a space at maximum occupancy. DCV systems can save from $0.05 to $1.00 per square foot. Buildings with highly variable occupancy and long operating hours in climates with moderate to extreme heating or cooling loads can see the greatest savings from DCV.