Improving the sustainability of an existing building is difficult enough when a company owns and occupies a building, but a project that involves an owner, building manager and tenant presents even more of a challenge.

Burns & McDonnell has worked since 2006 with the building manager and the James Campbell Company, owner of its world headquarters building, to turn it into a sustainable showcase for clients and the community. The facility earned an ENERGY STAR label in 2007, and the building team is working toward LEED Silver certification.

The mid-sized engineering/consulting firm has grown from 1,550 employees in 2003 to nearly 3,000 employees, making space an ongoing issue. Burns & McDonnell moved into its current corporate headquarters at 9400 Ward Parkway in 1996, and in 2011 will take over the lease of the connected facility at 9300 Ward Parkway, adding 217,000 ft².

The transition to a high performing building started with Burns & McDonnell conducting an energy audit in 2006, which identified measures to significantly reduce annual energy use. Burns & McDonnell worked with their property manager to develop a comprehensive energy program.

Sustainability projects involving tenants, property managers and building owners often suffer from the lack of incentives for each party to make investments or changes. The tenant may pay a flat fee for utilities based on the space that is rented, so reducing energy use does not result in financial savings. It’s difficult to convince building owners to make significant capital improvements if the payback in energy savings is decades away.

As the tenant, Burns & McDonnell was motivated to improve the sustainability of its office because of the firm’s work, which includes air quality, energy use and optimization, environmental restoration, sustainable/LEED design-build, sustainability reporting, renewable energy, waste management, water management, and wetlands and ecosystems. The property manager was already interested in improving the energy efficiency of the building and helped educate the owner on the benefits of investing in sustainable technology.

Dividing Costs

Burns & McDonnell overcame one of the biggest challenges of sustainability projects involving multiple parties: deciding how to divide the costs. The building owner assumed the capital costs for projects such as the boiler replacement. The property manager covered maintenance related costs such as the lighting retrofit. Burns & McDonnell paid for sustainability initiatives such as a photovoltaic array and a storm water management system.

The building team has taken an iterative approach toward implementing the energy program for Burns & McDonnell’s corporate headquarters. Focusing on energy efficiency first was a strategic step for the building team to meet the minimum ENERGY STAR prerequisite of 69 for the LEED Existing Buildings: Operations & Maintenance rating system. Several of the initially recommended energy improvements if the payback in energy savings is decades away.

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measures have been implemented, including a complete lighting retrofit, removal of inlet vanes, hot-water/ chiller-water variable volume pumping and boiler replacement.

Each measure was individually evaluated and implemented as a separate project. The improvements so far have contributed to reduced energy use and an improved ENERGY STAR rating. Annual site energy use for 9300 and 9400 Ward Parkway has been reduced to 101.6 kbtu/ft² from 112.9 kbtu/ ft² in 2005, and the ENERGY STAR rating has improved from 80 to a current rating of 89. Upgrades implemented through mid-2009 have cost approximately $457,000, while sustainability initiatives have cost approximately $1 million.

**Lighting Retrofit**

Advanced lighting technology reduces the energy consumed by lighting systems while retaining or improving the level and quality of light produced. These technologies include the introduction of high-efficiency fluorescent lamps, electronic ballasts and lighting controls.

Burns & McDonnell retrofitted all T12 and 32 W T8 fixtures to 28 W T8 lamps with high-efficiency electronic ballasts. The 28 W T8 fluorescent light system is approximately 40% more energy efficient than conventional cool white fluorescent lamps and standard magnetic core and coil ballasts.

The 28 W T8 lamps fit in the existing standard T12 and T8 bi-pin sockets without luminaire modification, lowering installation cost. The electronic ballasts specifically developed for the T8 lamps replace the old core and coil ballasts. Electronic ballasts operate at high frequencies, which reduces the power requirements to produce the same amount of light as the existing T12 lighting system. Electronic ballasts also reduce the tendency of fluorescent lamps to flicker or ballasts to hum.

All incandescent lamps were retrofitted with compact fluorescent lamps and ballasts. Incandescent lit exit signs were replaced with light emitting diode (LED) type exit signs. The LED fixtures meet National Fire Protection Association standards for exit lighting levels while using only 2 to 3 W per sign.

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**TOTAL ENERGY USE**

**ENERGY STAR RATING VS. ENERGY USE**

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Burns & McDonnell World Headquarters originally used metal halide (MH) fixtures for the canopy entryway illumination. Metal halides have good color rendition, high quality light and long lamp life. However, they significantly degrade over time by supplying lower light at the same energy levels, which was the case during the initial energy audit in 2006. New premium-efficiency electric motors with VFDs were installed, allowing the new pumps to operate at less than 100% of their speed capacity. By slowing the speed of the water pumps during low load periods, only the hot/chilled water required to satisfy load is circulated throughout the building. Typically, a 25% reduction in pump speed results in a 50% to 60% reduction in power consumption. A 50% reduction in pump speed typically results in a 70% to 90% reduction in power consumption.

Reduction of Inlet Vanes
The air-handling units at Burns & McDonnell’s corporate headquarters had variable-frequency drives (VFDs) installed on the fans prior to the initial audit, but the original inlet vanes were also still in place and locked open. The inlet vanes served no operational purpose since the VFDs could control fan speed and airflow. Removing the inlet vanes from the fans decreased the pressure loss in the air system, which resulted in less energy required to circulate the same amount of air.

Variable Volume Pumping
Burns & McDonnell converted the heating hot water and chilled water systems to a variable volume configuration. The hot-water and chilled-water pumps had previously been operating at a constant speed. New premium-efficiency electric motors with VFDs were installed, allowing the new pumps to operate at less than 100% of their speed capacity.

Condensing Boiler Installation
The installation of two 1,500 mBtu condensing type boilers during winter 2008–09 is the most recent efficiency implementation. The original low-pressure steam boilers were solely used in conjunction with steam-to-hot-water heat.

ENERGY AT A GLANCE
Energy Use Intensity (Site) 101.6 kBtu/ft²
Natural Gas 24.77 kBtu/ft²
Electricity 76.83 kBtu/ft²
Annual Source Energy 163 kBtu/ft²
ENERGY STAR Rating 89

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gas emissions: the work at hand.
eliminating the inefficiencies of the steam-to-water heat exchange. The boiler control sequencing and variable volume pumping are controlled through the building automation system. The sequence is designed to achieve the maximum heating water temperature differential, allowing the boilers to operate in their most efficient condensing mode for the maximum number of hours and minimizing the use of the steam boilers.

Burns & McDonnell recommended the condensing boilers to the property owner and manager after modeling the building and evaluating the potential heat load reduction from the ongoing lighting retrofits.

The hot water now is circulated through the building using new variable volume hot-water pumps to large variable-air-volume (VAV) air-handling units. These units serve VAV double duct terminal units, providing warm air to the building spaces.

The new condensing boilers provide the heating required during low and intermediate load conditions. This eliminates the need to use a large steam boiler when the loads are significantly less than the design condition, decreasing energy lost through excessive boiler cycling.

One of the two original steam boilers has been decommissioned, and the other only is used at low outside temperatures when it can run efficiently at full load without cycling. The condensing boilers heat the hot-water circulating loop directly instead of producing steam, eliminating the inefficiencies of the steam-to-water heat exchange.

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This screenshot of the eQUEST modeling program shows the heating and cooling scheme for selected zones of the building. This illustrates the level of detail considered in the building model, taking current and future loads into account before finalizing the boiler selection for optimal efficiency.

Burns & McDonnell holds a dedication ceremony to mark the completion of its storm water management system and to explain the importance of reducing storm water runoff and improving water quality. Elected leaders and government officials, including U.S. Rep. Emanuel Cleaver II, D-Mo., participated in the event.
all sink fixtures have reduced sink water use by 77%. The property manager is retrofitting all existing urinals and toilets for a predicted annual water use reduction of 50%. Burns & McDonnell and the building owner are sharing the cost of the plumbing retrofits.

The building management team is monitoring and analyzing these retrofits on a monthly basis. The estimated payback for these fixtures ranges from 1.9 years for the low flow aerators to 21.3 years for the one-eighth gallon urinals.

The bifacial photovoltaic modules collect sunlight from the front and back.

The back side of a panel generates electricity from ambient light that has passed through the panel or is reflected off surrounding surfaces, while the front side operates simultaneously, resulting in higher power generation than standard single-sided panels.

**Photovoltaic System**

Burns & McDonnell installed a photovoltaic (PV) system at the world headquarters to demonstrate solar technology. It consists of an array of six pole-mounted panels with a total of 24 PV modules. The bifacial modules collect sunlight from the front and back.

The back side of a panel generates electricity from ambient light that has passed through the panel or is reflected off surrounding surfaces, while the front side operates simultaneously, resulting in higher power generation compared to standard single-sided panels.

**Payback Analysis for Fixture Changeout**

<table>
<thead>
<tr>
<th>Fixtures</th>
<th>Implementation Cost per Fixture</th>
<th>Total Cost</th>
<th>Annual Savings</th>
<th>Payback Years</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low Flow Aerators 2.2 to 0.5 gpm</td>
<td>$100</td>
<td>$3,500</td>
<td>$1,800</td>
<td>1.9</td>
</tr>
<tr>
<td>Urinals 1.0 to 0.125 gallons per flush</td>
<td>$1,500</td>
<td>$34,000</td>
<td>$1,600</td>
<td>21.3</td>
</tr>
<tr>
<td>Toilets 3.5 to 1.6 gallons per flush</td>
<td>$1,200</td>
<td>$64,000</td>
<td>$4,100</td>
<td>15.6</td>
</tr>
<tr>
<td>Combined Payback</td>
<td><strong>$101,500</strong></td>
<td><strong>$7,500</strong></td>
<td><strong>13.5</strong></td>
<td></td>
</tr>
</tbody>
</table>

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**Water Savings**

Installation of new water fixtures is occurring throughout the world headquarters building to reduce water use by 30%. Low flow aerators added to
Storm Water Management
A series of bioretention cells and bioswales maximize storm water infiltration and improve water quality. This system combines innovative technology with traditional and natural storm water control.

The combination of native vegetation, new grading, piping, inlets and treatment units captures and treats more than 37% of the approximately 19 million gallons of rainwater that falls on the campus annually. The system reduces storm water runoff by 18% (3.4 million gallons per year). This project is especially important to Burns & McDonnell because it helps reduce the pressures on Kansas City’s combined sewer system, which collects rainwater, domestic sewage and industrial wastewater.

In addition to reducing storm water runoff, these systems reduce pollutants such as motor oil, metals and tire residue from parking and driving surfaces, while providing an attractive enhancement to the landscape around the campus, slowing rainwater close to the source and cleaning it with plants and natural materials is really what nature intended all along.

The building features a demonstration green roof that uses a waterproof membrane overlaid with soil to grow plants and other vegetation. This vegetated roof reduces both the rate and volume of runoff by retaining 70% of the precipitation that falls on it. The rainfall is stored in the plants and soil until it evaporates or transpires back into the atmosphere. The soil also acts as a natural filter, so any water that does run off contains fewer pollutants.

LESSONS LEARNED
Education and Communication As a part of its effort to reduce building water use, the building team initially installed two waterless urinals on a trial basis. The team decided to collect employee responses before deciding whether to install waterless urinals throughout the building. However, the building team did not give employees any advance notice before installing the new urinals. The responses received were mostly negative, which the building team attributed to the lack of education. The building team removed the waterless urinals after two weeks and decided to retrofit the restrooms with low flow one-eighth gallon flush urinals.

Start Small Don’t try to tackle everything at once when addressing the sustainability of an existing building. The changes at Burns & McDonnell have taken place over the past three and a half years. Taking one step at a time also gives the building team time to prepare building users for the changes.

Community Awareness Burns & McDonnell invited residents from surrounding neighborhoods in 2008 to a program marking the opening of Burns & McDonnell’s storm water management system and explained how the system would benefit the community.

Ongoing Improvements
The building team continues to re-audit, evaluate and implement measures on an ongoing basis to continually strive towards energy efficiency. Burns & McDonnell develops new sustainability initiatives each year, which are based, in part, on suggestions received from employees. Past initiatives have included building improvements and carpooling programs.

ABOUT THE AUTHORS
Candice Denis-Wood, LEED AP is a sustainability specialist for Burns & McDonnell. Laura Girard, PE, LEED AP CEM, is a project manager for the Energy Services group of Burns & McDonnell.

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