The majority of buildings that we live and work in are more than a few years old and not especially sustainable. The Szencorp Building was one such building—a four-story office building in South Melbourne, Australia, originally constructed in 1987 with no particular view towards sustainability. That changed in 2004, when Szencorp bought and refurbished the building.

The old building relied almost entirely on artificial heating, cooling and lighting, consuming a great deal of energy. The new building features a mixed mode air-conditioning system, much greater levels of natural lighting and much more efficient mechanical systems.

It is also an ongoing project—while the refurbishment was completed in late 2005, its occupants use monitors and data loggers installed throughout the building to constantly review and fine-tune the building’s performance. As a result, energy and water consumption per square foot have so far been dropping every year since the refurbishment.

The building is an open book, too, as Szencorp has made the monitoring results available to the public every step of the way and has been candid about the systems that have and haven’t performed.

Façade

The building has a narrow east-west floor plan. In its original incarnation, this restricted natural light penetration and discouraged the use of natural ventilation, so one of the first issues that needed addressing was changes to the façade.

The original face of the building was replaced with full-height low-emissivity glass and external shading. This helps to maximize daylight penetration while also minimizing glare and heat gain.

HVAC

The building uses a mixed-mode air-conditioning system, controlled by the central building management system (BMS).

A weather station on the building’s roof feeds data on external conditions directly into the BMS, which in turn automatically opens panels in either end of the façade to allow for natural ventilation when conditions are appropriate (when internal temperatures are above 77°F and external temperatures are below 66°F). The same system is also used to purge warm air at night.

When required, mechanical air conditioning is supplied by a gas-fired variable refrigerant flow system. The gas-fired unit generates less greenhouse gas emissions than an equivalent electric unit and also lowers electricity demand during peak tariff periods.

Each floor of the office is divided into five zones. Passive infrared motion sensors connected to the BMS, which in turn automatically opens panels in either end of the façade to allow for natural ventilation when conditions are appropriate (when internal temperatures are above 77°F and external temperatures are below 66°F).

The same system is also used to purge warm air at night.

When required, mechanical air conditioning is supplied by a gas-fired variable refrigerant flow system. The gas-fired unit generates less greenhouse gas emissions than an equivalent electric unit and also lowers electricity demand during peak tariff periods. Each floor of the office is divided into five zones, Passive infrared motion sensors connected to the BMS are installed in each zone,
allowing the air conditioning to be shut down in unoccupied areas. At 72°F ± 3°F the system runs in ventilation-only mode.

Ventilation in the building’s two basement car park levels is controlled by sensors that turn exhaust fans on only when set threshold levels of carbon monoxide are detected in the air.

The building’s servers are also located in the basement levels, removing their heat load from the air-conditioned office spaces. No additional cooling is provided for the servers.

A dehumidification unit was originally included in the air-conditioning system design and was installed during the refurbishment. After the building’s first year of operation, it was found that the office maintained appropriate conditions without additional dehumidification. As a result the unit was decommissioned in early 2007, reducing energy consumption by around 1.15 MWh.

**Lighting**

As discussed previously, a complete re-engineering of the building’s façade has allowed much greater levels of daylight to enter the office space. The majority of artificial lighting is provided by T5 fittings, supplemented by conventional compact fluorescents. Artificial lighting is controlled using the same infrared motion sensors as the ventilation system. The design process also considered a displacement air-conditioning/chilled beam system, but it was rejected because the floor-to-ceiling height would not be sufficient to allow proper mixing of the airstreams. Humidity control and access issues with the existing elevators and stairwells also precluded the use of this system.

Szencorp purchased a typical office building (top) in 2004 and transformed it using energy- and water-saving technologies. The original façade (top) of the building was replaced with full-height low-emissivity glass and external shading (bottom). This renovation maximized daylight penetration while minimizing glare and heat gain.
sensors that control the air-conditioning system — lights turn on automatically when an area is occupied, and turn off when it is not. Originally, lights turned off when no motion was detected for 15 minutes. In early 2007, this time was reduced to 10 minutes, delivering an energy savings of about 30 kWh/year.

The lights are also automatically dimmed when enough daylight enters the space, so full artificial lighting power is not required.

Car park lighting is automated and linked to motion sensors as well. It turns off after five minutes of inactivity. Motion sensors also were installed in the building’s elevator in March 2007 to ensure it is only lit when in use.

Some areas of the building (the elevator, level three board room, and ground floor foyer) were originally fitted with halogen downlights. These were replaced in February 2007 with more energy-efficient compact fluorescent fittings, reducing energy consumption in these areas by about 68% while still emitting the same amount of light.

During the first year of operation, it was discovered that electronic lighting ballasts were consuming power in standby mode when the fittings they serve were turned off. This problem was rectified by installing a universal bus transceiver on each floor to switch the lighting circuit off when the building is unoccupied, saving approximately 5 MWh/year.

**Water**

Two 500 gallon water storage tanks are located in the building’s basement, along with an ultraviolet greywater treatment system.

## Airtightness Testing - Not Just for Homes Anymore

Airtightness testing of homes has been around for more than 20 years. Various energy programs and fluctuating energy bills have provided homeowners with an incentive to improve the airtightness of their homes. Energy tax credits can also be received by the homeowner but only if the house airtightness has been verified that it is less leaky after remodeling than before.

In England, airtightness testing of buildings over 10,000 square feet was the first regulation initiated to reduce energy consumption. Efforts to make commercial buildings more energy efficient in the U.S. has only recently been incorporated into various “green” initiatives. Tests of commercial buildings show that they tend to be more leaky than the average house, based on air leakage per square foot of surface area. That means that commercial buildings are less energy efficient than the average house.

To measure the actual airtightness of a large building means more air is needed to maintain a reasonable test pressure. The Energy Conservatory, a leader in airtightness testing, has kits available to directly measure more than 18,000 cubic feet per minute of air leakage. Multiple kits and fans can be used simultaneously to generate more air for accurate and reliable measurements of air leakage for testing before and after retrofitting.

For more information on multi-fan systems contact The Energy Conservatory at 612-827-1117 or visit our website at www.energyconservatory.com.
Greywater from hand basins and showers is piped to the basement, where it is treated and stored for flushing toilets. Rainwater also is harvested and stored in the tanks for the same purpose.

Ideally, the water storage tanks would have been located on the roof to gravity-feed the building’s requirements. However, it was found that the roof could not structurally support the tank—a limitation of working with an existing building. On the upside, housing the water storage tanks in the basement allowed for some of the building’s existing piping infrastructure to be reused. Bathrooms feature waterless urinals and sensor-operated hand basins, which supply water that has been premixed to 86°F. A solar heat-pump system provides the domestic hot water (DHW). Water efficient taps, toilets and showerheads are used throughout the building.

Blackwater harvesting was considered during the design phase, but was rejected on the basis that not enough space was available in the building for such a system, and also that it would lead to substantial recurring maintenance and licensing costs (operation of such systems in Melbourne requires a license from the local Environment Protection Authority). Pumping, filtration and monitoring equipment would also have added to the building’s energy consumption.

Factors beyond the owner’s control have meant that water-saving initiatives haven’t been quite as effective as expected. Australia’s ongoing drought has meant that water-saving initiatives haven’t been quite as effective as expected. Some issues also were identified with the building’s greywater system, which were causing it to use more potable water than required. It was replaced in September 2007 with a new system—42.65% of the total amount used for this function.

The roof was refurbished to house a range of features that enable the building to run efficiently. These features include a weather station, a gas-fired air-conditioning system, evacuated tube solar hot water and PV arrays. Also on the roof is an entertainment area with a deck and a barbecue grill, which is shaded by an amorphous PV array.

The rear of the building features a large deck on level one, which sits above the car park. Large windows on each level allow natural light to enter the building. Since this photo was taken, a crystalline array has been installed to generate power and provide shading from the afternoon sun for staff working at the rear of level four.

ASHRAE Tools for LEED® v2.2: Products to Aid in the Design, Construction and Operation of High-Performance Green Buildings

Leadership in Energy and Environmental Design (LEED®) is a hot topic today, and for good reasons. By some estimates, investing just 2% more in LEED-compliant construction will save ten times that amount over the life of the building. On top of that, studies indicate that workers are healthier, happier and more productive in LEED-compliant buildings.

ASHRAE is serious about encouraging your participation. That’s why we give you three ways to save:

**Savings #1: ASHRAE Tools for LEED® v2.2.**

All of the following publications are referenced in LEED® v2.2:

- ANSI/ASHRAE/IESNA Standard 90.1-2004 User’s Manual .................................................. $93.00 $74.00
- ANSI/ASHRAE Standard 62.1-2004, Ventilation for Acceptable Indoor Air Quality ................... $60.00 $48.00
- ANSI/ASHRAE Standard 55-2004, Thermal Environmental Conditions for Human Occupancy .................. $47.00 $39.00
- Advanced Energy Design Guide for Small Office Buildings ............................... $62.00 $49.00
- Advanced Energy Design Guide for Small Retail Buildings ............................... $62.00 $49.00
- Advanced Energy Design Guide for K-12 School Buildings ............................... $62.00 $49.00
- Procedures for Commercial Building Energy Audits .................................................. $58.00 $39.00

**TOTAL if purchased separately:**

- $609.00 $479.00

**Product Code:** B86999

**TOTAL cost for the LEED Tools package:**

- $426.00 $335.00

**Savings #2:** Use the Advanced Energy Design Guides to create buildings saving 30% or more in energy costs over buildings meeting the minimum standards.

**Savings #3:** Become a member of ASHRAE. That’s right: if you’re not a member yet, you’re missing out on some big savings— not to mention great benefits and cutting-edge information on HVAC&R.
Despite these issues, the building still uses 94% less water than the Australian industry average.

A five-star NABERS (National Australian Built Environment Rating Scheme) Water rating, the highest offered under the government-operated scheme, requires water consumption of less than 7.5 gallons/ft² per year. The Szencorp Building used just 1.8 gallons/ft² per year in its second year of operation.

Materials and Other Features

Recycled and sustainable materials feature prominently in the Szencorp Building. Products from ECS, a Szencorp group company which occupies two levels of the Szencorp Building, were used throughout the facility.

Possibly the most interesting materials choice in the building is its internal walls, many of which are constructed from recycled cardboard that has been treated with a fire retardant. Remaining walls are constructed from low-emission medium-density fiberboard, which is powder coated to reduce off-gassing and improve indoor air quality.

Recycled timbers have been used throughout the building—some were even recycled from the building’s original incarnation. Recycled aluminum was used for the ceiling tiles, and all the building’s carpets are recyclable.

Boardroom tables are made from recycled woods and meeting room chairs feature non-chromium treated leather. Low volatile organic compound (VOC) materials were used throughout the building.

When the building first opened, it featured two photovoltaic (PV) arrays on the roof: a 484 ft² crystalline array at the rear of the building’s roof, and a smaller amorphous array, which doubles as a covering for the rooftop barbecue area. Together these arrays generated 5.9 MWh/year.

An additional crystalline array was added on the building’s west-facing rear façade in January 2008, increasing the building’s total on-site generation capacity to approximately 7.9 MWh/year. In addition to the increase in electrical generation capacity, the new array also shades the level four windows and reduces cooling loads during summer in the area.

Transport

The Szencorp Building is located close to a number of public transport routes, and bicycle storage, shower and changing facilities are provided in the basement levels. Cycling facilities have not been used extensively since the building’s opening, however, and only two of the building’s 25 staff rode to work regularly during the spring and summer of 2007—the majority still drove their cars.

The company is now considering a number of ways to encourage more staff to either ride, walk or catch public transport to work, including cycling allowances, improved shower facilities and staff sponsorships in sporting events.

The building also is performing well in other areas. A post-occupancy study carried out in September 2006 found self-assessed staff productivity was 13.1% higher than in the company’s previous office. This result puts the building in the top 11% of rated Australian buildings for perceived productivity.

Comfort, health and overall also were rated above average by the study, and the building rated in the top 11% of the Building Use Studies data set for overall building performance and meeting user needs.

Readers can view live BMS data and performance reports of the building at its Web site (www.theszencorpbuilding.com).

A plug-in vehicle gives Szencorp employees a more sustainable transportation option. Szencorp purchases power produced from renewable energy sources and offsets all business car and air travel through the purchase of carbon credits.

Some staff who need to use a car during work hours don’t have this option, so the company worked with the University of Technology in Sydney to develop a more sustainable mode of automotive transport. That project culminated in 2008, when the building became home to Australia’s first plug-in hybrid electric vehicle. The converted Toyota Prius was retrofitted with additional batteries which allow it to be driven without using its petrol tank for at least 10 miles.

The car can be charged using renewable energy from a standard power point but most interestingly, energy stored in the car can also be fed back into the building to augment the output of the building’s PV arrays.

Performance

The level of scrutiny applied to the building since the refurbishment was finished appears to have paid off. Electricity consumption was 74 MWh in the building’s first year of operation, 70% lower than prerefurbishment usage. In its second year the building only used 68 MWh—8% less than the first year, and 71% less than prerefurbishment usage. Gas and water consumption were reduced by 22% and 37%, respectively, between the first and second years of operation.

The building has achieved Australia’s highest energy and water performance ratings, based on measured usage.

LESSONS LEARNED

Probably the most important lesson to be learned from the Szencorp Building is the value of monitoring and constant building improvement.

The building design received a six-star Green Star rating—the highest rating awarded by the Green Building Council of Australia (equivalent to LEED® Platinum status).

A process of monitoring and constant refinement has allowed the building to be improved beyond its design intent. The building now has been occupied for three years and as every year passes, water and energy consumption has decreased.

Public accountability has been important to Szencorp. Comprehensive wart-and-all reports on the building’s performance are published annually, and live metering and BMS feeds are available for the public to view at the building’s Web site, www.theszencorpbuilding.com.

Some key data points for operations and energy performance over the last two years include:

<table>
<thead>
<tr>
<th>Performance Metric</th>
<th>Design Intent</th>
<th>First Year</th>
<th>Second Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electricity Consumption</td>
<td>95 MWh</td>
<td>74 MWh</td>
<td>68 MWh</td>
</tr>
<tr>
<td>Gas Consumption</td>
<td>245 GJ</td>
<td>367 GJ</td>
<td>286 GJ</td>
</tr>
<tr>
<td>Water Consumption</td>
<td>41,448 gallons</td>
<td>31,994 gallons</td>
<td>20,064 gallons</td>
</tr>
<tr>
<td>Normalized Whole-of-Building Emissions</td>
<td>0.01444 ton CO₂/ft² per year</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The building also is performing well in other areas. A post-occupancy study carried out in September 2006 found self-assessed staff productivity was 13.1% higher than in the company’s previous office. This result puts the building in the top 11% of rated Australian buildings for perceived productivity.

Comfort, health and overall also were rated above average by the study, and the building rated in the top 11% of the Building Use Studies data set for overall building performance and meeting user needs.

Public accountability has been important to Szencorp. Comprehensive wart-and-all reports on the building’s performance are published annually, and live metering and BMS feeds are available for the public to view at the building’s Web site, www.theszencorpbuilding.com.

A plug-in vehicle gives Szencorp employees a more sustainable transportation option. Szencorp purchases power produced from renewable energy sources and offsets all business car and air travel through the purchase of carbon credits.

Some staff who need to use a car during work hours don’t have this option, so the company worked with the University of Technology in Sydney to develop a more sustainable mode of automotive transport. That project culminated in 2008, when the building became home to Australia’s first plug-in hybrid electric vehicle. The converted Toyota Prius was retrofitted with additional batteries which allow it to be driven without using its petrol tank for at least 10 miles.

The car can be charged using renewable energy from a standard power point but most interestingly, energy stored in the car can also be fed back into the building to augment the output of the building’s PV arrays.

Performance

The level of scrutiny applied to the building since the refurbishment was finished appears to have paid off. Electricity consumption was 74 MWh in the building’s first year of operation, 70% lower than prerefurbishment usage. In its second year the building only used 68 MWh—8% less than the first year, and 71% less than prerefurbishment usage. Gas and water consumption were reduced by 22% and 37%, respectively, between the first and second years of operation.

The building has achieved Australia’s highest energy and water performance ratings, based on measured usage.

LESSONS LEARNED

Probably the most important lesson to be learned from the Szencorp Building is the value of monitoring and constant building improvement.

The building design received a six-star Green Star rating—the highest rating awarded by the Green Building Council of Australia (equivalent to LEED® Platinum status).

A process of monitoring and constant refinement has allowed the building to be improved beyond its design intent. The building now has been occupied for three years and as every year passes, water and energy consumption has decreased.

Public accountability has been important to Szencorp. Comprehensive wart-and-all reports on the building’s performance are published annually, and live metering and BMS feeds are available for the public to view at the building’s Web site, www.theszencorpbuilding.com.

Some key data points for operations and energy performance over the last two years include:

<table>
<thead>
<tr>
<th>Performance Metric</th>
<th>Design Intent</th>
<th>First Year</th>
<th>Second Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electricity Consumption</td>
<td>95 MWh</td>
<td>74 MWh</td>
<td>68 MWh</td>
</tr>
<tr>
<td>Gas Consumption</td>
<td>245 GJ</td>
<td>367 GJ</td>
<td>286 GJ</td>
</tr>
<tr>
<td>Water Consumption</td>
<td>41,448 gallons</td>
<td>31,994 gallons</td>
<td>20,064 gallons</td>
</tr>
<tr>
<td>Normalized Whole-of-Building Emissions</td>
<td>0.01444 ton CO₂/ft² per year</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The building also is performing well in other areas. A post-occupancy study carried out in September 2006 found self-assessed staff productivity was 13.1% higher than in the company’s previous office. This result puts the building in the top 11% of rated Australian buildings for perceived productivity.

Comfort, health and overall also were rated above average by the study, and the building rated in the top 11% of the Building Use Studies data set for overall building performance and meeting user needs.

Readers can view live BMS data and performance reports of the building at its Web site (www.theszencorpbuilding.com).

ABOUT THE AUTHOR

Stuart West is a freelance writer and former editor of EcoLibrium®, the official journal of the Australian Institute of Refrigeration, Air Conditioning and Heating.